

VOLUME 3

TECHNICAL SPECIFICATIONS

**EMERGENCY RECONSTRUCTION WORKS
FLOOD PROTECTION SYSTEM „MAČVA: SAVA – DRINA“,
LOT 1 EAST ZONE**

**Section 1:
DRENOVAC - ČEVRTIJA
Reconstruction of the right embankment
of the Sava River
(km: 18+030 to km: 23+100)**

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1. LIST OF ABBREVIATIONS

1.	BoQ	Bills of Quantities
2.	CA	Contracting Authority
3.	ConstBook	Construction Book (presented executed works)
4.	Day	Calendar Day
5.	DD	Detailed Design
6.	DIN	German Standards
7.	DNP	Defects Notification Period
8.	EmDefWL	Water level for proclamations of Emergency Flood Defence
9.	EmW Design	Emergency Works Design – temporary Technical documents, according to the act of Government of the Republic of Serbia (Conclusion No25, March 2016), based on Article 143 of the Serbian Law on Planning and Construction.
10.	EN	European Norms
11.	FP	Fire Protection
12.	H&S&E	Health, Safety and Environment
13.	IEC	International Electrotechnical Commission
14.	ISO	International Organisation for Standardisation
15.	LAN	Local Area Network
16.	LS	Lump sum
17.	m.a.s.l.	Meters above sea level
18.	m.b.g.l.	Meters below ground level
19.	m/d	Man-day
20.	MSDS	Material Safety Data Sheet
21.	OSHA	Occupational Safety and Health Administration
22.	PA	Provisional Acceptance
23.	PAC	Provisional Acceptance Certificate
24.	PBAB	Concrete and Reinforced Concrete Rulebook (<i>Serbian executive act: Pravilnik o betonu i armiranom betonu</i>)
25.	PE-HD	High Density Poly-Ethylene
26.	pcs	Pieces
27.	PP	Polypropylene
28.	PM	Project Manager
29.	PPA	Partial Provisional Acceptance
30.	PS KAL REV	Existing Pump Station “Kalenića – Revenica”
31.	PVC	Polyvinyl Chloride

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32.	PWMC	Public Water Management Company (Beneficiary)
33.	QAP	Quality Assurance Plan
34.	QAS	Quality Assurance System
35.	RAL	Colouring system (<i>Reichs-Ausschuß für Lieferbedingungen und Gütesicherung</i>)
36.	RegDefWL	Water level for proclamations of Regular Flood Defence
37.	RC	Reinforced Concrete
38.	SRPS	Serbian standards
39.	Survey “0” TDoc	Survey Technical Documentation of initial terrain state
40.	TA	Technical Assistant
41.	TR	Technical Requirements
42.	TS	Technical Specification
43.	WL	Water level

2. GENERAL REQUIREMENTS

2.1. BACKGROUND OF THE PROJECT

2.1.1. Flood protection emergency works - Project description

After the flood event in May 2014 that caused major damages to Mačva and PWMC “Srbijavode”, the cities of Belgrade and Šabac, and the Municipality of Bogatić concluded Agreements on joint financing of reconstruction works on Mačva’s flood protection system, which would include reconstruction and rehabilitation of the levee / embankment, as well as other structures in the immediate vicinity that hindered the safety of the defensive line during the floods in 2014.

The Agreements include works in two zones: the East Zone in the length of ~ 5 km and the West Zone in the length of ~ 20 km.

Funds for financing the investment of “reconstruction of Mačva’s flood protection system” have been provided upon the proposal of PWMC “Srbijavode” within the IPA programme for 2014, *Action Plan for support in eliminating the consequences of floods that will be funded through a financial agreement between the Republic of Serbia and EU for 2014.*

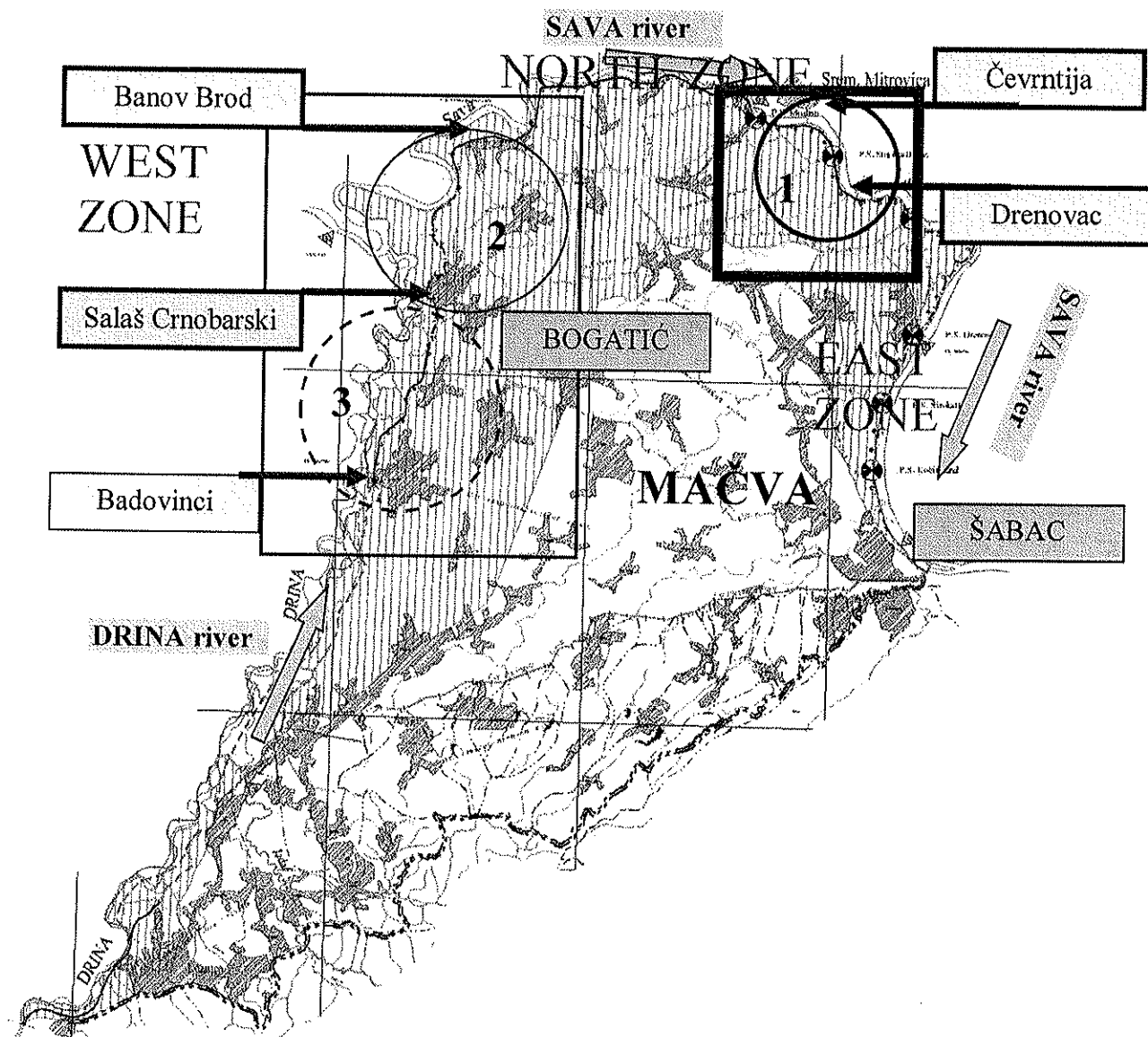
So far and in accordance with the provisions of the Agreement, PWMC “Srbijavode” has successfully completed several tasks providing necessary preconditions for reconstruction of Mačva’s flood protection system.

The following tasks have been completed:

1. *An Expertise on the flood events with the concept of improving the protection of the wider Macva area from high flows of the Sava and Drina Rivers* (“Jaroslav Cerni” Institute),
2. The technical documentation for works - *Emergency Reconstruction Works Designs* (EmW Design) for the Protection System Mačva.

The EmW Design includes 3 sections of the Flood Defence line in Mačva area:

- 1) Section 1: Flood Protection System „Mačva: Sava – Drina“, East zone: Drenovac - Čevrtija - reconstruction of the right embankments of the river Sava (km: 18+030 – km: 23+100), (5,070 m).
- 2) Section 2: Flood Protection System „Mačva: Sava – Drina“, West zone: Banov Brod – Salaš Crnobarski - reconstruction of the right embankment of the Sava river and of the Drina river (km: 52+832 - km: 63+753), (10,921 m).
- 3) Section 3: Flood Protection System „Mačva: Sava – Drina“, West zone: Salaš Srnobarski – Badovinci - reconstruction of the right embankment of the Drina river, km: 63+753 - km: 71+280, 7,527 m). Note: reconstruction works on this section are finished and are not the subject of the procurement.



Based on this design, and in accordance with Article 143 of the *Law on Planning and Construction* (“Official Gazette of the Republic of Serbia”, number 132/14), those works shall have the status of emergency works, and shall be carried out without previously obtaining a building permit, “because the structure is being built immediately before or during natural disasters, or for the purpose of eliminating harmful consequences of these disasters, immediately after their occurrence”:

- PPMC “Srbijavode” submitted to the competent Ministry of Construction, Transport and Infrastructure a request for consent to carry out the works in question by applying this provision, in accordance with the Decision on

Emergency Works that was issued by a competent municipal authority at the proposal of the Emergency Situations Headquarters of the city of Šabac.

- Pursuant to Article 143, Paragraph 3 of the Law on Planning and Construction, the said Decision on Emergency Works determines an obligation to immediately initiate the procedure and, in parallel with the emergency works, obtain all planning and other documents in order to obtain a building permit for these capital structures of general interest in public ownership, based on which they become permanent structures, “within one year from the cessation of dangers that caused its construction, i.e. the execution of works“.
- In its memo (number 001-00-00252/2015-07 of 6th April 2015), the competent Ministry of Construction, Transport and Infrastructure confirmed that, due to their urgency and significance, the works in question could be executed as emergency works, in accordance with the said provisions of the Law on Planning and Construction.

Furthermore, the following documents relevant for the emergency reconstruction works of the flood protection system Mačva were prepared (Emergency Works Design):

- Technical specification of the works
- Bill of Quantities
- Design drawings

2.1.2. Subject of the procurement, Contracting Authority and Beneficiary

Subject of the procurement are **Emergency Reconstruction Works for the Flood Protection System Macva - East Zone Drenovac-Čevrtnija (5.313 km), Section 1: Reconstruction of the right embankment of the Sava River From km: 18+030 to km: 23+100 in Serbia.**

The current document for procurement presents Technical Specifications (TS) that define the requirements for execution of those Emergency Reconstruction Works.

The Contracting Authority is the European Union, represented by the European Commission on behalf of and for the account of the partner country, Serbia.

The direct Beneficiary is the Public Water Management Company „Srbijavode“ (hereinafter PWMC „Srbijavode“), and the target groups are Municipality of Šabac and citizens of flooded area.

2.2. LOCATION – CURRENT SITUATION OF THE FLOOD PROTECTION

The Municipality and the city of Šabac are situated in the northern part of north-west Serbia, at the right side of the Sava River, in Mačva area.

Existing Mačva's Flood protection system includes the area bordered by the Drina and Sava Rivers. In this area, there are around 400,000 ha of the most fertile land and two larger settlements – Šabac and Bogatić, and 35 smaller settlements and villages with a total of about 130,000 residents, and numerous industrial and infrastructural facilities. Mačva's protection

system is designed as a system that comprises three technical units – zones: East Zone (from km 0+000 to km 23+342), North Zone (from km 23+342 to km 52+832) and West Zone – (from km 52+832 to km 71+280).

2.3. SCOPE OF THE WORKS

The total length of embankment for reconstruction on this Section 1 is 5.070 m.

Since the works have the status of emergency works (Flood Protection System „Mačva: Sava – Drina – East Zone, Section 1 - Drenovac - Čevrntija - reconstruction of the right embankments of the river Sava (km: 18+030 – km: 23+100), (5,070km), they will be carried out without previously obtaining a building permit, according to the act of Government of the Republic of Serbia (Conclusion, 25 of March 2016), based on Article 143 of the Law on Planning and Construction. This act also obliges PWMC "Srbijavode" (as Beneficiary) to complete the obtaining procedure of building permits within one year after completion of the above mentioned protection infrastructure.

For these reasons producing of “As Built Design” (as part of Bill of Quantities) is extremely important for the Beneficiary.

According to this, it is assumed that the present works will be executed in line with the technical documentation, which has the status of Emergency Works Design.

- Besides the need to carry out complete reconstruction of the levee with higher level of the crown (1.2 m above the high water level of the Sava river - 100 years return period) on the stretch from ~ 5 km, the importance of the structures along the levees, which have a significant function during flood events in terms of protection against waters and successful implementation of flood defence, was also recognized.
- Based on the flood events in 2014, the great importance and role of the access and service roads for successful flood defence was recognized. Stable communication, which allows for a smooth transport of resources and equipment during floods, proved to be one of the important factors for a rapid response and a successful defence. For these reasons, the design provides for the reconstruction of service roads on the crown, on both sides of the levee, as well as 6 access roads in the protected area that ensure stable communication and transport of resources.
- Also, during flood events in May 2014, a critical section was recognised with dangerous signs of suffusion process through dike's body. For this reason, specific technical solutions were defined in the EmWDesign for the protection against water leakage and suffusion process (underground diaphragm).

During the 2014 floods, a significant risk to levee stability appeared in the zone of melioration canals and PS Kalenica Revenica controlling the underground levels of Mačva's systems. For these reasons, the importance of the reconstruction of certain parts of these facilities was recognized, having in mind that they pose a danger in floods.

Note: The new flood wave on the Sava River was recorded in March 2016. Due to the announced critical high water level, the Government of the Republic of Serbia declared a

State of Emergency (March 15). An order was issued to PWMC "Srbijavode" to take preventive measures and works at all critical locations (Conclusion of the Government). According to this Order, PWMC performed emergency intervention works along the flood protection embankment on the concerned section:

1. Small improvised embankment was formed ($\sim 2.0 \text{ m}^3 / \text{m}$ on the crown of the dike) along the entire length - quality coherent material was used from the borrow-location.
2. Access and service roads were prepared for possible flood defence works and activities

These works were carried out in accordance with the technical solutions of the EMW Design (existing embankment is not disturbed; routing paths are aligned with the designed). For these reasons, it is particularly important that the initial state of the embankment is recorded and verified by the Engineer.

2.4. CLIMATE

In Mačva area, the climate is warm and temperate. There is significant rainfall throughout the year in Šabac. Even the driest month still has a lot of rainfall. This climate is considered to be Cfb according to the Köppen-Geiger climate classification. The average temperature in Šabac is 11.6 °C.

The average annual rainfall is 699 mm.

- On average, the warmest month is August,
- On average, the coolest month is January,
- June is the wettest month,
- March is the driest month.

2.5. DRAWINGS PROVIDED BY THE CONTRACTING AUTHORITY

All basic drawings necessary for preparation of Contractor's Proposal are enclosed in Volume 5 of the tender documentation.

All construction works shall be performed in compliance with the requirements of the provided technical and working designs, the regulations in force and these TS.

3. CONSTRUCTION SITE

3.1. FENCING AND SIGNBOARDS AT THE CONSTRUCTION SITE

The Contractor must maintain the security of its activities, including fencing of the construction site according to the regulatory requirements;

- 1) The Contractor should not start any activity, before the Engineer and the Beneficiary have agreed that the fences or other protective measures planned by the Contractor are sufficient to prevent, in a reasonable way, any obstruction or interference in the existing court activities.
- 2) The Contractor shall fence the construction site. The fence shall be installed in line with the regulations on occupational health and safety and a sketch of the construction site approved by the Engineer. The cost for fencing will be as specified in BoQ.
- 3) A Signboard, prepared according to the “Visibility Guidelines of the European Union”, shall be fixed on the temporary fence adjacent to the entrance gate to the site;
- 4) The Contractor shall obtain instructions from the Engineer regarding information to be displayed on the signboard. The dimensions and text on the board shall be as per the requirements in the latest version of the EU “Visibility Guidelines” which can be found at http://ec.europa.eu/europeaid/work/visibility/index_en.htm. The Contractor shall not undertake or allow billposting or advertising of any kind upon the Works without the written consent of the Engineer. At finalization of works (Provisional Acceptance), all temporary fences, gates and signs erected by the Contractor must be removed;
- 5) The Contractor shall install commemorative plaques at the main site in line with the above manual and in agreement with the Contracting Authority after Provisional Acceptance.
- 6) Construction site board prepared in accordance with the Law on Planning and Construction shall be placed on the temporary fence adjacent to the entrance gate to the site;
- 7) Temporary fences, gates and signs placed by the Contractor must be maintained in good shape until the completion of construction works;
- 8) The Contractor shall provide the whole information concerning the regulations and procedures governing the use of local facilities for access, transport, storage facilities and in compliance with them to take measures for providing the necessary documents;
- 9) The Contractor shall be aware of existing restrictions and shall be responsible for their observance during construction;
- 10) The Contractor shall be liable for all damages on the existing infrastructure caused by him - they shall be repaired at its expense;
- 11) The Contractor will be responsible for ensuring the control of any access or the right to leave the boundaries of the construction site, so that it does not lead to interference with the locals or damage to public or private property as a result of the entry or exit of its employees and subcontractors;
- 12) The Contractor shall indemnify and hold harmless the Contracting Authority against any accusations arising from its failure to comply with the above point, including legal fees and costs.

3.2. SITE SERVICES

Where utility services are not already available on the site, the Contractor is to make its own arrangements for the supply of electricity, water, telephone and sewerage until such time as the permanent works are available for use.

The Contractor shall provide and maintain wherever required adequate supplies of electricity at a suitable voltage and compressed air for all operations to be undertaken to complete the Contract. The Contractor shall also make these services available to subcontractors and, when instructed by the Engineer, to other contractors and employees of the Engineer.

The Contractor shall be responsible for entering into any agreements with the appropriate suppliers, and shall issue all notices and pay all fees, dues, rents, charges and other costs incurred thereby. The Contractor shall, in connection with such supplies, adopt precautions to ensure the safety of all personnel.

3.2.1. Site Lighting and Electrical Power

The Contractor shall provide and maintain efficient temporary lighting and power supplies for all parts of the works as may be necessary and shall, in connection with such supplies, adopt precautions to ensure the safety of all personnel.

3.2.2. Drinking Water and Technical Water

The Contractor shall provide wherever required adequate supplies potable and service water of proper quality and pressure for all operations to be undertaken to complete the Contract. The Contractor shall also make these services available to subcontractors and, when instructed by the Engineer, to other contractors and employees of the Engineer.

The Contractor shall be responsible for entering into any agreements with the appropriate suppliers, and shall issue all notices and pay all fees, dues, rents, charges and other costs incurred thereby.

3.2.3. Hygiene

The Contractor shall clean as necessary and maintain the site in a hygienic condition and shall comply with the equipment of the Safety Officer appointed by the Engineer and any instructions of the Engineer.

The Contractor shall provide, maintain and remove at the end of the Contract or when directed by the Engineer, adequate toilet facilities including flushing toilets, hot water and showers for the use of its own staff and that of the Engineer adjacent to or as part of their site offices and additional suitable facilities in various parts of the site as necessary for the use of its workmen.

3.3. TEMPORARY SITE FACILITIES

- 1) The Contractor, prior to the start of construction works, shall submit a draft *Design for the organisation and execution of construction*. The Design must be submitted no later than 15 days before the planned start of construction works. The design must indicate the work zones, as well as areas for temporary storage of necessary construction materials and goods, and areas for temporary settlements for the personnel of the Contractor and Engineer.
- 2) The Contractor shall provide and install all necessary facilities/installations for accommodation of its staff, including dressing and rest containers, toilets, drinking and washing water, electricity, etc. All costs for temporary facilities shall be included in the Bid.

3.3.1. Facilities for the contractor and Engineer

- 1) The Contractor shall hand over the fully equipped office to the Engineers within 2 weeks of being ordered to do so.
- 2) The cost of office and accommodation shall be paid by the Contractor and shall be included in the unit prices in the Bill of Quantities.
- 3) All the offices, furniture and equipment, provided to the Engineers under item 3.4.2 and 3.4.3 for perusal during the implementation of the works remain property of the Beneficiary. The assets will be handed over to the Beneficiary in one month time after the date of issuance of the Provisional Acceptance for the works.
- 4) The Contractor shall procure, at its own risk and expense, all additional facilities outside the site that may be necessary for its work.

3.3.2. Offices

The Contractor shall design and place, at the location defined by the Beneficiary and the Engineer, the facilities (Office for Engineer) indicated in Table 1 below. Before placing the facilities the Contractor shall arrange terrain on this location (paths, parking places, external lights...)

Table 1- Facilities for the Engineer

Room	Size	Furniture
Container Type Office (Locality is defined by the Beneficiary and the Engineer) Together with necessary circulation space, covered entrance porch and parking places for minimum two vehicles.		
One Office	15 m ²	2 Desk ≥ 2 m ² , with file drawer and drawers, all lockable, incl. keys; 1 low table ≈ 1 m ² ; 2 chairs with rolling casters, 1 file cabinet, steel, lockable incl. keys, 50/150/50 cm; 1 bookshelf, 1 m x 2 m, 30 cm deep; 1 coat stand; 1 wastepaper basket 1 AC unit (cooling and heating) inverter type 12 BTU
One Meeting room	15 m ²	1 Desk ≥ 4 m ² ; 8 visitors' chairs; 1 wastepaper basket 1 AC unit (cooling and heating) inverter type 12 BTU
One Kitchen - tea room	6 m ²	1 cupboard; 1 table (1 m ²) 1 refrigerator, capacity ≥ 150 l; 1 boiler 10 l; 1 locker
One Toilet	6 m ²	1 boiler 30 l 1 complete sanitary facilities
One Store	9 m ²	1 bookshelf, 1 m x 2 m, 30 cm deep; 2 low tables ≈ 1 m ² ; 2 fire extinguishers, wall mounted and 1 first aid kit

All external doors shall be fitted with a secure lock for which a minimum of three keys shall be provided.

All windows shall have double vacuum glass, anti-mosquito gauze and venetian blinds.

Lighting shall be of the led raster type (40-60 W/room).

All offices shall have at least two grounded electrical sockets, rooms exceeding 10 m² floor area, having at least one additional socket per 5 m² of floor area or part thereof.

The Contractor shall provide external lighting (at each side of the container) for the office and arrange for collection and disposal of waste.

The Contractor shall supply, install and maintain in the offices, equipment and furniture which shall be new, undamaged and complete with all necessary keys.

The Contractor shall supply, install and maintain furniture such as desks, cupboards, drawing tables and plan chests, chairs and shelves, etc. in the numbers, trademarks and quality as approved by the Beneficiary and the Engineer.

The Contractor shall arrange internet connection.

3.3.3. Equipment

- 1) 4x4 Vehicle, 4-5 seats, 5-Door, diesel, >100 hp, with AC, Central Locking, ABS braking system, Radio/MP3/CD, including fuel and maintenance, for the exclusive use

- of the Engineer and its staff for the entire duration of the contract. The vehicle will be maintained by the Contractor in all respects (fuel, insurance, taxes, license, all maintenance) and in the event of the unavailability of the vehicle for whatever reason and at any time, the Contractor shall provide a replacement vehicle,
- 2) Compact digital camera, in carrying case, minimum 10 megapixels and 4 x optical zoom function, including 2 x 4Gb memory cards and additional battery,
 - 3) AC units of sufficient capacity equal to the gross volume of all the rooms served, complete with all supports, electrical and plumbing work;
 - 4) Two Lap-top computers 7th generation, 15.6", intel Core 7, Windows certified OS
 - 5) Multifunctional Laser Printer/Scanner/Copier/Fax size A3 with scale up/down function, minimum 12 pages/min, double-sided printing function, automatic paper feeding and collating function, 3 paper trays,
 - 6) Separate High speed internet connection with access in each office (hard wired or wireless),
 - 7) Two mobile smartphones: waterproof, shockproof, touchscreen, 4,5 inch, Android, Colour: (24-bit) 16.777.216, 4G, Octacore processor, at least RAM 3Mb, Li-on battery 3800 mAh; external charger 2A.
 - 8) The Contractor shall supply consumables, such as fax/photocopy paper (A4/A3 sizes), computer diskettes and CDs, towels, soap, toilet paper, disinfectant, and cleaning materials as required. The cost of telephone, internet and fax usage shall be borne by the Contractor.
 - 9) Local transportation is at the cost of the Contractor.

3.3.4. Protective equipment for the Engineer

The Contractor shall initially provide the Engineer with protective clothing and equipment, as follows, and, as the Engineer considers necessary, provide replacement items under the provisions for maintenance of the Engineer's facilities. Prior to making this provision, the Contractor shall obtain a list of appropriate sizes from the Engineer. As and where the Contractor's methodology, activities or planned testing programme may require additional protective equipment (such as gloves, earplugs, goggles, torches etc) the Contractor shall make these available to the Engineer and when the need arises.

The protective equipment remains the property of the Beneficiary.

3.3.5. Topographical Survey Equipment

Principal items of the survey equipment shall be procured by the Contractor to be used by the Engineer, and are listed below. All equipment shall be as good as new, calibrated and with all necessary carrying containers, etc:

- 1) 1 Piece: Precise automatic level including tripods (Wild or similar)
- 2) 1 Piece: Total station including tripod, complete with reflectors, poles and brackets
- 3) 2 Pieces: Metric extending levelling staffs with vertical bubble

- 4) 2 Pieces: 30 m (enamelled or otherwise protected) steel bands
- 5) 1 Piece: Wet and Dry bulb thermometer
- 6) 4 Pieces: 3 meter-ranging rods
- 7) 2 Pieces: 5 meter steel lath
- 8) 1 Piece: Builder's spirit level 1000 mm long
- 9) 1 Piece: Disto laser distance meter, up 200 m, measuring accuracy ± 1 mm, including tripod

Supply of wooden pegs, crayons, spray paint, nails and all other items required for setting out and measuring the work shall also be provided.

A set of precise survey equipment as well as all of the ancillary and consumable items, attendance and assistance necessary to measuring the works, determining the necessary scope and quantities of any works and determining the precise levels and locations of any parts of the Works shall be maintained and kept by the Contractor for the Engineer's needs within the duration of the Contract and until all measurement relevant to the Final Payment Certificate has been completed and agreed,.

The survey equipment remains the property of the Beneficiary.

3.3.6. Facilities for the Contractor

The Contractor shall provide and maintain on site suitable site offices for its own use. It shall also provide and maintain on approved sites, sufficient stores, tanks and workshops for the proper storage of materials, fuel plant and equipment.

The stores shall be of such size and construction to provide adequate storage and protection of stocks of material, fuel, spares, etc. in quantities ensuring uninterrupted progress of the work. Workshops shall be suitably equipped to ensure carrying out of major repairs, overhaul or modification by the Contractor of all plant and equipment in or on the Works. The Contractor shall allow in its rates for all costs related to provision of the offices and workshops for its own use.

Prior to construction of the site facilities, the Contractor shall prepare drawings for site facilities which will cover the following aspects of the works:

- Location and arrangement of the Constructor's buildings and offices, including access facilities, utilities and fencing;
- Location and arrangement of work-yards, workshops, depots and stores for equipment, fuel and materials, including access facilities, electricity, water and telephone connections and fencing;
- Location of and proposals for the temporary works required for constructing the Works;
- Working drawings and calculations for all the temporary works proposed by the Contractor for constructing the Works.

3.4. SITE CLEANING

The Contractor shall make every effort to keep the site tidy and in orderly manner and to take at any time every possible precaution against the contamination of subsoil and groundwater.

The Contractor shall be responsible for making all arrangements for the disposal of solid and liquid wastes from the site. Furthermore, it shall give strict instructions to all its employees to use the sanitary accommodation provided at the site.

3.4.1. Access and Public Roads

The Contractor shall, at its own expense, carry out all protective works and strengthening of public streets and roads used by it as necessary to avoid damage from heavy loads and plant moved to the site.

It shall also construct, maintain and remove temporary access roads as it may require for carrying out the works at its own expense.

Note: According to BoQ items of the Preparatory Works, (Volume 4) these costs are included in Contractor unit prices.

The Contractor shall observe all restrictions, which apply to public roads.

The Contractor shall comply with all reasonable restrictions, which may be imposed by the Engineer, the Police or other competent Authorities.

Public and private streets, roads and other surfaces used by the Contractor shall be kept free from dirt and rubbish and be cleaned as required by the Engineer. Immediately after ceasing the use of any temporary road, the Contractor shall restore the road to the agreement of the Engineer and the responsible Owner Authority.

Before any work in, or affecting the use of, any highway or road is commenced, the Contractor's proposed method of working, including any special traffic arrangements, shall be agreed with, and confirmed in writing by the Engineer and the Authorities.

The Contractor shall inform the Engineer, of any requirements of, or arrangements made with, the Highway / roads, and Police Authorities.

Barriers shall be fixed around trenches in streets and pedestrian areas and properly signs posted. All barriers on roads and pedestrian areas shall be lit with warning lights during night time or when there is poor visibility.

Where the diversion or closure of any existing road is needed, the Contractor shall provide and maintain an alternative one, which shall be operational before the existing one is closed.

Where ramps are required, they shall be provided and maintained according to a standard for the class of traffic.

3.4.2. Temporary Access

The Contractor shall provide and maintain all footways and structures necessary for the purposes of the Contract. Upon completion of the works, unless instructed otherwise by the Engineer, the Contractor shall remove such footways and structures and restore the ground to the agreement of the Engineer.

The Contractor shall provide and maintain all temporary paths, ladders and staging on and about the Sites necessary for the purposes of the Contractor and shall remove such paths, ladders and staging when no longer required.

3.4.3. Public Roads Cleanliness

The Contractor shall minimize pollution of public roads.

The Contractor shall take all measures to keep all public roads clean of any spillage or droppings from its own and its sub-contractor's vehicles travelling to and from the site. All such spillage or droppings shall be immediately cleared to the agreement of the Engineer and appropriate Public Authority. The Contractor shall indemnify the Engineer against all claims by the third parties, which may arise out of the Contractor's failure to comply with this Section.

Reinstatement of public roads shall be carried out as soon as is practical after completion of the Permanent Works and before the section of the road or pavement is re-opened for public use. Reinstatement shall be maintained by making good any subsidence, shrinkage, defect, imperfection or fault during the Defects Correction Period.

The types and thicknesses of the materials used in the road reinstatement shall be, as a minimum, as those of the existing construction.

Reinstatement where not specifically required by the Authorities shall comprise an additional depth of sub-base material as instructed by the Engineer. Original surface materials may be placed by hand with the wearing course upper most. The method of placing and compacting of materials shall be similar to that for road base construction, to the same surface tolerance, and to suit levels of the surrounding undisturbed road or pavement.

Only materials approved by the Engineer shall be used for reinstatement.

3.4.4. Storage of Equipment and Materials in Public Space

Construction materials and equipment shall not be stored outside the limits of the site.

Where Works are to be completed in public spaces, all plant and excess material shall be removed immediately from the site upon completion of the relevant task so as to limit public objections and complaints.

3.4.5. Traffic Arrangements

The Contractor shall as far as required, comply with all requirements and recommendations of the Police and Authorities regarding traffic arrangements and road safety measures on public roads outside the construction sites.

The Contractor shall, where necessary, provide all barriers and traffic signs agreed by the Engineer.

Traffic diversions, if necessary, shall be planned and arranged with the responsible Authorities by the Contractor and harmonized with the Engineer. No diversion shall be implemented without a written consent of the responsible Authority and after given information to the Engineer. Access to the site shall be available to vehicles of emergency services and residents in the areas.

All traffic signs and traffic control signals, as necessary and/or may be required by the Police Authority for the safe direction and control of the traffic shall be provided, placed and maintained by the Contractor on the appropriate sites and locations on the access to the sites. The location and size of all such signs and the lettering thereon shall be agreed by the Engineer before placement of the signs.

The Contractor shall reposition, cover or remove signs as required during the progress of the works.

4. CONTRACTOR'S GENERAL RESPONSIBILITIES

4.1. MANAGEMENT OF THE PROJECT BY THE CONTRACTOR

- 1) The Contractor shall provide the Quality Assurance Plan (QAP) for the management and execution of construction works;
- 2) The QAP should reflect the management structure and clearly describe the duties, responsibilities and powers of each member of the Contractors' staff;
- 3) The representative of the Contractor and its staff must possess experience and qualifications according to the contract, RS Law and type and scope of works;
- 4) This QAP will be updated and provided again whenever there is a change in personnel.

4.2. APPROVAL AND INSTRUCTION BY THE ENGINEER

Where reference is made in this Specification, the Bills of Quantities or in the drawings for approval, instruction or direction, they shall be given by the Engineer.

Approvals, instructions or directions by the Engineer shall not relieve the Contractor from its liabilities and responsibilities under the Contract.

4.3. QUALITY ASSURANCE PLAN

- 1) The Contractor shall be responsible for assuring such quality of materials, works and processes that shall comply with the requirements of the Specifications.
- 2) In order to meet the specified requirements, the Contractor shall implement Quality Assurance System presented in Quality Assurance Plan containing the following details:
 - Quality control procedures;
 - Personnel responsibilities;
 - Procurement procedures;
 - Testing procedures;
 - Equipment and measurement devices;
 - Frequency of testing, measurements etc.;
 - Holding points in production for inspection;
 - Rejection and corrective procedures;
 - Documentation and communication
 - H&S and Environmental Plan.
- 3) The Contractor shall be liable to keep a register of all materials delivered on site or implemented in the construction to be accessed for review upon request by the Engineer or Contracting Authority. Also, the Contractor shall maintain archive of the whole correspondence and instructions.

The Contractor shall within 28 days of the date of the Letter of Acceptance provide the Engineer with the Organisation chart containing names, CVs and duties of all key personnel whether or not they are related to quality assurance directly.

4.4. WORK PROGRAMME

4.4.1. Form of submissions

The Work Programme presented by the Contractor shall consist of a detailed schedule of all construction works and phases. Once approved, the Work Programme shall be binding for the construction works on site.

4.4.2. Requirements

The Contractor shall present a Work Schedule for execution of the works with distribution of resources and manpower, including volume of works, number of workers for the stage, coordination of activities, interaction with different participants in the process, time limit for execution and sequence of the works.

4.4.3. Work Programme

Pursuant to the requirements, the Work Programme to be submitted by the Contractor shall show the planned monthly rates of progress between the programme dates for commencement and completion of each major item or work for the various stages of construction, in accordance with the Conditions of Contract.

The Work Programme shall take into account climatic conditions, groundwater, geo-technical data, completion of critical components by the Contractor or other contractors, water supply service conditions and other conditions, to ensure the completion of the works in accordance with the Contract.

The Contractor shall not be permitted to commence any construction work on that part of the works until the Engineer has no objection to the method statements, drawings and calculations. Sufficient time for approval of drawings materials and method statements must be allowed for in the Work Programme for each component.

The Contractor shall allow in its Programme a reasonable period for work to be carried out by Public Utility Services, Authorities and the Beneficiary where necessary. The Beneficiary will provide all necessary assistance in liaising with such Authorities.

The Contractor shall also allow in its Programme sufficient time required for provisional acceptance and for the maintenance periods (Defects Notification Period) as stipulated in the Contract.

4.5. MONTHLY PROGRESS REPORTS

During of the execution of the Contract, the Contractor shall follow the progress of activities relative to the time schedule and shall submit to the Engineer Monthly reports for the results of its activities, conforming to the following requirements:

- 1) The Report to be provided to the Engineer in 1 hardcopy in Serbian and English languages as well as digitally (on CD enclosed to the Report);
- 2) Diagrams with detailed progress description, Contractor's documents, delivery, construction works, assembly and tests;
- 3) Digital photos (on CD enclosed to the Report);
- 4) Linear chart (schedules) for the current Stage, showing the actual and the planned progress;
- 5) Provision of resources - actual and planned;
- 6) Diagram for labour flow - actual and planned;
- 7) Report, reflecting all considerable differences from the construction programme, and if necessary, explanation for the proposed steps to be undertaken for the completion of the approved programme;
- 8) Statistics on safety and environment protection;
- 9) Financial Statement.

When actual work progress differs from that shown in the Construction Programme, the Contractor shall submit an updated schedule to the Engineer. The updated time schedule shall be current to the last day of a calendar month and shall show the detailed "work-as-executed" programme in respect of work carried out. They shall be submitted within ten working days of the following month at the latest.

4.6. PROGRESS PHOTOGRAPHS

Digital colour photographs showing the progress of the Works in detail shall be taken by the Contractor every week, from positions to be selected by the Engineer.

The Contractor shall hand over the corresponding electronic files to the Engineer on a CD, as well as an electronic list numbering and labelling each photograph (location, date when taken and a brief description or title).

4.7. CONTRACTOR'S DOCUMENTATION

4.7.1. General

- 1) For design, works and supply use of metric units is compulsory.
- 2) All documents will be issued in English. Official documents, which are to be presented to state or municipality authorities, will be also issued in Serbian.
- 3) Works documentation (see Chapter 4.7.3.) will be in English and in Serbian, except Construction Log, which will be in Serbian.

- 4) Reports and correspondence documentation will be in English and in Serbian.
- 5) When submitted as computer files the documents shall be under Windows, texts in MS Word, Tables in MS Excel, drawings in ACAD, time schedules in MS Project.

4.7.2. Detailed Design Drawings

The Contractor shall prepare, if needed, detailed design drawings developing the drawings included in this Tender Dossier and taking into account the Contracting Authority's Requirements, written in the present Technical Specifications. Contractor's drawings will be checked and can be applied after a written consent is issued by the Engineer and the Beneficiary.

4.7.3. Works documentation

The Contractor shall be liable to provide the Engineer with due documentation as per local Regulations. The Contractor shall keep/maintain the following Works documentation:

- 1) Inspection Book (forms laid down by the Law of the Republic of Serbia),
- 2) Construction Log (forms laid down by the Law of the Republic of Serbia),
- 3) Measurement Book (forms laid down by the Law of the Republic of Serbia),
- 4) All necessary certificates (for material, equipment and other) during the works execution.

The Works Site Manager shall keep the Construction Log and submit the Measurement Book sheets of the executed works along with each invoice. The Measurement Book has to be verified by the Engineer.

The Construction Manager has to enter the following data into the Construction Log:

- Number and qualification of workers executing the works,
- Number and type of construction machinery used for works execution,
- Weather conditions under which the works are executed,
- How the works are executed and if there is any deviation from the design, contract and regulations in doing so.

4.7.4. As-built design

- 1) Based on a survey of executed works, as-built technical documentation will be prepared by the Contractor and delivered to the Engineer (in accordance with Law on Construction and Planning).
- 2) As-built drawings for all executed works must be delivered in digital form and 3 (three) printed and bind hard copies, signed by the Responsible Designer and the Engineer.
- 3) Contractor is obliged to support the Beneficiary during technical acceptance and make necessary corrections in the submitted documentation and designs upon the request of Authorities in order to obtain a use permit.

4.7.5. Operation and maintenance manuals

- 1) The Contractor shall provide comprehensive operation and maintenance manuals for the delivered equipment including a full technical description and operational characteristics thereof. The Contractor shall provide 2 copies in both English and Serbian of each of the manuals bound loose leaf in ring binder folders.
- 2) Manuals shall be prepared in accordance with the approved standard. Manuals shall also be subject to the approval of the Engineer.

5. HEALTH & SAFETY AND ENVIRONMENT PROTECTION

5.1. HEALTH & SAFETY

5.1.1. General requirements

Without limiting the Contractor's obligations under the Conditions of Contract, the Contractor shall take all measures and precautions necessary to ensure the health, safety and welfare of staff, labour, and other persons authorised to be on the Site, as well as visitors and third parties. The Contractor shall prepare H&S&E Plan and develop detailed sequence and safety measures in the Organisational plan for the management and execution of the works.

The Contractor shall:

- 1) Fully comply with the *Law on Safety and Health at Work (Official Gazette of the Republic of Serbia no. 101/2005, 91/2015)*.
- 2) Appoint a member of staff responsible for all matters related to health and safety for the duration of the Contract according to RS regulations.
- 3) Provide and maintain equipment in a safe working condition and adopt safe methods of work.
- 4) Adopt methods for the use, handling, storage, transport, and disposal of materials, and substances which are not injurious to health and safety.
- 5) Provide and maintain adequate lighting, signing, and fencing of the Works.
- 6) Provide adequate protective clothing and safety equipment, including such information, instruction, training and supervision as are necessary to ensure the health and safety of all persons employed on or entering on the Site in connection with the Works.

Safety equipment shall include but not be limited to:

- safety helmets,
 - protective footwear with integral steel toe-caps,
 - safety glasses, welding goggles and other eye protectors,
 - ear defenders,
 - safety harnesses,
 - high visibility reflective vests,
 - fire extinguishers.
- 7) Provide and maintain access to all places on the Site in a condition that is safe and without risk of injury.
 - 8) Provide and maintain adequate water, waste water and waste collection, for all offices, workshops, and laboratories erected on the Site.
 - 9) Provide and maintain adequate sanitary units at locations where works are in progress.
 - 10) Appoint a member of its staff to be responsible for the safety of the Works throughout any shutdown period and notify the Engineer of the name and contact telephone number of the responsible person.

- 11) Report all accidents to the Engineer and appropriate authorities at the time of occurrence or as soon as possible thereafter.

5.1.2. Testing and certification of mechanization and equipment

- 1) The Contractor shall provide and maintain equipment for lifting, embedding and transporting materials and must comply with all relevant requirements of the standards in Serbia;
- 2) All equipment must be regularly maintained in accordance with the recommendations and standards of the manufacturer, according to local laws and recommendations of the relevant authority;
- 3) The Contractor shall prepare and update a register of certificates of testing of the equipment used on construction sites according to RS Law;
- 4) The Contractor must appoint competent personnel responsible for the operation of all kinds of equipment. They must provide evidence that they have passed training and have respective license for operating the specific equipment;
- 5) All the technological equipment (with test certificates) used on or around the site must be equipped with the necessary protective devices that will be in continuous readiness;
- 6) Should the Engineer consider the Contractor's method of working unsafe or that there are insufficient or inadequate safety barriers or other devices or that there is insufficient safety or rescue equipment, the Contractor shall change its method of working or install or strengthen safety and rescue equipment if so instructed. Such instructions shall not relieve the Contractor of any of its responsibilities under the Contract.
- 7) The Contractor shall immediately notify the Engineer about any accident that occurs, whether on site or off site, in which the Contractor is directly involved, and which resulted in any injury to any person whether directly concerned with the site or a third party. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the accident.
- 8) Transportation of any material by the Contractor shall be in suitable vehicles, which do not cause spillage when loaded, and all loads shall be suitably secured. Any vehicle shall be removed from the site, which does not comply with this requirement or any of the local traffic regulations and laws.
- 9) The Contractor shall ensure access to sites at all times to any authorised external institutes or experts carrying out safety inspections.

5.1.3. Fire protection

During the performance of the Contract the Contractor shall make arrangements to the agreement of the Engineer for the protection of the permanent works and any temporary works and any adjacent property from fire and, if required, it shall give the Fire Authority access to all facilities periodically to inspect the fire prevention arrangements.

Particular care must be exercised in connection with the operation of electric arc welding equipment, oxyacetylene cutting equipment and other processes involving the use of naked lights. Special arrangements will be necessary for the storage of highly flammable liquids on the site.

The Contractor shall remove all waste and material of a flammable nature and take other steps as the Engineer may require but this shall not relieve the Contractor of any of its obligations under the Contract.

5.2. ENVIRONMENT PROTECTION

5.2.1. General

- 1) The Contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the Works and all associated operations on or off site are carried out in conformity with statutory and regulatory environmental requirements.
- 2) The Contractor shall take all measures and precautions to avoid any nuisance or disturbance arising from the execution of the Works. This shall be achieved wherever possible by suppression of the nuisance at source rather than abatement of the nuisance once generated.
- 3) The provisions of these Sub-Clauses shall only be disregarded in respect of emergency work required for the saving of life or property or the safety of the Works.
- 4) In the event of any spoil or debris or silt from the Sites being deposited on any adjacent land, the Contractor shall immediately remove all such spoil debris or silt and restore the affected area to its original state to the agreement of the Engineer.
- 5) The Contractor should comply with the guidelines of the Banks in this regards as well as those for resettlement and rehabilitation of the affected population.

The offer should include appropriate cost-effective mitigation measures, which should form part of the project cost.

Environmental Management Plan (EMP) shall be prepared by the Contractor incorporating proposals concerning the implementation, management and monitoring of the environmental components of the project.

Within one month from the commencement of the works, the Contractor shall submit an EMP with operational details of its proposals to the Engineer for approval.

5.2.2. Environmental officer

The Contractor shall nominate an Environmental officer qualified to promote and maintain environmental management during construction and implement the approved Environmental Management Plan.

This officer shall have authority to issue instructions and take precautionary measures to prevent environmental accidents, including but not limited to the establishment of environmentally friendly practices and to train the staff and labour accordingly.

5.2.3. Environmental protection during construction period

The Contractor shall use such construction methods and shall maintain all borrow/stockpile/spoil disposal area so as to assure the stability and safety of the Works and any adjacent feature, to assure free and efficient natural and artificial drainage and to prevent erosion.

The Engineer has the power to disallow the methods of construction and/or the use of any borrow/stockpile/spoil disposal area if in their opinion the stability and safety of the Works or any adjacent features are in danger, or if they disturb natural or artificial drainage, or if the method or use of the area will promote undue erosion.

Following excavation for the works, the Contractor shall take all steps necessary to complete drainage and slope protection works in advance of each rainy season. Erosion or instability or sediment deposition arising from operations not in accordance with the Specifications shall be repaired immediately by the Contractor at its expense. The Contractor shall also take all steps necessary to complete drainage in advance of each winter rainy season in the areas excavated for borrowing materials.

Notwithstanding approval of the intended method of working, the Contractor shall at all times be responsible for constructing the earth works in accordance with the Specifications, the Design and drawings.

Where directed by the Beneficiary, the Contractor shall recultivate the land on slopes, used borrow pits and other areas which may include verges, spoil disposal areas, stock pile areas, quarries, access tracks, plant sites, camps, land slide scars, gullies, and stream and river banks. Prior to placing top soil and/or establishing vegetation on embankments, all fill material not compacted to the required standards shall be removed from the side slopes.

The Contractor shall be responsible for supplying sufficient planting material to carry out all re-vegetation work, and shall establish and operate plant nurseries as necessary and shall make its own arrangements for procuring cuttings, slips and seed for growing.

5.2.4. Prevention of pollution

The Contractor shall ensure that its activities do not result in any contamination of land or water by polluting substances.

The Contractor shall implement physical and operational measures such as: earth dikes of adequate capacity around fuel, oil and solvent storage tanks and stores, oil and grease traps in drainage systems from workshops, vehicle and plant washing facilities and service and

fuel ingress and kitchens, the establishment of sanitary solid and liquid waste disposal systems, the maintenance in effective condition of the same assures, the establishment of emergency response procedures for pollution events, and dust suppression, all in accordance with normal good practice and to the agreement of the Engineer.

5.2.5. Protection of trees and vegetation

Unless otherwise provided in these Specifications, the Contractor shall ensure that no trees or shrubs or water side vegetation are felled or harmed except for those required to be cleared for execution of the Works. The Contractor shall protect trees and vegetation from damage to the agreement of the Engineer and the Beneficiary.

The Contractor shall be responsible for obtaining any necessary felling permits and for ensuring the disposal of felled trees in accordance with prevailing regulations. No tree shall be removed without the prior approval of the Engineer and the Beneficiary.

In the event that trees or other vegetation not designated for clearance are damaged or destroyed, they shall be repaired or replaced by the Contractor at its own expense to the agreement of the Engineer and the Beneficiary.

5.2.6. Use of woods as fuel

The Contractor shall not use or permit the use of wood as a fuel for cooking, space and water heating in all its camps and living accommodations. Any wood so used must be harvested legally, and the Contractor shall provide the Engineer and the Beneficiary with copies of the relevant permits if required.

5.2.7. Fire prevention

In addition to the provision of adequate fire-fighting equipment at its offices, workshops, construction areas and other facilities to the agreement of the Engineer and the Beneficiary, the Contractor shall take all precautions necessary to ensure that no vegetation along and outside the area of the permanent works is affected by fires arising from the execution of the Works.

Should a fire occur in the natural vegetation or plantations adjacent to the project area for any reason the, Contractor shall immediately take all measures to suppress it. In the event of any other fire emergency in the vicinity of the Works the Contractor shall render assistance to the civil authorities to the best of its ability.

Areas of forest, shrub or plantation damaged by fire considered by the Engineer and the Employer to have been initiated by the Contractor's staff or labour shall be replanted and

otherwise restored to the agreement of the Engineer and the Beneficiary at the Contractor's expense.

5.2.8. Relation with local communities and authorities

During execution of the Works the Contractor shall minimize the impact of its activities on existing communities.

Where communities are likely to be affected by major activities the Contractor shall liaise closely with the concerned communities and their representative and if so directed, it shall attend additional meetings arranged by the Engineer and the Beneficiary to resolve issues and claims and minimize impacts on local communities.

Any problems arising from its operations which cannot be resolved by the Contractor shall be referred to the Engineer and the Beneficiary.

The Contractor shall be responsible for any compensation due or reinstatement necessary with respect to any damage caused by it to areas outside the Site and no separate payment will be made in this regard.

5.2.9. Water supply for construction

The Contractor shall make its own arrangements at its own expense for water supply for construction and other purposes.

Only clean water free from deleterious materials and of appropriate quality for its intended use shall be used. In providing water the Contractor shall ensure that the rights of and supply to existing users are not affected either in quality, quantity or timing.

In the event of a dispute over the effect of the Contractor's arrangements on the water supply of others, the Engineer shall be informed immediately and shall instruct the Contractor as to appropriate remedial actions to be undertaken at its expense.

5.2.10. Environmental considerations

The following environmental protection measures shall be observed during the execution of the construction of the works:

- **Demolition material** - Reuse of demolition materials as backfill for trenches and excavations or/and hard fill for construction foundations and roadways is possible, unless contaminated or hazardous materials such as asbestos are identified. The Contractor will be responsible for environmentally safe disposal of any material resulting from the demolition and other site materials with approval from the relevant local Authorities at a designated licensed disposal facility.
- **Excavated soil** - Reuse of excavated natural soil, which is free of cohesive components, salt, sulphate and/or clay materials, may be used as backfill for trenches and excavations. The Contractor will be responsible for environmentally safe

disposal of surplus materials with approval from the relevant local Authorities at a designated licensed disposal facility.

- **Ground water** - Temporary and/or permanent groundwater lowering may be required. The Contractor shall apply appropriate dewatering measures as required and shall also ensure that adequate measures are implemented to control surface water discharge.
- **Air pollution** - Construction may give rise to dust and construction equipment exhaust emissions. Due note shall be taken of the proximity of residential housing to the works. The normal health and safety controls will be required to safeguard the residential and passing population.
- **Noise pollution** - Construction works may cause annoyance caused by noise. The normal health and safety controls will be required to safeguard the residential and passing population.
- **Maximum noise levels** - During construction works the Contractor shall comply with the local and national requirements. The Contractor shall be legally responsible and financially liable to observe Serbian environmental legislation.
The noise levels shall be in accordance with the relevant Serbian noise environmental legislative.
Noise and disturbance shall be kept to the reasonable minimum as far as required for this project. The Contractor's attention is drawn to the close proximity of some residential areas. All plant and tools used at such sites above or near ground level shall be silenced or of a silent type.
The Contractor shall take all necessary steps to ensure that its workmen carry out their duties in a quiet manner particularly when working at night.
- **Pollution prevention** - The Contractor shall not pollute or unnecessarily disturb lands, roads and other places on and around the Site. No trees or other vegetation shall be removed except to the extent necessary for the Works.

The Contractor shall take all reasonable precautions to prevent:

- **Silting, erosion of beds and banks and pollution of rivers and watercourses;**
- **Interference with the supply to or abstraction from underground water sources;**
- **Pollution of the surface waters at site.**

The Contractor shall provide, maintain and remove on completion of the works, settling lagoons and other facilities to avoid pollution caused by the Contractor's operations such as but not limited to quarrying, aggregate washing, concrete mixing and grouting.

5.2.11. Water quality

- 1) The Contractor shall prevent any interference with the supply to or abstraction from or the pollution of water resources (including underground percolating water) as a result of the execution of the Works.

- 2) Areas where water is regularly or repetitively used for dust suppression purposes (including without limitation stockpiles for concrete-batching and asphalt plants) shall be laid to fall to specially-constructed settlement tanks to permit sedimentation of particulate matter. After settlement, the water may be re-used for dust suppression and rinsing.
- 3) All water and other liquid waste products arising on the Sites shall be collected and disposed of at a location on or off the Sites and in a manner that shall not cause either nuisance or pollution.
- 4) The Contractor shall not discharge or deposit any matter arising from the execution of the Works into any waters except with the permission of the Engineer and the regulatory authorities concerned.
- 5) The Contractor shall at all times ensure that all existing stream courses and drains within and adjacent to the Site are kept safe and free from any debris and any materials arising from the Works.
- 6) The Contractor shall protect all watercourses, waterways, ditches, canals, drains, lakes and the like from pollution, silting, flooding or erosion as a result of the execution of the Works.
- 7) The Contractor shall submit details of its temporary drainage systems (including all surface channels, sediment traps, washing basins and discharge pits) to the Engineer for approval prior to commencing work.

5.2.12. Air quality

- 1) The Contractor shall devise and arrange methods of working to minimize dust, gaseous or other air-borne emissions and carry out the Works in such a manner as to minimize adverse impacts on air quality.
- 2) The Contractor shall utilize effective water sprays during the delivery and handling of materials when dust is likely to be created, and to dampen stored materials during dry and windy weather.
- 3) Stockpiles of materials shall be sited in sheltered areas, away from sensitive areas. Stockpiles of friable material shall be covered with clean tarpaulins, and sprayed with water during dry and windy weather. Stockpiles of material or debris shall be dampened prior to their movement, except where this is contrary to the Specification.
- 4) Any vehicle transporting no coherent material shall not be loaded to a level higher than the side and tail boards, and shall be covered with a clean tarpaulin in good condition. The tarpaulin shall be properly secured and extend at least 300 mm over the edges of the side and tail boards.
- 5) In periods of high wind, dust generating operations shall not be permitted within 200 m of residential areas having regard to the prevailing direction of the wind.
- 6) Construction vehicles and machinery shall be kept in good working order and engines turned off when not in use. Appropriate measures shall be taken to limit exhaust emissions from construction vehicles, machinery and plant.

- 7) An advance warning shall be given to potentially affected persons, so that some measures can be taken by them before commencement of works, especially before dismantling/demolition.

5.2.13. Noise

- 1) The Contractor shall consider noise as an environmental constraint in its planning and execution of the Works.
- 2) The Contractor shall take all necessary measures to ensure that the operation of all mechanical equipment and construction processes on and off the Site shall not cause any unnecessary or excessive noise, taking into account applicable environment requirements. The Contractor shall use all necessary measures and shall maintain all plant and silencing equipment in good condition so as to minimize the noise emission during construction works.

5.2.14. Preservation of archaeological finds and burial sites

The Contractor shall take all necessary measures to protect any archaeological features, antiquities, burial sites, or other finds, immediately report such finds to the Engineer and appropriate authorities, and allow adequate time for experts to visit and survey the finds, all according to RS regulations. Such finds shall be protected by means of suitable fencing and barriers to the agreement of the Engineer unless or until approval is given to remove or relocate the finds to allow the Works to proceed.

5.2.15. Preservation of existing landscape

The Contractor shall exercise care to preserve the natural landscape in the vicinity of the Works and shall conduct its operations so as to prevent any unnecessary destruction, scarring, or defacing of existing landscape features. The removal of trees, bushes, and other natural vegetation shall only be carried out with the prior approval of the Engineer. On completion of substantial parts of the Works the Contractor shall make proposals for reinstating the landscape and natural vegetation and, on approval by the Engineer, shall carry out such reinstatement to the agreement of the Engineer.

5.2.16. Measures for decreasing the negative environmental impact

In order to mitigate negative environmental impact, the Contractor should propose necessary actions in its Environmental Management Plan (EMP), such as:

- 1) to create adequate organisation for execution of construction works which shall comply with local construction regulations;
- 2) to provide water sprinkling of the construction site and service roads;
- 3) to create organisation for control on the facilities storing fuel and lubricants and on the technical condition of the machines in order to avoid accidental oil spills;

- 4) along the construction site, waste water should be treated and sedimentation tanks and oil separators should be placed if needed;
- 5) to foresee the necessary maintaining and drainage measures for the construction site, access roads and service roads, in order limiting the erosion processes;
- 6) to specify the quantity and type of waste and how its disposal is intended to be transported and removed from the site area;
- 7) measures for fast conservation of unfinished works at unfavourable conditions.

6. MATERIALS

6.1. GENERAL

- 1) All materials used shall be of the best quality as specified and described in the Specification, EmW Design, Drawings and the Bills of Quantities. Where in the Design Drawings and/or BoQ the products are brand named, this should be understood as supplemented by 'or equivalent'. These materials shall be procured from approved manufacturers or suppliers.
- 2) The Contractor must secure the compliance with the Specification of materials or plant to be provided under this Contract before the supplier or manufacturer is proposed for approval to the Engineer.
- 3) The Contractor shall take into consideration the local climatic and other environmental conditions when selecting and proposing the materials. The quality of the material has to be confirmed by the attests and suppliers certificates, all according to TS and RS regulations.
- 4) Whenever possible, the Contractor shall provide equipment of a similar nature from the same manufacturer, e.g. electric motors;

The Contractor shall note that particular attention will be paid to these requirements. In cases where the proposed equipment is not standardized with regard to manufacturer and type, the Contractor shall be required to provide conclusive technical justification; considerations of price alone will not be accepted. Equipment and components that have not been standardized will not be accepted.

6.2. ORIGIN

Certificates of origin have to accompany the products proving that supplies originate from an eligible country as stated in GC of the Contract.

6.3. CONFORMITY OF MATERIALS

All materials implemented during construction shall be in compliance with the requirements of:

- Requirements of the local legislation;
- REGULATION (EU) No 305/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 March 2011 laying down harmonized conditions for the marketing of construction products;
- The present Technical Specifications;
- Requirements of the design documentation.

All materials applied shall be accompanied with quality certificates to prove their concordance with the requirements set out in the design, the Specification and the Code for Civil Construction Works.

The Contractor shall make diligent efforts to procure the specified materials. Where, due to different reasons, the materials required by the Contract are not available, substitute materials may be used but with the prior approval by the Engineer and the Designer.

7. TECHNICAL REQUIREMENTS FOR EXECUTION OF WORKS

7.1. TECHNICAL REQUIREMENTS

7.1.1. Purpose of the technical requirements

The purpose of the technical requirements is to provide quality performance of works to comply with technical regulations and standards. Therefore, the Contractor is obliged to adhere strictly to them and to perform all the works that are the subject of this project, in accordance with technical requirements, design documentation, accompanying drawings and Bill of Quantities.

In addition, technical requirements define the method of measurement. Therefore, bidders are required to include all costs for not separately analysed and measured items in the unit prices of the existing ones.

7.2. GENERAL TERMS

7.2.1. Notice of Commencement

The Contractor shall give a written notice to the Engineer of its intention to commence works (Notice of Commencement).

Also, according RS law, Notice of Commencement must be submitted to competent Local and National Authority.

The works shall not be commenced until written approval has been received from the Engineer.

7.2.2. Technical specification for works

Technical Specifications are an integral part of the Tender Documentation, and are Annexed to the Works Contract.

The Contractor is fully familiar with all details of the EmW Design, as well as with all local regulations, local standards (SRPS), common practice of trade and circumstances for their execution. Nevertheless, it is understood that, whenever local regulations, local standards (SRPS), or any common practice of trade, are subject to any interpretation, clarification, ambiguity, or dispute, a ruling by the Engineer will prevail, always provided that such ruling will be fully in compliance with and will be based on the subject local regulations, local standards (SRPS), as well as in accordance with common practice of trade, and any such

ruling by the Engineers and subsequent instruction in that respect, will not constitute any ground for variation order and/or any additional payment.

Communication between the Contractor and the Beneficiary (also Designer), during the works will be carried out exclusively through the Engineer.

All works must be carried out precisely and professionally. Prior to application, the Engineer must examine all material and all his comments referring to material and quality of work will be obligatory for the Contractor. The agreed prices include all fully completed works and final products ready for use.

ICS Number	Standard Number	Year	TITLE
03.120.10	SRPS ISO 9001	2008	Quality management systems-Requirements
	SRPS ISO 10001	2008	Quality agreement-Customer agreement-Guidelines for codes of conduct for organisation

The Contractor will be responsible for any and all damages caused by the Contractor during any works, to any third party, structure, main building or adjacent buildings, and any and all repair works and compensations of any kind will be at the Contractor's expense.

According to BoQ: Preliminary works: Item A-I / 1.1.):

- The Beneficiary will provide to the Contractor the area necessary for organisation of the building site
- All other matters in this regard will fall within the competence of the Contractor
- Supply of water, electricity and all other raw materials to the site, all the time during the execution of the works, will be the sole liability of the Contractor, including all costs and necessary administrative procedures.

Before starting the works, the Contractor is required to be familiar with local terrain conditions, regulations, access roads, borrow pits, landfills and all possible other factors that could affect the smooth performance of the works (Beneficiary's responsibility is to provide necessary information about mentioned conditions).

Prior to the commencement of the works, and also in the course of the execution of every work item, the Contractor will ask the Engineer for any explanations and clarifications required, therefore, the Contractor will solely bear full material responsibility for all works not completed in accordance with the concept and details of this EmW Design.

The Contractor will be responsible to keep records on the progress of works in the measurement book and have it controlled and verified by the Engineer.

Any damage caused by exceeding the designated area of expropriation, falls on the Contractor.

Property relations (permanent and temporary expropriation at works area) are not the subject of this Contract, and property and expropriation issues are the Beneficiary's responsibility.

Upon the completion of the works the Contractor will remove from the building site and other used areas all its tools, machinery, surplus material, etc. so as to have the site neatly arranged as defined in the investment-technical documentation, and all other areas restored in same condition as before the construction.

All construction works must be carried out under the conditions and in the manner prescribed by RS Law on Construction and Planning.

For all works, applicable Serbian regulations and standards shall prevail.

The Contractor shall transport materials along the roads provided by the Beneficiary. Routes of access and service longitudinal roads are defined in the design documentation. Access roads must be kept passable during construction period. After completing works, access and longitudinal service roads must be constructed and repaired as defined in EmW Design and Bill of Quantities.

For all the works the Contractor is obliged to give the warranty period of 1 year from the date of Provisional Acceptance. Within this period, the Contractor is obliged to remedy all the defects that are resulting from poor quality of works.

Initial survey (according to BoQ): Before starting the works the Contractor shall survey and mark the route. All geodetic marking must be present in the *Survey documentation of initial terrain state* (Survey "0" Doc)

All geodetic marking must be checked before starting work and approved by the Engineer.

Except where otherwise specified all levels shall be in meters above Sea level (m.a.S.l) with accuracy of three decimals. The data for all levels shall be based on benchmarks approved by the Engineer.

During the period of construction of the Works, The Contractor shall establish and construct necessary additional benchmarks, which shall be protected and checked periodically.

The Contractor shall be responsible for constructing the Works in accordance with the data on levels. Benchmarks and other points of reference in the vicinity of the Site(s) will be supplied to the Contractor by the Engineer before execution of the Works.

The Contractor shall maintain a record of the levels of all the benchmarks and shall submit one copy of the records to the Engineer immediately after the completion of the survey work.

The survey instruments to be used by the Contractor shall be suitable for the work to be executed and shall be maintained in a first class condition. For all survey instruments used in the Works the Contractor shall submit recent calibration certificates issued by competent authorities. Further calibration of the instruments shall be carried out every six months.

The Contractor shall provide, for State Quality Control Inspection, a schedule of the main phases of the construction.

Labelling of cross sections is performed by the Contractor in a clear and understandable manner, so that there are no errors in the works. Any errors caused by incorrect marking of the route are borne by the Contractor.

Locations of borrow pits are provided by the Beneficiary (the cadastral plots are defined in the design documentation and BoQ).

Site preparation consists of cutting and removal of trees and shrubs, and is carried out only along the designed work area (embankment and surrounding area of the river and defended side).

Since the quality of works depends on the meteorological and hydrological conditions during the works, the Contractor is obliged to continually monitor the meteorological and hydrological conditions during the works.

- 1) In general, the Contractor is required to adjust its own dynamics and methodology of the work with field conditions, meteorological and hydrological conditions, without delays or interruptions in the period of performance of the work (works will take place throughout the year, during which there can be different meteorological and hydrological conditions).
- 2) Emergency delays and possible temporary interruptions are possible only in case of exceptional hydrological conditions - when entering high water and rising water levels that may threaten coastal areas.
- 3) The technical documentation (Synchron work plan for reducing the risk of large water PPMC „Srbijavode“- synchron plan of works) defines the critical locations and critical work operations and critical (emergency) hydrological conditions that could affect the dynamics and quality of works.
- 4) As a matter of prevention, critical locations on the site must be protected from adverse hydrological impacts, in a timely manner, in accordance with the synchronization plan of works. Synchronization plan of works imposes restrictions on the length of the opening / decrease elevation of the embankment and defines special requirements during critical hydrological conditions. The Contractor has to include in its offer all costs that may arise in such defined conditions of works.
- 5) PPMC "Srbijavode", in accordance with the applicable regulations, defines procedures to be followed during unfavourable hydrologic extraordinary circumstances. They are defined for different stages (regular and extraordinary flood protection, emergency situation) of flood protection. The procedures and way of notification of the Engineer and Contractor are included in technical documentation and special conditions. Orders for performance of certain works and implementation of measures in the course of flood defence will be issued by the Engineer to the Contractor and will be in accordance with these procedures.
- 6) Critical hydrologic conditions are defined in the EmW Design with respect to the authoritative water levels, laid down in this design by the PPMC "Srbijavode"

(observation post, gauging rod, water level at which certain Flood Defence Phase is proclaimed / cancelled).

- 7) PWMC "Srbijavode" has defined, in accordance with the applicable regulations, the role of third parties (in charge under Operation plan for the flood defence for relevant section of the embankment), as well as obligations of the Contractor in the course of flood protection
- 8) In the BoQ there are defined items for works performed by the Contractor under the critical work operations, implementing preventive protective measures (forming temporary protective structures, hiring equipment, machinery and manpower).
- 9) Damages caused by non-observance of prescribed procedures in performing critical operations are borne by the Contractor.

The Contractor is obliged to keep and preserve all completed works up to the final acceptance and has to safeguard the site for this purpose. The cost for it should be included in the unit price and will not be paid separately.

7.3. TECHNICAL STANDARDS AND REGULATIONS

In accordance to these Technical Requirements the Contractor shall ensure that its performance incorporates the following key principles

- For all required works and services specified in this Tender Dossier, the relevant Serbian standards and codes of practice shall apply. In any case, if Serbian standards are more strict or dominant, they shall apply to replace other standards given or not in other parts of this document.
- For works and services where no relevant Serbian standards or codes of practice exists the latest European Standards and code of practice shall be applied.
- The proposed application of other standards and code of practice for certain works and/or services shall be such as to ensure equal or higher than specified quality and safety of works, and to facilitate operation, inspection, maintenance, repairs, lubrication and similar operations.
- In any case, National standards and code of practice have to be used for each service and work, accompanied with explanations, to demonstrate to the agreement of the Engineer that application of these standards and code of practice shall give required quality, safety, functionality and durability of the completed works.
- The applicable version of any standard shall be that valid 28 days prior to the latest date for submission of tenders.

7.3.1. Matters not covered by the Standards

Any materials and workmanship not fully specified herein or covered by the Standards, Codes or Manuals shall be of such type and quality so as to produce a required quality of

work. In such circumstance the Engineer shall determine whether all or any of the materials offered or delivered to the site are suitable for use in the Works and the Engineer's decision in this respect shall be final and conclusive.

7.3.2. Civil Works

The term "Civil Works" means the obligations of the Contractor to perform all manufacturing, excavation, building, structures and other construction Works.

The following shall be included, but not limited to, within the limits of the Works:

- Site investigation levelling, excavation, filling and other earth works;
- Demolition of existing structures and removal of debris;
- Civil works related to complete drainage systems and structures necessary for the disposal of process waste, overflow and drainage water and waste
- Landscaping and similar area works with plant roads, temporary roads, and site facilities;
- All other works from the Contractor's Offer whether specified or not in the BoQ or any other Contract Document (including the Contractor's proposal), as necessary for the completion of the Works and the operation thereof, and as required under the terms of the Contract;
- Excavation of trenches, laying of underground diaphragm, welding and protection;
- Soil stabilization using a binder (with laboratory recipe) to improve the characteristics of the soil;
- Excavation of trenches, laying of pipes, welding and protection of the pipes, transport and disposal of excess and demolished materials;
- Reinstatement of any existing facilities demolished during construction;
- All temporary and provisional works necessary for proper execution of the Contract (temporary roads, keeping excavation free of water, excavation sheeting and bracing, etc.).

7.3.3. Mechanical Installations

The term "Mechanical Installations" shall mean the obligations of the Contractor under the Contract to cover all manufacturing, delivery, assembling and installation, testing and commissioning of the required mechanical equipment and machinery for the proper completion of Works, which shall be performed by the Contractor.

The following shall be included, but not limited to, within the limits of the Works:

- Mechanical equipment and machinery, including motors and pumps and spare parts;
- Complete piping system, incl. armatures and fittings;

- Complete equipment for installing the underground diaphragm;
- Specialized mechanization with integrated equipment for stabilization and homogenization of the soil " in situ cold recycling":
- Workshop equipment;
- All other auxiliary materials of any description and all materials.
- Spare parts for fixed and mobile mechanical equipment.

7.3.4. Dealing with surface and underground water

The Contractor shall be responsible for dealing with water, whether from existing watercourses, surface water and storm water, drainage systems ground water, underground springs or any other source or cause. In discharging and diverting water it shall avoid flooding or damaging other works or services, causing erosion and polluting watercourses.

The Contractor shall provide all temporary works and do all things which may be necessary to maintain those parts of the existing water supply, sewerage, and drainage systems and water courses which may be affected by its operations in a condition not less satisfactory than they were prior to the commencement of the works, and shall maintain the normal flows therein at all times until the connections to the new system shall have been made except when written permission to interrupt the flows has been obtained from the Engineer.

The Contractor shall submit its proposal to the Engineer accompanied with a schedule for maintaining the drainage systems and water courses affected by the Works. The Contractor's method proposed for each location shall be subject to the review of the Engineer. Such review will not relieve the Contractor of its obligations under the Contract.

The Contractor shall perform all works for maintaining flow in existing drainage systems and water courses including but not limited to the construction of diversion systems and relocations and other works necessary during the construction period including the removal and dismantling of such works on completion as required by the Engineer.

The Contractor shall, as specified in the design, keep the working area free from water whether caused by floods, storms or otherwise so that the works can be constructed in dry conditions.

Unless otherwise specified, the Contractor shall furnish, install, maintain and operate all necessary equipment for de-watering and keep free from water the location where construction works are in progress.

The de-watering shall be done in a manner that will prevent loss of fines from the foundation, keep stability of excavated slopes and result in all works being performed free from standing water, and enable backfilling and proper compaction of the materials.

The Contractor shall be responsible for dealing with storm water, whether from normal or extraordinary rainfalls and weather conditions or any other source or cause. In discharging

and diverting water it shall avoid flooding or damaging other works or services, causing erosion and polluting watercourses.

The Contractor shall perform all works for maintaining storm water flows and shall, as required by the Engineer, keep excavations free from water and sewage whether caused by tides, floods, storms or otherwise so that the works can be done in dry conditions.

Note: detailed critical work operations are presented in this Technical Specification, which are possible and expected during critical hydrological scenarios (see section 7.27.). TS also presents Synchronization Plan of mandatory preventive measures (part of Contractor Offer and of BoQ in Contract).

7.3.5. Existing Underground Utilities/Structures

The Contractor shall (for its own safety) search for, locate and identify all buried utilities such as, for example, power cables, gas lines, water pipes, telephone cables.

The Contractor shall locate these utilities/structures sufficiently in advance of its construction operation and use modern detection equipment, satisfactory to the Engineer, in order to minimize the risks of damage or interruption of these utilities/structures. The Contractor shall take full responsibility for any damage caused by its operations to these utilities. Any damage shall be repaired without any delay at its own expense.

No excavating machines shall be used in the immediate vicinity of cables and/or pipelines unless approved by the Engineer. Special care shall be taken to ensure that the existing facilities are accessible in the case of an emergency.

Temporary works which may be necessary in the vicinity of the existing facilities during the execution of the works shall be maintained by the Contractor and shall be removed as soon as practicable. Before the commencement of works that might affect or damage neighbouring structures, the Contractor shall prepare a "Record of Evidence" by experts indicating and establishing the condition of the structure. This "Record of Evidence" should include photographs to prove any existing defects of utilities/structures prior to commencement of the works.

The Contractor shall indemnify the Employer and PWMC (as the Beneficiary) against all claims arising from any damage, injury etc. caused to the utilities as a result of its construction activities associated with this Contract.

7.3.6. Contractor's Equipment

Details of all Contractors' Equipment to be used in the execution of the Works shall be submitted to the Engineer prior to its use.

The Engineer's consent to use such Equipment will not be unreasonably withheld, but if, in the Engineer's opinion, circumstances arise which make it desirable that the use of the said

Equipment should be suspended either temporarily or permanently, the Contractor shall change the method of performing the work affected and it shall be deemed to have no cause for claims against the Engineer on account of having to carry out the work by another method, nor it shall be deemed to have cause for claim if any order issued by the Engineer results in the Contractor's Equipment having to stand idle for a period of any duration whatsoever or having to be removed.

In particular, where it is impossible due to the proximity of, and danger to, existing roads, structures, or services, to excavate except by hand methods, then in such cases it shall be deemed reasonable for the purpose of this Clause for the Engineer to withhold consent to use the Equipment.

7.3.7. Other Contractors on the Site

The Contractor shall make appropriate allowance for liaison and co-operation with other Contractors who may be working on the Site which may interfere with the Works under this Contract.

In case it is necessary for other contractors employed by the Beneficiary, and employees of the Beneficiary to work on and around the Site, such other contractors and employees may reserve areas for use (example: food defence activities and works by the Chief of Flood Defence orders). The Contractor shall not enter or use these areas without the prior written permission of the Engineer, unless such entry is permitted elsewhere in the Contract, and shall not obstruct access to such areas without having provided an acceptable alternative access.

The Contractor shall not interfere in any way with any works, whether the property of the Engineer or of a third party and whether the position of such works is indicated to the Contractor by the Engineer or not. The Contractor shall respect the construction and finish of works and articles supplied or installed by others and will be held responsible for any loss or damage thereto if caused by it, its employees or its subcontractors.

7.3.8. Subcontracted Works

The Contractor shall appoint subcontractors for the work for which the Contractor is not experienced, recognized or approved.

The Contractor shall submit for consent, the names of all proposed subcontractors and suppliers of special manufactured items with full details of the company, reference list and all other documentation needed for approval of the subcontractors and shall indicate the precise sections of the work for which each will be responsible.

The Contractor shall be solely responsible for the overall co-ordination of the Contract. Direct formal communication between its sub-contractors and the Engineer will not be allowed.

7.3.9. Materials in Stacking Yards

Considerable quantities of material shall need to be stored during the execution of the Works. The Contractor shall take all reasonable precautions to protect these materials from any damage including fire and theft and shall furnish evidence of the insurance cover in this respect.

For these materials, after the Engineer's control and approval, payment may be accepted and performed up to 80% of its value, as per Article 14.5 of the General Conditions of the Contract.

7.3.10. Method Statements

The Contractor shall provide, in writing, a description of the arrangements and methods it intends to apply for the execution of the Works.

Method Statements (MS) shall show in detail the methods proposed by the Contractor for carrying out the principal activities of construction in full safety. In particular, the Contractor shall indicate the resources (plant, personnel, materials) to be allocated, timing and sequencing, emergency/contingency measures, and any other information required to clearly detail the proposed methods. All necessary health and safety and environmental measures required shall be clearly indicated.

This will be supported by calculations for temporary works for supporting excavated faces and shuttering of concrete. Flowcharts, sketches and drawings shall be included if necessary.

Proposed MS will be submitted to the Engineer (also to the Beneficiary) for approval. The Engineer (in cooperation with the Beneficiary's representative) will review and provide its comments within 10 days. The Contractor shall make final corrections (if any) and submit them to the Engineer for final approval, 15 days before the commencement of relevant work. Written agreement shall be obtained before any work is commenced.

7.3.11. Provisional Time Schedule

The Defects Notification Period (DNP) shall be twelve (12) months under the Contract and shall commence after completion of the Works.

The Completion Period for all works under the Contract shall be eighteen (18) months.

The duration and sequence of the various activities constituting the Works may be varied by the Contractor to suit its own proposals for carrying out the works, subject to the approval of the Engineer, but no consideration will be given to any request by the Contractor to extend the Contract completion dates.

7.3.12. Standards on the Site

The Contractor shall purchase and keep on Site at least one copy of each of the relevant Standards, Codes and Manuals or approved National Standards which are referred to in the Specification. In addition, the Contractor shall keep on Site a copy of any other Standard, Code, Manual, or National Standard, which applies to materials supplied.

Copies of the standards shall be made available for reference at all times at the office of the Engineer.

Should the Engineer require an English or Serbian translation of any of the Standards or Manuals, the Contractor shall provide a translation within 7 days of receiving a written request from the Engineer.

7.4. MARKING THE ROUTE AT THE BEGINNING OF WORKS AND RECORDING INITIAL (“0”) TERRAIN STATE

The Contractor shall establish and provide, where necessary, benchmarks during the period of construction of the Works, which shall be checked periodically. The Contractor shall be solely responsible for carrying out these operations. It shall make the control points and benchmarks available to the Engineer together with the relevant records.

The Contractor shall provide the Engineer, for approval, with drawings showing the locations and levels or co-ordinates as appropriate of each and every temporary benchmark and survey station used for the setting out of the works.

The Contractor shall be responsible for constructing the works in accordance with the data on levels, benchmarks and other points of reference in the vicinity of the site(s) if they are not shown on the drawings.

The Contractor shall carry out marking of the object and boundaries of land intended for the construction site (expropriated area), and land for temporary occupancy (borrow pits, landfills, access ramps and other facilities related to construction works).

The control of this field work shall be carried out by the Engineer, but this control shall not relieve the Contractor of responsibility for the correct marking of works.

The Engineer can perform geodetic control, with due notice to the Contractor on the day and time of their geodetic control so that the Contractor could provide necessary small tools and supplies as well as auxiliary work force.

The duty of the Contractor shall be to:

- develop micro trigonometric network for all objects, which will be the basis for horizontal marking,
- develop hybrid networks for all objects, which will be the basis for all the height markings,

- in the field, bookmark all the main points and wasps of facilities beyond the reach of possible works,
- set up, secure and preserve and maintain all benchmarks, points and other surveying marks required in the performance of facilities, as well as for the execution and control of performed works.

7.4.1. Geodetic route marking

Items foresee marking (stakeout) route on-site prior to the commencement of works, the establishment of benchmark points along the route, recording of cross sections and built diagnostics by entering the data in the cadastre carried out by authorized institutions for this type of work.

Upon completion of the works, Contractor is obliged to submit a written certificate (in the Construction Log) to the Beneficiary on executed geodetic recording of built construction, issued by the authorized institutions (cadastral administration of property).

7.4.2. Recording of initial state

Before starting the works the Contractor shall:

- Based on the EmW Design and existing geodetic documentation, mark the design route, as well as cross sections for calculation. Cross-section profile for calculation should be done in line with the design. Cross-section profile density has to be greater at locations where deviations from the design have been identified. Marks and benchmarks must be clearly identified, so that they could be easily seen on the route in order to give the required orientation. Geodetic securing of points also needs to be carried out.
- record the baseline condition of profiles on the basis of which calculation of quantities will be made, and prepare *Survey technical documentation of initial terrain state*, along the route of works. Locations where the embankment is crossed by the existing infrastructure, must be recorded in detail and presented in the Survey “0” Tdoc.
- Any discrepancies must be certified by the Engineer. In case of any mismatching of Survey “0” Tdoc with the EmW Design, the Contractor shall immediately inform the Engineer, and this is to be notified in the Construction Log. If it is determined that there are significant differences in the amounts of necessary works, the Contractor is obliged to carry out adjustment of designed objects to the conditions on the ground, according to the plans that will be obtained from the Engineer. The calculation of the payment shall be made according to the actual quantities of the works performed.

- Calculation of the works will be done according to recorded cross-sections of performed work segment, based on comparisons with the accepted and signed by all parties (Engineer, Beneficiary and Contractor), Survey “0” TDoc and measurements noted in the Construction Book (ConstBook) and confirmed by the Engineer, Beneficiary and the Contractor.

7.5. DEMOLISHING AND PROTECTION OF WORKS

7.5.1. General

No demolition of any existing structure shall be carried out until it has been approved by the Engineer in writing.

The complete demolition shall be carried out including the foundations, unless otherwise specified in the design or directed by the Engineer.

7.5.2. Disposal of Demolished Materials

All materials arising from the demolition and clearance of the structures and other objects on the site shall be disposed of the Site, unless specified otherwise and instructed by the Engineer.

7.5.3. Backfilling and Finishing

All excavated holes shall be backfilled with soil compacted to the same density as the surrounding soil and the surface shall be finished to the existing ground level and to the agreement of the Engineer.

7.5.4. Protection of Existing Objects

The Contractor shall not demolish or remove any existing buildings, structures or other objects including trees, whether indicated on the Drawings or not, unless on a specific instruction from the Engineer.

The Contractor shall take every care and precaution to protect any of these objects from damage, including houses, buildings, fences or trees, which are situated on or near the Site(s).

Any property situated in close proximity to the Works shall be protected against any damage which could be caused by vehicles, subsidence, vibration, etc. Any damage caused shall be repaired by the Contractor to conform to the condition of the property prior to damage and to the agreement of the Engineer.

7.6. CLEANING THE FIELD, CUTTING OF TREES AND REMOVAL OF STUMPS

Before the start of works, marking of the border of work zone should be done, which includes:

- route of designed embankment
- work area covering the area surrounding the embankment with future service road in foreland (width 10 m)
- Cutting and removal of trees out of the work area, removing stumps from the track of embankment and future service road in foreland, cutting the stumps from the area surrounding the embankment in width of 10m.

Wood, cut, classified and properly stacked on the previously approved site, shall belong to the Contractor.

The Contractor is obligated to pay the prescribed fee for harvested wood.

Cleaning shall be done in accordance with the regulations.

The Contractor is obliged to execute harvest activities by hiring the licensed staff.

Wood must be properly cut, classified (firewood and technical wood) and temporarily stored outside the site on the area which will be provided by the Engineer - protected fenced area.

Burning of wood is not allowed.

The Contractor shall take all necessary protective measures.

After removal of trees and stumps the Contractor and the Engineer will perform recording, which will serve as a basis for determining the amount of the executed works.

7.6.1. Cutting of shrubs and trees up to 7cm in diameter, from the work area

Combined (manual and mechanical) cutting of shrubs and trees up to 7 cm in diameter, with the disposal aside, grinded for biomass;

Removal, out of work zone (loading, transport, unloading on the landfill - the distance up to 5.0 km);

7.6.2. Removal of wood and stumps from the work area

Cutting trees, into the logs no shorter than $L=2.05$ m;

- Disposal of trees on the side, removing them outside of the work area (loading and transport to the secured landfill up to 15.0 km);
- Machine stump removal;

- Loading, transport and unloading of trees and stumps, branches, deposit (trees and stumps are disposed in a controlled manner, and branches are grinded with the use of protective measures);

7.6.3. Protections

Trees and/or other vegetation to be preserved shall be kept out from the clearing operation and be protected from injury during execution of the Works.

7.6.4. Road Signalization

The Contractor shall uninstall road signalization (street lighting, traffic signs or traffic lights) that has to be removed during the progress of the Works.

Installation of the road signalization shall take place at its original location, in a condition at least equal to the one prior to removal and as soon as practicable after completion of the works at particular location.

7.6.5. Notice of Commencement

The Contractor shall give a written notice to the Engineer of its intention to commence the clearing and grubbing operations (Notice of Commencement).

The works shall not be commenced until written approval has been received from the Engineer.

The Contractor shall ensure that all clearing and grubbing are carried out far enough in advance of other construction operations within the relevant areas in order to avoid delays.

7.7. TECHNICAL REQUIREMENTS FOR EARTHWORK - CONSTRUCTION OF THE EMBANKMENT

7.7.1. General

The Contractor shall give a written notice to the Engineer of its intention to commence earthworks on any part of the Site at least seven days in advance, and shall provide the Engineer with all relevant documentation the Engineer may require for the purpose of carrying out measurements.

Earthworks shall not be commenced until written approval has been received from the Engineer.

Excavation will be controlled by geodetic surveying in the presence of the Engineer. All excavations must be brought up to the level envisaged in the design, which will be checked and accepted by the Engineer. All data must be shown in sketches, profiles and a sufficient number of measures in the construction book and must be certified by the Engineer.

Details of the excavation are defined in the design.

Within 5 days after receiving the plan of excavation, the Engineer shall approve or reject in writing the Contractor's plan, partly or entirely. In case of rejection of the plan, the Contractor shall submit a new plan for the excavation.

No excavation can start if the plan had not been approved and signed by the Engineer.

Control of the excavation and the amount of material is to be geodetically checked in the presence of the Engineer, and the Contractor is obliged to eliminate identified discrepancies.

In addition to work operations from the general description, the unit price for each item of earthworks shall also covers all working operations provided in the respective item.

7.7.2. Removing of humus

Removing of humus top soil is done before other earthworks. Humus is removed from the crown and slope of embankment to future defended and undefended feet of the newly designed embankment. Removing of humus will be performed by machine within the design specified thickness or by of the instruction of the Engineer.

Removal of humus can be done only after the required labelling.

The excavated humus is used to form the walls of temporary cassettes for dredged sand used for incoherent part of the embankment. Humus is moved to a temporary landfill at an approximate distance of 30 m or immediately outside the embankment base with newly designed defended side, in parallel with the designed route of the embankment, taking into account that a deposit is done within the expropriated zone.

Temporary humus landfills should be of appropriate geometric shape and compact enough to allow reception of dredged sand in the cassette. Protective film and other technical measures to prevent the endangerment of privately owned land must be applied.

The Contractor, on the basis of the technology of construction of drainage part, by installation of dredged sand from borrow pits of sand, defines the optimum number and arrangement of cassettes and ensures stability and waterproofing of cassette walls.

Where ordered by the Engineer, topsoil shall be stripped from the whole or a part of the Site to a depth of 30 cm or to such other depths as indicated in the Contract or such other depths and over such areas as the Engineer may direct, and set aside for re-use as a separate operation prior to any further excavation which may be required.

Topsoil shall include any surface material capable of supporting vegetation and suitable for use in soiling areas to be grassed or cultivated.

The Contractor shall not dispose of surplus topsoil without a written permission of the Engineer.

7.7.3. Trial Investigative holes

The Contractor shall excavate trial investigative holes it may require to determine the position of underground services, sub-soil drains or for any other reason.

The Contractor shall arrange refilling and reinstatement of trial holes immediately when the required information is obtained.

The reinstatement of the surfaces of trial holes shall be carried out upon the written approval of the Engineer.

7.7.4. Inspection by the Engineer

When the specified levels or limits of any excavation are reached, the Engineer will inspect the ground exposed and if it considers that any part of the ground is by its nature unsuitable the Engineer may direct the Contractor to excavate further.

Such further excavation shall be refilled to the specified levels or limits with concrete, selected excavated material or selected imported material.

Should the material forming the bottom or sides of any excavation, while acceptable to the Engineer at the time of inspection, subsequently become unacceptable due to its exposure to weather conditions or due to groundwater, flooding or moisture contents, the Contractor shall remove such damaged, softened or loosened material using approved methods and excavate further to a solid surface. Such further excavation shall be deemed to be additional Excavation works and material emanating therefrom shall be removed from the Site.

7.7.5. Crossing Watercourses

Where the excavation crosses streams, ditches, culverts and other watercourses, the Contractor shall be deemed to have allowed for all the additional measures necessary for the proper construction of the Works at these crossings including maintaining the full flow of water.

7.7.6. Levelling of the Areas

Areas around or on top of structures shall be levelled to the required levels as indicated on the drawings or instructed by the Engineer.

The Contractor shall take all due precautions to prevent any damage to the structures during the levelling.

The levelling of areas around structures shall be carried out by approved methods. Any damaged item shall be replaced or repaired at the Contractor's expense and to the agreement of the Engineer.

7.8. GROUND TREATMENT

Any ground treatment proposed by the Contractor to improve the bearing capacity and/or settlement characteristics of the soil must be supported by a full method statement and design calculations with a statement of the minimum performance to be achieved.

Where directed by the Engineer, the Contractor shall carry out a field trial investigations of the proposed treatment to demonstrate that it meets the stated performance criteria.

7.9. THE CRITERIA FOR ASSESSING THE QUALITY OF MATERIALS

Technology of reconstruction and construction works on the embankment is described in detail in Chapter 7.16 of this Technical Specifications (with schematic drawings).

The embankment involves spreading earlier hopped up materials, rough and fine planning, wetting and compaction of the material according to the dimensions given in the design.

All inorganic materials which satisfy the following criteria can be used for the embankment:

- Moisture content should be approximately close to optimal (according Proctor compaction test min 95%).
- Minimum dry bulk density (realized in the laboratory with the energy of 600 KN/m³) should be greater than 14.7 kN/m³, for the permitted load of the embankment vehicles during operation. Otherwise, it may be less.
- Air humidity should be less than 25%.
- Yield less than 65%, and plasticity index of less than 30%.
- Coefficient of permeability for coherent material built less than 10⁻⁷ m/s.
- The coefficient of uniformity $C_u = D_{60} / D_{10}$, ($C_u > 5$, uniform composition for coherent material), and ($5 < C < 15$ - moderately uniform composition, for incoherent material).

Proof of eligibility and testing materials conducted at each site changes in the quality and types of excavated material.

7.10. PREPARATION OF THE EMBANKMENT SUBSOIL

Rebating of subsoil is performed with the use of bulldozer rippers in a layer 30 to 50 cm thick, with compacting, using single drum padded vibrating devices. The compaction of the subsoil is carried out according to the current regulations and standards (SRPS U.E8.010 and mere U.E1.010). The results of compaction must be controlled by the Engineer, and further work is subject to approval by the Engineer. The calculation for performed work is done per m².

7.11. CONSTRUCTION OF THE EMBANKMENT

7.11.1. Excavation of material from the existing embankment body

This position includes the excavation of coherent materials from the existing embankment with transport to body of the embankment screen.

7.11.2. Construction of the embankment screen by coherent material

This position involves working with machines on spreading, coarse and fine planning, wetting and compaction of material from the excavation.

Filling is done mechanically, in layers of maximum 0.30 m.

In parallel with the filling, compacting of material from local excavation is done by appropriate means.

Filling is done according to profiles, altitudes and laid down inclines from the design.

The optimum thickness as a function of the number of crossings and the resulting compaction is determined on the test section. Details of test regime on the test section, such as the thickness of the layers and the number of crossings (depending on the type and characteristics of the machinery that will be used for building) are given in the following technical requirements:

If the material is not of appropriate moisture for filling, evenly spread layer should be dried or dabbled, in order to achieve optimum moisture (SRPS U.B1.038) for installation. Optimal moisture is confirmed by tests on a test section.

Each applied layer is compacted to the required compaction capacity $M_s=30$ MPa.

Control of incorporation into the body of the embankment consists of a visual inspection, field and laboratory tests.

Visual inspection shall be the control of: layer thickness, embedding methods, material homogeneity, impurities in materials, cleaning and wetting of the surface layers, roughening etc.

Field tests involve checking of realized compaction capacity of each of layers (30 cm high).

Previous laboratory tests involve checking a moisture content to define optimal (Proctor compaction test), and at last tests of realized Coefficient of permeability of embankment screen.

Delivery of materials is carried out on already completed and compacted part of the embankment. When there are heavy rains it is allowed to move around already built embankment.

Tamping of end edge of the embankment should be made with light rollers or handy machines. When working, the material must not be allowed to slip on already constructed

parts of embankments and slopes must be protected from erosion due to rainfall. Damaged parts of the slope need to be repaired and material re-incorporated by the same procedure as the main works. Embedding must achieve the necessary impact resistance. Compaction is carried out evenly over the entire width and length of embankments. Compaction of material should provide the necessary level of permeability.

Embankment slopes are particularly compacted, after removal of any excess material that is outside the profile of the embankment.

7.11.3. Construction of the embankment ballast by incoherent material

Dredging of sand into the prepared cassette in order to develop part of the embankment of the incoherent material and service roads in foreland consists of sand excavation in borrow pit, in the bed of the river Sava, with the use of dredge-sender/ re-fuller and transportation pipelines.

Through the pre-assembled steel pipes, with dredging pipes, sand with water (pulp) is pushed to the site into prepared cassettes, where the sand is precipitated from pulp, and the water still flows toward the outlets where it is evacuated into the channels or pumped into the river.

In addition to dredged material for the part of the embankment of incoherent material, material for making ramps on defended side of the embankment should also be dredged.

In addition to the above mentioned works, the unit price covers transportation, moving and installation of steel pipeline, construction of the pier on the coast and intervention in cases of evacuation of dredged water through the drain and maintaining of cassette with the use of bulldozers.

The Contractor, using technology of installation of dredged sand, from secured area of borrow pit, defines the optimum number and distribution of cassettes and therefore the optimal number and distribution of sites of temporary pier for vessels in the area of reconstruction of the embankment, as well as the length of piping, location and length of drainage canals.

7.11.4. Separation of incoherent material from cassette walls

Mechanical excavation of incoherent material for separation from the humus prisms and uniform depositing on the defended embankment slope in the amounts shown in the BoQ. In this way draining of dredged sand is provided.

This BoQ works item also covers making of slits in the body of the embankment and cassette on a distance determined by the Contractor according to its technology.

7.11.5. Profiling the defended slope of the embankment

Mechanical excavation is considered to encompass filling-profiling part of the embankment of the incoherent material using a bulldozer to the designed line of defended side of embankment. The crown and the slope of the embankment should be planned to the angle and slope defined in the EmW design and with possible deviations as defined in the design.

7.11.6. Humus coverage

Previously removed and deposited humus will be used for top soiling of the embankment body. Before the humus is returned, shallow grooving of the slope (10 - 20 cm) is done, at a distance of 1.0 m parallel to the axis of the embankment. Then, the humus layers 10-15 cm thick are applied. Top soiling is done from the bottom to the top of the slope.

After the topsoil is placed, light tamping shall be performed with the mechanical equipment. Until the grass is seeded, the surface humus must not be allowed to dry out. The final thickness of the humus cover is defined by the design (cross-sections). Finished surfaces must comply with the design.

During these works the Contractor is obliged to respect the marked boundaries of expropriation.

7.11.7. Grassing

Grassing should be performed after the top soiling and planning are done, according to meteorological conditions. The choice of species should be carried out according to local conditions, and the following mixture of grass seed is recommended for the treatment of an area of 1.00 ha:

Grassing of the embankment:

- Meadow bolt	15 kg
- Orchard	10 kg
- Trefoil	8 kg
- French ryegrass	8 kg
- Red clover	4 kg
<hr/>	
Total:	45 kg per 1 ha

If it is necessary to perform repair on grass-covered slopes, seeding of the grasslands should be done with a mixture of grass seed with the following composition:

- Orchard	7 kg
- Meadow bolt	2 kg
- Grass meadow	1 kg
- Smooth browengrass	4 kg
- French ryegrass	2 kg
- Red clover	2 kg
- Trefoil	2 kg
<hr/>	
Total:	20 kg per 1 ha

This measure applies only in those places where the density of original grassing is lower, and repair turf after major floods and prolonged droughts.

Reception of completed works shall be carried out by the Engineer.

7.12. BORROW PITS FOR MATERIAL

7.12.1. Borrow pit of coherent material for making the embankment screen

Note: Balance amount of coherent material for the embankment screen is included in the BoQ item/ B: Reconstruction of the embankment: B-I / 2.

Available amount of coherent material from the body of the existing embankment is not sufficient for the formation of the screen. Additional amounts of high quality coherent materials are provided:

1. From borrow pit under the existing body of the embankment, in the zone of the future ballast of the embankment (geological exploration works have demonstrated the quantity and quality of materials for installation in embankments screen). Substandard material was temporarily used in 2014 for the formation of temporary flood protection along the route or temporary protection embankment in the zone PS Kalenića Revenica.
2. From the small Flood protection dike on the crown (~2,0 m³/m), made during flood defence in March 2016.
3. From the borrow pit 15 km away, which has already been formed (on a cadastral plot provided by the Beneficiary).

The Contractor shall report the amount of extracted material, with an Elaborate on balance of recovered coherent materials.

After use, borrow pits must be cultivated in accordance with the given description of works (rough spreading, levelling with the falling for draining).

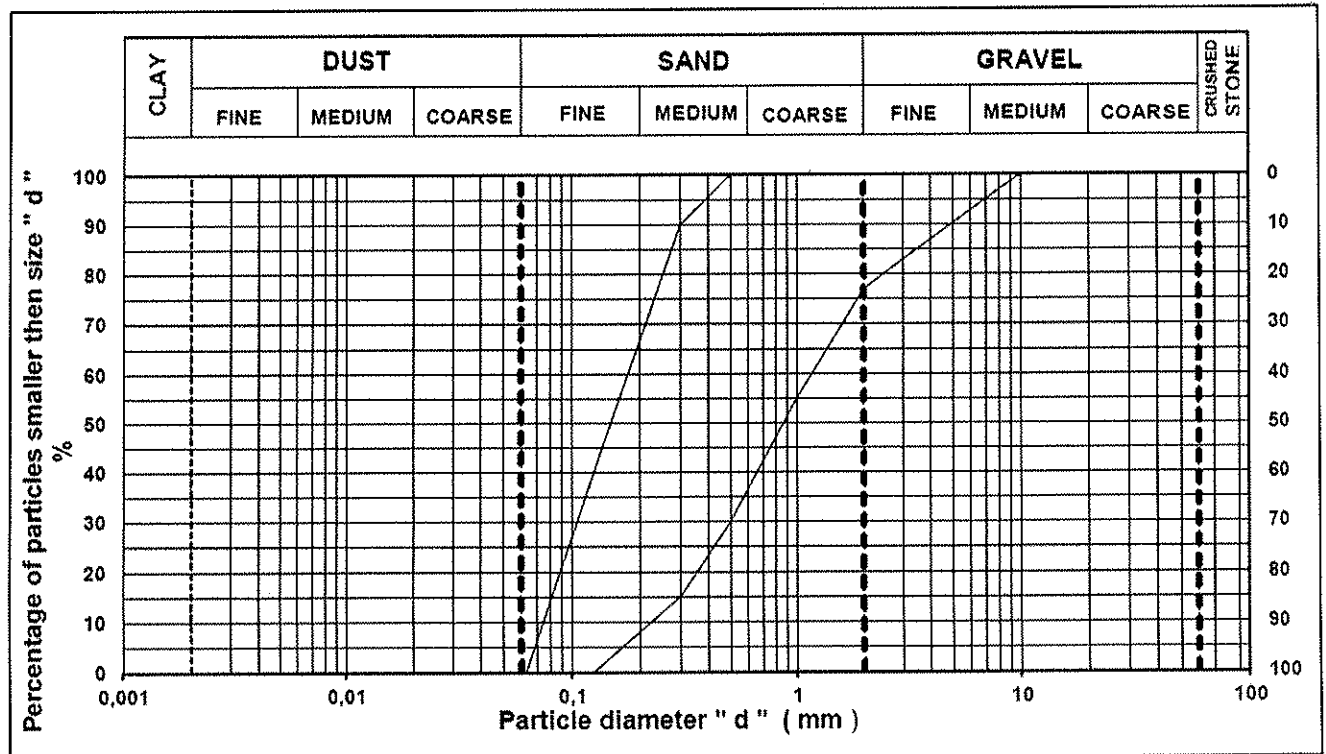
7.12.2. Borrow pit of incoherent material for making ballast of the embankment

Borrow pit of incoherent materials (riverbed of the Sava River):

1. The borrow from the riverbed with official permission provided by the Beneficiary (on next section of the river): 1. from km 113+000 to km 115+450; 2. from km 119+000 to km 120+200, from km 126+700 to km 129+000, or
2. Other borrow pit at a distance from the construction site - the route of embankment up to 10 km, for which the Contractor will provide the necessary permission according the Serbian Water Law and subordinate legislation: previous geological field investigation, survey, Technical documentation for dredging (made by licensed designer), obtaining permission from PWMK (the approximate period for implementation of the procedure: ~3 months)

Before using the borrow pits (1. and 2.), the Contractor must carry out surveying, control testing of representative samples of sediment material from the river bottom, and provide a written consent of the Engineer and Beneficiary for installation in the embankment ballast.

The installation of incoherent material of particle size distribution shall be approved in the range in accordance with the attached diagram of granulometric structure (enclosed in EmW Design).



After using the borrow pit from the riverbed, the borrow pit is geodetically recorded, built status is defined and the balance is constituted.

The Contractor is obliged to report the amount of extracted material, together with the Study on the balance of recovered materials.

The Contractor is exempted from the payment of compensation for the material extracted from the riverbed.

7.12.3. Geotextiles

The Contractor shall carry out the works described in accordance with the appropriate standards or equivalent local or international standards.

The materials shall comply with standards, but shall not be limited by the following:

- | | |
|-----------|-------------------------------|
| DIN 53352 | Mass per unit area |
| DIN 53354 | Break resistance / elongation |
| DIN 53363 | Tear strength |
| DIN 53854 | Density |
| DIN 53857 | Tensile strength |

DIN 53885	Compressibility
DIN 54307	Puncture strength
DIN 60500	Hydraulic properties of geotextiles
EN ISO 10319	Tensile strength (wide width)
EN ISO 10320	Identification of geotextiles at the construction site
EN ISO 10321	Tensile test on seams and joints by wide width method
EN ISO 10722	Damage to geotextiles during installation in grained material
EN ISO 11058	Water Flow (normal to plane)
EN ISO 12236	Static puncture strength (CBR)
ENV 12447	Resistance against hydrolysis
EN ISO 12956	Characteristic opening size
EN ISO 12957	Friction values
EN ISO 12958	Water flow capacity (in plane)
ENV ISO 12960	Resistance against liquids
EN ISO 13427	Abrasion test
EN ISO 13431	Tensile creep test
EN ISO 13437	Sampling and testing of geotextiles at the construction site
ENV ISO 13438	Resistance against oxidation

The applications of geotextile fabrics are divided into the following three main classes:

Drainage: under all rubble rip-rap, including cyclopean stone and under gabions; wrapped around drains, pipe joints, and edge-drains; filter behind walls, etc.;

Erosion Control: silt fence and staked silt barrier;

Stabilization: separator between embankment and soft subsoil, reinforcement and pipe bedding.

The geotextile shall be of the type appropriate for the intended use. The geotextile fabric shall be a woven or non-woven fabric consisting of long-chain polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamides or polyvinyl chloride formed into a stable network such that the filaments or yarns retain their relative position to each other. The base plastic shall contain stabilizers and/or inhibitors to make the filaments resistant to deterioration due to ultra-violet light (except for subsurface and stabilization classification), heat exposure and potential chemically damaging environment. The fabric shall be free of any treatment, which may significantly alter its physical properties. The edges of the fabric shall be salvaged or otherwise finished to prevent the outer yarn from pulling away from the fabric.

Synthetic filter fabric used for reinforcing grades (in water environments under block or rock covers) shall conform to the following specifications:

Fabric Properties	Requirements
1. Tensile Strength	min. 50 kN/m
2. Tensile Strength at 5 % elongation	min. 60% of tensile strength acc. to No.1
3. Elongation at max. load	max. 10%
4. Puncture resistance	min. 6 kN
5. Cone drop penetration	max. 8 mm
6. 10% fraction of pore size distribution	0.15 – 0.4 mm *
7. Permeability normal to plane	15 - 22 l/m ² /s *
8. Weight	min. 200 g/m ²

Synthetic filter fabric used as filter (protection of drainage pipes etc.) shall conform to the following specifications:

Fabric Properties	Requirements
1. Tensile Strength	min. 25 kN/m
2. Tensile Strength at 5 % elongation	min. 30% of tensile strength acc. to No. 1
3. Elongation at max. load	max. 25%
4. Puncture resistance	min. 2 kN
5. Cone drop penetration	max. 15 mm
6. 10% fraction of pore size distribution	0.4 – 0.5 mm *
7. Permeability normal to plane	100 l/m ² /s *
8. Weight	min. 120 g/m ²

*) Fabric material shall have a permeability and characteristic pore size as required by the specific need or directed by the Engineer. Generally, low porosity fabric shall be used at the toes of slopes and around inlets. High porosity fabric shall be used in drainage ways.

Fabric material shall have a minimum of 10 years of expected usable construction life at a temperature range of 0° to 40°C.

The Contractor shall furnish two certified copies of a test report from the manufacturer certifying that the geotextile to be incorporated into the completed project meets the requirements of this Specification. The certified test reports to be issued by the manufacturing company shall be attested by a person having legal authority. The Contractor shall also furnish two 100 x 100 cm samples of the geotextile for product identification and any onsite testing. In addition, the manufacturer shall maintain test records as required by this Specification. These records shall be made available to the Engineer on request.

The fabric shall be wrapped in a protective covering which is sufficient to protect it from sunlight, dirt, and other debris during shipment and storage. After it is placed, the geotextile shall not be left uncovered for more than 2 weeks. Traffic or construction equipment will not be permitted directly on the geotextile.

Torn or damaged geotextile shall be replaced or patched. The patch shall extend 1 m beyond the perimeter of the tear or damage.

Overlaps shall be as specified by the manufacturer or as directed by the Engineer. In order to reduce overlaps, the geotextile fabric may be sewn together. Seams of the fabric shall be sewn with thread meeting the chemical requirements and minimum seam strength requirements given for the fabric and application. Sewn seams shall be lapped a minimum of 10 cm and double sewn.

Non-sewn seams shall have a minimum overlap of 50 cm except where placed under water where the overlap shall be a minimum of 100 cm. All seams shall be subject to the approval of the Engineer.

The geotextile shall be placed and anchored on a prepared surface approved by the Engineer. The geotextile shall be laid loosely so that placement of the overlying materials will not stretch or tear the geotextile. Where geotextile is placed above water, the backfill placement shall begin at the toe and proceed up the slope.

Where geotextile is placed under water, the long dimension shall be placed parallel to the direction of flow. Successive geotextile sheets shall be overlapped in such a manner that the upstream sheet is placed over the downstream sheet. As the geotextile is placed under water, the backfill material shall be placed on it to the required thickness. The geotextile placement shall not progress more than 15 m ahead of the backfill placement.

Rip-rap, stone filling (heavy) or stone filling (medium) shall not be dropped onto the geotextile from a height greater than 0.3 m. Slope protection and smaller sizes of stone filling shall not be dropped onto the geotextile from a height exceeding 1 m.

If the above conditions cannot be met, a protective layer shall be placed on top of the geotextile (i.e. wire mesh, steel wire fabric used for concrete reinforcement, etc.). The surface upon which the geotextile is to be placed shall be within reasonable conformity to the proposed grade. The geotextile shall be laid loosely so that placement of the overlying material will not stretch or tear the geotextile. The overlying course shall be placed in 1 lift and compacted as approved by the Engineer.

The geotextile shall be placed to conform loosely to the shape of the trench.

After the filter material is placed, the geotextile shall be folded over the top of the filter material to produce a minimum overlap of 30 cm. The geotextile shall then be covered with the subsequent course.

7.13. FILLING

7.13.1. General

Extensive filling is hereinafter referred to as provision of the final ground levels (including slopes), which are shown in the design, or raising of ground levels at the required locations (taking into account the thickness of cover necessary for landscaping).

Back-filling is hereinafter referred to as backfill of excavations for structures or pipes.

Filling includes generally loading and transport of materials from intermediate stockpiles, placing of fill material in layers, adjusting of moisture content, compaction to the specified density and trimming of compacted surfaces.

No backfill work shall be carried out until approved by the Engineer.

7.13.2. Fill Materials to be provided by the Contractor

Except where otherwise specified, the Contractor shall be responsible for the location of suitable sources of natural materials for the execution of the Works, whether such sources are on the Site or not, and for obtaining all necessary permissions, including certificates of occupancy, quarry licenses and water rights.

Materials available on the Site or materials made available or supplied by the Employer shall be used for the execution of the Works if the quality of such materials is sufficient.

It is the Contractor's responsibility to obtain, transport and place materials when needed for the executions of the Works. The Contractor shall obtain the approval of the Engineer for the areas as well as for the materials he proposes to use.

Where specified or ordered by the Engineer, fill material for incorporation in the Works shall be obtained from approved borrow areas after the completion of any tests to confirm the suitability of the material.

Upon completion of excavation, the Contractor shall trim, grade and leave the borrow area in a tidy condition to the agreement of the Engineer and, if ordered, shall carry out without charge any further earthworks necessary to prevent accumulation of water in the area.

7.13.3. Fill Materials obtained from the Site Excavations

If the excavated materials are found to be appropriate for fill, these materials can be used with the approval of Engineer up to level excluding topsoil. If it is not sufficient, additional fill material shall be provided. Excavation materials shall be sorted and graded.

7.13.4. Preliminary Tests for Compacted Fill

If ordered by the Engineer, materials proposed for use as compacted fill (other than the materials previously excavated at the same location on the site) shall be tested on site in accordance with the procedures as prescribed in DIN 18196 to determine its characteristics and suitability.

7.13.5. Safety filling near the other structures

The Contractor shall arrange the timing and rate of placing of back-filling or of filling to structures in such a way that no part of the Works is over stressed, weakened, damaged or

endangered. The layers of material shall be so placed as to maintain adequate drainage and to prevent accumulation of water.

In particular, the placing of material around concrete structures shall commence only after they have been completed and have attained their full specified strength. The material shall be placed so as to exert a uniform pressure around the structures.

Regardless of the method of back-filling adopted, the Contractor shall ensure that back-filling to excavations is carried out to the agreement of the Engineer. The Contractor shall take all necessary precautions to ensure that no damage is caused to the Permanent Works or to adjacent structures.

Where backfill is to be placed on two or more sides of the structure, it shall be placed simultaneously on the opposite sides so that the difference in level never exceeds 0.30 m, or as otherwise instructed.

7.13.6. Back-filling of Excavations for Pipes or Cables

The bedding zone below, lateral and above the pipe or cable shall be filled and carefully compacted by a method approved by the Engineer to avoid change in alignment and level of the pipes or cables.

Unless specified otherwise, the excavation for pipes or cables shall receive a minimum layer of approved bedding material below the pipe or cable of depth in the trench according to EN 1610 but at minimum within the following range: 0.15 m (internal diameter of pipe up to and including 1.0 m or for cables); 0.2 m (internal diameter of pipe above 1.0 m). Lateral bedding shall be formed by spreading and compacting bedding material over the full width of the trench. Sufficient bedding material shall be provided to allow the pipes or cables to be worked into the bedding material and firmly supported to true line and level.

Sufficient space shall be left to enable the pipe joints to be made, tested and inspected and the Contractor shall ensure that at least three quarters of each pipe length is fully supported. Before any further filling, the pipeline has been tested and approved by the Engineer. Pipe trenches shall be carefully filled with bedding material. Unless specified otherwise for the specific pipe types, all pipes shall be covered by bedding material to a level of 0.3 m above the top of the pipes. Unless specified otherwise for the specific cable types, all cables shall be covered by bedding material to a level of 0.2 m above the top of the cables.

The bedding material for plastic pipes (PE-HD, PVC) shall be according to the manufacturer's requirements.

The bedding material for concrete and steel pipes shall consist of sand-gravel, graded 0/25 mm.

The bedding material for cable conduits and cables shall consist of sand, graded 0/2 mm.

The remainder of the trench shall be back-filled with approved selected material in accordance with the Contracting Authority's Requirements.

The difference in level of backfill on either side of pipes shall not exceed a maximum of 0.2 m. Backfill to structures shall generally be carried out as soon as practicable.

Embedding of pipes and cables includes the supply of bedding material, preparation of the bed, placing of embedding layers (not more than 0.1 m compacted thickness) and compaction either by hand or with appropriate machines to the specified density below and around the pipes. The embedding works shall be carried out in compliance with DIN EN 1610.

7.13.7. Stanks to Pipeline with granular material

When pipes are laid with granular material or backfill, a stank (which is an impermeable barrier designed to prevent groundwater flow along the trench) shall be provided across the full width of the trench and for the complete depth of the bedding. Fill between stanks shall not exceed 50 m intervals and shall be generally midway between manholes or thrust blocks. Stanks shall be provided at any points where pipe trenches pass through or into impermeable strata whose permeability is lower than that of the adjacent ground so as to form a restriction to the flow of groundwater. In these cases, the stanks shall be formed so as to restore the continuity of the impermeable or low permeability, stratum where it has been intersected by the trench excavation.

The stank shall consist of:

- a) 300 mm long plug of clay, clayey soil or other approved impermeable soil, or of a mixture of sand and bitumen, consolidated in an approved manner.
- b) layer of plastic sheeting, minimum thickness 1 mm, cut to fit around the pipe across the full width of the trench and laid of the granular bedding or fill material at the natural repose angle.

All methods must form an impermeable barrier.

Bitumen shall not be used for trenches containing thermoplastic pipes.

The cost of providing stanks shall be included in the Contractor's rates for pipe laying.

7.13.8. Back-filling of Excavations for Structures

Compacted fill shall consist of approved material, spread and compacted in layers approximately horizontal and of uniform thickness with a slight outward slope and of a compacted depth not exceeding 0.2 m after compaction.

Soil lumps larger than 0.1 m in size shall be broken before compaction. The moisture content of the soil shall be carefully controlled either by the natural drying or wetting with a fine spray before filling.

Compaction shall be carried out by mechanical rollers, power rammers, vibro-tampers vibrating plate compactors or other approved plant so as to produce the specified density determined in accordance with DIN 18126 or such other minimum dry density as may be otherwise specified or ordered by the Engineer.

Required Compaction for Various Fills:

Dry density of compacted fill 100% of the maximum dry density:

Dry density of compacted fill 95% of the maximum dry density according to DIN 18126:

Formation levels and pipe/cable bedding fills, Final backfill of trenches in general

Main Tests and Standards

The Contractor shall carry out all tests in accordance with SRPS standards.

The Contractor shall be responsible for the design, installation, maintenance during construction, and where appropriate, removal of all support works needed for trenches and other excavations (timbered walls with concrete or wood infill, sheet pile walls, etc.). The Contractor shall submit details of its proposal for excavation support to the Engineer for approval, which details shall include such drawings, calculations or other explanatory matter as the Engineer may require, but such approval shall not relieve the Contractor of its responsibilities under the Contract. No excavation work may proceed until the Engineer's approval has been given to the Contractor's proposals.

The Contractor shall not remove temporary works supporting the excavations until the Permanent Work is sufficiently advanced in the Engineer's opinion to permit such removal which shall be executed under the personal supervision of a competent foreman. Where the removal of excavation support works is considered by the Engineer to endanger existing structures thus making them liable to subsidence damage, the Contractor shall leave such support works in place, removing only the minimum necessary to allow the reinstatement of the surfaces.

Works for pit sheeting and bracing close to private or public properties, structures and utilities shall be carried out with low vibration and low concussion.

7.13.9. Temporary Sheeting and Bracing

The Contractor shall be responsible for the design, installation, maintenance during construction, and where appropriate, removal of all support works needed for trenches and other excavations (timbered walls with concrete or wood infill, sheet pile walls, etc.). The Contractor shall submit details of its proposal for excavation support to the Engineer for approval, which details shall include such drawings, calculations or other explanatory matter as the Engineer may require, but such approval shall not relieve the Contractor of its responsibilities under the Contract. No excavation work may proceed until the Engineer's approval has been given to the Contractor's proposals.

The Contractor shall not remove temporary works supporting the excavations until the Permanent Work is sufficiently advanced in the Engineer's opinion to permit such removal which shall be executed under the personal supervision of a competent foreman. Where the removal of excavation support works is considered by the Engineer to endanger existing structures thus making them liable to subsidence damage, the Contractor shall leave such

support works in place, removing only the minimum necessary to allow the reinstatement of the surfaces.

Works for pit sheeting and bracing close to private or public properties, structures and utilities shall be carried out with low vibration and low concussion.

7.14. LANDFILLS FOR DISPOSAL OF LOW-QUALITY MATERIAL

The material that is not suitable for embedding or is in excess from excavation shall be deposited. Depositing material from the excavation will be performed on surfaces which are defined in Bill of Quantities.

If the need arises, the Contractor may also undertake temporary depositing of excavated material at places determined by the Engineer, on the ground that is already expropriated.

Upon completion of works, or because the need for the temporary deposit of materials from the excavation ceased, the Contractor is required to drive all the remaining material to permanent landfills, and bring the place where temporary landfills were, into its original condition, or arrange it in the way determined by the Engineer.

Depositing of material must be conducted in such a way that landfills are always dried and planned. Slopes of the landfill and the landfill itself must be stable.

The arrangement of temporary landfill is not paid separately but is considered to be included in unit prices for excavation.

7.15. TECHNICAL REQUIREMENTS FOR ACCESS AND SERVICE ROADS

7.15.1. Formation and profiling of the access road

Removal of vegetation from the area of the future roads.

Creating a substructure of road of incoherent material, excavation, relocation of materials to the zone of the service road on the defended side, roughly spreading material in layers of 30cm in the area of service roads on the defended side, compaction evenly over the entire width with application of prescribed measures for achieving compaction: $M_s=40.0$ MPa;

Making the final layer of the road of CSA (crash stone aggregate) the width of 3.5 m; thickness $d=30$ cm.

Material must meet the terms of quality of all standards for this type of work.

7.15.2. Access road to PS KALENIĆ-REVENICA - surfacing asphalt concrete

Pavement of asphalt concrete over already made base layer in thickness and in the area given in the design, which includes provision of all plant, equipment, materials and labour and performing all operations in connection with the production, transport and placing the asphalt concrete.

For making of the pavement, asphalt concrete mark AB-16 is used, under the terms of SRPS U.E4.014 (1983).

Bitumen is used as a binder polymer (BIT 90 + 0.5% DOP for improvement of adhesion + 5% polymer).

7.15.3. Access road on the crown of downstream section of the reconstructed embankment - upgrading level and stabilisation of the embankment crown from Drenovac settlement

Results of hydraulic analysis within Expertise of Flood Event have indicated that the existing embankment needs to be upgraded, on the section from km 8+950 to km 18+030, which was reconstructed before the May 2014 flood wave. Access road also needs to be provided along the defence line from the access ramp in the area of Drenovac settlement until the section in question being reconstructed.

The optimal upgrading solution is to use coherent lower quality material excavated from the section under reconstruction (BoQ works item B-I/ 2.1.2.) with stabilization and homogenization technology by applying the approved recipe of binders, which improves the quality of this, previously unusable, material up to the necessary level to make it usable for the embankment upgrade (Chapter 7.16.3. of the Technical Specifications).

Available quantity of this material (BoQ works item) is sufficient for upgrading and stabilization of the downstream section of embankment in the length of 9.080 m.

It is necessary to previously remove the current layer of gravel from the embankment crown to the degraded service road in the defended area of the existing embankment, and to compact it.

7.15.4. Service road on the undefended side of the embankment - formation and profiling

The Contractor shall construct substructure of road of incoherent material that has to be created by excavation and subsequent relocation of material to the zone of service road on the river side of dike - undefended side, by roughly spreading the material in 30cm layers in the area of the service road (B=3,5 m).

Required compaction of layers is $M_s=30$ MPa, and the final layer of CSA stone with thickness of 30 cm and $M_s=40$ MPa.

Material must meet terms of quality of all standards for this type of works.

The slopes in the area surrounding the embankment have to be top-soiled and grassed in accordance with technical requirements for these works: top-soiling of service road slopes with exquisite humus from landfill.

7.15.5. Service road on the defended side - drainage carpet in the ballast of the embankment

The sub-soil has to be consolidated and further strengthened by using mechanization in order to construct the consolidated service road and multiple crossings on the defended side. Non-woven polypropylene geotextile has to be laid on a prepared subsoil service road (before making the final layer of sand and a layer of crushed stone), in accordance with the technical requirements for installation of these types of material.

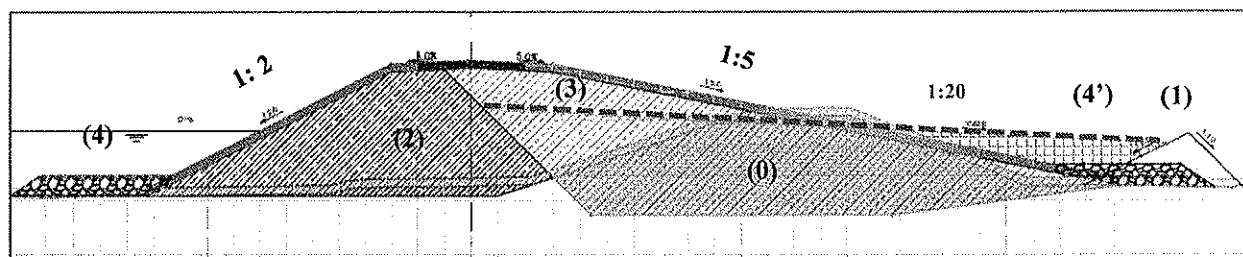
The drainage road substructure has to be constructed on the defended side (incoherent material is transported from the temporary landfill that is formed with the excavation material). This item (3.2) covers rough spreading of incoherent material transported from the temporary landfill. Required compaction of layers is $M_s=30$ MPa, and the final layer of CSA stone has to be 30 cm thick, with the compactness of $M_s=40$ MPa.

Material must meet all the requirements in terms of quality of all standards for this type of work.

The slopes of the area surrounding the embankment have to be top-soiled and grassed in accordance with technical requirements for these works: service road slopes have to be top-soiled with exquisite humus from landfill in the layer of $d=20$ cm thickness; longitudinal displacement (up to 20 m) of the deposited material (humus), spreading and planning of humus along the slope is needed.

7.16. TECHNOLOGY OF RECONSTRUCTION AND CONSTRUCTION WORKS ON THE EMBANKMENT AND ACCESS ROADS

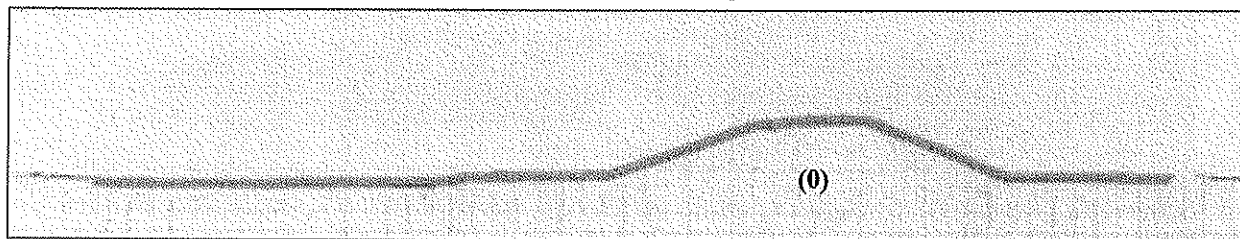
7.16.1. Technology of reconstruction and construction works on the embankment



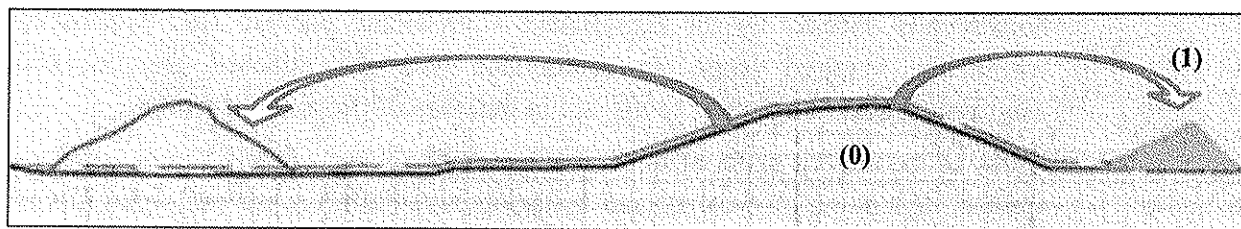
Schematic drawing No 1: Embankment cross-section (existing state, phase of construction, final state)

Schematic drawing 1 presents the embankment with a screen of coherent materials (2), using material from the existing embankment (0), ballast of incoherent material (3), made by dredging of sand/gravel from the river bed, with service roads ((4) and (4')) on both sides (the road on the defended side (3') with the function of drainage "carpet"). Also, position of temporary "wall" (1) of the cassette/reservoir for dredging sand/gravel and water mixture is shown (with temporary level slope of 1:20).

The process of reconstruction of the embankment on the right bank of the Sava River is given in the technological scheme, and consists of the following:

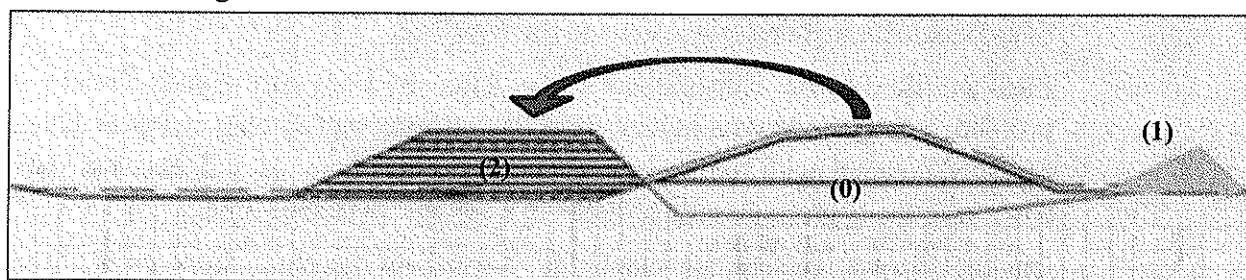


Schematic drawing No 2: Existing state cross-section



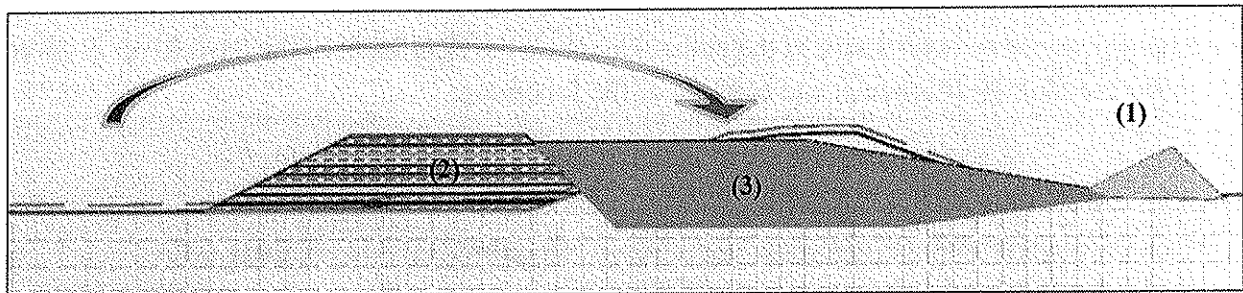
Schematic drawing No 3: Preparatory works

- Preparatory works intended for area surrounding the embankment, with clearing of vegetation.
- Construction of the temporary wall (1) of the reservoir/cassettes for the sand/gravel/water mixture: remove the topsoil from the existing embankment (0) by bulldozers in a layer of 30 cm and produce a wall of the removed topsoil with slope 1: 2 and 1: 1 and a minimum height of 0.80 m above the temporary level of dredged sand in the cassette.



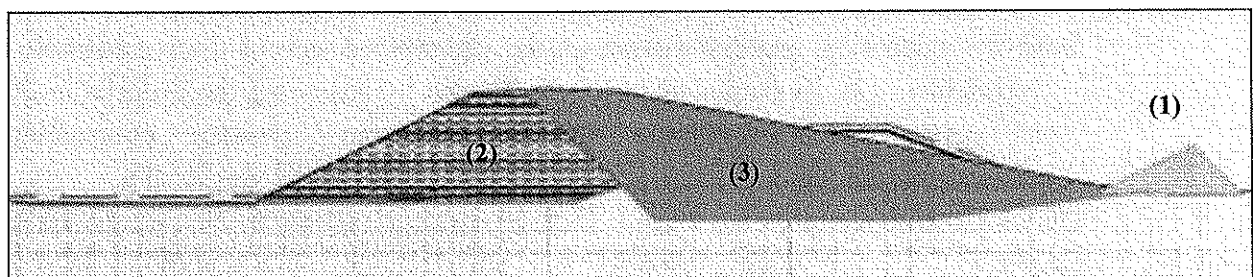
Schematic drawing No 4: Excavation and installation of the embankment screen

- Excavation of cohesive material of the hull of the existing embankment (0) from the defended side, and installation on the undefended side of the reconstructed embankment (2). Embankment screen is formed by spreading the material in 30 cm layers and compacting it by static or dynamic compacting mechanization/equipment, in order to achieve compaction of $M_s=30\text{MPa}$;



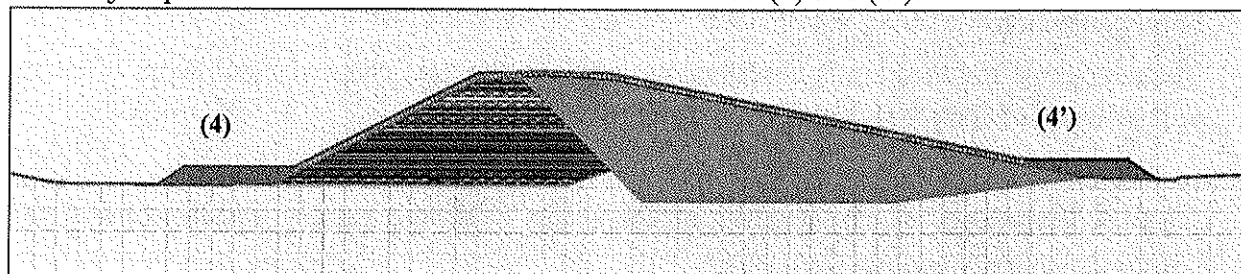
Schematic drawing No 5: Refilling of the incoherent material into the prepared area

- Excavation of incoherent material from the riverbed of the Sava river - from borrow pits defined by the Beneficiary - providing particle size distribution within the required range (in accordance with the attached granulometric diagram), transport by water to the site in the zone of the route of works.
- Cross of incoherent material in the ballast embankment (two different ways are applied, depending on weather and hydrological conditions and the possibility of vessels to access the coast in the area of the construction site):
 - a. Refilling incoherent material into the prepared barges of dredger from borrow pits in the minor riverbed of the Sava River.
 - b. Deposit on the coast in the zone of section of the reconstructed embankment, no further than 5 km from the place of installation. Loading, transportation of incoherent material in the pre-prepared cassettes/reservoir (3).
- After siltation (mixture of water sand/gravel) from the cassette, by gravity, the liquid product is returned to the river via specially constructed outlets in the hull of embankment and drainage canals to the river bed.
- Final profiling of the embankment body. After the body of the embankment is profiled, it is covered with humus from the cassette wall in a 30 cm thick layer. Surfaces covered with humus are planned with accuracy of ± 3 cm, and then sown with the appropriate mix of herbs in a suitable period of time.
- On the crown, surface pavement is formed of crushed stone-gravel and compacted up to $M_s=40$ MPa.



Schematic drawing No 6: Refilling incoherent material into the prepared area – full embankment body

The Project provides access routes and mutual service road (4) and (4'):



Schematic drawing No 7: Service roads on the both sides of the embankment body

7.16.2. Technology of construction of the access, service roads and loading ramps

Service roads on undefended sides of the embankment: To create a service road in foreland, filling of existing pits with incoherent material is envisaged, after removing the humus layer $d=20$ cm in the width of 3,5 m. Inclination of the service road body is 1: 2. Required compaction of layers is $M_s=30$ MPa, and the final layer of gravel - crushed stone thickness of 20 cm is $M_s=40$ MPa. Slopes of service roads are planned, covered with humus and grassed.

Service roads on defended sides of the embankment: Service road on the protected side is designed with a drainage function in the leg of the ballast: the removal of humus is envisaged in the width of 3.5 m, longitudinal and transversal levelling, installation of geo textile, forming the body of the drainage gravel surfacing and compaction to the prescribed value.

Access roads on the embankment section from km 18+030 to km 23+100: To create the access roads (construction site roads during the construction and during the exploitation of the construction, as well as access roads for maintenance and flood control) filling is envisaged, after removing the humus layer of $d = 20$ cm in the 3.5 m width, levelling and compacting.

Required compaction of layers is $M_s=30$ MPa, and the final layer of CSA stone is 30 cm thick and compacted to $M_s=40$ MPa. (supporting layer, $d=20$ cm will be made of CSA 0/63 mm and final layer, $d=10$ cm, will be made of CSA 0/31,5 mm).

For access to PS Kalenića Revenica, the existing road along the left bank of canal will be asphalted.

Access road on the downstream embankment section km 8+950 – km 18+030: For access road from Drenovac settlement on the crown of downstream section of the reconstructed embankment it is necessary to lift the level and stabilize the embankment crown. Technology of stabilisation is described in details in the next chapter. Final layer, $d=10$ cm, will be made of CSA 0/31,5 mm, compacted to $M_s=40$ MPa.

Access embankment ramps: Bodies of embankment ramps are formed by the coherent material (with the undefended side of the bank) or of the incoherent material (with the defended side of the bank). Final layer of slopes is made of humus with grassing.

Roadway surface of the access road to the crown of the embankment and access output section of the embankment crown is formed using technology of stabilization and homogenization.

Technology of stabilization is described in details in the next chapter. Final layer, d=10cm, will be made of CSA 0/31,5 mm, compacted to Ms=40 MPa.

7.16.3. Technology of construction of the access road and ramps: stabilization of the final layer of low quality material

Performance of works

Before the stabilization, the surface of earth material layer should be prepared.

Grinding is performed by specialized machine for soil stabilisation (with integrated equipment for soil homogenisation and stabilization – “in-situ cold recycling” mechanization). Depth of grinding and mixing with binder and compaction is determined in such a way that the projected layer depth of 30 cm is obtained.

Necessary quantity of binder per unit of surface is spread on the ground layer. Spreading is performed mechanically, by spreading machine, thus ensuring sufficient spreading uniformity.

Earth material and binder are mixed by machinery until homogenous mixture is obtained. Homogeneity of mixture is checked against colour uniformity.

Certain quantity of water is added during mixing, as necessary, or partial drying is performed in order to obtain optimal moisture.

Mixture is compacted immediately or after certain time, which depends on the type of binder and material, and it has to be determined by previous laboratory tests.

Compaction is performed by taper-foot rollers, pneumatic and smooth rollers until the required compaction uniformity is achieved.

If the stabilized layer is not quickly covered with another layer, it is necessary to moisturize it until it is covered, and minimum for 7 days. It is also acceptable to moisturize it for 3 days and to spray it with an anti-evaporation agent. Stabilization must not be performed when it is raining, at low air temperatures (below 5°C), as well as short time before the temperature drops below 0 °C. It has to be covered with an appropriate layer before winter.

Tests

Tests during stabilization of soil with lime included:

- Pre-tests
- Control tests

Regulations according to which tests are performed (SRPS):

- U.B1.010 - sampling,
- U.B1.012 - determination of soil Moisture Content,
- U.B1.014 - determination of Specific Weight,

- U.B1.016 - determination of Density,
- U.B1.018 - determination of Particle Size Distribution (diagram),
- U.B1.020 - determination of Atterberg borders,
- U.B1.024 - determination of combustible and organic material,
- U.B1.030 - determination of Compressive Strength of the soil,
- U.B1.038 - determination of Optimum Water Moisture Content,
- U.B1.042 - determination of California Bearing Ratio – CBR test,
- U.E9.026 - Construction of stabilized soil with the usage of lime and construction of the bearing layers for roads stabilized with lime
- EN 459-1 - construction lime – definitions, specifications and conformity criteria
- EN 459-2 - construction lime – test methods
- EN 459-3 - construction lime – conformity evaluation

Previous tests

Previous tests include:

- all previous tests of material components and preparation of the pre-working composition (the Binder Recipe) in laboratory conditions;
- transfer of the Binder Recipe to the stabilization mechanization, and determination of the necessary working mixture composition in the construction conditions;
- determination and adoption of technology of work on the tested section;

Transfer of results of the Binder Recipe to mechanization at the construction site.

When transferring results of the previous working composition to the machinery at the construction site, accurate weight ratios of dosing certain material components are determined.

When doing this, existing moisture of the basic material being used is taken into consideration in the way that only difference of water quantity necessary to have the mixture within prescribed moisture limits is added.

Samples of fresh mixture on which tests are performed are taken from test production with the aim to confirm requested stabilization characteristics. At least three samples of mixture are tested in order to control:

- particle size distribution
- uniaxial compressive strength with test tubes which are previously maintained for 7 days in wet chamber.

If during these tests results that match laboratory findings are obtained, stabilization can start.

In case that this compliance is not reached, necessary tunings are performed before the works start.

The person performing stabilization is obliged to maintain the adopted working

composition constantly while working on the construction site.

Determination of work technology on the test section

Necessary section should have the surface of minimum 600 m². Achieved compaction is determined on the freshly placed layer, before binding, at minimum four points for every single work stage.

Particle size distribution is controlled at these points. The test is performed at minimum two points, on samples made from the fresh mass and with uniaxial compressive strength, after the prescribed maintenance of 7 days in the moist area.

If the test shows that the quality, matching the one obtained in laboratory conditions is achieved, the work can be continued, if not - it is discontinued.

Control tests during work

These tests imply the following minimum of testing during construction performed by the Contractor as part of its Quality Assurance Programme:

- testing of compaction degree (in relation to standard Proctor procedure) of freshly placed layer on every 500 m²;
- testing of particle size distribution of mineral mixture composition on every 300 m²;
- testing of California bearing ratio CBR on every 500 m²;
- testing of compressive strength on test tubes made out of fresh mixture on every 1000 m² of constructed layer;
- constant control of uniformity, profile accuracy and depth of placed layer on every cross profile.

Requirements that the placed stabilization layer has to comply with

Placed layer of stabilized mixture must meet the following conditions:

- achieved degree of compaction must be minimum 95%;
- uniformity measured by 4 m long levelling rod or by other appropriate apparatus must be within limits of ± 3 cm;
- minimum California bearing ratio CBR must be 5%
- deviation of thickness of the performed layer must not be higher than ± 5 cm;
- minimum compressive strength after 7 days 0.2 MPa and after 28 days 0.3 MPa;
- constructed stabilization must show the necessary homogeneity in terms of achieved compaction.

Measurement and payment

Payment is made per square metre (m²) of lime stabilized layer of material, measured and accepted by the Engineer at the construction site. Quantity, determined in the previously described way, will be paid per the agreed unit price and per unit of measure, and this payment is complete compensation for the all work, equipment, tools and everything else necessary to perform the works above described in this chapter.

7.17. CONCRETE

After the Contract commencement, the Contractor shall submit for the Engineer's approval a Method Statement with proposals for organisation of the on-Site concrete works according to these Specifications.

The Method Statement shall include the following items:

1. Plants proposed.
2. Location and layout of concrete plant.
3. Proposed method of organisation of the concrete production facility.
4. Quality control procedures for concrete and concrete materials.
5. Transport and placing of concrete.
6. Details of formwork including striking times and procedure for temporary support of beams and slabs.
7. Protection and curing.

The quality of Concrete and its components has to be in accordance with the technical specifications and Standards:

- Regulation on technical measures and requirements for concrete and reinforced concrete (hereinafter PBAB);
- The RS Standards (hereinafter referred to as SRPS).

The Contractor is required to obtain a copy of all standards set forth herein and hold it on-site.

7.17.1. Type of Cement

The type of cement used shall be as specified in the design or as ordered by the Engineer. Sulphate resisting cement shall be used for all concrete in contact with sewage and drain water or subjected to moist air or atmosphere here from, unless otherwise agreed with the Engineer. Portland cement shall be used in all other concrete, unless otherwise agreed by the Engineer. The cement shall either be delivered in sealed bags marked with the manufacturer's name or in bulk consignments in a manner approved by the Engineer.

Before cement is ordered and delivered to the Site, the Contractor shall submit a detailed list of the sources, country of origin and manufacturer's brand names of the types of cement proposed for usage to the Engineer for its approval.

7.17.2. Quality of Water

The water used for all Works shall be potable, clean, fresh and free from objectionable quantities of silt, organic matters, alkali, salt or other impurities.

The water used for mixing concrete and mortar, washing of aggregates and for curing the concrete, shall be from an approved source and shall contain no deleterious matter which significantly affects the reinforcement, setting time, strength or durability of the concrete or

which has any effect on the appearance of the hardened concrete by discolorations or efflorescence.

The Contractor shall provide the Engineer, free of charge, with samples of the water proposed for use on the Works in order to enable the Engineer to carry out such tests as deemed required. Water samples will be delivered sufficiently in advance of the tests. The tests shall be carried out before the water is required for use and at such other times during the course of the Contract as the Engineer may direct.

If required by the Engineer, the Contractor shall, without extra cost, treat the water taken from any other source to such a degree as may be necessary in order to render it suitable for mixing concrete and mortar.

7.17.3. Aggregates

Aggregates for concrete shall be obtained from sources approved by the Engineer. Fine aggregates shall consist of natural sand unless otherwise approved.

Except as may be modified hereunder (fine and coarse) aggregates for all types of concrete shall comply in all respects with BS 882 "Concrete aggregates from natural sources". They shall be hard, strong and durable and shall contain no harmful material of sufficient quantity to affect adversely the strength or durability of the concrete or, in the case of reinforced concrete, to attack the reinforcement.

Fine and coarse aggregate shall comply with the following physical requirements:

- 1) The proportion of void forming hollow shells in fine aggregate and retained on a 2.36 mm BS sieve shall not exceed 3%.
- 2) The clay, fine silt and dust content shall not exceed the following limits:
 - Coarse aggregates 1% by weight
 - Natural sands 3% by weight
- 3) Fillers (for water tight concrete)
 - Fly ashes max. 2% of cement contents
 - Silica max. 2% of cement contents
- 4) The flakiness index and elongation index of coarse aggregates as measured in accordance with BS 812 shall not exceed 20% and 35% respectively.
- 5) The absorption of fine and coarse aggregates as measured shall not exceed 3% by weight.
- 6) The aggregate impact value for coarse aggregates as measured shall not exceed 30%.
- 7) Fine aggregates shall be clean, sharp, coarse naturally occurring sand
- 8) Coarse aggregates shall be obtained by mechanical crushing and screening.
- 9) Fine and coarse aggregates when tested in accordance with ASTM-C88, using Na₂S₂O₄ solution, shall show a loss not greater than 10% or 12% respectively by weight.

Fine and coarse aggregates shall comply with the following chemical requirements:

- 1) Fine and coarse aggregates shall not contain more than 0.10% and 0.05% respectively by weight of chlorides (as NaCl). If either material exceeds the above limits the material shall still be acceptable in this respect provided the total sodium chloride concentration in the mix complies with Paragraph “Concrete Mix Design”.
- 2) Fine and coarse aggregates shall not contain more than 0.40% by weight of acid soluble sulphates (as SO₃).
- 3) Coarse aggregates shall be a minimum of 85% by weight calcium carbonate.
- 4) fine and coarse aggregates shall not be potentially reactive with alkalis.

If this requirement cannot be met the Contractor shall adopt constituents for its concrete such that either:

- 1) the cement material shall have a reactive alkali content not exceeding a maximum value of 0.6% by mass when defined and tested in accordance with the method prescribed, or
- 2) the total mass of reactive alkali in the concrete mix shall not exceed 3 kg per m³ of concrete when defined, tested and calculated in accordance with the method prescribed.

The Contractor shall notify the Engineer of its proposals for complying with this requirement at the time of commencement of the Works.

If, in the Engineer's opinion, the aggregates fail to comply with, or if there are doubts as to the uniformity of their compliance with the specified requirements, it will order all aggregates to be washed before use in the Works. When washing is ordered, it shall be done by using water of the quality specified in Paragraph “Water” and using methods and plant approved in advance by the Engineer and all costs shall be paid by the Contractor.

The Contractor's attention is drawn to the fact that it may be necessary to combine two or more fine aggregates, or remove some fractions by hydraulic classification, in order to achieve the grading as specified.

The maximum size of aggregates required will not normally exceed 40 mm. At least four separate size ranges of aggregate are required as follows:

- fine aggregate: 8 mm
- coarse aggregate, nominal size: 16 mm
- coarse aggregate, nominal size: 32 mm
- coarse aggregate, nominal size: 40 mm (Mass Concrete)

Each size of fine and coarse aggregate shall be stored in separate bins or on areas covered with steel plate, concrete or other hard and clean surfaces, which shall be self-draining and protected from contamination by earth or other deleterious matter.

Fine and coarse aggregates shall be stored in such a way so as to avoid the two materials from becoming intermixed.

The Contractor shall provide the Engineer with samples of the fine and coarse aggregates proposed for use in the Works. Samples shall be of a size sufficient to carry out all

preliminary tests specified which the Engineer may order in addition to the concrete tests specified for the Concrete testing, and to provide a 50 kg sample for comparison purposes described below. The samples shall then be tested in the presence of the Engineer by the Contractor in accordance with the Specification or the Engineer's request.

If the source of aggregates is changed at the Contractor's request and with the approval of the Engineer at any time during the course of the Works, all sampling and testing described in the relevant Paragraphs shall be repeated at the Contractor's expense.

After approval has been given for any particular aggregate, a sample weighing at least 50 kg of the approved aggregate shall be retained by the Engineer as a standard against which all future samples shall be compared.

During the course of the Contract, fine and coarse aggregates shall be tested at the Site as often as required by the Engineer and at the Contractor's expense.

All concrete work will be carried out fully in accordance with the Final Design, Structural Analysis and applicable regulations and standards.

The EmW Design will define concrete quality, separately for each Structural Analysis item, including crushing strength after 28 days (C) and class of concrete, frost resistance, as well as number of test samples for each Structural Analysis item, provided that the Contractor will be obliged to fully observe the above stated.

Natural aggregate mixture will be used for concrete C12/15 at the maximum; all other concrete quality will be made from separated aggregate, which will be comprised under the unit price.

The concrete will be mixed mechanically from aggregate, cement and water, subject to the Engineer's approval, following the prevailing regulations:

MATERIAL	ICS Number	Standard Number	Year	TITLE
Cement	91.100.10	SRPS B.C1.011	2001	Cement - Portland cement, Portland composite cement, blastfurnace cement, pozzolanic cement, composite cement - Definition, classification and technical conditions
		SRPS B.C1.012	1996	Cement - Delivery, packing and storage density
		SRPS ENV 196-4	1995	Methods of testing cement - Quantitative determination of constituents
		SRPS ENV 197-1	1997	Cement - Composition, specifications and conformity criteria - Part 1: Common cements
Natural and crushed aggregate	91.100.15	SRPS B.B2.009	1986	Raw materials for production of aggregates for concrete – Technical requirements
		SRPS B.B2.010	1986	Aggregate for concrete – Technical requirements
		SRPS B.B3.100	1983	Crushed aggregates for concrete and asphalt
		SRPS B.B8.040	1982	Crushed aggregate for concrete and mortar - Examination of aggregate with organic impurities
		SRPS B.B8.042	1984	Natural and crushed aggregate - Chemical analysis of

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	91.100.30	SRPS U.M1.057	1984	Concrete - Grading of aggregate for concrete
Water	91.100.30	SRPS U.M1.058	1985	Concrete - Water for making concrete - Technical requirements and testing methods
Admixtures for concrete	91.100.30	SRPS U.M1.034	1996	Concrete - Admixtures for concrete - Definitions and classification
		SRPS U.M1.035	1996	Concrete - Admixtures for concrete - Quality requirements and testing
		SRPS U.M1.037	1981	Concrete - Admixtures for concrete - Previous testing

The aggregate has to be clean, without organic impurities, or earth (acceptable up to 2% by weigh), otherwise the aggregate has to be washed.

The Contractor will be under obligation to present evidence on quality of material used for concrete manufacturing (cement, aggregate, water).

The concrete quality and executed works have to be in accordance with prevailing regulations:

ICS Number	Standard Number	Year	TITLE
91.100.30	SRPS ISO 2736-1	1997	Concrete tests - Test specimens - Part 1: Sampling of fresh concrete
	SRPS ISO 2736-2	1997	Concrete tests - Test specimens - Part 2: Making and curing of test specimens for strength tests
	SRPS ISO 4012	2000	Concrete - Determination of compressive strength of test specimens
	SRPS ISO 4013	2000	Concrete - Determination of flexural strength of test specimens
	SRPS ISO 4109	1997	Fresh concrete - Determination of the consistency - Slump test
	SRPS ISO 4848	1999	Concrete – Determination of air content of freshly mixed concrete – Pressure method
	SRPS U.M1.051	1987	Concrete - Production control in the concrete plants
	SRPS U.M1.021	1997	Concrete - Classification by compressive strength
	SRPS U.M1.055	1984	Concrete - Method of test for resistance of concrete against freezing
	SRPS U.M1.015	1998	Concrete – Concrete, hardened – Determination of the depth of penetration of water under pressure
	SRPS U.M1.016	1992	Concrete - Method of test for resistance of concrete against freezing and thawing
	SRPS U.M1.045	1987	Transport and delivery of ready-mixed concrete
	SRPS U.E3.050	1981	Prefabricated concrete units - Technical requirements for manufacture and installation

The Contractor will be under the obligation to prepare design documentation for the concrete works fully in accordance with the article 232 of the Rules on concrete and reinforced concrete (BAB 87) and to deliver for the Engineer's approval.

The concrete works will be executed by qualified work force only, respecting technical specifications and prevailing regulations, national and international standards for such type of works.

Prescribed number of samples will be tested by an accredited testing laboratory at the Contractor's expense. The Engineer will be entitled to request additional sample testing, up to the maximal number of samples foreseen under the regulation, free of any additional expense on its side. Should the Engineer request additional sample testing, exceeding the maximal number of samples foreseen under the regulation, then in case of unsatisfactory test results expenses will be borne by the Contractor.

Concreting will not commence prior to the inspection and acceptance of the reinforcement by the Engineer.

Only plain concrete casting will be done manually in 5-15 cm layers, the reinforced concrete casting will be done mechanically with vibration, provided that vibration equipment will be in accordance with the type of structure, subject to the Engineer approval.

Prices cover fully completed work per unit measure, except the price for fabrication of the reinforced and prestressed concrete, where reinforcement and cables will not be included in the concrete price.

Contractor procures the form material, which shall remain in its possession upon use. During reuse, material must be cleaned from concrete, dirt, etc. Prior to concreting, plate must be wetted well. Form, supports and scaffolding are not paid separately, but are included in concreting unit price.

CONCRETE CLASSIFICATION FOLLOWING NEW SRPS U.M1.021

ICS Number	Standard Number	Year	TITLE
91.100.30	SRPS U.M1.021	1997	Concrete - Classification by compressive strength (neq ISO 3893:1977)

The common regulation for concrete in the Republic of Serbia is “the Regulation for Concrete and Reinforced Concrete” (always referred to as: “BAB87”), meanwhile, applying newly introduced 1997 standard SRPS U.M1.021 (Concrete - Classification by compressive strength - ISO 3893:1977) and “BAB87”, certain discrepancies appear. The newly introduced standard SRPS U.M1.021 refers to EUROCODE 2 and EN 206 and subsequently defines 28 days compressive strength [N/mm²] using, either a cylinder Ø15 cm / 30 cm test sample, or a 15 cm cube test sample, compared to the 20 cm cube test sample usual and prescribed for “BAB87”.

Please find below a table presenting and emphasizing such discrepancies:

“MB” following ”BAB 87”	Concrete Classes following EUROCODE 2 & EN 206	28 days Compressive Strength [N/mm ²]	
Cube 20 cm	C [Cylinder Ø15 cm / 30 cm] / [Cube 15 cm]	Cylinder Ø15 cm / 30 cm	Cube 15 cm
MB 10	C 8/10	8	10
MB 15	C 12/15	12	15
MB 20	C 16/20	16	20
MB 25	C 20/25	20	25
MB 30	C 25/30	25	30
MB 35	C 30/37	30	37
MB 40	C 30/37	30	37
MB 45	C 35/45	35	45
MB 50	C 40/50	40	50
MB 55	C 45/55	45	55
MB 60	C 50/60	50	60

7.17.4. Formwork

Formwork for concrete shall be rigidly constructed of approved materials and shall be true to the shape and dimensions. Formwork shall be constructed of material or lined with materials as may be necessary to achieve the finishes specified in this section. The formwork design shall be submitted to the Engineer for approval before construction commences.

All material brought onto the Site as forms, struts or braces shall be new materials.

Faces in contact with concrete shall be free from adhering grout, projecting nails, splits or other defects. Joints shall be sufficiently tight to prevent the leakage of cement grout and to avoid the formation of fins or other blemishes.

Formworks for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimension of panels vertical and all joints aligned, in accordance to PBAB/87.

If openings of the formwork for the escape of water used for washing out are made, they shall be formed so that they can be conveniently closed before placing the concrete.

Connections shall be constructed to permit easy removal of the formwork and shall be strong enough to retain the correct shape during consolidation of the concrete.

Metal ties or anchors within the form shall be so constructed as to permit their removal to a depth of at least 50 mm from the face without injury to the concrete. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left shall be of the smallest possible size. Spreader cones or ties shall not exceed 25 mm in diameter.

Before any concrete is placed, forms shall be properly cleaned by washing out with water and/or air under pressure to remove sawdust, shavings, metal and other foreign matter. All water shall then be drained and mopped out from the formwork. In no case shall concrete be

placed in the forms until such forms have been approved by the Engineer. Such approval shall not relieve the Contractor of its responsibility for the formwork.

Details of any fixtures to be cast into the concrete shall be approved by the Engineer. No fixtures shall be attached to the concrete by shot-firing without prior permission of the Engineer. Notwithstanding any such authorisation, the Contractor shall take full responsibility for any damage caused to the structure and make good to the agreement of the Engineer.

Shuttering shall include all temporary moulds for forming the concrete together with all temporary constructions required to support such moulds.

The Contractor shall bear the sole responsibility for the safety and stability of the forms, scaffolds etc., and in case of collapse, excessive deflections, buckling and/or any other changes in shape, the damage shall be repaired by the Contractor at its expenses.

7.17.5. Placing and compaction of concrete

Mixing, placing and curing of concrete shall be made in accordance with PBAB/87 and relevant RS standards.

a) Preparatory work

The Engineer's approval in writing shall always be obtained before any concrete is placed in the Works. All constructional plant and materials required, or which may be required during the concreting work and for curing shall be on site and the Contractor shall be fully prepared for the work. The Engineer's approval to place concrete shall only be given after such preparations and other relevant requirements of the Technical Specifications have been carried out and complied with.

b) Concreting

The methods of conveying and depositing concrete shall be such as to prevent segregation of the materials and shall be approved by the Engineer before concreting begins. The placing and compaction of concrete shall be carried out under the direct supervision of a competent member of the Contractor's staff.

Concrete shall be placed directly in the Works as soon as possible without the need for re-handling and not more than 45 minutes after mixing and, in any case, before the initial setting has taken place. If any delay has occurred after mixing and the concrete has begun to set, it shall not be used in the Works and shall be removed from the site. Unless otherwise agreed by the Engineer on the basis of satisfactory site trials, concrete shall not be dropped into place from a height exceeding 1.5 m.

Concrete shall be deposited in approved quantities and horizontal layers of such depth as to permit thorough incorporation with the layers below by vibration, spading, ramming and

working. If, for unforeseen reasons, it is necessary to stop concreting before completion of a section, then construction joints as specified shall be formed and further concreting shall be suspended for at least 24 hours.

Concrete shall not be placed under water without the written approval of the Engineer. The Contractor shall submit its detailed proposals of the plant and method for underwater concreting.

The method of placing concrete under water shall be such as to keep as much as possible of the concrete being placed out of direct contact with the water so as to avoid any rapid movement or agitation of exposed surfaces. The work shall, where possible, be carried out in one operation.

Where this is impracticable, laitance, washed out aggregate or foreign matter which may have accumulated on the previously placed concrete shall be completely removed prior to additional concrete being placed. This concrete shall then be placed directly on the cleaned surface.

During and after concreting underwater, pumping or dewatering operations in the immediate vicinity shall be suspended until the Engineer permits them to be continued.

c) Concreting in hot weather

The Contractor shall take great care during hot weather to prevent the cracking or crazing of concrete. The Contractor shall arrange for concrete to be placed in the early morning or late evening as directed by the Engineer.

The Contractor shall pay particular attention to the requirements specified herein for curing. Formwork shall be shaded from direct exposure to the sun both prior to placing of the concrete and during its setting. The Contractor shall take appropriate measures to ensure that reinforcement in the section to be concreted is maintained at the lowest temperature practicable.

Concrete at placing shall have a temperature of not more than 32°C. If necessary, the Contractor shall cool the aggregates and mixing water by methods approved by the Engineer. Where necessary, the Contractor shall design, install and operate a cooling system by which cooling water is pumped through a piping system in order to decrease the heat of hydration during concreting. The proposal for such a cooling system shall be submitted to the Engineer for approval well in advance of the concreting operations.

The temperatures of ambient air, concrete at various levels and intervals not exceeding 5 m and cooling water where applicable shall be measured by means of thermocouples and recorded.

d) Concreting in cold weather

Cold weather is defined as the situation existing at the Works, where either or both of the following conditions existing:

The air temperature at the time considered is below 2°C

The mean daily air temperature over three or more successive days has dropped below 5 °C.

Under no circumstances may concrete be placed in contact with frozen ground or formwork, or in contact with ice, snow or frost on the ground or on formwork or reinforcement. Concrete shall not be made with frozen materials.

Concreting may proceed in cold weather provided that special precautions are taken to ensure that the surface temperature of the concrete at the time of placing is not less than 5°C for a succeeding period of at least:

- 4 days when the cement used in the concrete is ordinary Portland cement
- 4 days when the cement used in the concrete is rapid hardening Portland cement.

Such precautions may include the following:

- Warming the aggregates and heating the water, provided that the temperature of either does not exceed 60°C. Water and aggregates shall be mixed for a period sufficiently long for them to acquire a uniform temperature before cement is added.
- Completely surrounding the freshly placed concrete with a cover and heating the enclosed air, which shall be kept moist. Draughts of hot or dry air shall not be directed at surfaces.
- Insulating the formwork and finished concrete surfaces.
- Providing screens to protect the concrete from air currents.

The Contractor shall provide the Engineer with details of the precautions it proposes to take to protect the concrete from the effects of low temperatures and with details of the methods it proposes to use to assess the correct timing at which such protection may be removed. No concreting shall be done in cold weather prior to the approval the Engineer for the proposed measures.

e) Compaction of concrete

The Contractor shall regard the compacting of the concrete to be of fundamental importance. A watertight concrete of maximum density and strength shall be obtained.

Concrete shall be thoroughly compacted during the operation of placing and shall be thoroughly worked around the reinforcement and embedded fixtures and into corners of the formwork and moulds.

Mechanical vibrators shall be of the immersion type with a frequency of not less than 6000 vibrations per minute and as approved by the Engineer. A sufficient number of vibrators shall be used to handle the maximum rate of concrete production with a 50% allowance for standby units during any period of concreting. All operators handling vibrators shall be trained in their operation.

Every care shall be taken to see that reinforcement and fittings attached to the shuttering are not disturbed and that no damage is caused to concrete that has already set or to the internal face of the shuttering by using immersion type vibrators. In areas of congested reinforcement, it may be necessary to use small diameter pokers and the Contractor shall supply suitable sizes of pokers for each part of the work. Vibration of concrete by hammering the shuttering with hand tools shall not be permitted.

The duration of vibration shall be limited to that required to produce satisfactory compaction without causing segregation. Vibration shall not be continued after water or excess grout has appeared on the surface.

f) Protection and curing of concrete

Concrete shall be protected from damage by climatic conditions (direct sunlight, rain, snow or frost), running water or mechanical damage during curing. All methods to be used for curing and protection of freshly placed concrete shall be subject to the prior approval of the Engineer.

The maximum and minimum ambient temperatures and humidity shall be measured and recorded each day by the Contractor. The records shall be made available for the Engineer's inspection.

As finishing proceeds, all exposed surfaces shall be covered with a wet hessian sheet followed by a reflective polythene sheet. These shall be securely fastened around the edges and supported in order not to damage the finished concrete surface. As soon as practicable, the hessian and polythene shall be lowered into close contact with the concrete and securely weighted or fastened down to prevent wind blowing underneath. The hessian sheet shall be maintained in a moist condition at all times and shall be inspected at intervals not exceeding 6 hours. Concrete shall be kept moist on exposed surfaces for a period of not less than 10 days or as approved by the Engineer.

During very hot weather conditions, the Contractor may be required to cool formwork containing concrete by spraying with water. This shall be carried out where directed notwithstanding and whatever other measures the Contractor may have employed for the curing of the concrete.

7.17.6. Remedial treatment of concrete surfaces

Any remedial treatment to concrete surfaces shall be agreed with the Engineer following inspection immediately after the stripping of formwork and shall be carried out without delay. Any concrete surface which is found to have been treated before inspection by the Engineer shall be rejected.

Any minor surface blemishes shall be repaired to the agreement of the Engineer immediately after completion of curing.

7.17.7. Penetrating sealants

In order to achieve high quality characteristics of visible surfaces of newly constructed hydraulic concrete components (head and wing walls) inlet RC structures, susceptible to the impact of frost and abrasion from drifts and coarse objects, penetrating sealants should be applied. Application of penetrating sealants helps the following characteristics to be achieved: increase of concrete surface hardness, concrete pressure resistance, concrete surface resistance to wearing and abrasion, in addition to enhanced adhesion potential of concrete surface for other finishing coatings.

Penetrating sealants should be applied entirely in accordance with manufacturer's instructions, including preparation of the new concrete surface (or surface of old cleansed concrete).

- All concrete surfaces which are to be treated with penetrating sealants should be meticulously cleansed. Paint, glue, oil and grease should be removed either by scraping, rinsing or other environmentally friendly chemical procedure.
- Fill damages – cracks and ruptures. Remove residue. (fine cement particles on the surface of the fresh concrete – due to moving of water towards the surface in the case when larger quantities of water are being used for preparation of the product).
- Remove salt residue. (powdery layer of degradable salt crystals on the new concrete after evaporation of the surface water)
- Remove visible dust and earth.

Once the formwork is removed (after 24hrs at the most), immediately soak the surface with penetrating sealant. In this case, it is essential to remove all remaining oil, originating from formwork or moulds.

The second coating of penetrating sealant should be applied after 24hrs.

Prior to application of penetrating sealants, the Contractor is obligated to provide the Engineer with relevant certification documents and get its approval.

7.17.8. Admixtures

Depending on weather conditions and in order to achieve high quality characteristics and impermeability of placed concrete, admixtures, accelerators retardations, ductility enhancers or combination of admixtures should be used, of the quality equivalent to admixtures of the quality L20, L10, BV, hyper, LPA.

Admixtures application should be entirely in accordance with manufacturer's instructions.

Prior to application of admixtures, the Contractor is obligated to provide the Engineer with appropriate certificate.

7.18. REINFORCEMENT WORKS

The Contractor shall carry out the works described in accordance with the appropriate standards or equivalent local or international standards.

ICS Number	Standard Number	Year	TITLE
91.080.40	SRPS EN ISO 15630-1	2008	Steel for the reinforcement and prestressing of concrete - Test methods - Part 1: Reinforcing bars, wire rod and wire
	SRPS EN ISO 15630-2	2008	Steel for the reinforcement and prestressing of concrete - Test methods - Part 2: Welded fabric

The works included in this section of technical descriptions, consist of the acquisition of machinery, equipment, materials and labour and performing all operations in connection with reinforcing steel in accordance with the terms and conditions of contracts in full compliance with this section Technical description, drawings and instructions of the Engineer.

Reinforcement steel shall be in accordance with the Regulations on technical standards for concrete and reinforced concrete / PBAB 87 /, application guidelines and related standards:

SRPS C.K6.020 Hot-rolled steels. Concrete steels Specification (1987).

SRPS C.K6.120 Hot rolled steels. Concrete steels shape and dimensions (1986).

SRPS U.M1.091 Construction welded wire mesh (1986).

Standards provide for shape and dimensions, as well as the test methods for the quality requirements laid down in PBAB '87.

Wires and rods of soft steel, high-value natural hard ribbed steel bar and wire mesh of soft cold drawn wire are used for reinforcing structures and concrete elements .

All reinforcement shall be clean and free from pit corrosion, loose rust, mill scale, paint, oil, grease, adhering earth, or any other material that may impair the bond between the concrete and the reinforcement or that which may cause corrosion of the reinforcement or may be detrimental to the quality of the concrete.

Storage of reinforcement shall be on racks or supports clear of the ground. Different types and sizes of reinforcement shall be kept separate.

7.18.1. Smooth fitting SF 240/360

Smooth fitting / SF / is made from soft reinforcing steel quality 240/360 and is made in the form of wires and rods. For reinforced concrete structures soft steel reinforcement, of circular cross section, is made according to the approved procedure.

7.18.2. Ribbed reinforcement RR 400/500

Ribbed reinforcement / RA / from naturally hard steel quality 400/500 is made in the form of wires and rods. For reinforced concrete structures, corrugated steel reinforcement, of circular cross section, is made according to the approved procedure.

7.18.3. Welded wire mesh MAG 500/560

Welded wire mesh are made of cold drawn wire of smooth steel quality 500/560. Mesh, wire diameter and spacing, tolerance and others shall be determined by SRPS U.M1.091.

7.18.4. Protection valves

Steel for the reinforcement must be protected from damage at all times. When incorporated into the structure, it must be free of dust, loose flakes slag and rust, paint, oil or other foreign material.

7.18.5. Bending

Bars for reinforcement should be carefully cut and bent by a qualified worker. They must be bent in cold templates and should not noticeably deviate from the shape and dimensions shown on the drawings. Sharply bent parts must be avoided and must not be of smaller radius than those indicated in Table 24 PBAB a '87.

7.18.6. Installing and connections

All the reinforcing steel must be installed correctly - bars at each intersection must be connected by wire, so as to maintain the position shown in the drawings during the concrete setting. Limiting to prevent contact between the fitting and formwork and reinforcement between the lines shall be made of precast concrete blocks, or other suitable materials of approved forms and dimensions. Concrete cubes must be of such dimensions that they can be filled with concrete. Coarse gravel, crashed stone or brick, metal pipes and wooden coasters are not allowed. Viewing mounted reinforcement is done macroscopically.

Tolerances are moving in the following ranges:

Tolerances between individual rods

- With pillars and beams - 10 mm.
- With plates and walls- 15 mm.

Discrepancies between the rows of reinforcement height, as well as the deviation of the protective layer of the projected measures

- With elements having constructive height greater than 1 m..... - 10 mm.
- With beams and slabs of a thickness exceeding 10 cm..... - 5 mm.
- With a thickness of less than 10 cm..... - 3 mm.

Deviation of stirrups to the horizontal or vertical

7.18.10. Tolerances

Tolerances in placing reinforcement shall be:

For members 60 cm or less in depth: +/- 0.5 cm

For members more than 60 cm in depth: +/- 1.5 cm

7.19. STONE WORKS

7.19.1. General conditions

The stone used for the regulation work in preparing the rock dumps of crushed stone is obtained from the quarry, and should meet the following requirements:

- Grit stone material depending on the type of work should be of the mean diameter of 30 cm, ranging from 15-60 cm;
- The stone should be resistant to abrasion and cold, whose compressive strength is not less than 100 N/mm²,
- Stone should have a certificate of being suitable for this type of work. According to the approval no need to have a 35% loss in weight after 5500 rpm, and its resistance to frost should be satisfactory (according JUSB.B8.001).

7.19.2. The substrate of sand and gravel stone (or concrete) lining

Natural sandy-gravel or crushed stone material will be used as a basis for stone or concrete lining. Material for surface stone cladding should not exceed grain size of 50 mm. Material for surface concrete lining should not exceed the grain size of 40 mm. Spreading is carried out in layers according to the design.

Measurement for payment is made according to the number m³ of material embedded in the substrate. Price should include excavation, transport, waste, installation, compaction, surface preparation and others.

7.19.3. Stone works for the protection of the slope and banks of canal

The stone used for the regulation works in preparing the protection of the coast by installing crushed stone on the previously prepared surface - geotextiles and buffer.

Stone should meet the following requirements:

- Grit stone material depending on the type of work, should be of the mean diameter of 30 cm, ranging from 15-60 cm;
- The stone should be resistant to abrasion and cold, whose compressive strength is not less than - 100 N/mm²;
- Stone should have the certificate of being suitable for this type of work.

- According to attest shall lose 35% in weight after 5500 revolutions, and its resistance to frost should be satisfactory (JUS B.B8.001).

7.19.4. Making protection of bank of canal by installation of rolled crushed stone

Stone protection of landfills will be made of the stone to the measures and dimensions shown on the drawings. Stone resistant to the influence of weathering and frost will be used for creation of the landfill, as defined by the standard JUS B.B8.044, JUS and JUS B.B8.001 B.B8.013. The minimum strength of rock pressure should amount to 100 MN / m². Quality of stone for hydro regulation work is proven by attest.

Quality of stone for hydro regulation work is proven by attest. The coarseness of crushed stone $d=30$ cm was adopted, with grain composition characteristic as defined by JUS U.C5.020 - $d_{max} / d_{50\%} = 2$; $d_{50\%} / d_{20\%} = 2$ ($d_{max}=60$ cm; $d_{50\%}=30$ cm; $d_{20\%}=15$ cm). The stone is built in revetments by direct unloading from the means of transport, and then rough alignment (combined mechanical and manual) is performed - rolling.

7.19.5. Making of groundwork of geo textile

After completing the preparation of the field, as a basis for the development of base layer riprap banks of the canal and repair of roads, a non-woven geo textile is placed. Non-woven geo textile products are needed from pure polypropylene fibbers of high strength.

The geo textile must meet the following specifications:

- Tensile strength (tensile strength) ≥ 22 kN/m (EN ISO 10319)
- Elongation (Elongation at break) $\geq 55\%$ (EN ISO 10319)
- Resistance to breakage (CBR test) ≥ 3500 N (EN ISO 12236)
- Dynamic perforation test (Dynamic perforation) ≤ 15 mm (EN ISO 13433)

Before using nonwoven geo textile the Contractor shall obtain the Statement on the properties of geo textiles (Declaration of performance - DoP) and present it to the Supervision for approval.

Samples of incoming materials are tested in a laboratory for the testing of materials, provided that the results must comply with the Declaration on the properties of geo textiles, which manufacturer had delivered with the very material.

The Contractor selects samples for testing in the presence of the Engineer with a commitment that at least one sample must be taken for each 10,000 m² of material that arrives.

Non-woven geo textile is laid on a solid and levelled foundation soil. The subsoil must be free of major irregularities and without roots, or other materials that can cause damage (perforation) to geo textile.

Connecting of geo textile should be done in the way that geo textile is a continuing entity (mutually overlapping tape must be at least 20 cm).

A layer of sand 30 cm thick is placed over the geo textile, then gravel of granulation 0-63 mm of minimum thickness 15 cm.

Calculation of work is done by m² of surface on which geo textile is laid.

When installing the geo textile, care should be taken that overlaps are performed properly in order to prevent slipping of geo textile. Overlapping should go in the direction of the filling material while preventing the crease of geo textiles or making sure the geo textile is evenly tightened across the surface of the ground.

Unit price includes the cost of purchase, transportation and laying of geo textile.

7.20. PIPELINE

The gravity outflows of drain irrigation canal, designed as typical inlet AB building, PP tubular outlet of corrugated pipes 2 DN1500 mm and pouring AB building with prefabricated cap - PE-HD sluice gate DN1000.

Unit outlet AB head with clasps - instrument PE-HD irreversible flap 3 DN1000 was designed on the thrust pipelines 3 DN1000 within PS “Kalenića – Revenica”.

Making of pouring concrete elements of the casting facilities, includes the development of the frontal lobe AB walls filling and pouring facility of gravity drain 2 DN1500 as well as frontal and wing walls pouring facility, all in accordance with the design, with holes for mounting of standard assembly-disassembly PE-HD system, given by type: PE-HD sluice gate DN1500.

NOTE: Attest documentation (quality of the material) will be under the Engineer. If the quality is not satisfactory, the Engineer shall order the Contractor to eliminate all deficiencies at its own expense.

7.20.1. Technical requirements for making of pipelines

At the locations defined in the design (PS "Kalenića Revanica"), a type outlet is applied, which consists of 2 PE-HD parallel slide gate valves DN 1500, 2 PP aqueduct of corrugated pipes DN 1500 and fuelling AB head at the upstream end of the culvert.

7.20.2. Corrugated pipes

The Contractor shall carry out the works described as appropriate - the material properties of the pipe must be in accordance with the following standards:

prEN13476-1, prEN13476-3, EN ISO 9969, EN 476, EN 1610, ENV 1046th
All seals must be made in accordance with EN 681-1. Fittings should be delivered with pipes and fittings must meet the requirements for pipes type SN8:

- The pipe material is polypropylene PP-B (polypropylene copolymer), two layer corrugated pipes with smooth internal and profiled external surface, nominal ring stiffness SN10 ($\geq 10 \text{ kN/m}^2$) and ring flexibility $\geq 30\%$, in lengths of 6 meters (without socket) and durably marked in accordance with SRPS EN13476-3
- Pipes are produced in accordance with ISO 9001

Backfilling the excavation and backfill compaction should be done in accordance with the manufacturer's instructions, depending on the characteristics of the soil and the presence of underground water.

The pipes must lie evenly over the entire length.

Internal transport, installation in trenches in accordance with DIN EN 1610 and the manufacturer's instructions, to a preformed substrate, the projected decline, with geodetic control;

- Geodetic control and approval by the Engineer
- Application of protective measures for workers in the basic trench
- The Contractor shall obtain appropriate certificates for material quality
- In accordance with the graphic documentation and standards for this type of work

7.20.3. Gravity drain pipeline of Channel « BITVA »

PP corrugated pipes must meet the following basic requirements:

- Resistance to parietal pressure
- Water yield
- Resistance to internal hydrostatic pressure

PP corrugated pipes for wastewater DN 1000 SN 8 according to DIN 16961, SN 8 (according to ISO 9969), the connected socket integrated in the tube.

The wall of the inner tube must be designed for high-pressure cleaning (120 bars at the nozzle), the minimum wall thickness according to EN 13476th

Material properties of pipes and fittings must meet the requirements of EN 13476th

Storage of PP corrugated pipes should be according to the manufacturer's instructions and strictly followed.

For safety reasons trench width must be at least DIN EN 1610. Trench must be without water, until the installation works are done. Trench excavation is to be carried out entirely according to the details attached to the project. In places where pipes are connected, it is necessary to do the excavation in width and depth sufficient to accommodate the nozzle tube, so that muff would not be lying on the compacted soil and thus create a point load. Deepening of the trench for PP corrugated pipes is approximately 15 cm.

If the work is performed with protective covers, they should be dismantled gradually as the backfilling progresses, and in parallel on both sides so as to avoid sudden pressure to occur on one side, which would lead to displacement of the tubes from the set position.

After the excavation, the trench must be cleaned of larger pieces of earth and stones with a diameter greater than 16 mm and plan with accuracy of ± 3 cm. The trench is then saturated with sand or small earthen material at a thickness of at least 10 cm + 1 / 10d in cm. The caul is beaten in with the use of vibration plate.

Preparation of trays should be made so that each element of the pipeline relies solely on its slot and not to burden the adjacent elements of the pipeline. In addition, the cradle of one element should be prepared so that the element rests evenly over the entire length.

Pipes and fittings need to be checked for damages before installing them. Damaged pipes and fittings shall not be installed.

Before laying the pipes it is necessary to review them. The ends of the pipe where the process of fusion is happening (socket and straight tube end) should be free of damage, cleaned of dust and other dirt and dry. This should be done in good faith with the control, because the success of the execution of the merger largely depends on the correctness and purity of the parts where the elements are joined together.

The pipes should be installed so that the nozzle is pointing in the opposite direction of the water flow or progression installation of pipelines.

Appropriate machinery and equipment are needed for installation of pipes: crane of capacity and ability needed to move around the field in the particular route; feeder tube in the pipe that is installed inside or outside pipes; the required number of appropriate cables; a device for compacting reservoirs and dikes around the pipes and instruments to monitor the horizontal and vertical position of the tube.

The force required for insertion (installation) of the tube is 0.6 from the weight of the pipe that is installed.

Retraction is done by the force in the axis of the tube by means of a device set for it (tirfor).

PP corrugated pipes are connected via connecting muffers and rubber seals. Connection procedure is as follows:

- Pipes and fittings need to be measured according to the crash and direction, and set per project. Changes of direction are not allowed.
- Before installation, socket and pipe end (sealing ring) must be cleaned.
- On PE and PP corrugated pipes, in the second rib, a rubber seal is set and coated with lubricant. The medium is supplied by the manufacturer of the pipe.

7.20.4. Pressure pipelines in pumping stations

Pressure pipeline from pumping station 3 DN1000, with associated fittings, air valves are designed for replacement due to age (over 40 years), dilapidation and need for reconstruction in accordance with the reconstruction of the embankment.

Pipelines will be made of steel welded tubes with segmental arches and welded joints.

All fittings and valves must be tested. Welding on site. Welding is performed by an authorized welder.

Control of welds

After the installation a pilot study is performed on the pressure pipeline in accordance with regulations.

Irreversible PE-HD flaps are installed in the new AB pouring facility.

The calculation is done per m' built-in pipeline

7.21. ASSEMBLING-DISSASSEMBLING PE-HD PROTECTION EQUIPMENT

7.21.1. PE-HD Gate DN 1500 in the gravity drain pipeline

Complete PE-HD flood protection raising panel DN1500 is installed onto the inlet RC head walls of the standard inlet structure, previously prepared for installation (by mounting of steel frame from rectangular pipe 100 x 40 x 4 mm, external dimensions 2.685 x 1.500 mm, including 1 longitudinal beam (pile cap) of the same material. With 6 pcs. of welded anchor bolts M 16 x 265, 4 pcs. M 16 x 220 in addition to 24 pcs. of M 16 x 350 mm, of the quality 8.8. Applied anti-corrosion protection should be based on epoxy resin, basic and finishing layer.

Complete PE-HD flood protection raising panel DN1500, consists of the following components:

- Bearing plate from PE-300 of dimensions 2.865 x 1.500 mm $s \geq 40$ with inserted replaceable EPDM gasket and all necessary assembling openings. (Gasket replacement should be feasible without disassembling of the protection plane or removal of its components!)
- Self-standing frame from PE-300, consisting of inter-frames $s \geq 60$ mm and covering frame $s \geq 40$ mm.
- Covering frame should be previously prepared for installation of protection against vandalism. Head beam with steel reinforcement and completely covered welded joints.
- Easy sliding plate of the flood protection raising panel from PE-300 $s \geq 30$ mm with all necessary stabilizers.

- Stainless steel drive unit with opposite bearing of Ø70 mm and counter nut RG 7, with quartering 26 x 26 for sheave support (sheave without blocking wedge and with rotation handle). Protection against vandalism for anchor bolts with completely covered wedging.
- Sealing between service flanges and assembling frame (described in separate item) by double EPDM gasket.

Delivery of the gate should be accompanied by:

- certificate of factory testing in accordance with DIN EN 10204 – 2.3 (including certificate on used raw materials, grade 2.2),
- certificate on performed welded joints testing in accordance with DVS 2206 – 3.3.1.4 and professional certificates of engaged welders DVS 2212).

Assembling-disassembling PE-HD system – PE-HD Flood protection raising panel DN1500, should be delivered to the construction site and installed onto previously constructed outlet head of the standard RC inlet structure with installed steel frame and mounted bearing plate, corresponding to this system.

Bearing assembling plate should be delivered ex works to the construction site and professionally installed into the formwork and reinforcement. Bearing assembling plate should be fixed in such a manner to entirely prevent its movements in the course of constructions.

Installation of this system comprises or auxiliary and finishing works (construction, assembling and control works) in addition to supplementary material and construction until completing of the entire inlet structure.

7.21.2. PE-HD non-returnable valves DN 1000 on pressure pipeline of the PS «Kalenića Revenica»

Assembling PE-HD Flap Cover DN1000 in accordance with the detail from Detailed Design should be of the equivalent quality as „System NOAH water secure systems“ entirely in accordance with the following details:

Complete PE-HD Flap Cover DN1000 is installed on outlet RC structure head walls previously prepared for installation (by mounting of the steel frame from rectangular pipe of 100 x 40 x 4 mm and 1.250 x 1.250 mm of external diameter, including diagonal infillings of the same material at all 4 corners (with 20 pcs of welded anchor bolts M 16 x 250, of the quality 8.8, and diameter of Ø 1.160 mm). Anti-corrosion protection to be applied is based on epoxy resin, basic and finishing layer.

Complete PE-HD Flap Cover DN1000 consists of the following components:

- Bearing assembling plate with inserted connecting socket for connection to the PP corrugated pipes DN1000, DIN 16961, ID red,
- Front sealing plate of PE-300 with welded PE-HD caisson shaft DN 1000, DIN 16961, $s \geq 25$ mm, of the length 170 mm.
- Inter-flange from PE-300 with welded PEHD socket for connecting of PE-HD corrugated pipes ID 1000, D=1200 mm, insertion depth app. 240 mm. All PE-HD components should be entirely hermetically welded to each other.
- Flap Cover body from PEHD solid wall caisson shaft in accordance with DIN 16961, front flange from PE-300, $s \geq 30$ mm bilaterally hermetically welded to the flap cover body, of at least 1.200 mm in diameter, contact surface inclined for 10 degrees in relation to the vertical pipe axis.
- Service flange from PE-300, octagonal, $s \geq 30$ mm also bilaterally hermetically welded to the flap cover body, with 20 punched openings of diameter $\varnothing 17$ mm, in the opening circle 1.160 mm, external dimensions at least 1.250 x 1.250 mm, with trimmer of the component for protection from vandalism. Sealing between service flange and bearing assembling plate (described in separate item) by double EPDM gasket.
- Covering plate from PE-300 $s \geq 30$ mm, with all required brackets and reinforcing from PE-300 $s \geq 30$ mm, with inserted EPDM gasket. The gasket should be replaceable. Cover plate opening angle should be at list 60 degrees, with upper the stop bead.
- Calibrating weight inserted into cover plate and completely insulated with PE-HD cover.
- Stainless steel arbour, also completely insulated with PE-HD cover, including possibility of disassembling for the purpose of maintenance.
- Protection against vandalism for anchor bolts with completely covered wedging.

Delivery of the PE-HD Flap Cover should be accompanied by:

- factory testing certificate in accordance with DIN EN 10204 – 2.3 (including certificate on used raw materials, grade 2.2),
- certificate on performed welded joints testing in accordance with DVS 2206 – 3.3.1.4 and professional certificates of engaged welders DVS 2212).

Assembling-disassembling PE-HD Flap Cover should be delivered to the construction site and installed onto previously constructed outlet head of the standard RC inlet structure with installed steel frame and mounted bearing plate, corresponding to the system.

Bearing assembling plate should be delivered ex works to the construction site and professionally installed into the formwork and reinforcement. Bearing assembling plate

should be fixed in such a manner to entirely prevent its movements in the course of construction.

Installation of the system comprises or auxiliary and finishing works (construction, assembling and control works) in addition to supplementary material and construction until completing of the entire inlet structure.

7.21.3. Technical requirements for locksmithing

New steel profiles and sheets will be used to create steel frames pipes.

Corrosion protection of materials is to be performed with the use of appropriate protective coatings.

Locksmith elements must be tested and supplied with test certificates of authorized organizations. They must be durable and safe, according to the current standards. The Contractor is obliged to submit the details with the description of hardware, method of installation and corrosion protection to the Investor for approval.

Measurement for the payment will be made per unit and include all the necessary materials. The Contractor must ensure and document that the conditions and assumptions used in the structural calculations comply with the actual conditions of soil, excavations method, cross section of the trench, compaction, materials, earth cover etc.

Pipe lowering shall be carried out in a safe manner in accordance with applicable safety regulations and normal practices.

Bitumen coated pipes shall be handled with suitable slings which do not damage neither pipe nor coating. A sufficient number of lifting machines (e.g. side booms) shall be used to ensure that the pipe is not subject to detrimental stresses.

The Contractor shall, before lowering the pipe, ensure that the bottom of the trench is even and free from stones and other deleterious matter which may damage the coating.

The lowering-in procedure shall ensure that the pipe is not subjected to shocks or unnecessary stresses.

If a section is damaged during lowering, it shall be taken up again, repaired and relowered. Any damage which may affect the structural quality of the pipeline shall be treated as directed by the Engineer. The Contractor shall bear all costs associated herewith.

Where possible the ends of all lowered pipeline sections shall be closed with watertight caps. The Contractor is responsible for keeping the pipeline internally clean and free from foreign matter.

Any additional excavation required after the pipe has been lowered shall only be carried out with the permission and in the presence of the Engineer.

Each pipe, immediately before being laid, shall be carefully cleaned and examined for soundness. Any pipe which is damaged or has any perceptible objections will be rejected by the Engineer and replaced at the Contractor's expense.

The formation of excavation for pipelines shall be even and free from stones and other protrusions. Pipes shall be laid in a dry excavation. If the formation of the excavation lies below the water table, the Contractor shall install a dewatering system, to the approval of the Engineer. Dewatering shall continue until all works below the water table are completed or as otherwise directed by the Engineer.

Each pipe shall be laid accurately to line and gradient so that the finished pipeline shall be in a straight line both in horizontal and vertical planes. The Contractor shall use suitable mechanical equipment, preferably hand operated, for pushing the pipes at the joints.

Where pipelines are to be constructed in trenches the Contractor shall provide, fix and maintain at intervals not exceeding 10 m, or at such points as may be directed by the Engineer, properly painted sight rails and boning rods of predetermined measurement for the boning in of individual pipes to correct alignment. The bobbing rod shall have a horizontal shoe to rest on the invert. The sight rails shall be situated vertically above the line of pipes or immediately adjacent thereto and there shall at no time be less than three sight rails in position on each length of pipeline under construction to any gradient. Consideration will be given by the Engineer to alternative methods for controlling alignment such as laser beam instruments.

The Contractor shall keep the interior of pipes clean and free from water, dirt, stones and other foreign matter as installation proceeds, and at the end of the day's work or at other times when installation work is not preceding the open ends of the pipes shall be sealed off by a suitable stopper. The Contractor shall take such precautions as are necessary to prevent pipes from floating.

The pipes shall be positioned and bedded in the trenches on the compacted bedding layer and jointed in an approved manner. The jointing of all pipes shall be carried out in strict accordance with the manufacturer's instructions. All joint holes have to remain uncovered until passing the prescribed pressure test to the Engineer's agreement. Concrete blinding layers shall be made of concrete C12/15 and shall be applied over the full width of the bottom of the trench in a minimum layer thickness of 10 cm. Any concrete bed shall be allowed to set and be thoroughly washed down before pipe laying commences.

The design also includes the reconstruction works on evacuation facilities of irrigation Channel "Bitva", which intersect with the existing route of the embankment, in the zone PS "Kalenića Revenica":

- Gravity drainage piping - fail the sluice gate;
- Pressure pipeline from pumping station.

Together with the technical requirements which are given for the reconstruction of the embankment, they include all the positions that are represented in the design.

The calculation of performed work shall be done according to the design, according to the quantities from the site book and accepted by the Engineer.

7.21.4. Boring Path Report

The Contractor shall furnish a Bore Path Report to the Engineer within 14 days of the completion of each bore path. The completed As-Built-Plans shall be submitted to the Engineer within 30 calendar days. The report shall contain:

- 1) Location of project.
- 2) Name of person collecting data, including title, position, and company name.
- 3) Investigation site location (contract plans station number or reference to a permanent structure within the project right of way).
- 4) Identification of the detection method used.
- 5) As-built placement drawings showing roadway plan and profile, cross section, boring location and subsurface conditions as defined in Bore Path Drawings below. Plan elevations shown shall be referenced to the given bench mark and to the used grid system and datum. These drawings shall be done to the same scale in black ink on white paper, of the same size and weight as the contract Drawings.

7.21.5. Testing

When there is any indication that a pipe has sustained damage and may leak, the work is to be stopped and the damage investigated. The Engineer may require a pressure test. The testing may consist of one of the following methods but shall always meet or exceed the testing requirements:

- 1) Manufacturer's pressure testing recommendations for the type of pipe being installed are followed. The Engineer shall be notified and may be present during the test to review the test results for compliance. The pressure test shall be performed within 24 hours. A copy of the test results shall be presented to the Engineer. If the pipe is not in compliance with specifications, the Engineer may require it to be filled with flowable fill.
- 2) Product carrier pipes installed without a casing must meet pressure requirements set by the Manufacturer. If the Manufacturer does not require pressure testing, the Engineer may require at least one test. A copy of the test results shall be submitted to the Engineer. If the pipe is not in compliance with specifications, the Engineer may require it to be filled with flowable fill.

Where leakage could adversely affect pavement or shoulder integrity, a water tight joint is required.

7.21.6. Building Pipes through Structures

Where pipes pass through a concrete wall or structure they shall be protected with a surround of concrete monolithic with the external face(s) of the structure. For pipes with nominal diameter of less than 600 mm, unless otherwise shown on the approved drawings, the concrete surround shall extend 300 mm from the wall or structure and shall have a thickness of 300 mm. For pipes with nominal diameter of 600 mm or more, unless otherwise shown on the approved drawings, the concrete surround shall extend 500 mm.

On spigot and socket jointed pipelines, except where otherwise specified hereafter, the length of the pipe passing through a wall shall be such that the concrete surround extends to the limit of the pipe socket.

The first pipe that is clear of concrete surround beyond the external face of a concrete wall or structure shall be a short length of either spigot and socked or double spigot to suit the flow direction and pipe material. The effective length of this pipe shall be 1.5 times the nominal bore or 600 mm, whichever is the greater.

Any over-excavation adjacent to a structure and beneath the formation level of a pipe trench to be excavated to make a connection to a plugged or capped pipe laid by the Contractor shall be backfilled to the formation level of the trench with concrete C12/15. This concrete shall be extended to the limit of the over-excavation along the line of the pipe trench and across the full width of the pipe trench or to the limit of the excavation whichever is the lesser.

The building-in of pipes in concrete walls and concrete slabs shall be deemed to be included in the unit price for concrete works. The building-in of pipes in manhole walls shall be deemed to be included in the unit price for manholes.

7.21.7. Connecting to Existing Pipes

Where the drawings indicate that a connection of any kind to be made into an existing pipeline, or whenever directed by the Engineer to make such a connection, the Contractor shall investigate and verify all such connections at the start of the works. The Contractor shall excavate trial holes when necessary, to ensure that the materials to be furnished under the Contract will be suitable for making the connections.

The Contractor shall note that the period of interruptions of the existing service pipeline shall be kept to the minimum and shall arrange to make such connections at periods agreed with the Engineer.

The new pipe and connection together with any adjacent portion of the existing pipeline, which may have been disturbed by the Contractor, shall then be tested for leakage. Any existing pipe failing to pass the test due to damage occurring during the connection operation shall be removed and replaced by the Contractor. The test shall be repeated until a satisfactory test is obtained. Any additional cleaning and disinfection procedures required in respect of the connection shall be performed by the Contractor at no additional cost.

7.21.8. Flange Connections - Standards

Wherever pipes and fittings are connected by flanges, the following standards shall apply:

- DIN 2527 Blind flanges, nominal pressures 6 to 100
- DIN 2561 Oval screwed flanges, nominal pressures 10 and 16
- DIN 2566 Screwed flanges, nominal pressures 10 and 16
- DIN 2627-2638 Welding neck flanges
- DIN 2641/42 Lapped flanges
- DIN 2655/56 Lapped flanges, plain collars
- DIN 2690-92 Sealing for flanges with plain contact surfaces
- DIN 2693 Sealing rings for flanges with groove, nominal pressure 10- 40

7.21.9. Fittings, Valves and Accessories

The nominal working pressure of valves, fittings and accessories shall be 1.0 or 1.6 MPa. All valves, dismantling pieces, flexible couplings connections to pipes shall be flanged supplied with bolts, gaskets, etc.

Surface boxes, covers and other accessories shall be supplied for all valves and fittings for which manholes with access opening are not foreseen. Access openings shall be positioned directly above the valves, fittings or accessories to allow dismantling with lifting facilities.

7.21.10. Testing of Pipelines

Before pipe testing the trench must be filled on the pipe barrels, leaving the joints uncovered so as to prevent the pipeline from moving whilst leaving the joints accessible. Thrust blocks must also be constructed before testing. On roads with heavy traffic the backfilling at joints may take place before testing if the Engineer so allows in writing. At least a two-day notice must be given in writing to the Engineer before pressure testing of any section is commenced.

Pipes shall be filled and tested in sections of convenient lengths, which must not exceed 500 m. Where pipes are laid with steep gradients the length of pipes tested at any one time shall be as directed by the Engineer.

The ends of pipes under test shall be closed by means of caps or blank flanges with anchors all provided by the Contractor. Valves must not be used for this purpose. All scour valves and air valves shall be replaced by blank flanges before the commencement of the tests.

After laying, jointing and anchoring the pipe shall be slowly and carefully charged with water so as to avoid water hammer and all air shall be released through the upper pipe end or in case of an intermediate high point by installing a service connection with a tap. Pipes internally lined with mortar shall be allowed to stand full for at least 24 hours before testing.

The test pressure shall be applied by means of a manually or motor operated test pump connected to the pipe and two parallel installed pressure gauges calibrated at an approved testing laboratory.

The pipe joints shall be inspected for leakage during the test. Should leakage of water occur at the joints, the joints shall be reassembled to eliminate such leakage or, should this not prove possible, the Contractor shall supply and assemble new joints at its own expense. Should any pipe or joint burst or should water leak through the body of a pipe or joint, the Contractor shall forthwith remove the faulty pipe or joint and replace them with new at its own expense. In all the above cases the length under test shall be re-tested as above described and the process repeated, if necessary, until the pipeline satisfactorily withstands the prescribed test.

A test report shall be prepared in respect of each and every test performed. The test report shall contain as a minimum the following data:

- Number and date of the test
- Description of the stretch tested with unambiguous indication of the extremities of the stretch
- Sketch showing in the order of laying, the number and the characteristics of the pipes, the fittings the specials and other apparatus incorporated in the stretch
- Duration of the test, test pressure, results obtained
- Decisions relative to possible repair works and conclusions

The test report shall be signed by the Contractor and the Engineer.

The Contractor shall provide labour, install and work the test pump, pressure gauges and all other equipment required for the test and it shall fill the pipes with water and subsequently empty them after the test, all to the approval of the Engineer. Water drained from the pipes shall be discharged in a way that does not affect the stability of the Works or adjacent structures.

The Contractor shall be deemed to have allowed for all expenses in connection with pipe testing.

All tests shall be conducted in the presence of the Engineer.

If any leak in joints or evidence of defective pipe is disclosed, the work shall be immediately detected and corrected or replaced to the Engineer's agreement. No makeshift repairs or application of patching compounds shall be permitted. After the correction is made, supplementary tests shall be run until a satisfactory working condition is obtained.

With the approval of the Engineer pipelines with an internal diameter greater than 100 cm may alternatively be tested by a combination of visual inspection from the inside and the use of equipment designed to test the tightness of individual joints. This test, however, does not

relieve the Contractor of its obligation to guarantee watertightness of pipelines. Furthermore, individual joints have to be testable (i.e. double gasket with spacing and devices to connect test equipment).

7.21.11. Testing of Gravity Pipelines [

Gravity pipelines shall be tested with water or air in accordance with DIN EN 1610.

The test pressure is a minimum of 5 m head of water above the crown of pipe measured at the deepest invert level of the pipe to be tested but maximal 5 m. The test pressure time will be a minimum of 30 minutes. The losses shall be replaced steadily.

The pipe will be taken as watertight if the replaced water losses during 30 minutes are less than 0.2 l/m^2 (wetted inner surface) and if the joints are watertight (see above) and if no other leakage is visible.

7.21.12. Testing of Pressure Pipelines

Pressure pipelines (together with all specials and valves incorporated) shall be tested with water in accordance with DIN 4279 and prEN 805:

Description	Test Pressure	Test Duration	Test Criteria
Ductile cast iron pipelines	NP 10: 1.5 MPa NP 16: 2.1 MPa	ND ≤ 200: 3 hours 200 < ND ≤ 400: 6 hours ND > 400: 12 hours	max pressure drop for NP 10: 10 kPa NP 16: 15 kPa
Steel pipelines	NP 10: 1.5 MPa NP 16: 2.1 MPa	ND ≤ 200: 3 hours 200 < ND ≤ 400: 6 hours 400 < ND ≤ 700: 12 hours ND > 700: 24 hours	max pressure drop for NP 10: 10 kPa NP 16: 15 kPa
Reinforced concrete pipes	1.4 x NP (NP < 0.25 MPa) NP +0.1 MPa (NP > 0.25 MPa)	ND ≤ 700: 12 hours ND > 700: 18 hours	average replaced water losses during the first 6 hours less than 0.15 l/m ² /hour (wetted inner surface)
Prestressed concrete pipes	1.5 x NP (NP ≤ 1 MPa) NP +0.5 MPa (NP > 1 MPa)		average replaced water losses during the first 6 hours less than 0.02 l/m ² /hour (wetted inner surface)
PVC (Poly Vinyl Chloride), PE-HD	Test according to DIN 4279		
GRP	Test methods of DIN 4279 shall be applied		

7.22. PVC PIPES

The Contractor shall carry out the works described in accordance with the appropriate standards or equivalent local or international standards.

In addition to the standards listed in Part G of these Tender Requirements the following standards shall apply:

DIN 8061	PVC pressure pipes quality requirements
DIN 8062	PVC pressure pipes dimensions
DIN 8063	PVC pressure fittings
DIN 8080	PVC pressure pipes testing
DIN 19534	PVC non-pressure pipes and fittings
EN 1329	Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure
EN 1401	PVC Plastics piping systems for non-pressure underground drainage and sewerage
EN 1453	Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure – with structured wall
EN 1452	PVC plastics piping systems for water supply
prEN 1456	PVC plastics piping systems for underground drainage and sewerage under pressure
EN 1566	PVC-C Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure
EN 12200	PVC External rainwater down pipe systems
prEN 12731	PVC-C plastics piping systems for hot and cold water

PVC pipes shall be capable of withstanding ultraviolet degradation. A rodent inhibitor shall be incorporated in the material of the pipe.

The Contractor shall inform the manufacturer of the climatic and transporting conditions at the site of the Works and shall seek its advice on the storage of PVC materials on site. Except in the case of flanged joints and where otherwise specified or approved by the Engineer, pipe joints shall be flexible and sealed with a rubber ring or gasket to the approval of the Engineer and shall withstand the various tests specified in the applicable standards. Splicing joints are not allowed.

For pipes with a nominal bore of 600 mm or less the joints shall be capable of withstanding a deflection of not less than 1.5 degrees in any direction and for pipes with a nominal bore of more than 600 mm 0.5 degrees in any direction. All pipes shall be capable of withstanding a "draw" of 13 mm over and above the initial jointing allowance.

The initial jointing allowance is the gap measured parallel to the centre line of the pipeline and shall not be less than 6 mm or more than 13 mm or as otherwise recommended by the

pipe manufacturer and approved by the Engineer. Pipes and fittings shall be indelibly marked prior to laying to indicate the correct initial jointing allowance.

7.23. PE-HD PIPES

The Contractor shall carry out the works described in accordance with the appropriate local or international standards.

In addition to the standards listed in Part G of these Tender Requirements the following standards shall apply:

DIN 8074	PE-HD pressure pipes, dimensions
DIN 8075	PE-HD pressure pipes, dimensions
DIN 19533	PE-HD/LD pressure pipes for water supply, requirements
DIN 19537	PE-HD /LD non-pressure pipes and fittings
DIN 16963	PE-HD fittings
DVGW W 330	German Association for Gas and Water: Guideline “Approval testing of welders”
EN 1519	PE-HD /LD plastics piping systems for soil and waste discharge (low and high temperature) within the building structure
prEN 1555	PE-HD /LD Gas pipe systems
prEN 12201	PE-HD /LD non-pressure pipes for water supply
prEN 12318	PE-X plastics piping systems for hot and cold water
prEN 12666	PE-HD /LD non-pressure pipes for sewerage
prEN 13244	PE-HD /LD pressure pipes

7.23.1. Welding

PE-HD pipes and fittings shall be jointed by heating-element butt welding.

The Contractor shall provide all necessary personnel, equipment and materials.

Only skilled welders and welding operators who can document qualifications relevant for pipeline welding will be accepted by the Engineer. Prior to the performance of any production welding operators shall qualify for the relevant welding procedures according to DVGW W 330.

Surfaces to be welded have to be sufficiently clean, to avoid deterioration of weld quality by any dirt, oil, grease or other contamination.

Each pipe or component shall be visually inspected to ensure that it has not sustained any visually determinable damage. Disposition of damaged items shall be resolved in consultation with the Engineer’s Representative.

Vibration inducing operations carried out in the vicinity of welding machine are prohibited during welding operations.

After welding, the joint shall be checked visually. In case of any of the following imperfections, the pipe ends shall be cut and welded again:

- different high welding beads on pipe end
- welding beads too narrow and too tall
- welding beads too small
- crack on the centre of welding beads
- offset too high (10% of pipes wall thickness is tolerated)

7.24. CORRUGATED PIPES

The material properties of the pipe must be in accordance with the standards:

- prEN13476-1,
- prEN13476-3,
- EN ISO 9969,
- EN 476,
- EN 1610,
- ENV 1046th

All seals must be made in accordance with EN 681-1.

Supply, delivery, moving along the route, installing PP-B (two layer) corrugated pipes with smooth internal and profiled external surface, nominal ring stiffness SN10 ($\geq 10 \text{ kN/m}^2$) and ring flexibility $\geq 30\%$, in lengths of 6 meters (without socket), as PIPELIFE PRAGMA PP SN10.

The ring stiffness of coupler (connecting element) must be the same as the declared ring stiffness of the pipe i.e. in class SN10, sealing ring made of EPDM an integral part of each pipe. For diameters up to DN400 coupler is friction welded, while for dimensions over DN500 coupler is coextruded with additional polyester ring to ensure water resistance and ring stiffness.

Pipe colour is different from black, to guarantee the use of virgin raw material. Pipes are laid on sand bedding in accordance with the manufacturer's instructions, and are connected with integrated fittings. Backfilling the excavation and backfill compaction should be done in accordance with the manufacturer's instructions, depending on the characteristics of the soil and the presence of underground water. The pipe must lie evenly over the entire length.

7.25. EMBANKMENT LEAKING PROTECTIVE WORK - VINYL UNDERGROUND DIAPHRAGM (UVD)

The Project provides technical solutions on critical sections on which the counter filters protection is formed - installing underground PV diaphragm depth of 7,7 m, in the previously prepared ditch trench and working platform for the operation of the machinery.

Filtering protective works are planned for the two critical sections:

1. CRITICAL SECTION 1. (km: 18+600:19+087),
2. CRITICAL SECTION 2. (zone of PS Kalenića Revenica)

Filtering protection of embankment - Underground Vinyl diaphragm (UVD), is designed as a continuous (H = 7,7 m): Installing by setting up certified vinyl planks using specialized machinery with equipment and tools on the projected route to the projected depth. Choosing the type of UVD - Vinyl diaphragm must be certified, technical characteristics in accordance with standard ISO 9001:2008 id 9105076957. (Density: min 1400 kg/m³; Tensile strength: \geq 40 MPa; Bending strength: \geq 65 MPa (before/after thermal ageing at required temperature 0C and time duration); Tensile/bending elasticity modulus: \geq 2500 MPa; Resistance of climatic ageing at required parameters, proven by required tests methods). Equivalent types GW 458 /10.4 mm.

The design envisages the following operations with the description of site and geotechnical conditions, materials, equipment:

- Preliminary works for making filtering protection,
- Earthworks for preparing the installation of UVD,
- Geological profiling of Underground Vinyl Diaphragm (UVD)
- Final earthworks in the zone of UVD (after installation of UVD)
- Site conditions
- Geotechnical conditions
- Vinyl sheet piles
- Installation methods
- Installing and auxiliary equipment
- Selection of equipment and working parameters
- Installation of anchored walls
- Installation of load bearing walls

7.25.1. Preliminary works for making filtering protection

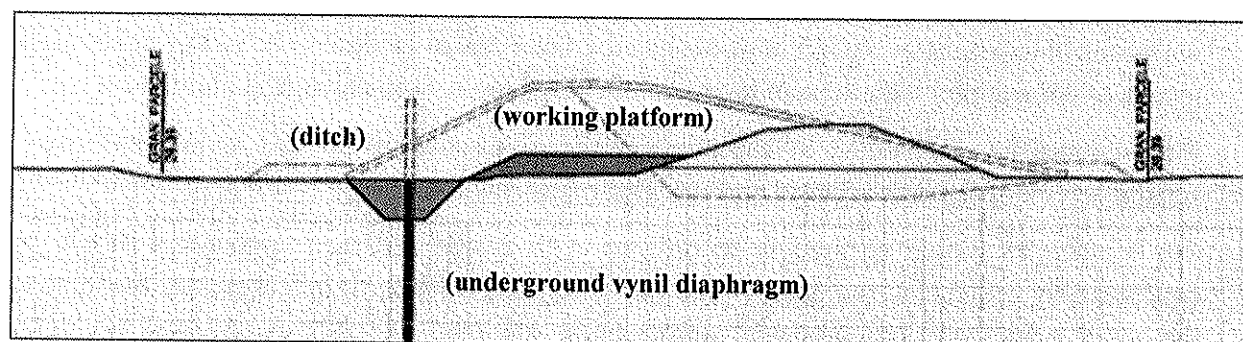
Preparation of the route for the installation of underground vinyl diaphragm (UVD)

Establishing and securing construction sites - provision of space for storing vinyl planks, parking specialized machinery for the production of UVD, equipment and materials.

Geodetic marking of designed route and base trench UVD and belt necessary for the operation of specialized machinery (earthen platform), alignment crown PVD, control recording baseline control during the preparation of UVD.

Recording of initial state of the base trench and platform for the installation of UVD is subject to field control of the Engineer;

7.25.2. Earthworks for preparing the installation of UVD



Installing of the UVD diaphragm

Excavation of trench for installation of UVD in the foot - subsoil of embankment screen and making aerial platforms for specialized machinery (working platform after installation of UVD becomes part of the embankment screen)

Mechanical excavation of trapezoidal trench (depth 2.0 m, a width of 2 m at the bottom, gradient bevel 1: 1), with removal aside on the route of working platform;

Developing a working platform for specialized machinery, compacting the existing subsoil and the buried material from the underlying trench for UVD, in layers, with control testing (compaction prescribed $M_s=30$ MPa). The Contractor provides geodetic monitoring of level crown of UVD and work conditions in the dry.

7.25.3. Geological profiling of Underground Vinyl Diaphragm (UVD)

Prior to the start of making anti-filtration protection, the Contractor shall perform geological investigations on the control points (a total of 12 wells, 12 m depth) along the route of UVD, distribution, and position in accordance with the technical documentation.

Geodetic marking of locations along the route of the base trench of UVD;

Mobilization of equipment, preparation for drilling, drilling, sampling of all layers;

Laboratory testing has to be done for all samples and the report of a specialized laboratory (grain size distribution, cohesion, internal friction angle, compressibility, coefficient of filtration) has to be completed. Report should define the depth of the layer with low filtration coefficient. Decision on changing the alignment of the crown and the bottom of UVD is made by the Beneficiary, upon request of the Contractor and with the consent of the Engineer.

7.25.4. Final earthworks in the zone of UVD (after installation of UVD)

Mechanical backfilling of the trench base of UVD, excavation of cohesive material from an existing embankment, spreading by hand around the built-vinyl diaphragm;

Mechanical compaction of material around and above the built-vinyl diaphragm, in layers, with control testing at every 0.5 m of compacted layer has to be done. The use of lightweight means of compaction with the aim to protect the diaphragm from damage is obligatory.

Final control of compaction of superficial layer of foundation pit and aerial platforms - subsoil screen of the embankment and working platforms

The vinyl piles should be used in accordance with design and their application should be confirmed by geotechnic soil survey. The walls, screens, safeguards and housings, made from the vinyl piles constitute essential construction elements in civil engineering building, directly influencing their technical safety. Installing of vinyl piles requires specialized equipment and should be carried-out by trained and qualified personnel of firms specialized in civil engineering branch.

The pile installation should be carried-out strictly in accordance with the design, while the information present herein is given only as help and general indication concerning designing and installing. The information present herein is in accordance with actual technical knowledge in the matter and cannot constitute any base for complains towards the piling manufacturer.

Pile wall – a row of mutually interconnected segments, vertically driven into soil, thus creating a compact, continuous, leak proof barrier

Load-bearing wall – pile wall supported upon the surrounding ground

Deepened side – it is the side of the retaining or partition wall where the ground or water level is lower

High side - it is the side of the retaining or partition wall where the ground or water level is higher

Line of deepening – it is the level of water or ground at the deepened side of the pile wall

High “H” – it is the distance from the line of deepening to top of the pile wall

Sub-crust – this is a general name for any material strewn at the high side

Rock filing – regular or rugged stone or concrete rubble having maximum volume and weight of 0,03 m³ and 75 kg, respectively and having minimum volume and weight of 0,003m³ and 7 kg respectively.

Substratum - ground at the both sides of the pile wall, beneath the line of deepening

Penetration - depth to which the piles should be driven beneath the line of deepening

Designing procedures – procedures aimed at calculation of the stresses generated within the ground and calculation of the required piles penetration depth and anchoring strength for the pile wall.

7.25.5. Site conditions

Site conditions should be verified before actual installation of the pile wall. All the ground and underground equipment on the building site like pipelines, electric energy cables, telephone lines etc., should be safeguarded as well as all obstacles like trees, bushes etc. should be removed, and, if the last proved to be impossible a decision concerning the change of the pile wall rout should be made.

In particular the following should be taken into consideration:

- Legal regulations and conditions
- Requirements of the project, contract and association standards
- Safety, especially when installing in close vicinity to people
- Influence of ground vibration on the surrounding buildings
- Influence of noise pollution on environnement
- Substratum stability in relation to machinery and equipment
- Availability water network, electric power etc.

Since strength parameters of the pile material decrease as the ambient temperature lowers, it is not recommended to install the piles in the temperature bellow +5⁰C.

7.25.6. Geotechnical conditions

Knowledge about the soil of the given sector of the installed pile wall segment and the ground water table is indispensable for things like: correct construction type selection, specifying the required pile penetration depth, correct selection of installation method and defining the required energy for driving in the piling. This knowledge is provided by a geotechnical soil survey.

Selection of the particular pile construction and the related technique of its installation depends mainly on the kind of soil.

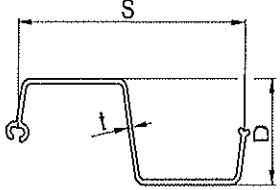
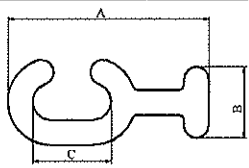
With regard to the vinyl piles installation technique, the grounds are of following kinds:

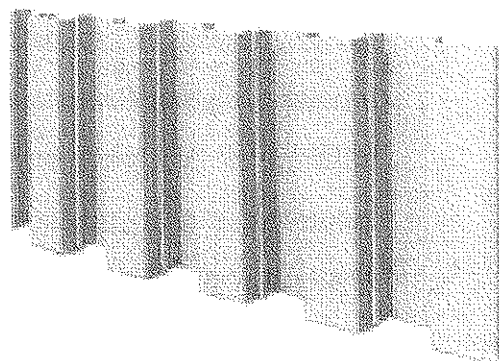
- Grained grounds, consisting of gravels, sands, and sandy slime. Pile driving in requires overcoming the resistance resulting from friction of the pile against the soil, which increases as the penetration deepens. The required energy for driving in depends on the density of the soil

- Sticky grounds, sticking together soils consisting mainly of clays and loams. Pile driving in requires cutting through sticking layers, and the energy needed for forcing the pile into the ground depends on force required for ground cutting and the size of the pile section
- Stony soils, consisting of solid rocks or boulders of various sizes, randomly scattered within the grained grounds. This type of soil is not fitted for applying driving in techniques for installation the vinyl pile

Most of the grounds along the pile penetration depth consist of series of layers, often intermixing with one another.

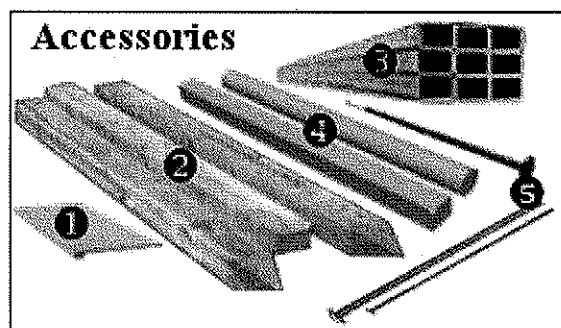
7.25.7. Vinyl sheet piles

<p>Vinyl piling</p> 	<p> $L \leq 10 \text{ m}$ $S = 300 \text{ mm}$ $D = 115 \text{ mm}$ $t = 5,5 \text{ mm}$ $1 \text{ m}^2 \approx 3,3 \text{ mb}$ $1 \text{ running meter} \approx 4,3 \text{ kg}$ </p>
<p>90° Angle connecting member</p> 	<p> $L \leq 10 \text{ m}$ $A \approx 45 \text{ mm}$ $B \approx 15,6 \text{ mm}$ $C \approx 17,6 \text{ mm}$ $1 \text{ running meter} \approx 0,6 \text{ kg}$ </p>



7.25.8. Accessories

For stringers there are applied either wooden scantlings (2) of section size from 8x4 to 20x10 cm and of length from 3 to 6 m or tin covered steel closed shapes (3) with section size from



60x40 to 120x80 mm with wall thickness from 2 to 6 mm and with length from 4 to 12 m. U-steel or double T steel bars electroplated coated or lacquered can be also applied

Steel bars are applied for spars (5) or ropes of section size from Ø 16 to Ø 32 mm and length 4 ÷ 6 m.

For fastening and screwing inside and outside stringers to pilings the tined or nitrated screws

and tap screws are applied, and for spars tightening nitrated or tined nuts with related washers, or stainless or electroplated adjusting right and left nuts are applied.

7.25.9. Installation methods

There are three currently applied basic methods of installation of pile walls made from vinyl sheet pilings.

1) Thrusting, the most often applied method, in which the pilings are mechanically forced into the ground, by using a vibration pile-driving hammer, following previously installed templates. Light equipment should be used, with not excessive impact power in order to protect the pilings against damaging. The kind of applied equipment depends on the state of the ground, piling penetration depth and the pilings strength.

2) Rinsing-out, this method is applied when piling installation is to be carried-out in tightly sticky or heavily compact grounds, in which the strength of piling driving hammers may prove to be insufficient for obtaining the required penetration depth, which may be caused by obstacles, present within the ground, or excessive hard soil. Increasing of impact force may damage the pilings. In this case the rinsing-out technique is to be applied. The rinsing-out technique is aimed at creation of pressure directly under the piling foot, which will loosen and remove the ground from under the piling. For the ground softening air or water pressure nozzles are used along with low or high-pressure water pumps. The pilings are initially forcibly driven into the softened ground, and next, at the end of penetration depth, they are rammed into the soil by means of impact hammers. The application of this method requires the designer agreement, and, upon completion of the installation, a thorough dehydration and hardening of the ground, at both sides of the wall, should be carried-out.

Three techniques of rinsing-out are commonly used:

- Rinsing-out with pressurized air
- Rinsing-out with water under low pressure
- Rinsing-out with water under high pressure

The vinyl piles are packaged in a special steel guide way to which are welded two or four steel pipes through which the softening fluid is being conveyed under the piling foot. High fluid pressure is more effective for the soil softening, but fluid flush, escaping from under the piling foot may cause harm to the workers.

The following table shows the technical specifications for rinsing-out methods:

Rinsing-out technique	Pipe diameter [mm]	Nozzle diameter [mm]	Fluid pressure [bar]	Fluid flow rate [dm ³ /min]	Recommended technique for the ground
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Pressurized air	25	5 – 10	5 – 10	4500 – 6000	sticky
Water under low pressure	20 – 40	5 – 10	10 – 20	200 – 500	Sand-gravel mix
Water under high pressure	30	1,2 – 3,0	250 – 500	20 – 60	gravel

3) Digging-in, this method is applied in case of building not deep pile wall, often in the stony soil, where using thrusting or rinsing methods are not applicable. The pilings are installed into previously dugout trench, which afterwards is filled-in at both sides of the wall with suitably selected sub-crust according to related project. Mechanical or chemical hardening of the applied sub-crust is recommended.

7.25.10. Installing and auxiliary equipment

For installing pilings by method of thrusting, impact hammers with mechanical, pneumatic, combustion engine or hydraulic drive are being applied. The hammers are operated by hand or by remote control, if they are mounted on the crane jib or on excavator jib.

When rinsing-out technique is used, there are needed water nozzles with high pressure pumps, electrically, pneumatically or combustion engine driven.

Auxiliary equipment consists of protective covering hoods (shields of shape which is fitted to the piling profile), to be put on the piling top, in order to take over the direct beater's impact thus safeguarding the pilings, ensuring at the same time holding plumb line when ramming and also reducing side flicker and vibration of the rammed pilings.

No matter what installing technique is being used, and which type of the ground, the use of guide-ways is strongly recommended, in particular when the length of installed pilings is greater than 2.5 m. When the thrusting technique is applied, use of protective covers placed on the punched piling top is recommended.

Recommended working parameters of equipment for installing the vinyl pilings:

Impact hammers

- Moment of inertia $10 \div 150 \text{ N}^* \text{ m}$
- Frequency $800 \div 3500 \text{ min}^{-1}$
- Amplitude $3 \div 10 \text{ mm}$
- Beater weight $10 \div 100 \text{ kg}$

Pneumatic hammers

- Ramming strength $1 \div 25 \text{ kN}$
- Frequency $50 \div 300 \text{ min}^{-1}$
- Beater stroke $3 \div 25 \text{ mm}$
- Beater weight $10 \div 100 \text{ kg}$

Hydraulic hammers

- Ramming strength $5 \div 25 \text{ kN}$
- Frequency $40 \div 100 \text{ min}^{-1}$
- Pressure $100 \div 250 \text{ bar}$
- Flow rate $75 \div 250 \text{ l/min}$

Water nozzle with electrically driven pump

- Output $5 \div 15 \text{ l/min}$
- Pressure $100 \div 200 \text{ bar}$
- Drive power $1,0 \div 15 \text{ kW}$

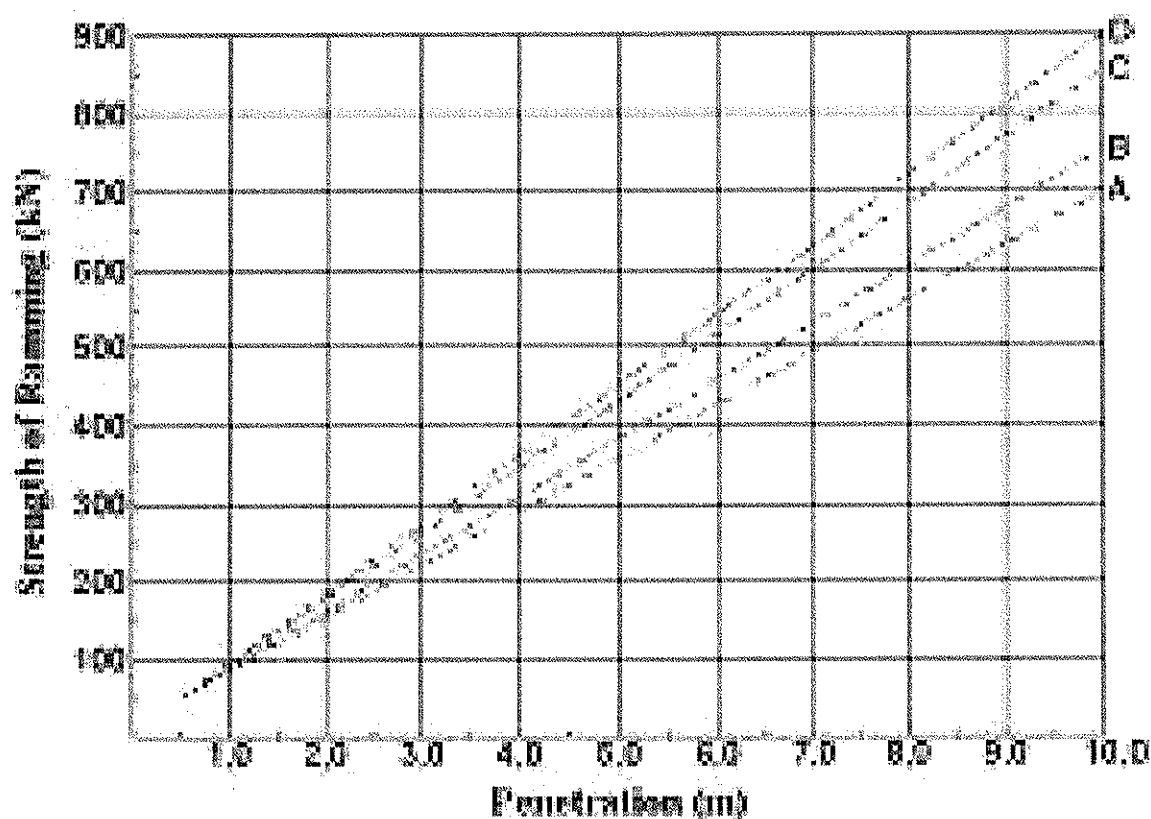
Water nozzle with combustion engine driven pump

- Output $40 \div 80 \text{ l/min}$
- Pressure $200 \div 500 \text{ bar}$
- Drive power $50 \div 100 \text{ kW}$

7.25.11. Selection of equipment and working parameters

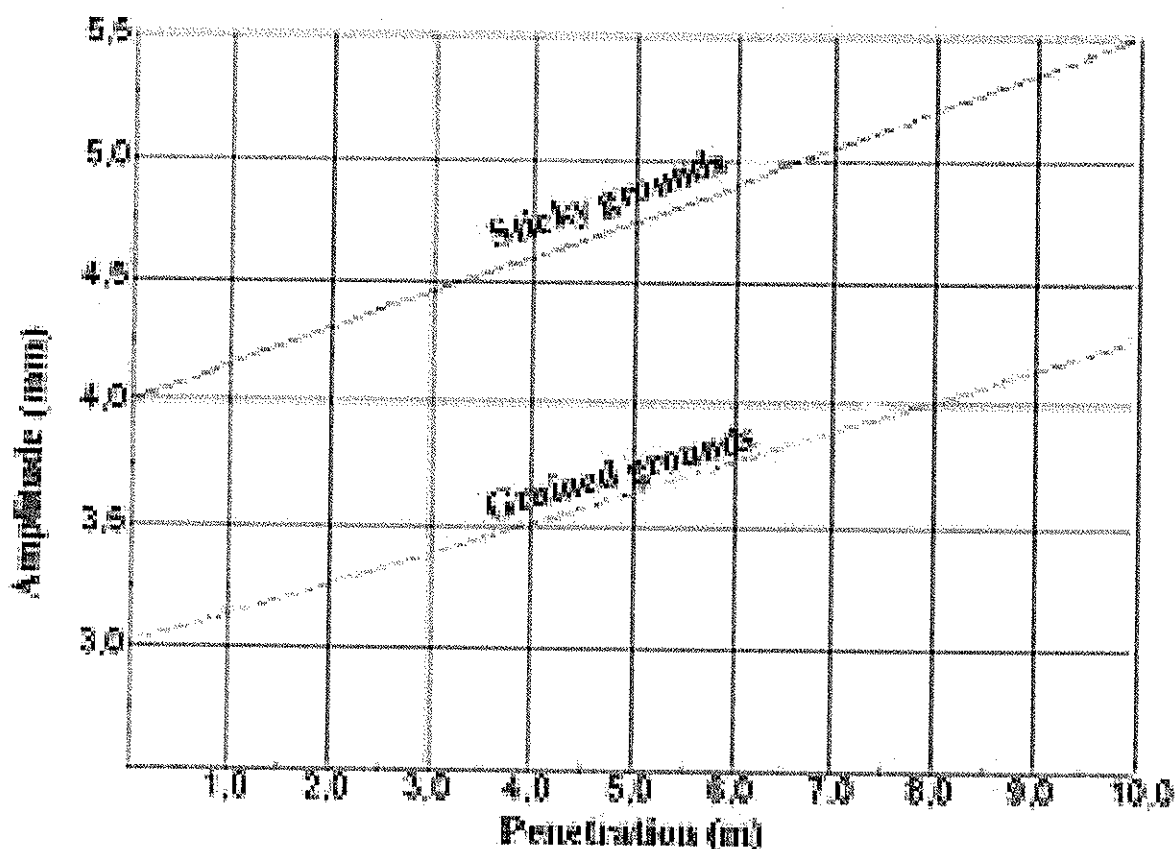
For thrusting-in vinyl pilings application of vibration hammers is recommended. The use of such hammers ensures speedy installation and maximum protection of the pilings against damages. When choosing the vibration hammer, the following parameter should be considered:

- **Frequency** – from which depends the magnitude of friction force when piling penetrates into the soil. Generally, for greater frequency, the friction is lower, and the effectiveness of driving-in is increased. Additionally, at greater frequency, the range of carried-out vibrations decreases, which results in lesser possibility of damaging the adjacent pilings which had been installed earlier.
- **Thrusting force** – from magnitude of which depends overcoming the frontal and lateral friction force. Drawing 4.3.1 illustrates relation between required impact force to depth of penetration for various kinds of grounds and various densities. Generally, the greater ground density, the greater should be ramming force, however, at not deep penetration, (up to 3 m) the ground density, equally for grainy as for sticky grounds, minimally influences the required ramming force
- **Amplitude** – is the length of impact hammer beater stroke. Increase of the amplitude increases the energy of impact imparted to the piling. In sticky ground, bigger amplitude is needed in order to remove the soil sticking to the piling side surface. Greater amplitudes are being obtained at the expense of decreased frequency. Next drawing (diagram) illustrates relation between amplitude to penetration depth. It should be noticed, that the data for the amplitude is related to the vibration hammer, and not to the piling oscillation.



Relation of thrusting force to the required penetration depth for various kinds of grounds and various ground densities

CURVE	KIND OF GROUND			
	grained	C_u [kN/m ²]	sticky	SPT Value N
A	Fine sand	0 - 45	Little sticky	0 - 10
B	Coarse sand	46 - 80	Medium sticky	11 - 30
C	Sand-gravel mix	81 - 150	Coherently sticky	31 - 50
D	Gravel	> 150	Strongly sticky	> 51



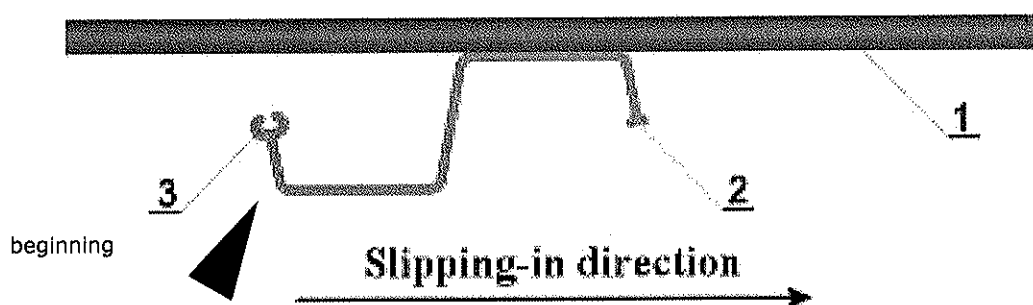
Relation of amplitude to the penetration depth for various types of grounds

7.25.12. Installation of load bearing walls

Load bearing walls, made from vinyl piles are recommended to be installed according the procedure as follow:

- 1) Mark the route of the load bearing wall by means of wooden stakes of cross section size 10 x 10 cm and length 150 ÷ 180 cm, thrust them at both route ends and stretch a string or rope, between them.
- 2) When installing pilings of considerable length, exceeding 6m, the use of additional, horizontal guiding frame is recommended, of height at least 150 cm above the soil level, made from wooden scantlings.
- 3) At the first (beginning) stake set the start master piling segment of 100 ÷ 150 cm length with its ball ending directed to the pilings route end, and, upon thorough alignment both horizontally and vertically, fasten it by means of some screws (M10x50÷60 mm) to the first stake.
- 4) Slide over the piling of the target length with its socket ending on the master piling segment ball end and thrust it on $\frac{1}{4} \div \frac{1}{3}$ of required penetration depth by means of an impact hammer.

- 5) Unscrew the screws and remove the master-piling segment.
- 6) Repeat the operation of thrusting the following piling segments of target lengths along the whole route, thrusting them no more than on $\frac{1}{4} \div \frac{1}{3}$ of required penetration length.
- 7) By means of gradual thrusting, at a step of about 0.5 up 1 m at a time, (using the adjacent pilings as guides), thrust all the pilings to the target depth. When carrying-out thrusting the pilings into the gravel or strongly sticky grounds, it is recommended to apply the piling front shields and guide ways.
- 8) All the time, during pilings installation, keep checking the pilings alignment and correctness of the partition being built up.



Required direction of insertion (1 – template; 2 – ball ending; 3 – socket)

7.25.13. Installation of anchored walls

Anchored walls made from vinyl piles of retaining type of maximum height „H” up to 2.5 m, should be installed in accordance with the following procedure:

- 1) Throughout the length of the partition wall being built-up position a template consisting of vertical wooden stakes (cross size 10x10 cm) spaced apart by 3÷5 m, and two horizontal beams fastened with nails to the stakes.
- 2) Put into the template a start master piling segment with its ball ending directed to the wall end, and, upon through alignment both horizontally and vertically, fasten the master piling segment at its both ends to the template beams by means of nails. (Drg. 5.2.1).
- 3) Slide over the piling of the target length with socket ending on the master piling segment ball end and thrust it into required penetration depth by means of an impact hammer..
- 4) In order to prevent pulling down the installed piling by the next one being installed, double fasten the already thrust piling to the upper and lower beam by means of electroplated wood screws (M10 x 50 ÷ 65 mm).
- 5) Pull out the nails and remove the start master piling segment.