

## SPECIFICATION PREFACE SHEET

**DEPARTMENT: ENGINEERING / CIVIL**

SHEET 1 OF 15

AREA: Grundartangi Reduction Plant

Spec. No: 00/02/TS001

REV: C2

### STANDARD TECHNICAL SPECIFICATION FOR EARTH WORKS

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**NORÐURÁL - ENGINEERING**

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## **1 INTRODUCTION AND SCOPE OF WORK**

In this Document the following words and expressions shall have the meaning hereby assigned to them except where the context otherwise requires:

**Engineer:** The Owner or any person or organization employed or engaged at any time by the Owner and authorized by the Owner, in writing, from time to time to act on behalf of the Owner in the execution of the items covered by this Document, in whole or in any part, for any or all purposes provided in this Technical Specification.

**Owner:** Norðurál hf (Nordic Aluminum Corporation Ltd.), an independent legal entity owned by Century Aluminum.

The work includes general excavation, filling and backfilling, and utilities outside of buildings foundations exterior face, cable conduits and draw pits. Building drains and building storm drains are covered by Sanitary Systems.

## **2 EXCAVATION**

### **2.1 General**

Excavation shall not commence unless approved by the Engineer. The Contractor shall be aware of obstructions such as pipes, conduits and cables in the areas to be excavated. The Contractor shall verify the existence and location of such obstructions before the start of excavation

Excavation limits shown on the Drawings indicate minimum cross sections of excavations. If the Contractor excavates outside these limits without a request to do so by the Engineer, he shall at his own expense backfill each unnecessarily over-excavated area to the satisfaction of the Engineer. Only approved fill may be used for such backfilling purposes in the Work.

### **2.2 Loose bulk excavation**

The areas to be excavated are shown on the Drawings. The areas shall be excavated down to a load-bearing bottom. The Engineer will evaluate which layers of soil have the required load bearing capacity for the work in question.

All excavated materials shall be disposed of and handled as follows:

Materials that will not be reused shall be dumped, i.e. transported to a spoil area. The Contractor shall level the spoiled material with a

bulldozer, dragline or other equipment he deems suitable. The Contractor shall seed the spoil area with grass, when it has been levelled to the satisfaction of the Engineer.

All stones shall be sorted. Stones of size exceeding 0.5 m shall be stored separately within the Project Area as directed by the Engineer. Other stones and gravel type materials shall be used for filling as directed in depths exceeding 800 mm from the filling surface, but not on top of utilities.

Frost susceptible soil shall be removed down to a depth 800 mm measured from the designed finished grade if not specified otherwise.

All excavated materials are the property of the Owner.

For excavation outside of excavation limits as shown on the Drawings, clause 2.1 General, shall apply.

### **2.3 Trench excavation**

Excavation for sewer and storm drain pipelines shall be carried out down to a load-bearing surface or to the depth shown on the Drawings. The Engineer will evaluate which layers of soil have the required load bearing capacity.

Excavation for water pipelines shall be carried out down to the depth shown on the Drawings.

Excavation for cable conduits shall be carried out down to a depth shown on the Drawings.

A separate trench excavation for earthband shall be 0,35 m wide and 0,9 m deep.

Excavated materials shall be handled according to the same rules as apply for bulk excavation, see 2.2 Bulk excavation.

For excavation outside of excavation limits as shown on the Drawings clause 2.1 General, shall apply.

### **2.4 Rock bulk excavation**

Rock is in this specification referred to as an earth layer that has to be excavated by systematic blasting or chiselling.

Blasting operation shall be conducted by great caution. Storage and handling of explosives and warnings of blasting shall in all regards be

in accordance with all respective regulations. Care shall be taken so as not to be damaged by blasting, i.e. by mat covering and by controlled blasting methods as applicable. Caution shall be exercised when blasting is done close to utility lines.

Caution shall be exercised when blasting or chiselling near structures.

Where blasting or chiselling is carried out in level within building perimeters, the depth from the design grade and under side of foundations to the rock shall be minimum 300 mm allowed for compacted filling.

If blasting or chiselling is needed for an utility line the rock level shall be below the utility line as specified in Trench excavation and all bumps in the slopes shall be removed within 200 mm distance from the inside of the utility line.

For rock excavation outside of excavation limits as shown on the Drawings clause 2.1 General shall apply.

All excavated rock shall be sorted. Stones of size exceeding 0.5 m shall be stored separately within the Project Area as directed by the Engineer. Smaller pieces and gravel type materials shall be used for filling as directed in depths exceeding 800 mm from the filling surface, but not on top of utilities.

## **2.5 Ditches**

The Contractor shall excavate new ditches as shown on the Drawings. The ditches shall be at least 1,2 m deep and 3 m wide at the bottom. Excavated soil materials from the ditches shall be placed into a dike on the bank beside the ditches as specified, or be transported to spoil area as directed. Rock shall be reused as directed.

## **3 Filling**

### **3.1 General**

Bulk filling shall not commence unless the substrate to be filled upon has been tested and approved by the Engineer. Trench backfilling and covering of utilities and cable conduits shall not take place until the correct installation of utilities has been verified and utilities testing has been performed and approved by the Engineer.

### **3.2 Bulk filling**

The Contractor shall fill areas he has excavated to the elevation indicated on the Drawings. The Contractor shall as soon as possible fill on top of hard moraine to protect it from softening up. The Contractor shall fill in accordance with details of the fill shown on the Drawings.

Bulk filling closer to final grade than 800 mm shall be non-frost susceptible and compactable, but filling further below final grade shall be compactable but does not have to be non-frost susceptible. Small size excavated rock may be used in bulk filling deeper than 800 mm below final grade.

Gravel bulk filling closer to final grade than 800 mm shall comply with the following requirements.

| Sieve size<br>mm | Weight percent<br>passing |
|------------------|---------------------------|
| 0,074            | 1,5 - 7                   |
| 0,125            | 2 - 14                    |
| 0,25             | 4 - 20                    |
| 0,5              | 5 - 28                    |
| 1,0              | 8 - 37                    |
| 2                | 13 - 48                   |
| 4                | 18 - 62                   |
| 8                | 27 - 83                   |
| 16               | 40 - 100                  |
| 32               | 55 - 100                  |
| 64               | 75 - 100                  |
| 128              | 95 - 100                  |

The grain size must not exceed 300 mm or half of the layer thickness which ever is less. If more than 3% by material weight is finer than 0,02 mm the frost expansion of the material shall be specially investigated. The following requirements shall always be fulfilled:

The ratio  $\frac{d_{60}}{d_{10}}$  shall be higher or equal to 4

More than 50 % of the material by weight shall be above 4,75 mm.

Particle size coefficient  $\frac{d^2_{30}}{d_{10} \times d_{60}}$  shall be higher than 1 and lower than 3.

The Contractor shall in the presence of the Engineer take samples of the material he intends to use and have it at his own cost analysed by a recognised laboratory.

The friction angle of the fill material shall be minimum 40° at specified compaction, see clause 3.5 Compaction testing. The Owner's Representative shall approve all fill materials.

Fills shall be compacted with equipment suitable for the layer thickness of the filling. In the following table minimum number of passes required for defined layer thickness and equipment weight is indicated. These requirements do not guarantee that the minimum requirements of clause 3.5 Compaction testing will be complied with and in that case they shall be fulfilled by further compaction.

| Compaction equipment              | Weight | Layer thickness | Number of passes |
|-----------------------------------|--------|-----------------|------------------|
|                                   | ton    | mm              |                  |
| <b>Vibratory plate</b>            | 0.25   | 250             | 6                |
| <b>Vibratory plate (trenches)</b> | 0.4    | 250             | 4                |
| <b>Vibratory roller</b>           | 2      | 250             | 6                |
| <b>Vibratory roller</b>           | 6      | 500             | 6                |
| <b>Vibratory roller</b>           | 10     | 750             | 6                |

Care shall be taken to compact the materials at their optimal moisture content.

When gravel fill has been graded and compacted the grade of the fill must not deviate more than 30 mm from what is shown on the Drawings. See also the clause 3.5 Compaction testing.

### 3.3 Trench backfilling

For trenches only gravel with 100 mm maximum size of stones shall be used. Close to pipes stones exceeding 30 mm size shall not be used. All fills in trenches shall be thoroughly compacted with appropriate equipment in 300 mm layers. Trench backfilling shall in this specification mean backfilling from top of utilities and cable conduit embedding materials to the level of the trench bank.

Trench backfilling shall comply with the same requirements of non-frost susceptibility, compactability, aggregate size distribution, sample taking and compaction as specified in the clause 3.2 Bulk filling. See also the clause 3.1 General.

### 3.4 Levelling layers

The Contractor shall place, as a base for asphalt pavement, in average a 50 mm thick levelling layer of crushed fill (pillow lava) 0-25 mm on top

of compacted bulk filling. The levelling layer shall extend 200 mm beyond of the pavement edge lines. The layer shall in no place be thinner than 40 mm after compacting. The levelling layer shall be compacted at optimum moisture content and after compaction the maximum deviation from correct grade shall not exceed  $\pm 20$  mm, measured on the centre of a square 300 mm plate. Where the longitudinal inclination is less than 10 o/oo the deviation from the longitudinal inclination shall not exceed 1 o/oo on 4 m straightedge. The compaction of crushed levelling material shall at optimum moisture correspond to 100% "modified proctor".

Three to five tons vibratory roller shall be used for compacting. The number of passes shall at least be 6. See also the clause 3.2 Bulk filling.

### **3.5 Compaction testing**

Compaction testing on fills shall be carried out by plate test using dia. 450 mm plate. The following requirements shall be fulfilled.

For each layer of bulk filling regardless of depth from final grade, the following test results shall be obtained:

$$E_2 \geq 120 \text{ Mpa} \quad \text{and} \quad E_2/E_1 \leq 2,5$$

For each layer of filling located below structures foundations, regardless of depth from final grade, the following test results shall be obtained:

$$E_2 \geq 150 \text{ Mpa} \quad \text{and} \quad E_2/E_1 \leq 2,5$$

The above indicated requirements correspond to the average of three plate tests executed in a succession.

The friction angle of the fill material shall be minimum  $40^\circ$  at this specified compaction.

The Owner's Representative determines where and when plate tests shall be carried out.

This item is not a pay item. Cost of plate test shall be included in filling.

### **3.6 Asphalt pavement**

The Contractor shall lay asphalt pavements within the Project Area shown on the Drawings.



The asphalt shall be placed in one layer, in average 50 mm thick after compacting. The Contractor shall use Y-12 wearing course asphalt mixture with B180 soft bitumen. The asphalt mixture shall comply with the following requirements:

|   |             |
|---|-------------|
| Percent air voids   | ≤ 3%        |
| Bitumen (asphalt cement)                                      | 6,7 - 7.2 % |
| Temperature on trucks leaving the asphalt plant               | 150-170 °C  |
| Temperature when dumped from trucks into the spreader         | ≥130 °C     |
| During hauling the asphalt mixture shall be suitably covered. |             |

The asphalt course shall on average have the correct thickness, with maximum deviation of 5 mm.

Compaction by 6-7 tons vibratory roller starting at once after placement of the asphalt shall at least be one pass forward and backward without vibration and three passes with vibration. The asphalt pavement shall then receive eight passes by a pneumatic roller followed by two passes forward and backward by 6-7 tons roller with or without vibration. When the asphalt has cooled sufficiently it shall be rolled several passes without vibration for smoothing and for elimination of rolling marks.

It is a requirement that percent air voids in a core specimen be ≤ 4.0%. In addition to the above requirements the specification "Malbikun" (Asphalting) published by "Gatnamálastjórnin í Reykjavík" (Reykjavik Road Authority) applies for asphalt work.

The asphalt pavement edges shall be straight. At certain locations asphalt will be placed up against building walls. All temporary edges of asphalt pavement shall be cut just before placing of asphalt pavement shall continue.

## **4 UTILITIES, CABLE CONDUITS AND DRAW PITS**

### **4.1 General**

The installation of utilities, and cable conduits and draw pits shall not start unless the Owner's Representative has approved the substrate upon which they shall be installed. In this specification utilities shall mean storm water drains and sewers including appurtenant manholes, drain stacks and septic installations, and water pipelines.

### **4.2 Storm water drains and sewers**

#### **4.2.1 Pipelines**

Pipes for this work shall be of concrete and be manufactured in accordance with DS400.3 and the sizes shall be as indicated on the Drawings. Pipes shall be laid on compacted backfill.

Sewer and storm water drain pipelines shall be embedded in fine gravel from trench bottom, 200 mm underneath invert, to at least 300 mm above utility lines. The embedding material shall be placed and compacted in two phases i.e. up to the pipe centreline and finally to the top.

Care shall be taken to lay the pipes as shown on the Drawings and the pipeline shall be straight and in level and grade. For jointing of pipes clamps specially made for that purpose shall be used. The pipe joints shall be made tight by the use of rubber gaskets. Special care shall be taken to ensure that the clearance between pipelines that cross is at least 100 mm. All connections to pipes shall be made by branch pipes. The pipelines shall incline in longitudinal direction as shown on the drawings.

When placing the pipes the bells shall be dug free ensuring that the pipes rest on the drum. Pipelines may not be covered before the Owner's Representative has verified the correct location and finish.

All pipe ends for later connections shall be securely closed with material and technique approved by the Owner's Representative. Place bells tops to receive downspouts 100 mm below finished grade.

The Contractor shall lay all pipes in main lines and to drain wells and shall end pipelines to downspouts above finished grade as shown on the Drawings.

After completion of pipelines finishing the Contractor and the Owner's Representative shall jointly verify that the pipelines have not been damaged and that they are straight and clean.

#### **4.2.2 Manholes**

Manholes shall be of concrete and be manufactured in accordance with DS400.3

If a pipeline transverses a manhole without a sharp bend, a half pipe sections (split pipe) shall be laid through the manhole. Half section pipes not commercially available the Contractor shall split by cutting. If shortening of pipes is required this shall also be done by cutting.

Where there is a sharp bend in a main pipeline a curve shall be shaped in the manhole invert and care shall be taken that the pipe section is

not diminished in the curve. Where a side branch joins the main pipeline, a curve in the streaming direction shall if possible be shaped in the manhole invert.

Manhole foundations may be precast or cast-in-place concrete and for this it is imperative that all concrete and concreting is of first class workmanship. The concrete shall be C35 according to ÍST EN 206-1:2000 and ÍST10:1971, I and II as applicable. The slump of all concrete shall be 50-80 mm. Placed concrete shall be protected against all kinds of stresses, rain, frost etc., until it has reached required strength. Usually concrete work shall not be started when ambient temperature of +3° C or less is likely unless special protection arrangements approved by the Owner's Representative have been made.

The circular precast manhole risers shall be provided with steps of steel spaced at about 250 mm intervals and when installed alternate placing of the steps shall be ensured. Joints between manhole risers shall be mortared. Risers for extending manholes shall be laid on mortar so as to obtain uniform resting for the entire circumference.

Manholes shall initially be equipped with a temporary cover about 300 mm below the fill final grade. After completion of compacting hand tools shall be used for digging down to the covers and the manholes extended so that final manhole covers shall be flush with the final surface. No other equipment but hand tools will be permitted for digging down to manholes.

The manhole cover shall be a first class cast iron cover of standard fabrication for traffic areas and equipped with adjustable frames where required, as approved by the Owner's Representative.

In sewers outside bulk excavated and filled areas the manholes shall be completed in one step with final concrete covers. The elevation of the manhole covers shall be flush with the final surface.

#### **4.2.3 Drain stacks**

This specification applies to installation of open area drain stacks and elevated drain stacks as shown on the drawings.

Drain stacks wells shall be made of concrete pipes of the diameter indicated on the Drawings. A 100 mm thick layer of concrete shall be cast underneath the drain stacks wells followed by back filling of fine graded gravel. The surrounding surface at drain stacks shall be graded with even slope towards the stacks.

Initially drain stacks wells shall be terminated 300 mm below fill grade and closed by a steel plate cover. Drain stacks wells shall be covered by filling materials.

After completed fill compaction the Contractor shall dig down to the top end of the drain stacks wells and extend the drain stacks wells upwards so that a drain grating to be installed will be 10-20 mm below final surrounding surface. Arrangement shall be made so that searching for open area drain stacks wells causes a minimum disturbance in the fill and on the surface.

Grating frames shall be placed in sand-mortar that shall be carefully spread underneath and around the frame to secure it in level and place. All drain grates shall fit to the well diameter as indicated. The Contractor shall lay in sand 1500x1500 mm of concrete bricks around drain stack as shown on the Drawings.

#### **4.2.4 Septic tanks**

The Contractor shall supply and install septic tanks of a standard fabrication of the size and location as shown on the Drawings. Only septic tanks approved by the Environment and Food Agency of Iceland (UMHVERFISSTOFNUN) will be accepted.

Septic tanks shall be installed in accordance with the septic tanks manufacturer's written recommendations.

This work shall include all necessary excavation and backfill.

#### **4.2.5 Oil- water separators**

The Contractor shall supply and install oil-water separators of a standard fabrication of the size and location as shown on the Drawings. The installation of oil-water separators shall be in accordance with the publication "Leiðbeiningar Nr. 2, Olíuskiljur", latest issue, published by the Environmental and Food Agency of Iceland (Hollustuvernd ríkisins), presently Environment and Food Agency of Iceland, (UMHVERFISSTOFNUN).

This work shall include all necessary excavation and backfill.

#### **4.2.6 Sieve pipelines**

Sieve pipelines shall be constructed by laying out dia. 110 PVC drainpipes with the slotted section faced down. The pipes shall lie in at least 200 mm thick sorted 6-10 mm gravel layer. On top of the sorted

gravel the Contractor shall lay out geotextile , 90 g/m<sup>2</sup>. The pipes shall be located as shown on the Drawings and shall be 2 m apart.

### **4.3 Water piping**

#### **4.3.1 Water Pipelines**

Water pipelines shall be laid in accordance with the Drawings and the Contractor shall furnish all materials and all work in this regard.

The Contractor shall lay pipes in straight lines between fixed points as shown on the Drawings. Trenches for water pipelines shall be backfilled with fine sand from trench bottom, 150 mm underneath invert, to at least 300 mm above water pipelines.

The pipes shall be manufactured of PEH in accordance with DIN 8074/8075 and be rated for 1 Mpa (10 kp/cm<sup>2</sup>) pressure. The pipes shall be jointed by welding, except where by special requirement valves are needed.

#### **4.3.2 T - Connections to main**

The Contractor shall furnish and install connections on main waterpipe, as shown on the Drawings. The connections shall either be standard T-connections or fast-T connections as appropriate. The connections shall be embedded in sand as specified above in clause 4.3.1 Water Pipelines.

#### **4.3.3 Gate valves**

The Contractor shall furnish and install gate valves on the water pipelines, as shown on the Drawings, the valves shall be in accordance with ISO 2531 PN-10 with a spindle. The Contractor shall provide all material and labour for connecting the valve to the pipelines. Great care shall be taken that the spindles do not bend out of vertical alignment during backfilling. Shovelling around the spindles shall only be done by hand tools.

The Contractor shall connect a spindle extension to the valve spindle and fasten it.

After completion of compacting the Contractor shall install the spindle protection pipe so that the cover of the protection pipe is flush with the surface. The Contractor shall furnish and erect spindle cover of cast iron and place concrete bricks around it as shown on the Drawings.

#### **4.3.4 Fire hydrants**

The Contractor shall furnish and install fire hydrants as shown on the Drawings. The fire hydrants shall meet or exceed AWWA CS02, latest revision and be furnished with two 63mm hose connections, one 114 mm pump connection and have a 150 mm bottom. The fire hydrants to be installed shall be self-emptying and the Contractor shall place at least half a cubic meter of crushed rock under and around the lower part of the fire hydrant. Prior to backfilling around the fire hydrant with finer material the Contractor shall place geotextiles on top of the crushed rock.

The elevation of the fire hydrants shall ensure 1250 mm distance from the centre of the supply water pipe to final grade at the location of the fire hydrant.

#### **4.3.5 Flushing and pressure testing**

Prior to final completion of water pipelines the Contractor shall flush the lines. The Contractor shall ensure that the flush water has a free passage from the pipeline end towards a sewer, so there is no risk that dirty water accumulates in the trench and re-enters the pipeline after flushing.

After flushing of the pipeline it shall be pressure tested with clean water followed by final finishing of joints where needed. The pipelines shall be covered with sand fill except at connections, which shall be visible during testing. The test shall be carried out using pressure of 1 Mpa for 8 hours showing no drop in pressure.

#### **4.4 Cable Conduits.**

The Contractor shall furnish and install PEH conduit pipes for low voltage, control and communication cables in the location and number shown on the Drawings. The conduit shall be laid on well graded, compacted 100 mm sand fill. Over the pipes the sand fill shall be at least 100 mm thick. The pipes shall be installed in such a manner that water pools cannot develop inside the pipes. All pipe ends shall be securely closed. Inside each pipeline there shall be a 7 mm nylon cord for later use. The location in coordinates in the plant coordinate system of all pipe ends shall be submitted to the Owner's Representative.

#### **4.5 Draw Pits**

The Contractor shall furnish and install draw pits as shown on the Drawings.

Draw pits shall be made of concrete and for this it is imperative that all concrete and concreting is of first class workmanship. The concrete

shall be C35 according to ÍST EN 206-1:2000 and ÍST10:1971, I and II as applicable. The slump of all concrete shall be 50-80 mm. Placed concrete shall be protected against all kinds of stresses, rain, frost etc., until it has reached required strength. Usually concrete work shall not be started when ambient temperature of +3° C or less is likely unless special protection arrangements approved by the Owner's Representative have been made.

The draw pit walls shall be provided with steps of steel spaced at about 250 mm intervals and when installed alternate placing of the steps shall be ensured. Optionally a prefabricated steel stair may be bolted to the concrete as accepted.

The draw pits manhole cover shall be a first class cast iron cover of standard fabrication for traffic areas and equipped with adjustable frames where required, as approved by the Owner's Representative.

All draw pits shall be provided with a drainpipe connection at the floor to be connected to the nearest storm water drain as shown on the Drawings. No water accumulation on the draw pit floor is accepted. Slope floor towards the drainpipe connection.