



Ski resorts of DIDVELI / BAKURIANI - GEORGIA

BAKURIANI LAKE PROJECT

This report concerning the Bakuriani lake project (for snowmaking and Leisure Lake) will include all the information about the conception of the lake.

1. General dimension

a) General hypothesis

Regarding our last 30 years of experience in the Alps for managing snowmaking project, water and energy resources, and the following hypothesis could be taken into consideration:

- The average global need for one season is around 90 cm, considering the alteration of snow and usury
- Possibility to produce snow and open the skiing tracks within 5 nights (60 hour) of cold (minus 2.5°C or less) for approximately 50 cm, before Christmas holiday period (50 to 60% of the full season)
- Generation of snow to ameliorate the quality of slopes and finalize the winter season in security (20/25% before the end of January and 2 times 10/15% after).

The importance and requirement of building some lakes are about 4 major points:

- The necessity to dispose the maximum debit to insure the opening of the ski resort after the first week of effective cold
- The limitation of energy consumption during the producing of snow, if the lake is situated at an upper altitude points from the ski track (between 2 and 3 times less electrical power needed)
- The insurance of the water quality, regarding the possibilities of filtration and settling of sediments
- The tourist possibilities opportunities around the lake, the building, shops and lift station around) and the unique landscape opened: walking, picnic, fishing, splashing, nautical ski, ...

Projecting a lake means also to secured the situation of water reserve and protect the bottom of the lake, in anticipation of any hazard. This can be traduced by the maintaining of about 20/30% of the global capacity at each time.

Venues of Lake Project need to be analysed scrupulously, as such an infrastructure is liable to natural risk and could drive so irreversible damage for goods and lethal trouble after an eventual dam breaking facing:

- *Snow avalanche (not considered along the actual venues studied)*
- Hydrological water flow
- Wind waves
- Geotechnical stability and foundation
- Seismicity resistance
- Overflow channel
- Waterproof guarantee
- Topographic and landscape optimizing
- Adaptation with the pump station implantation
- Possibilities of filling up



Snow-making lake

b) Didveli/Bakuriani needs

Regarding the previous general explanation, the water minimum needs to produce snow with the necessary security are the following on the Bakuriani venue, for 8 ha of slope to be prepared:

- 36 000 m³ for the all winter season
- 350 m³/h (100 l/s) of debit before the opening season.

The downside table shows the evolution of the volume into the lake, considering the different stage of snow producing, and taking into account the water take possible from water company downside the resort (50 l/s).



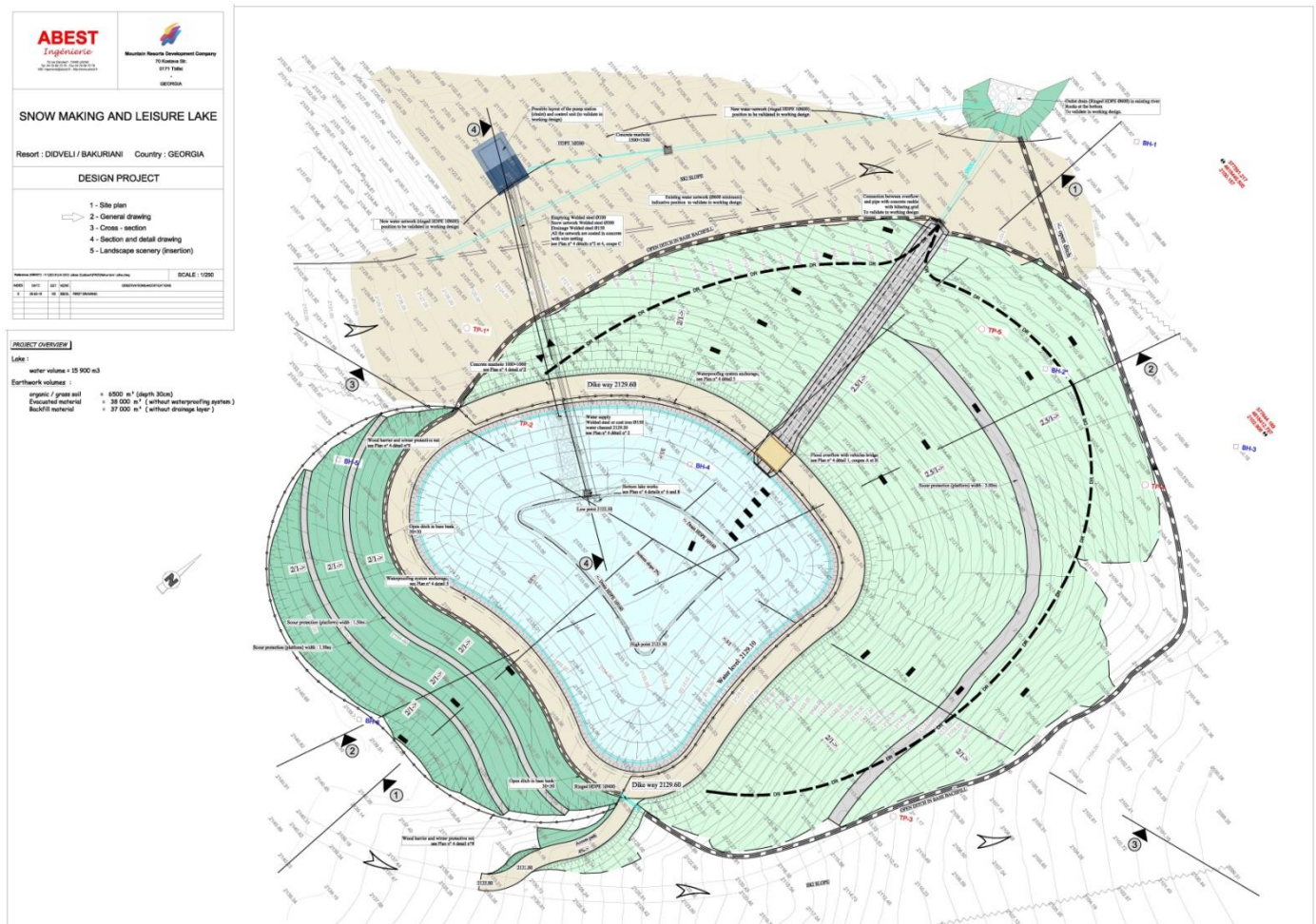
Winter season period	initial lake volume	snow producing	possible fill up (50 l/s)
01-05 december	15 500	19 800	9 000
05-31 december	4 700		90 000
01-15 january	15 500		54 000
15-25 january	15 500	9 000	36 000
25-31 january	15 500		9 000
01-22 february	15 500	3 600	72 000
22-28 february	15 500		9 000
01-15 march	15 500	3 600	54 000
	15 500	36 000	333 000

It demonstrates the absolute minimum need of lake water volume at 15 000 m³.

We have also considered that in Georgia, the administrative and reglementary constraint are harder with à lake further more than 100 000 m³. In the case of the Bakuriani Lake project it's not necessary to have a big lake due to the important possibility of filling up (50 l/s) during winter.

The volume of the Bakuriani Lake project is 15 900 m³ of water.

Finally, the setting-up of this lake was defined between the two existing ski slope (east and west side), the natural ground around and also the existing river below.



2. Stability of the lake

The stability of the lake was calculated with the GVIRGVINI Ltd study (conducted in December 2014 and January 2015) conclusion.

This conclusion (Borehole and pit) was interpreted to design the stability of the lake.

The conclusions have allowed showing the different geological layers (see the map 3 - Cross-section):

- Organic / Grass soil on approximately 30 cm to 40 cm - EGE1;
- Gravel in crushed stone clayey until 4,2 m to 6,5 m depth - EGE7 / EGE8;
- Sandy and Clay soil with gravel and crushed stone until 30 m - EGE2 to EGE6;

This conclusion shows that there are 2 geological layers (Organic clayey / grass soil with Gravel in crushed stone layer and sandy / clay soil layer).



The study show subterranean water circulation (towards 13,0 to 15,0 m depth) and also our visit has us allowed to notice in-rushes of water.

The seismic calculations were realized with as data:

- Magnitude = 8
- Acceleration = 0.16

All of this information allows us to do the stability calculation with TALREN software. TALREN allows the check of the stability of the geotechnical works, with or without strengthening: bank natures, scour protection, reinforcement backfill, elevations, dams and dikes work.

TALREN 4 v2.0.4 1150132.1
Retenue collinaire BAKURIANI

Données phase/situation / Page 1

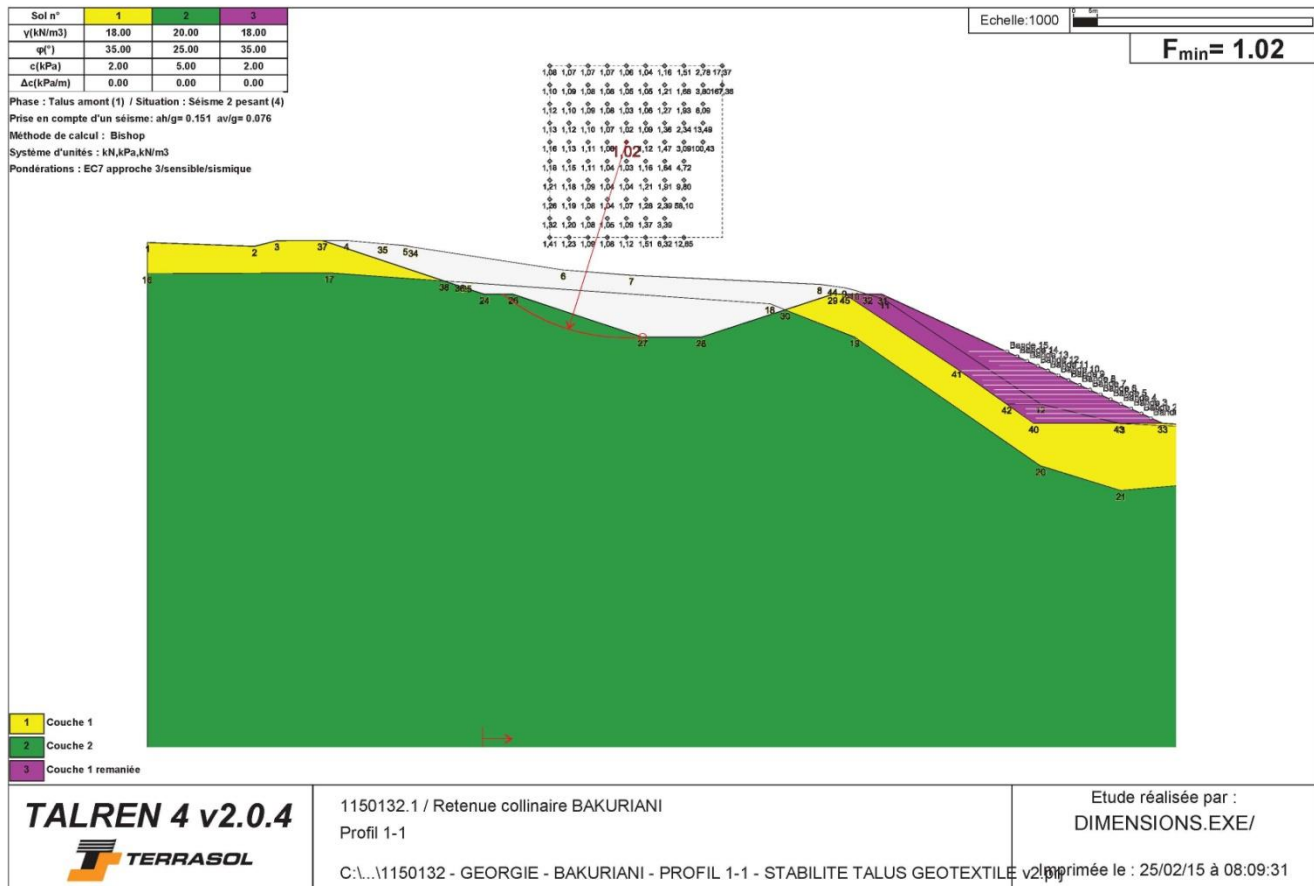
Données de la phase : Talus amont (1)

Enveloppe du talus

Segment	Segment	Segment
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4	5	6
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13	14	15
16	17	41

Segments de la phase

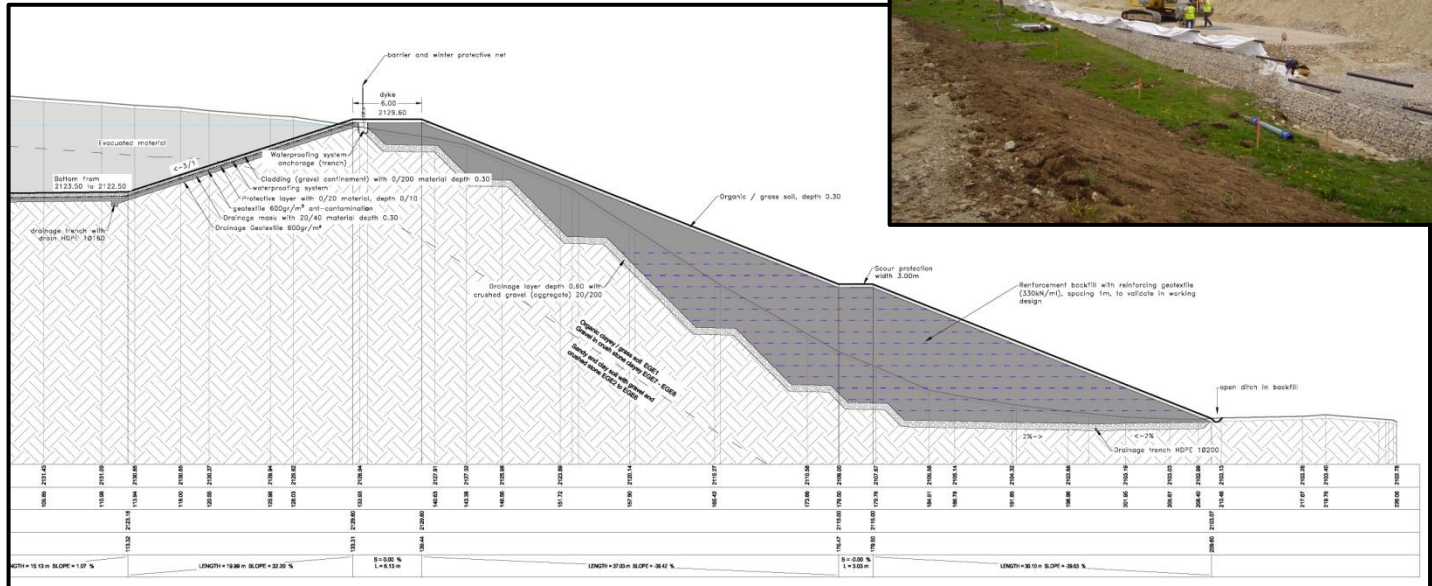
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Conclusion of the stability study:

- Elevation of dike with materials stemming from the excavation material (with EGE7/EGE8 material);
- Reinforcement backfill of the dyke (depth : 15m) with reinforcing geotextile (330 kN/ml), spacing 1m;
- Purge before the reinforcement backfill from 5 to 7 meters on the natural ground on the existing bank;
- Scour protection (1,5 to 3,0 m width);
- Possible purge if unfit materials (or if presence of water);
- Bank slope = 3/1 (inside the lake) and 2/1 to 2,5/1 (outside the lake);
- Consideration of the seismicity with safety factors of 1 minimum;

Reinforcement backfill



3. Hydraulic design

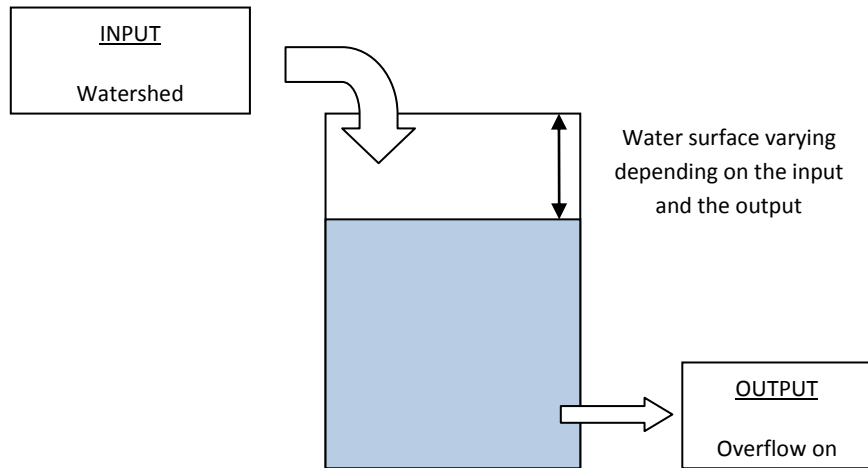
A spillway is planned for the Bakuriani Lake. This structure will provide the project with the ability to release excess or flood water to ensure the safety of the lake.

This technical note aims to present the hydraulic design of spillway which includes a weir, an open channel spillway and a plunge pool energy dissipater (dissipation Trench).

a) Methodology

The weir is calculated for an extreme flood. According to French legislation, the choice of the return period to consider for the design depends on the maximum head and the volume of the dam. A freeboard (revenge) of 40 cm and a 1 000 year event are considered.

The structure is designed for a 1 000 year flood in the lake's watershed and a water surface in the lake at 2128.60 m (crest weir elevation). A model is built considering at the same time the flow coming for the watershed, the lake itself and the overflow in the weir. The schema model is the following:



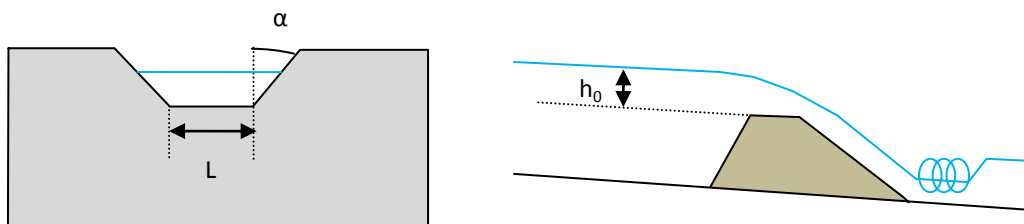
Schema of the model built for the design of the weir

b) Calculation of a 1000 year flood

The 1 000 year peak discharge of Bakuriani basin is evaluated to $0.92 \text{ m}^3/\text{s}$ with the rational method.

Bakuriani's watershed :		
Q10	Q100	Q1000
$0.25 \text{ m}^3/\text{s}$	$0.63 \text{ m}^3/\text{s}$	$0.92 \text{ m}^3/\text{s}$

A trapezoidal weir is planned.



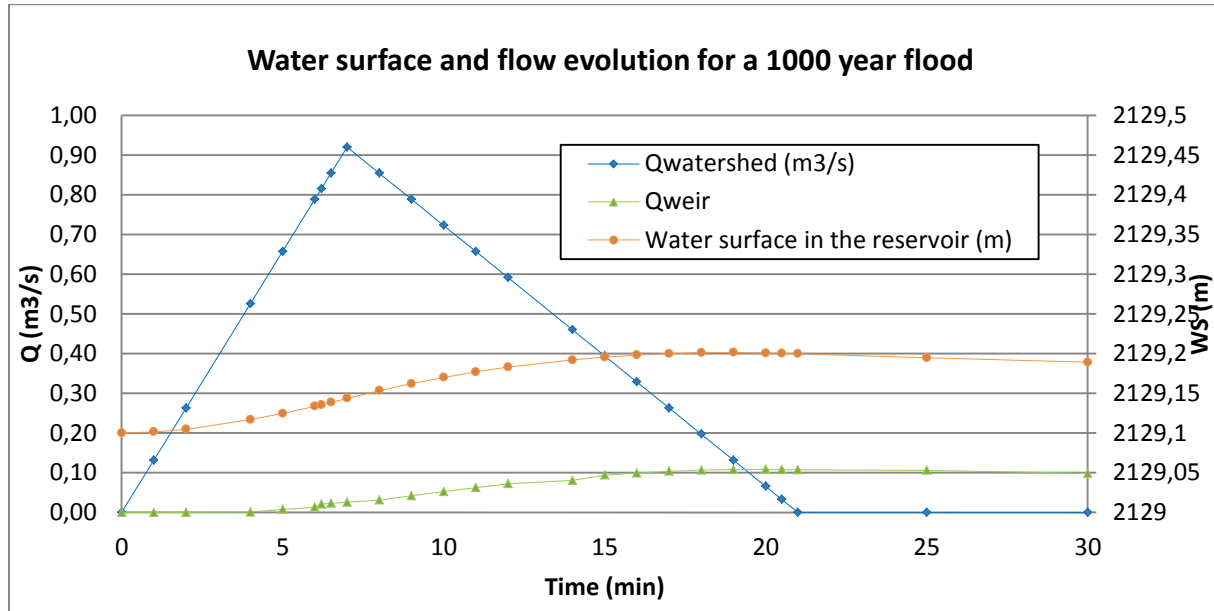
Weir schema

A multiplicative coefficient of 0.6 is added to compute the discharge over the weir to consider the roughness of the weir and the potential ice which can reduce the weir's efficiency.

c) Results

A Trapezoidal weir with a length of 3 m can evacuate a 1000 year flood. The head water on the weir is 0.10 m (highest water level at 2129.20 m).

The lake enables to reduce the peak of the flood of 90 percent: 0.11 m³/s instead of 0.92 m³/s.

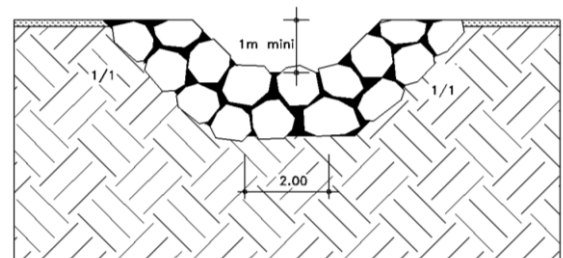


The maximum storage in the lake is around 520 m³.

d) Design of the open channel spillway

An open channel with the following size and a slope of 33 % is planned:

The capacity of this channel is estimated using the Manning-Strickler equation.



It appears that the capacity is higher than the flood over the weir in the 1000 year event case.

e) Emptying of the open channel spillway

At the end of the open channel spillway the water will go to the existing river through a water network (ringed HDPE Ø600 minimum).

Before the network, the channel area is widened to reduce the velocity flow.

This work is to be defined properly in the working design phase to be adapted according to the topographic information on the river and the slope.

4. Control unit

On the Bakuriani Lake, several elements of surveillance are necessary to assure the safety for the downstream but also the sustainability of the lake:

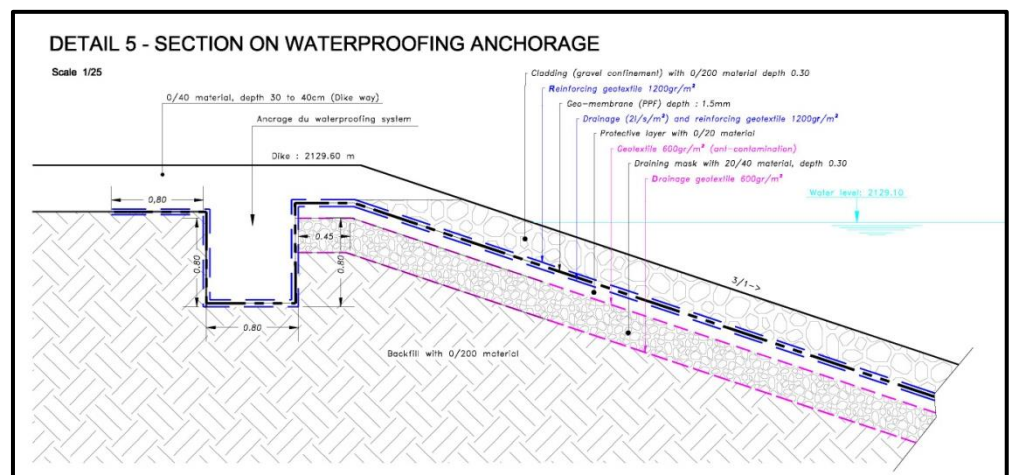
- Drainage trench at the bottom of the lake (1 central drainage trench) to collect water under waterproof system. These drainage trenches are returned to the pump station to be verified. This control permit to see possible leaks. This control must be collect also by an alarm if there a big quantity of water arrived on the pump station.
- Drainage layer under dyke, with 20/200 material, allows to assure the basis of the dike and to collect possible in-rushes of water.
- Monthly control of the weir overflow to be sure that there is no problem on it (ice, rocks, cracks...).
- To be sure there is no presence of water on the dike, the installation of piezometer is essential (position to be validated in working design).
- Control of the scour protection, the open ditch...
- It's also necessary to have some topographic point all around the lake (on concrete block) to assure a control of the stability of the lake during the year



Piezometer

5. Waterproofing system

The waterproofing system was dimensioned with the kind of material on the site, the possible presence of water and the slope of the bank. The surface of the waterproofing system is 5 500 m²





The waterproofing system will include:

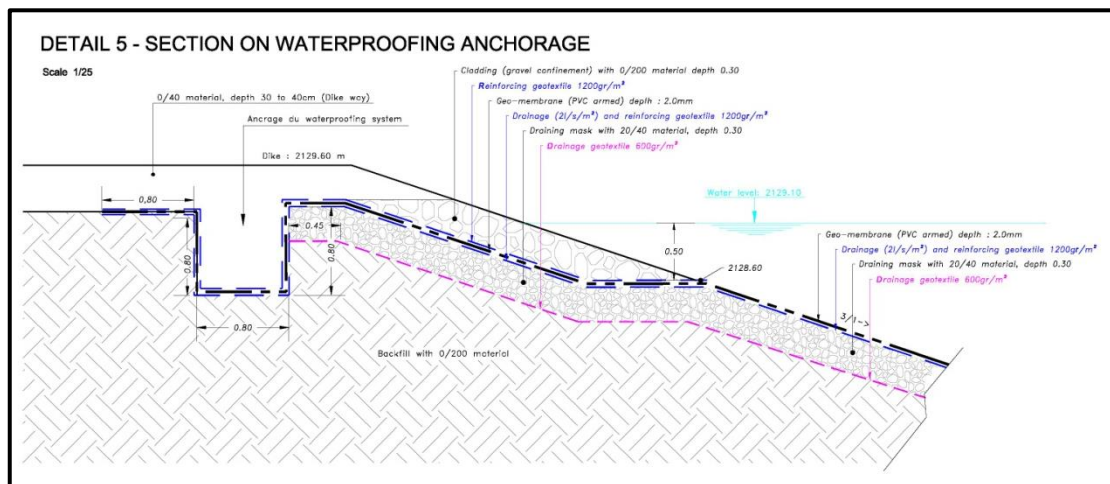
- One drainage geotextile 600 gr/m²;
- One draining mask (30 cm depth) with 20/40 material;
- One anti-contamination geotextile 600 gr/m²;
- One protective layer (10 cm depth) with 0/20 material or with brush material on the site;
- One drainage (minimum of 1,00 l/s/m according to the French norm) and reinforcing geotextile 1200 gr/m²;
- One geo-membrane (PPF, flexible polypropylene) 1,5 mm depth;
- One reinforcing geotextile 1200 gr/m² to protect the geo-membrane;
- One cladding (gravel confinement) layer with 0/200 material (from excavated material, 30 cm to 40 cm);



Waterproof system

This kind of waterproofing system will require the input of materials for draining, protective and cladding layers!

In variant, It's possible to limit the input of materials with a solution without cladding layer and with a different géomembrane (2,00 mm depth). This solution had the same volume of water but limit the leisure activity!





6. Volume of earthworks

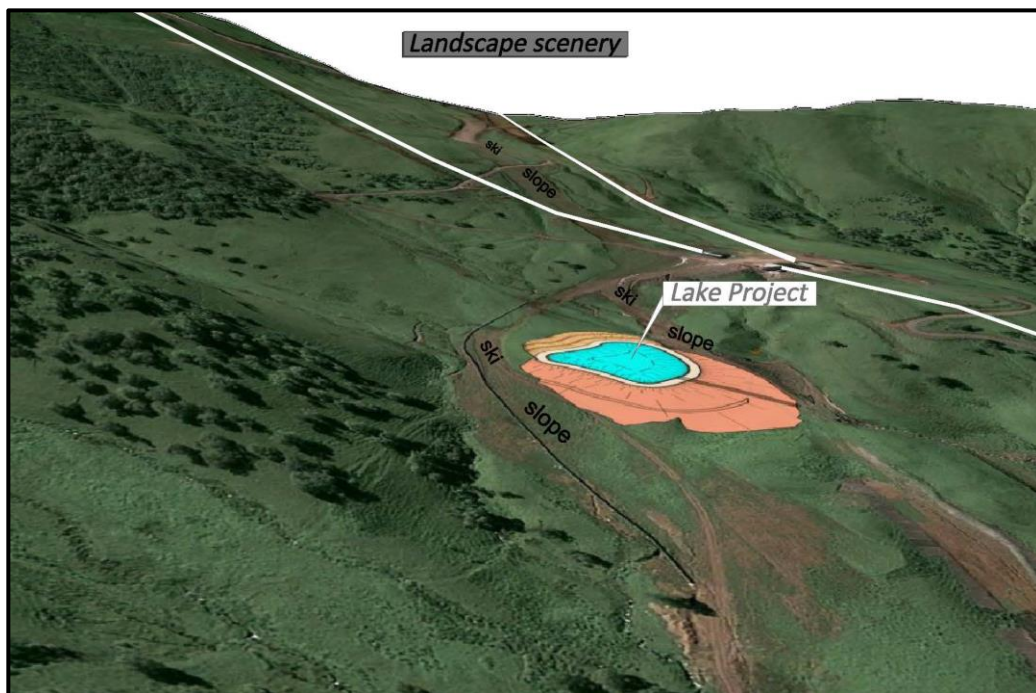
The balance sheets of the earthworks of the project are:

- Organic / grass soil, surface 2.2 hectares by 30 cm = 6 500 m³;
- Excavated material (without waterproofing system) = 38 000 m³;
- Excavated material for the waterproofing system = 4 000 to 7 000 m³;
- Purge (in case of water) = 5 000 to 20 000 m³;
- Excavated material total (without purge) = 51 500 m³;
- Backfill material (without drainage) = 37 000 m³;
- Backfill material (in case of purge) = 5 000 to 20 000 m³;
- Backfill material for drainage = approximately 9 000 to 15 000 m³;

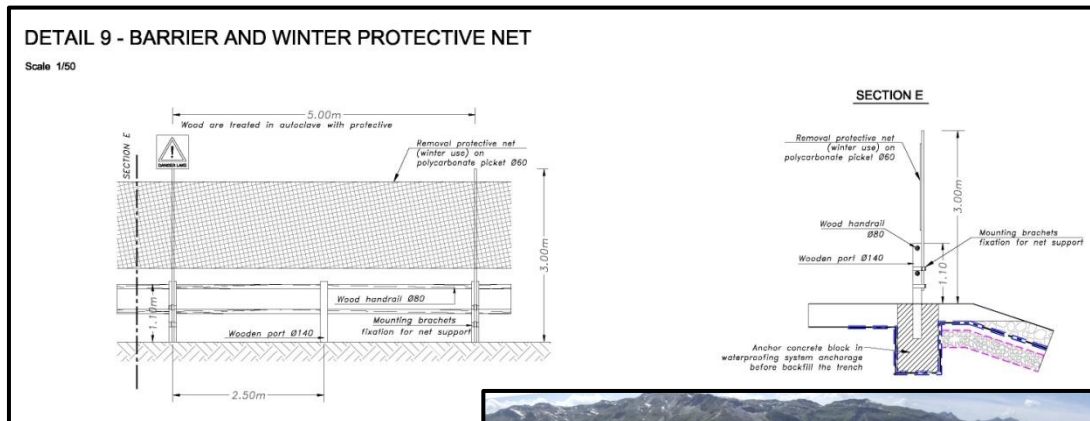
The Bakuriani site project allows re-using a small part of the excavated material for the technical compacted fill (with reinforcing geotextile) of the dyke with 0/200 material. But there is not enough good material for the waterproofing system (drainage, protective and cladding layer). It's necessary to had more information about the second geological layer (sandy and clay soil) to validate their re-uses or not.

7. Environment (insertion)

The setting-up of the lake was thought so as to become integrated as much as possible into the environment of the existing site (with the existing ski slope / pathway, the natural flood water / the river ...).



For this lake we suggest to have a wood barrier and to had in winter period a protective net to forbid the skiers to come down (to fall down!) and to indicate it in case of bad weather.



Wood barrier and winter protective net



The existing site is provided with a lot of quantities of organic/grass soil and will allow a backfill on all the banks, allowing better one regreening by the local vegetation.

8. Economical quote

The estimated price of building the Gudauri lake without working design studies, supervising of work and snowmaking pump station are approximately 1 250 000 €.

This price can be decomposed by kind of works:

- General earthworks = 500 000 €;
- Waterproofing system = 250 000 to 300 000 €;
- Networks (under dyke, emptying, snow networks, drainage, water supply ...) = 250 000 €;
- Concrete works (snow and emptying works at the bottom of the lake, concrete manhole, drainage, overflow, spillway ...) = 150 000 €;
- Surface treatment, net and fence = 100 000 €;

These prices were calculated on valuable French bases and can be adapted we Georgian company.

9. General schedule

The delivery time for the building of a lake such as 15 900 m³ (but with technical backfill) can be defined by:

- General earthworks = 4 to 5 month;
- Waterproofing system = 2 month;
- Networks = 1 month;
- Concrete works (overflow, drainage works ...) = 1 month;
- Surface treatment = 1 month;
- Filling up = 0.25 month

This schedule (9 to 10 months), can be reduce if you superpose works or by anticipating a maximum of works and by defining exactly each link between works (networks and pump station, earthworks and waterproofing system ...).



10. Particular point to validate in working design

After the realization of the Bakuriani lake project, several points are to validate and to defined in working design (execution phase):

- Kind of networks (concrete, welded steel, coast iron...) for the emptying from the pump station.
- Dimensioning and position of the emptying networks from the pump station.
- Concrete manhole dimensions.
- Calculation (validation) of the water channel of the networks.
- Dimensioning of the waterproofing system anchorage (depending on the membrane and geotextile).
- Characteristics of the waterproofing system.
- Layout of the pump station (according to the networks).
- Dimensioning of the pump station (size, interior design).
- Dimensioning of the vehicle bridge under the weir.
- Setting up the winter protective net or wood barrier.
- Evacuation of the drainage trench, open ditch and drainage mask.

- Covering networks (1, 5 meter minimum!).
- Protection against erosion in case of water.
- Possible purge under the dyke to the rocks.
- Type of the reinforcement backfill with reinforcing geotextile.
- Draining mask under waterproof system in case of water presence.
- Emptying of the open channel spillway
- Geotechnical survey for the sandy and clay soil.
- Scour protection.



Possible pump station

ABEST
Ingénierie

75 rue Dérobert - 73400 UGINE
Tél. 04 79 89 75 75 - Fax 04 79 89 75 76
Mél. ingenierie@abest.fr - <http://www.abest.fr>



Mountain Resorts Development Company

70 Kostava Str.

0171 Tbilisi

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GEORGIA

SNOW MAKING AND LEISURE LAKE

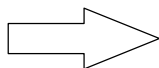
Resort : DIDVELI / BAKURIANI Country : GEORGIA

DESIGN PROJECT

1 - Site plan

2 - General drawing

3 - Cross - section



4 - Section and detail drawing

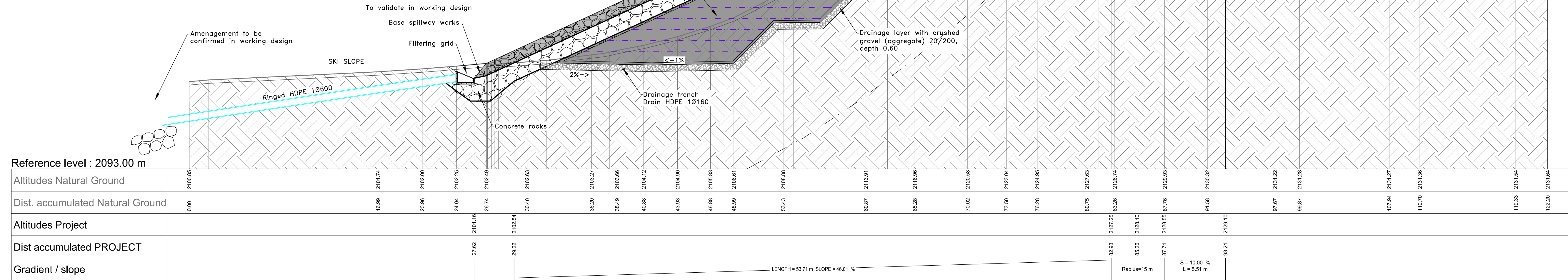
5 - Landscape scenery (insertion)

Reference (ABEST) : P:\2014\14-043 Lakes Gudauri\PRO\Bakuriani Lake.dwg

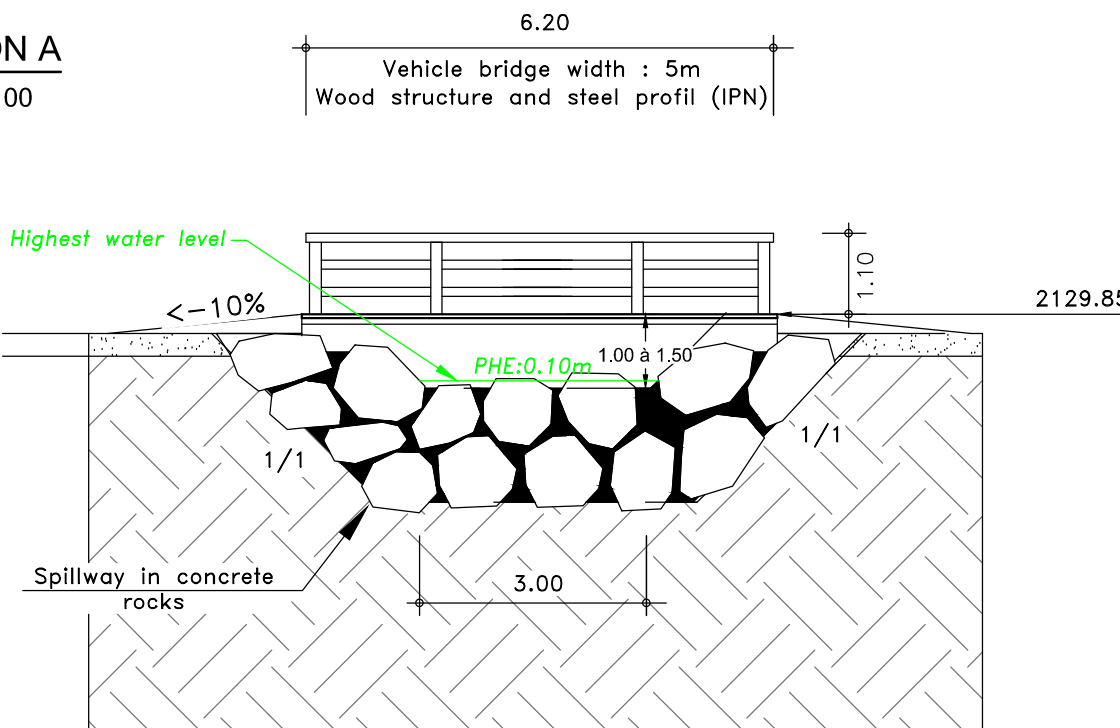
SCALE : on plan

INDEX	DATE	EST.	VERIF.	OBSERVATIONS-MODIFICATIONS
0	26-02-15	VB	BB/DL	FIRST DRAWING
A	05-03-15	VB	BB/DL	PAGE SETUP MODIFICATION

DETAIL 1 - SECTION ON FLOOD OVERFLOW (WEIR),
SCALE 1/200

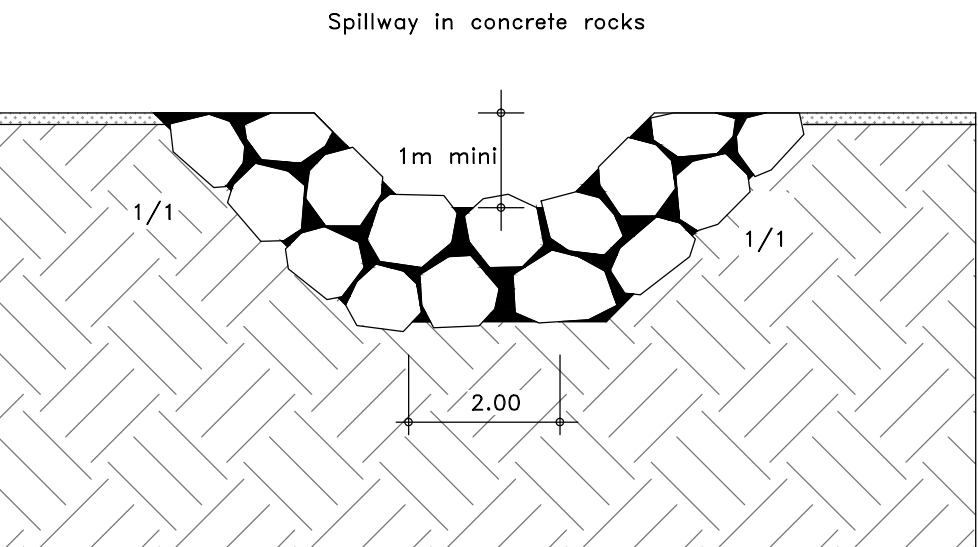


SECTION A
Scale 1/100



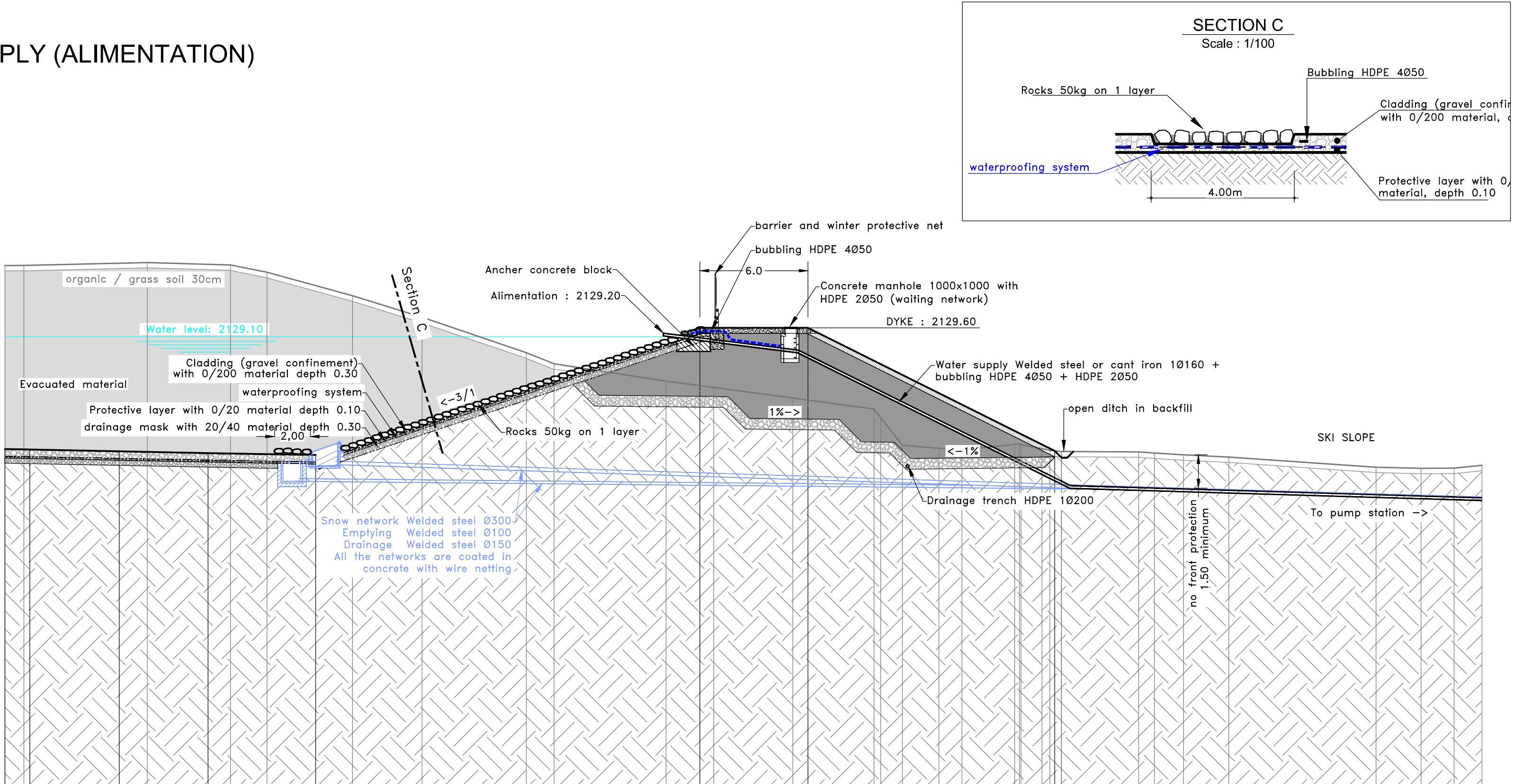
SECTION B

Scale 1/100



DETAIL 2 - WATER SUPPLY (ALIMENTATION)

SCALE 1/200

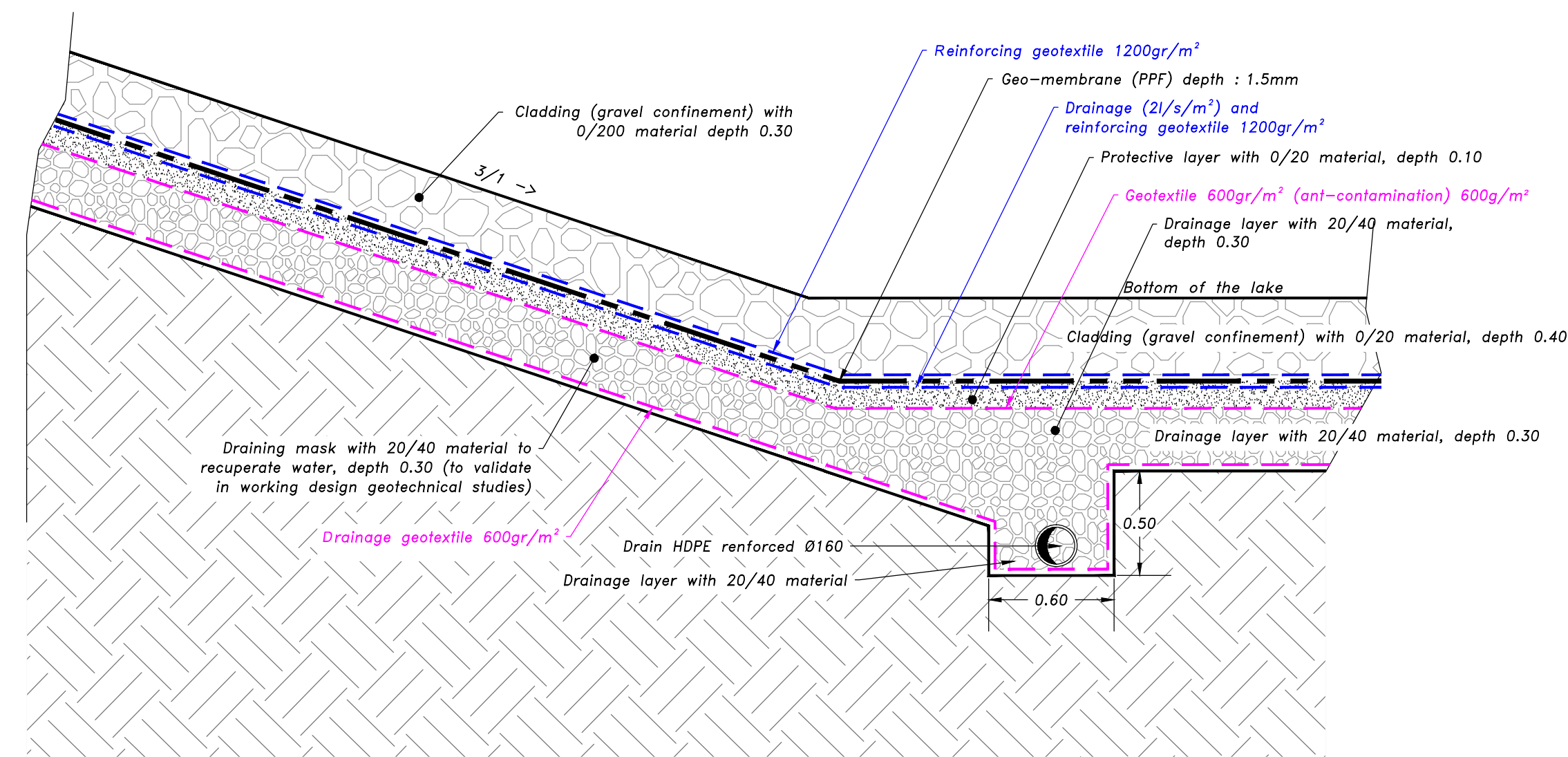


Reference level : 2104.00 m

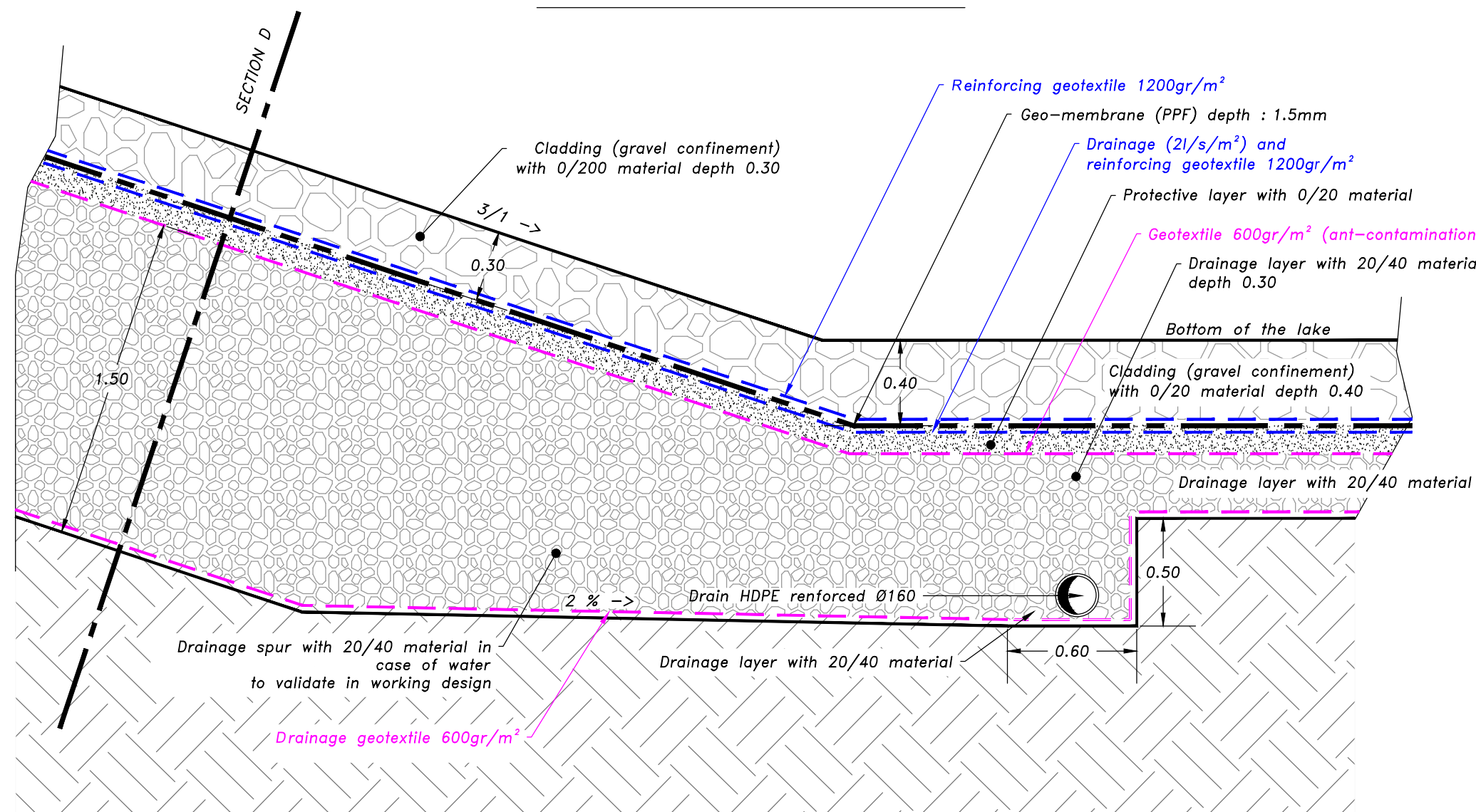
Altitudes Natural Ground	2133.08		2133.25		2133.12	2132.71		2131.40	2130.19		2128.21		2126.62	2126.27		2125.68		2125.06	2122.87		2123.09	2122.69		2122.67	2122.50		2122.38		2121.81	2121.75		2121.92
Dist. accumulated Natural Ground	0.00		7.95		12.60	14.65		19.42	23.30		29.13		36.94	39.59		44.01		48.55	52.18		56.41	59.01		63.34	65.85		68.38		76.60	79.11		82.51
Altitudes Project	2122.83		2122.70		2122.60		2122.50							2129.60		2129.60						2122.73										
Dist accumulated PROJECT	0.00		6.39		11.35		17.36							38.82		44.86						58.64										
Gradient / slope		LENGTH = 11.35 m SLOPE = -2.01 %				S = -1.66 % L = 6.01 m		LENGTH = 21.46 m SLOPE = 33.08 %							S = 0.00 % L = 6.04 m		LENGTH = 13.79 m SLOPE = -49.84 %															

DETAIL 3 - DRAINAGE
SCALE 1/25

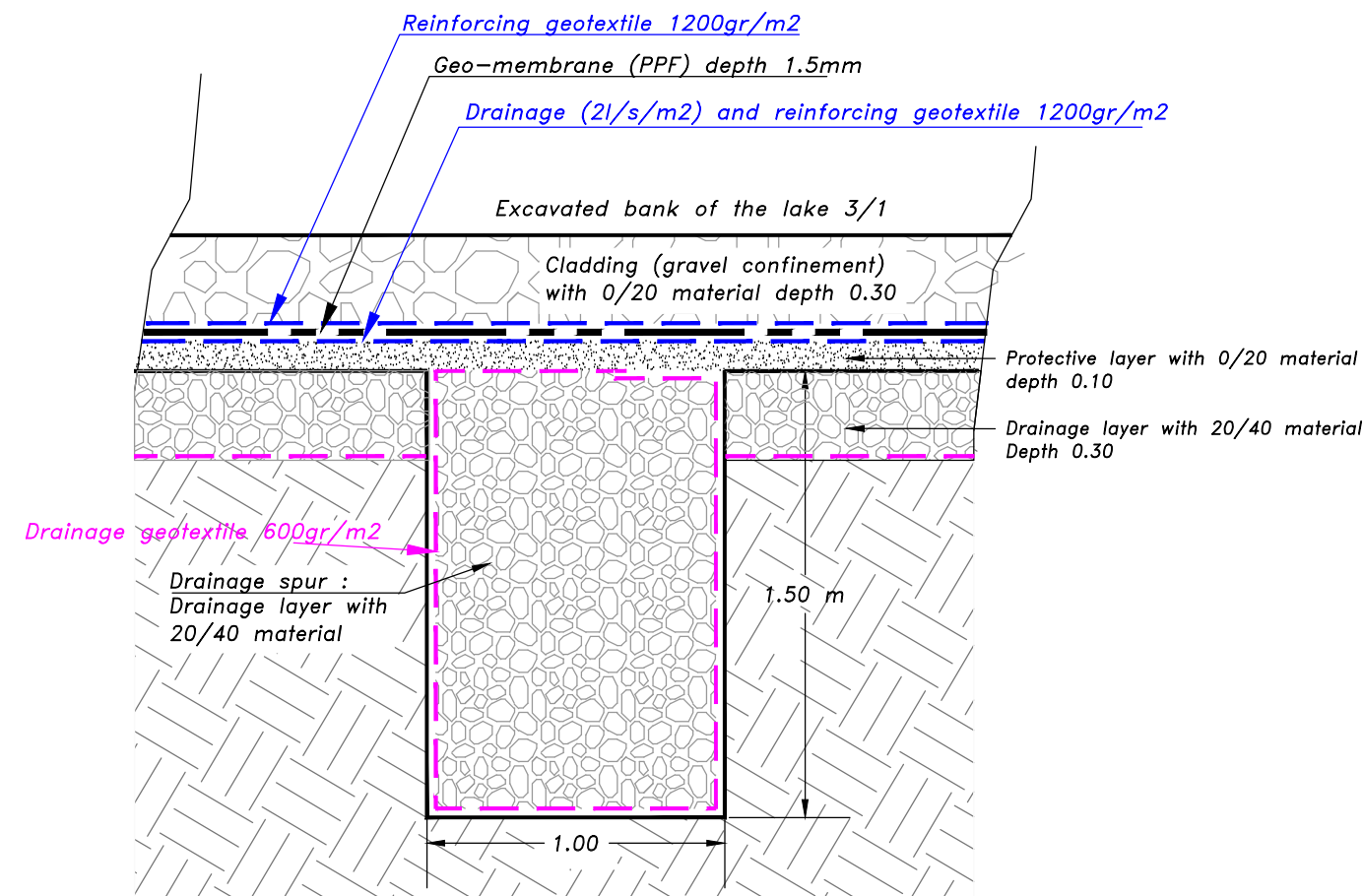
Draining mask- Excavated bank and bottom of the lake



Drainage spur - Excavated bank

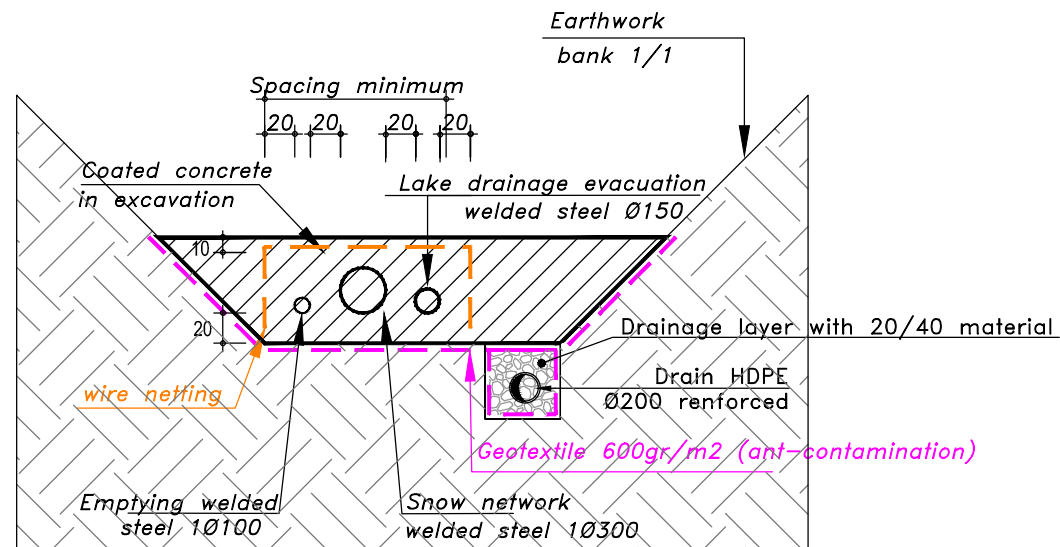


SECTION D (on drainage spur)



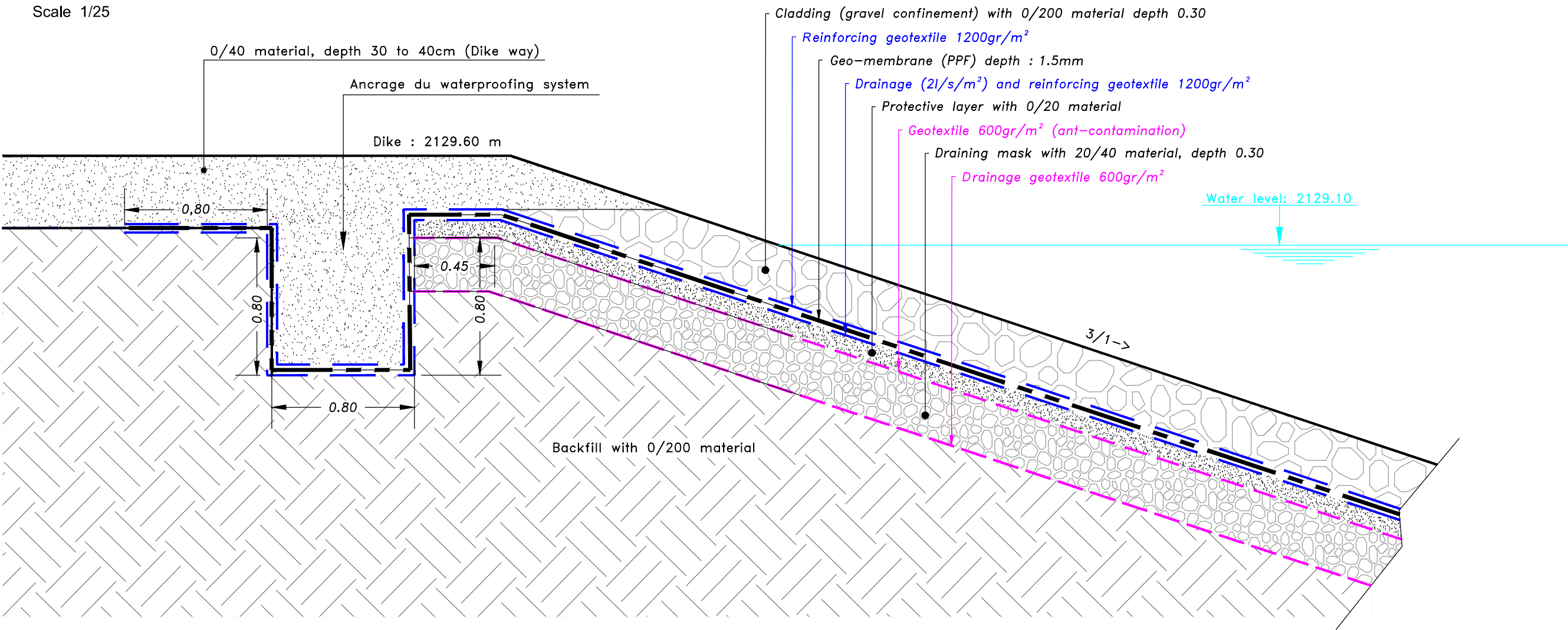
DETAIL 4 - NETWORK LAYING

Scale 1/50



DETAIL 5 - SECTION ON WATERPROOFING ANCHORAGE

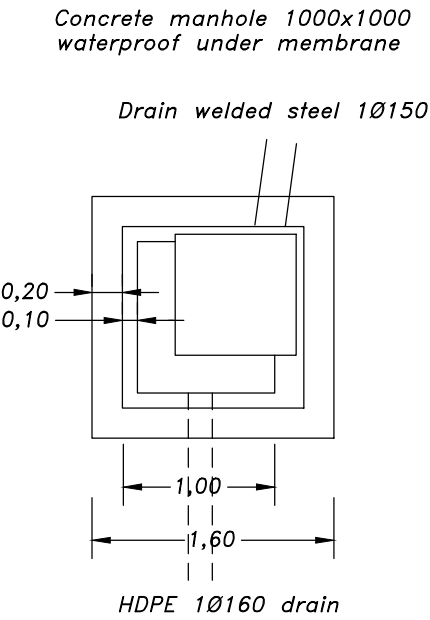
Scale 1/25



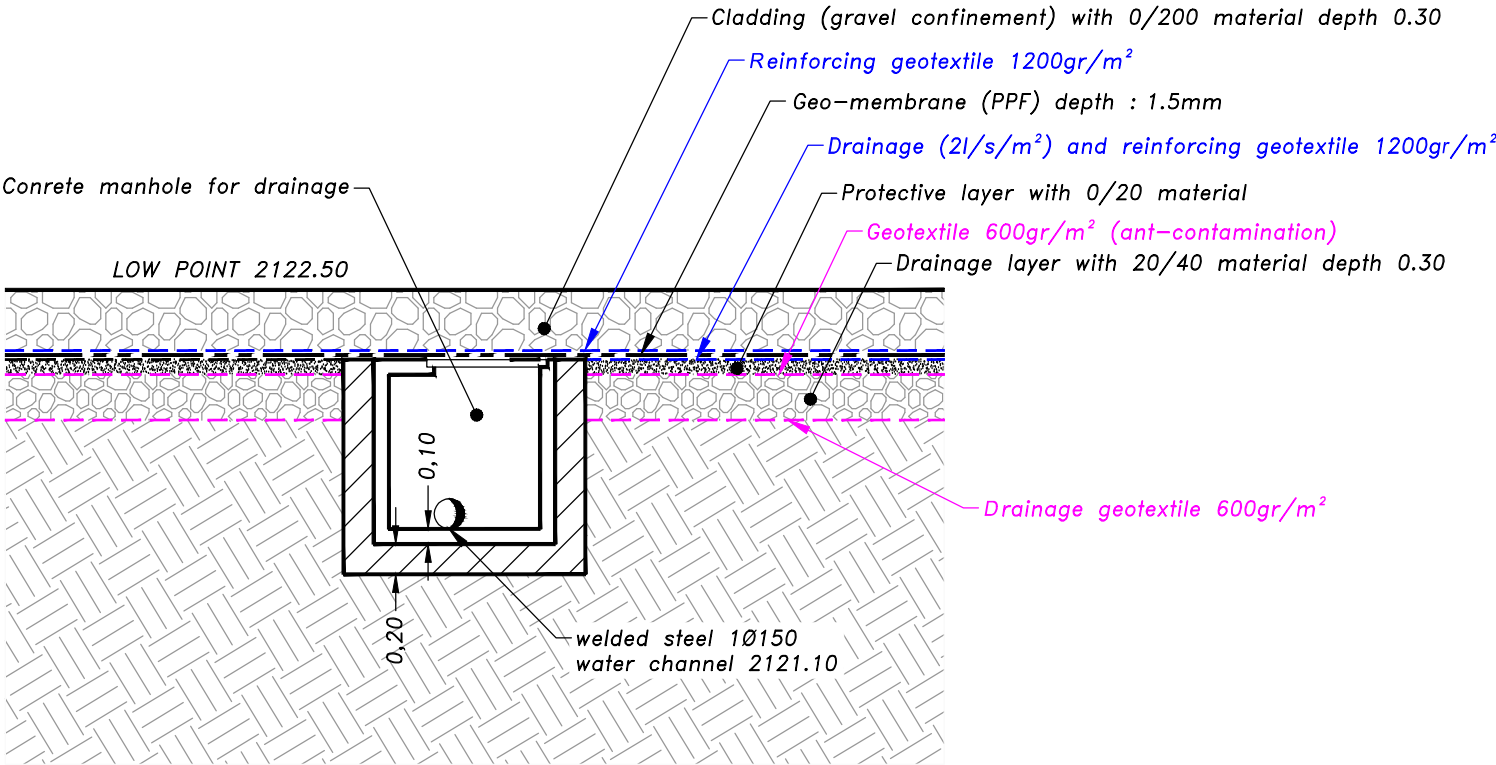
DETAIL 6 - DRAINAGE WORKS

Scale 1/50

Plan view



Section



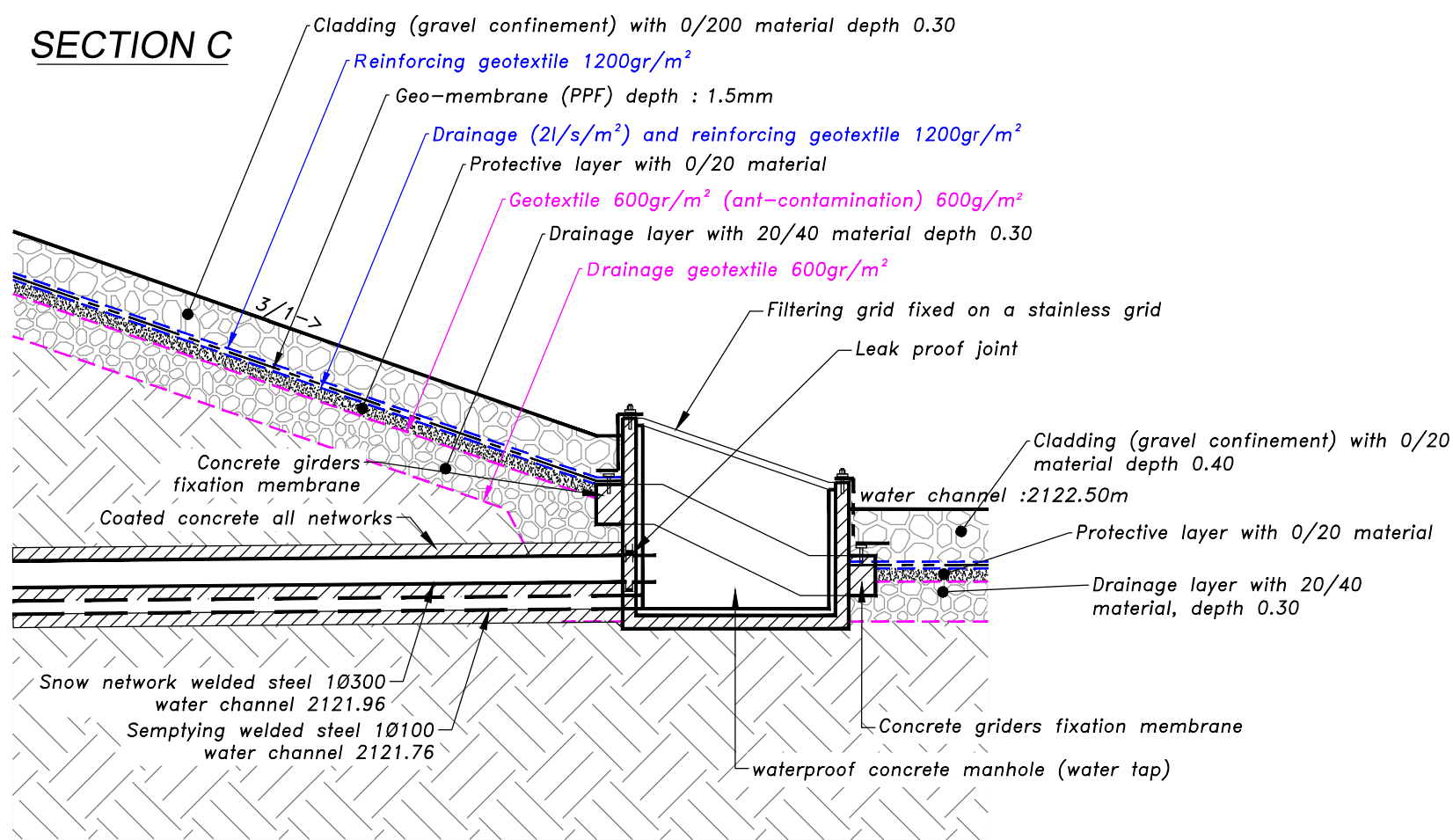
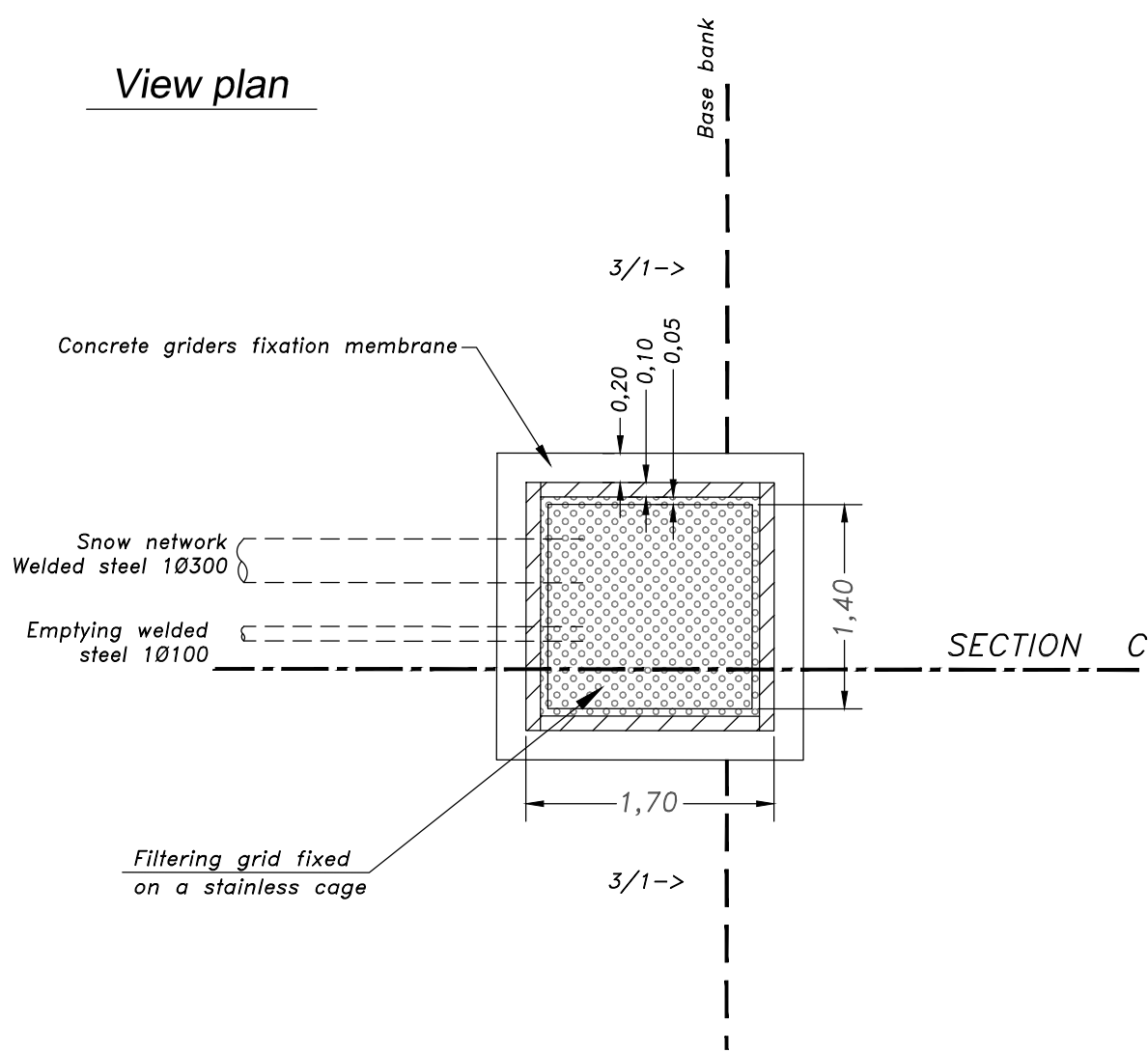
SCALE 1/200



Altitudes Natural Ground	2139.86	2139.13	2139.12	2139.40	2139.34	2137.76	2136.90	2135.86	2135.44	2134.89	2134.11	2133.83	2133.10	2132.93	2132.33	2132.14	2131.74	2131.43	2131.09	2130.85	2130.65	2130.37	2129.94	2129.82	2129.94	2127.91	2127.32	2125.98	2123.89	2120.14	2115.27	2110.59	2109.00	2107.67	2105.58	2105.14	2104.32	2103.69	2103.19	2103.03	2102.99	2103.13	2103.26	2103.40	2102.78	
Dist. accumulated Natural Ground	20.67	26.99	26.97	32.52	34.84	41.94	45.62	52.34	58.44	62.09	67.27	73.54	75.77	82.57	84.82	92.46	94.56	101.64	105.85	110.99	113.94	118.00	120.55	125.96	128.03	133.93	140.63	143.38	146.56	151.72	157.90	165.42	173.66	176.50	179.76	184.51	186.78	191.85	196.86	201.95	205.87	208.40	210.46	217.67	219.76	226.06
Altitudes Project		2139.22			2135.80		2132.60		2129.60					2125.99					2123.16							2120.60																				
Dist accumulated PROJECT		26.17			36.61		47.24		56.87		63.17			83.61					98.18							113.32																				
Gradient / slope																																														

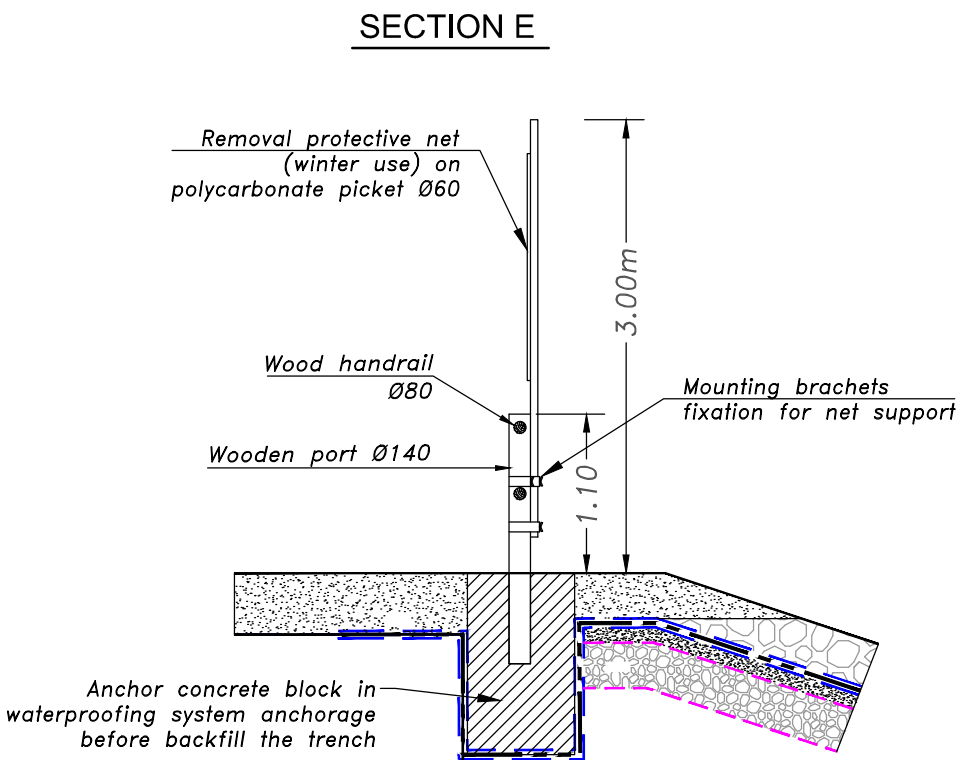
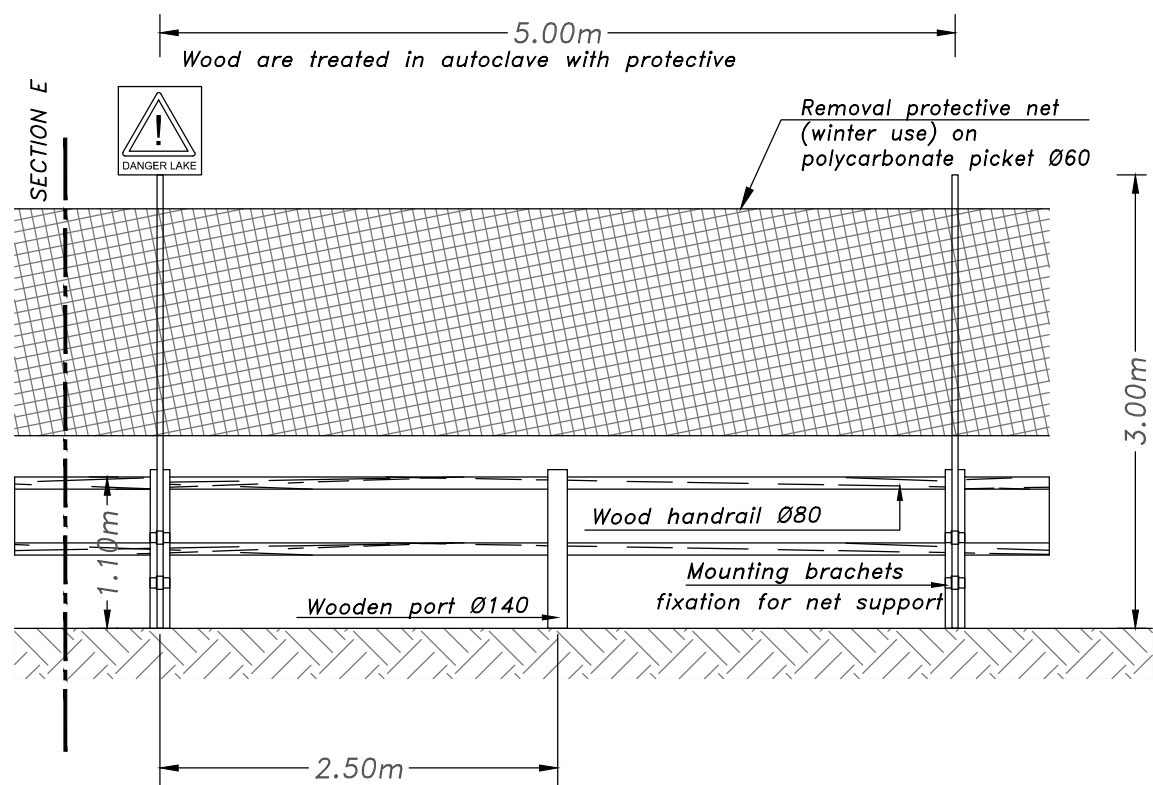
DETAIL 8 - EMPTYING AND SNOW WORKS

Scale 1/50



DETAIL 9 - BARRIER AND WINTER PROTECTIVE NET

Scale 1/50



7 - connection pipe

All pipes for :

- Drains under the dam
- Emptying under the dam
- Providing water to the pump station under the dam
- Filling up network from pump station to the top of lake

Will be welding stell.

Minimum thickness :

- | | |
|---|--------|
| - Drains under the dam | 4 mm |
| - Emptying under the dam | 5 mm |
| - Providing water to the pump station under the dam | 6.3 mm |
| - Filling up network from pump station to the top of lake | 3.6 mm |

Classical welding must be done on steel pipes.



1 - detailed explanatory card

a) General Works

- ✦ Studies of details, calculation notes, plans of all of the structures built
- ✦ The development of a playground construction and materials sorting installation
- ✦ The provision, implementation, maintenance of construction facilities, as well as their evacuation at the end of construction
- ✦ The provision and implementation of signals, signs and the protection of the site
- ✦ Setting up a fence around the grip of retainer, net and barrier to the right of the main entrance
- ✦ The realization of the tests requested
- ✦ The creation of the ways of construction and maintenance of these, including geotextile and ballast
- ✦ The implementation of all of the work
- ✦ The rehabilitation of sites and access.

b) Preparing works

- ✦ The realization of ditches and channels of runoff of water collection
- ✦ The purge of the materials unsuitable or saturated
- ✦ The creation of platform for hanging under the areas to receive the embankments dams, as well as areas of deposits
- ✦ The realization of the foundation under embankment spade
- ✦ The realization of drainage under embankments (carpet drainage and ditches to drain with manufacture of eyes collection and/or control)
- ✦ Stripping of topsoil on the right-of-way of the earthworks with placing in storage outside of the right-of-way of the worksite.

c) General earthwork

- ✦ Execution of the general earthworks for altitude withholding planning, routes, tracks
- ✦ All earthworks in dredged material necessary for the construction of platforms, including sorting, transport and temporary storage if necessary
- ✦ All earthworks as compacted fill necessary for the construction of the platforms after possible crushing and sorting
- ✦ The mining, shifting or pneumatic destruction of rocky passages
- ✦ The establishment of surplus materials on the trails in order to re - profiling the skiing track
- ✦ The upgrading of rocky materials
- ✦ The realization of ditches, drains with rejection to the natural environment
- ✦ The setting of forms of slope
- ✦ The purge and the reinforcement of rock slope anchorage
- ✦ The seat of the embankments for anchoring of the dikes
- ✦ Methodical put materials in embankment compaction
- ✦ The setting, grading, compaction of the bottom of the Lake shape
- ✦ Tests, the approval of the supervisor, materials of constitution of embankments as well as boards of trials and the enforcement procedure of the earthworks
- ✦ The realization of the tests of compaction and penetrometers

1 - detailed explanatory card

- ✦ The realization of a carpet draining into bottom of basin with realization of a peripheral collector
- ✦ The implementation of a layer of control and protection in fine materials
- ✦ The establishment of a geocomposite drainage and anti-punching under the geomembrane, with receipt of the bracket before installation of the seal
- ✦ The tightness of the geomembrane or similar basin including fastening on workpieces
- ✦ The implementation of a geotextile anti-punching under the confinement of banks
- ✦ The implementation of cladding gravel on all banks
- ✦ The realization of the geotextile and geomembrane anchoring trench
- ✦ The realization of leak and welding tests
- ✦ The implementation of control measures (first fill) and corresponding report
- ✦ Development of the overflow system of the lake rockfill, concrete and concrete flood smooth as well as slab stone walling for the water supply
- ✦ The bridge construction onto the overflow equipment, for less than 3.5t of vehicle, with wooden fence.

d) Network

- ✦ The realization of the tests of each network and/or passage of a camera control
- ✦ The realization of necessary trench with topsoil stripping, the opening, making the coating of pipes in sieve materials, filling, delivery in place of topsoil, raking or possible crushing (on request of the supervisor) and the sodding
- ✦ The supply and installation of pipes for water and air (bubbling Lake), the sliders and warning screens
- ✦ Neat fluid piping flushing and pressure testing
- ✦ The switch at the sleeves and all control operations and receipt thereof
- ✦ The cleaning and restoration of the land and the paths used after work
- ✦ The construction of networks of emptying pipe, supply the snow network and drainage welded steel
- ✦ These networks in a massive concrete coating
- ✦ The making of piece intake water and drain concrete embedded in the slope including supply and sealing of a grille protection in stainless steel and all constraints of attachment of the seal on the concrete
- ✦ The network of drainage of the lake and outlet for the natural stream

e) Finishing

- ✦ The establishment of the HDPE from the network of bubbling from the pump station to the top of dike in manhole
- ✦ Control dams, such as equipment that piezometers, topographic cue
- ✦ The realization of two culverts wood for crossing the Weir to the engine room
- ✦ Implementation of a visual measurement system of water levels in the lake mounted on water supply channel
- ✦ Setting up a mix earth/gravel on dyke road and railways schedule
- ✦ The replacement of topsoil and the preparation of soils on the right-of-way of the work of the restraint and deposits areas
- ✦ The implementation of a possible jute canvas on the slope before seeding
- ✦ The mechanical seeding on all the areas affected by the work.
- ✦ Wooden barriers and skiing track net protection.

1 - detailed explanatory card

a) General information

The evolution of machines will have to be strictly limited to the perimeter of useful work, defined in the beginning of the construction site and being the object of the installation plan.

The protection of flora and fauna will have to be assured and will be the object of a quite particular attention.

The mining and scrapping will be the object of all the useful capacities of safety chargeable to the company.

The company will have at her expense, the application of safety regulations in term of staff and road marking (according to recommendation of the safety coordinator or supervisor) during all time works.

b) Excavated material

The execution mode of the excavations material is left to the choice of the company, as far as it is against the general interests of the construction site.

A procedure of execution will be presented to Mountain Resort Development Company (MRDC) and supervisor, of work during the period of preparation (April and May 2015).

Excavation slopes will carefully be adjusted according to slopes indicated by the cross-section, and on working design plans.

Materials serving to build the dyke must be essentially in good shape (0/200 material). The products of the mining will be used for the greater part on the condition of being of calibre which can be compacted by maximal layer of 50 centimetres. The mining of materials will be executed so as to reused materials in elevation and if necessary materials will be crushed (without valuable capital gain) to be used in backfill material.

The company will have to execute the regulation of the platform according to the excavations: the tolerance of regulation to the prescript quotations will be three centimetres (3 cm) at the end of the works, after well-kept regulation of the shape.

Ditches will be established and maintained during the works to channel and evacuate running water.

All the rolling stones in the excavated material, which could spread outside the influences of the project, will be removed.

Slopes will carefully be drawn up and settled in a way such as they do not present either back of the lap, or irregularity and will be purged of all the elements which risk making it the uncertain stability.

c) Soil compaction

The bottom form will be settled and compacted with, if it turns out to be necessary, the contribution of materials fine as of 0/20 (stemming from the product of the crushing on the site of the materials of clearings).

The platform of collision (anchor), for the construction of the dyke, will be based on a compact ground with a light transverse slope (1 / 2 %). Before any beginning of the elevation, the bottom of earthwork and the prepared soil before embankment will have to be received by the Project manager and the supervisor.

1 - detailed explanatory card

d) Drainage

All means will be taken by the company to assure the natural drainage of the ground, to avoid the training of lands and erosions and to avoid the crushing of drains during the execution of the works.

A control operation of the networks of drainage will be operated before withdrawal of construction work, for possible restoration, included ditches.

A network of drainage will be installed in bottom of the lake and on excavation slopes, completed, if it turns out to be necessary, by draining masks or / and draining spurs on excavation slopes in case of in-rushes water.

Waters intercepted or drained within the framework of the excavations will be evacuated area by area, downstream, in the direction of the existing flood way below. Also, the flows discovered during the excavations of the restraint of height will be inevitably evacuated, after drainage and possible control of drains under the work, towards the existing wet zones and protected in the work zone.

e) Backfill material

Backfill material will be put by layer of 50 centimetres on average, with transverse slope from 1 to 2 %.

Continuous assessment of the compaction in the progress = $EV2 > 50 \text{ MPa}$ with $EV2/EV1 < 2$.

Quality controls of the elevations material will be realised, by patches essay and measures of the density and the moisture content according to prescriptions of the geotechnical company.

The company will have to supply all the necessary services for all the controls asked by the project manager.

Trial boards can be asked in prerequisite to the realisation of the dike, without capital gain to the market. The tolerance of execution of the excavations will be of ± 3 centimetres for the heights and 10 centimetres for the levelness.

Pipes and works (networks), which will have to cross dyke, will be set up after the realisation of the elevations of the dyke or beforehand if these pipes and works are under the basis of the elevations. The backfill material around the coated concrete (envelope of the networks) under dyke will be carefully realised, so as to keep the homogeneity of its body.

The body of dyke in elevation (internal profile according to profile and slope of outside bank 2/1 maximum) must be realised with good materials and validated by the geotechnical company. Beyond the body of dyke banks outer than 20 % at the most can be realised with excavated materials of less good quality.

The phasing and the adopted methodology will have to, in every case, aim at keeping the homogeneity of the body of the dike.

The sorting of materials and their specificity of re-use will respect a rigorous procedure, according to the conclusions of the geotechnical report.

The positive materials essentially clearings in the right of the restraint, will be mainly implemented (operated) on around ski slope, in punctual profiling.

1 - detailed explanatory card

If it's necessary, the elevations of dyke of the restraint will be studded by rocky blocks extracted from the general excavation and stemming from the mining of the rocky imprint : execution of a scour for anchoring blocks put in elevations of materials on hedgehog of blocks. This operation will be integrated into the price of putting in elevations of materials without capital gain.

In order to justify stability under descending earthquake, the following recommendations are to produce :

- ✓ For both lake of Gudauri and Bakuriani :

A purge of unconsolidated materials of poor quality after analysis at the opening of bottom of excavations at the beginning of work

- ✓ For Bakuriani Lake :

A strengthening of embankments of dyke by geotextile sheets,
With the following minimum characteristics :

- tablecloths of geotextiles spaced 1.00 m
- $T = 330 \text{ kN/m}$
- Type : geotextile polypropylene anchor of 8 meters within the materials reconstituted
- on a height equivalent to the lower 2/3 of the dyke.

f) Controls

All control will be realised :

- A) On the quality of the bottom of excavation by a visual inspection or possibly by an execution of static or dynamic penetrometer light in the suspect zones. These controls will be realized after compaction and before any elevation
- B) Measures of the moisture content will be also made, as well as essays of permeability to the operated materials
- C) Before the elevations, the company will have to realise a trial board to verify that their methodology of implementation corresponds well to the requirements of project manager and Geotechnical Company
- D) On the sorting of the excavated materials, by a visual permanent control, and possibly the Proctor essay and the moisture content
- E) On the good implementation of the elevations, by a visual control
- F) On the good compaction of every layer) of elevations, by patch essays following the modus operandi LCPC and its directives. The new layer will be brought only if the previous one is ended and considered satisfactory by the project manager
- G) On the holding of the elevations by the implementation of piezometer and topographic points X,Y,Z (during the first filling-up)
- H) A daily control of the flows will be made, concerning the drainages and the open ditches.

1 - detailed explanatory card

The reception of platforms, before the implementation of reinforced geotextile and geo-membrane, will be made in the presence of the company, of the project manager, the geotechnical company and of the person responsible of the waterproofing system.

A trial board of at least 50 m² will be realised before the realisation of the waterproofing system, to validate the conditions and the modes (implementation) of the constituents of the waterproofing system.

Before, during and after the execution of the waterproofing system, the quality controls of the waterproofing system can concern :

f1) Under waterproofing system

- Control of the geometry of the bottom of the lake by a statement of levelling
- Control of the nature and the quality of the granular materials of the bottom of shape and the layer support
- Control of the implementation of the materials of the layer support and drainage (draining trench, draining mask, drainage geotextile)
- Control of quality and the implementation of the geotextile placed under the geo-membrane (and the drainage geotextile).

f2) Geo-membrane

- Characteristics control of the identification and mechanical / chemical behaviour of the geo-membrane
- Control of the respect for the plan of waterproofing system and the procedure of implementation
- Control of the implementation
- Qualification ASQUAL of the welders, the works foreman and the material
- Control of the coverings of the geo-membrane, the welds, the anchoring, the connecting in the works
- Visual Check of accidental perforing
- Non-destructive testing to estimate the continuity of joints: visual inspection, test in the point (headland) in external edge of joint (simple weld), vacuum bell for the welds by extrusion and the triple points, put in pressure of the central channel for the double welds ...
- Destructive Controls to estimate the mechanical resistance of materials in the zone of the joint: taking of sample and essays of drive / coat and drive / cutting.

f3) Protection and confinement

- Control of the quality and the implementation of the reinforced geotextile set up on the geo-membrane
- Control of the protection layer and confinement (cladding)
- Control of the definitive profile of levelling of the work general topographic account (As-built drawings).

During the implementation of the waterproofing system, stop points will be planned. In these points, the company will need the agreement of the project manager of work to continue the works.

Stop points will be the following ones :

- Reception of the support and the draining trench, at the end of the excavation: contradictory reception between the companies of excavation and waterproofness
- Control of the quality and the waterproofness of the geo-membrane before covering (confinement); possibly realised by section not to block the progress of the works

1 - detailed explanatory card

Project manager supervisor of work or the Client (MRDC) can ask at any time for complementary (additional) essays without any payment for the company.

The services of the geotechnical supervisor company taken care by the Client (MRDC) will be:

- Visit of the excavation (at the beginning, current and at the end)
- Validation of the trial results and the re-use of materials (elevation, drainage, confinement)
- Reception of the bottom of the network under the dike
- Visit of reception of the support for the complex of waterproofing system
- Sizing and setting-up of the draining masks and/or the draining trench

All the other works are due to the company.



DETAILED QUANTITATIVE ESTIMATE

Objet : **BAKURIANI SNOW MAKING AND LEISURE LAKE**

Maître d'Ouvrage : **MOUNTAIN RESORT DEVELOPMENT COMPANY**

Devis : **14-043 BAKURIANI**

Price number	Label (works)	Unity	Planned quantity	Unit price (without tax)	Amount (without tax)	Remarks
1-Prepatory Work						
1.1	Preparation and site installation, brought and withdrawal of the material (equipment), implantation (setting out)	fixed price	1,00	- €	- €	
1.2	Studies and working drawing	fixed price	1,00	- €	- €	Level of the lake, volume of earthworks
1.3	Geotechnical complementary studies	fixed price	1,00	- €	- €	Material studies, reuse of material
1.4	As-built drawings	fixed price	1,00	- €	- €	At the end of the whole construction
1-Prepatory Work					0,00 €	
2-General Earthwork						
2.1	Excavated Organic/grass soil	m³	8 900,00	- €	- €	approximately 30 cm to 40 cm
2.2	Excavated material	m³	45 500,00	- €	- €	
2.3	Excavated material (adaptation for balancing material)	m³	5 000,00	- €	- €	To be validated depending of the volume of excavated material and draining material
2.4	Excavated material (possible purge under the dyke - backfill)	m³	53 750,00	- €	- €	To validate by a geotechnical company
2.5	Gains scraping (with ripper)	m³	10 000,00	- €	- €	Scraping if compacted gravel
2.6	Gains for explosive mining	m³	5 000,00	- €	- €	Price for memory (in case of rocks)
2.7	Backfill material for dyke construction	m³	36 300,00	- €	- €	Reuse of material to be validate by geotechnical survey
2.8	Backfill material for dyke construction (if purge, zone of loan)	m³	53 750,00	- €	- €	
2.9	Gains for reinforced backfil with reinforced geotextile	m²	72 040,00	- €	- €	To validate by a geotechnical company
2.10	Gains for creation of scour protection (platform)	m²	750,00	- €	- €	To validate by a geotechnical company
2.11	Gains for drainage material provision	m³	4 500,00	- €	- €	It depend of the quantity of reuse material
2-General Earthwork					- €	
3-Waterproofing system (with geo-membrane)						
3.1	Trenching for waterproofing system anchorage	lm	285,00	- €	- €	
3.2	Material for protective layer with 0/20 material (or brush material on site), depth = 10 cm	m³	250,00	- €	- €	
3.3	Drainage (2 l/s / m²) and reinforcing geotextile 1200 g/m²	m²	6 500,00	- €	- €	Dimensioning of the waterproofing sytem to be validated on working design
3.4	Reinforcing geotextile 1200 g/m²	m²	2 100,00	- €	- €	
3.5	Geo-membrane (PVC Armed), depth = 1,5 mm	m²	6 500,00	- €	- €	
3.6	Cladding (gravel confinement) layer with 0/200 material, depth = 30 to 40 cm	m³	225,00	- €	- €	
3.7	0/40 material, depth = 30 to 40 cm (dyke way)	m³	850,00	- €	- €	
3-Waterproofing system (with geo-membrane)					0,00 €	
4-Flood overflow (weir)						
4.1	Excavated material	m³	150,00	- €	- €	
4.2	Weir and Spillway in concrete rocks (with provision)	m³	450,00	- €	- €	
4.3	Vehicle bridge, wood structure and steel profile (IPN)	m²	35,00	- €	- €	Dimensionnning of the bridge, is to adapt of kind of bridge
4.4	Concrete girders (for waterproofing system fixation)	lm	10,00	- €	- €	
4.5	Waterproofing system fixation on concrete girders	lm	10,00	- €	- €	
4.6	Concrete works at the bottom of the flood overflow (manhole and filtering grid)	fixed price	1,00	- €	- €	
4.7	Ringed HDPE pipe Ø 600 Nominale Pressure NP10	ml	35,00	- €	- €	
4.8	Rocks (with frovision) on the existing river to adapt the emptying	m³	50,00	- €	- €	
4-Flood overflow (weir)					- €	



DETAILED QUANTITATIVE ESTIMATE

Objet : BAKURIANI SNOW MAKING AND LEISURE LAKE

Maître d'Ouvrage : MOUNTAIN RESORT DEVELOPMENT COMPANY

Devis : 14-043 BAKURIANI

Price number	Label (works)	Unity	Planned quantity	Unit price (without tax)	Amount (without tax)	Remarks
5-Water supply						
5.1-Alimentation						
5.1.1	Trenching for water supply	m³	85,00	- €	- €	Kind of networks
5.1.2	Gains for rocks on trenching	m³	25,00	- €	- €	
5.1.3	Welded steel or cast iron Ø 160	lm	55,00	- €	- €	
5.1.4	Detectable underground marker tape	lm	55,00	- €	- €	
5.1.5	Protective concrete (concrete fill)	m³	10,00	- €	- €	
5.1.6	Anchor concrete block (for alimentation)	unit	1,00	- €	- €	
5.1.7	Base slab in concrete rocks	m²	90,00	- €	- €	
5.1-Alimentation				TOTAL	0,00 €	
5.2-Bubbling						
5.2.1	Polyethylene pipe - HDPE Ø 50	lm	220,00	- €	- €	To be validated by the snow making process company
5.2.2	Detectable underground marker tape	lm	55,00	- €	- €	
5.2.3	Concrete manhole 1000 x 1000	unit	1,00	- €	- €	
5.2-Bubbling				TOTAL	0,00 €	
5.3-Waiting networks						
5.3.1	Polyethylene pipe - HDPE Ø 50	lm	110,00	- €	- €	
5.3-Waiting networks				TOTAL	0,00 €	
5-Water supply					TOTAL	0,00 €
6-Drainage						
6.1-Drainage (On the bottom of the lake)						
6.1.1	Drainage trench 1,00 m (depth) x 0,60 m (width) with drain HDPE Ø160	lm	130,00	- €	- €	In case of rocks
6.1.2	Gains for rocks on trenching	m³	25,00	- €	- €	
6.1.3	20/40 drainage material	m³	80,00	- €	- €	
6.1.4	Geotextile for drain (600 g/m²)	m²	450,00	- €	- €	
6.1-Drainage (On the bottom of the lake)				TOTAL	0,00 €	
6.2-Drainage under the waterproofing system						
6.1.1	Geotextile for drain (600 g/m²)	lm	6 500,00	- €	- €	
6.1.2	20/40 drainage material	m³	1 950,00	- €	- €	
6.2-Drainage under the waterproofing system				TOTAL	0,00 €	
6.3-Drainage (Excavated bank)						
6.3.1	Geotextile for drain (600 g/m²)	m²	2 500,00	- €	- €	
6.3.2	Draining mask with 20/40 material, depth = 30 cm	m³	750,00	- €	- €	
6.3.3	20/40 drainage material	m³	150,00	- €	- €	
6.3.4	40/80 drainage material	m³	150,00	- €	- €	
6.3-Drainage (Excavated bank)				TOTAL	0,00 €	
6.4-Drainage (Under dyke)						
6.4.1	Drainage trench 1,00 m (depth) x 0,60 m (width) with drain HDPE Ø200	lm	310,00	- €	- €	
6.4.2	20/200 drainage material for drainage layer, depth = 60 cm	m³	8 500,00	- €	- €	
6.4.3	Ditch creation	lm	400,00	- €	- €	
6.4.4	Concrete manhole 1000 x 1000	unit	2,00	- €	- €	
6.4-Drainage (Under dyke)				TOTAL	0,00 €	
6.5-Drainage (Upstream bank) - In case of water						
6.5.1	Geotextile for drain (600 g/m²)	m²	3 000,00	- €	- €	In case of water, to be validate at the beginning
6.5.2	Draining mask with 20/40 material, depth = 30 cm	m³	900,00	- €	- €	
6.5.3	Drainage trench 0,60 m (depth) x 0,60 m (width) with drain HDPE Ø200	lm	25,00	- €	- €	



DETAILED QUANTITATIVE ESTIMATE

Objet : **BAKURIANI SNOW MAKING AND LEISURE LAKE**

Maître d'Ouvrage : **MOUNTAIN RESORT DEVELOPMENT COMPANY**

Devis : **14-043 BAKURIANI**

Price number	Label (works)	Unity	Planned quantity	Unit price (without tax)	Amount (without tax)	Remarks
6.5.4	Drainage trench 1,00 m (depth) x 0,60 m (width) with drain HDPE Ø200	lm	50,00	- €	- €	
6.5.5	Drainage trench 1,60 m (depth) x 0,60 m (width) with drain HDPE Ø200	lm	50,00	- €	- €	
6.5.6	Ditch creation	ml	125,00	- €	- €	
6.5.7	Concrete manhole 1000 x 1000	unit	2,00	- €	- €	
6.5.8	Rocks for protection (with provision) against erosion	m³	50,00	- €	- €	
6.5-Drainage (Upstream bank) - In case of water				TOTAL	0,00 €	
6-Drainage				TOTAL	0,00 €	
7-Link (networks) between lake to pump station						
7.1-Earhtwork						
7.1.1	Excavated material	m³	1 500,00	- €	- €	
7.1.2	Gains for rocks on trenching	m³	150,00	- €	- €	In case of rocks
7.1.2	Backfill material for dyke construction	m³	1 500,00	- €	- €	
7.1-Earhtwork				TOTAL	0,00 €	
7.2-Concrete works						
7.2.1	Solid block of reinforced concrete for coated network under the dyke	m³	150,00	- €	- €	
7.2.2	Emptying and snow works	fixed price	1,00	- €	- €	See detail 8 (plan n°4)
7.2.3	Waterproofing system fixation on concrete girders	lm	10,00	- €	- €	
7.2.4	Protective concrete (concrete fill)	m³	10,00	- €	- €	
7.2.5	Concrete manhole 1600 x 1600 (drainage works)	unit	1,00	- €	- €	
7.2-Concrete works				TOTAL	0,00 €	
7.3-Drainage						
7.3.1	Welded steel pipe Ø 150	lm	75,00	- €	- €	
7.3.2	Reinforcing HDPE pipe Ø 200	lm	75,00	- €	- €	
7.3.3	Geotextile for drain (600 g/m²)	m²	350,00	- €	- €	
7.3.4	20/40 drainage material	m³	50,00	- €	- €	
7.3-Drainage				TOTAL	0,00 €	
7.4-Emptying						
7.4.1	Welded steel pipe Ø 100	ml	75,00	- €	- €	
7.4-Emptying				TOTAL	0,00 €	
7.5-Snow network						
7.5.1	Welded steel pipe Ø 300	ml	75,00	- €	- €	
7.5.2	Filtering grid (fixed on a stainless cage)	fixed price	1,00	- €	- €	
7.5-Réseau neige				TOTAL	0,00 €	
7-Link (networks) between lake to pump station				TOTAL	0,00 €	
8-Lake emptying (New water networks under ski slope)						
8.1	Trenching for emptying	m³	275,00	- €	- €	
8.2	Gains for rocks on trenching	m³	25,00	- €	- €	
8.3	Ringed HDPE pipe Ø 600 Nominale Pressure NP10	lm	140,00	- €	- €	Position to be validated, outlet, concrete manhole, kind of networks, dimensioning
8.4	Ringed HDPE pipe Ø 600 Nominale Pressure NP11	lm	35,00	- €	- €	
8.5	Envelope of pipes in riddled materials	lm	175,00	- €	- €	
8.6	Concrete manhole 1200 x 1200	unit	1,00	- €	- €	
8-Lake emptying (New water networks under ski slope)				TOTAL	0,00 €	
9-Secondary works and finishes (surface treatment)						
9.1-Barrier and Winter protective net						
9.1.1	Wood Barrier	lm	285,00	- €	- €	
9.1.2	Concrete block (anchorage of the barrier)	unit	115,00	- €	- €	



DETAILED QUANTITATIVE ESTIMATE

Objet : BAKURIANI SNOW MAKING AND LEISURE LAKE

Maître d'Ouvrage : MOUNTAIN RESORT DEVELOPMENT COMPANY

Devis : 14-043 BAKURIANI

Price number	Label (works)	Unity	Planned quantity	Unit price (without tax)	Amount (without tax)	Remarks
9.1.3	0/40 material	m³	50,00	- €	- €	See detail 9 (plan n°4)
9.1.4	Polycarbonate HD picket Ø60, height = 2,30 m	unit	58,00	- €	- €	
9.1.5	Mounting brackets (fixation for net support)	unit	116,00	- €	- €	
9.1.6	Removable protective net	m²	430,00	- €	- €	
9.1-Barrier and Winter protective net				TOTAL	- €	
9.2-Finishes (surface treatment)						
9.2.1	Backfill Organic/grass soil	m³	6 250,00	- €	- €	
9.2.2	Rocks	m³	50,00	- €	- €	
9.2.3	Panel "danger"	unit	6,00	- €	- €	
9.2.4	Lifesaver (safety buoy)	unit	4,00	- €	- €	
9.2.5	0/40 material	m³	50,00	- €	- €	
9.2.6	Wood table (1,50 m x 2,50 m)	unit	4,00	- €	- €	
9.2-Finishes (surface treatment)				TOTAL	0,00 €	
9.3-Control instruments						
9.3.1	Piezometer	unit	6,00	- €	- €	Location to be validated (for example, 4 ont the dyke and 2 on the scour protection)
9.3.2	Piezometric probe	unit	1,00	- €	- €	
9.3.3	Scale level (with a step of 25 cm)	fixed	1,00	- €	- €	Location to be validated
9.3.4	Topographic point	unit	6,00	- €	- €	
9.3.5	Reference station (topographic)	unit	2,00	- €	- €	Location to be validated
9.3-Control instruments				TOTAL	0,00 €	
9-Secondary works and finishes (surface treatment)				TOTAL	0,00 €	

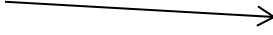
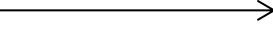
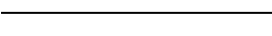
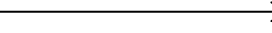
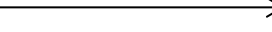
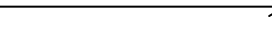
C U M U L S		
Montant H.T.		0,00 €
Montant T.V.A.	19,600%	0,00 €
Montant T.T.C.		0,00 €



EARTHWORK VOLUMES - BAKURIANI			
Excavated material		Backfill material	
Organic / grass soil	8 900,00	Draining Layer (under the dyke)	8 500,00
Gravel in crushed stone	27 300,00	Draining mask (in case of water)	1 650,00
Sandy and clay soil with gravel	18 200,00	20/40 drainage material	2 230,00
Purge (under the dyke) with Gravel in crushed stone	53 750,00	Dyke construction	37 800,00
Flood overflow	150,00	Dyke construction (if purge)	53 750,00
Link between lake and pump station	1 500,00	Protective layer (0/20)	250,00
Adaptation for balancing material	5 000,00	Cladding layer (0/200)	225,00
		Dyke way (0/40)	850,00
		0/40 material	100,00
		40/80 drainage material	150,00
		Weir and spillway rocks (with provision)	450,00
		Rocks for protection (with provision)	100,00
		Organic / grass soil	6 250,00
TOTAL =	114 800,00	TOTAL =	112 305,00



		MAY					JUNE					JULY					AUGUST					SEPTEMBER					OCTOBER					NOVEMBER					DECEMBER																
		Weeks																																																			
	Works	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53																
	Working Design																																																				
	Excavated grass soil																																																				
	General earthwork																																																				
	Link between lake and pump station																																																				
	Drainage																																																				
	Flood overflow (and spillway)																																																				
	Concrete works																																																				
	Water supply (alimentation)																																																				
	Waterproofing system (with confinement)																																																				
	Lake emptying																																																				
	Finishes																																																				
	Wood barrier and winter protective net																																																				
	lake filling up																																																				

EARTHWORK VOLUMES MOVEMENT - BAKURIANI				
Organic / grass soil (30 cm)	8 900,00		Organic / grass soil Dyke construction (not technical)	6 250,00 2 650,00 Total = 8 900,00
Gravel in crushed stone	27 300,00		Draining layer Draining mask 20/40 drainage material Dyke construction (reinforced) Protective layer Cladding layer 0/40 material 40/80 drainage material	8 500,00 1 650,00 2 230,00 14 195,00 250,00 225,00 100,00 150,00 Total = 27 300,00
Sandy and clay soil (with gravel)	18 200,00		Dyke construction (reinforced) Dyke way For ski slope	14 850,00 850,00 2 500,00 Total = 18 200,00
Purge (Gravel in crushed stone)	53 750,00		Dyke construction (reinforced after purge)	53 750,00 Total = 53 750,00
Flood overflow (weir - spillway)	150,00		Dyke construction	150,00 Total = 150,00
Link between lake and pump station (Sandy and gravel)	1 500,00		Dyke construction	1 500,00 Total = 1 500,00
Adaptation for balancing material (Gravel) - Minimum	4 455,00		Dyke construction	4 455,00 Total = 4 455,00
			Provision: Weir and spillway rocks Rocks for protection	450,00 100,00 Total = 550,00
TOTAL = 114 255,00			TOTAL = 114 255,00	Provision = 550,00

2 - specification of the materials

Drainage and reinforced geotextile :

Density :	1250	g/m ²	
Tensile strength :	23	kN/m	
Puncture resistance :	5.8	kN	
Drainage :	2	l/s/m ²	
Permeability :	0.055	ms ⁻¹	

Polypropylene membrane (GUDAURI) :

Density :	0.9	g/cm ³	
Thickness :	1.5	mm	
Breakage resistance :	23	N/mm	800%
Puncture resistance :	1.1	kN	
Steam permeability :	<1.10 ⁻⁶ m ³ /m ² .day		

Reinforcing geotextile :

Density :	1200	g/m ²	
Tensile strength :	22	kN/m	
Puncture resistance :	5.8	kN	

Global calculation of stability of the waterproof complex must be provided by the company, with its offer :

Specific weight of cladding layer : 25 KN/m³

Including if necessary all the additional net and gravel retention grilling to justify the full stability of the complex;

Including the internal friction angle of each product justification;

Including the slip angle coefficient security of the complex;

Including the anchorage trench calculation, regarding the complex composition proposed;

Global security coefficient might be more than 1.35.

PVC membrane (BAKURIANI) :

Thickness : 3 mm

Armed with frame of polyester, 65kN of minimum resistance