MONITORING AND MITIGATION PLAN OF UNGURI PEAT PRODUCTION SITE

(PROJECT NR 23/4345)

Approved:

Aadu Niidas

Member of the Board

Compiled by:

Anna-Helena Purre

Environmental specialist

Martin Küttim

Environmental specialist

Marge Uppin

Hydrogeologist

Kristel Veersalu

Mining engineer, EstQF level 7

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INTRODUCTION

SIA Unguri (aaddress Cēsu nov., Raiskuma parish, "Ungursalas", LV-4146, Latvia, registry code 49503002863) owns mining permit AP23ZD0044 (previously 8/45; permit number in information system KS-16807; valid until 13.03.2036) for peat production on Unguri peat production site. Unguri peat production site is in Cēsu county on territory of Raiskuma parish, on cadastrial units 42740100128, 42740100151, 42740100152, 42740100156, 42740100158, 42820100041, 42820100056, 42820100057 and 42820100061. Total area of Unguri peat production site is 483,16 ha (permit area) and rental area is 559,07 ha.

Unguri peat production site is completely prepared for peat production, drainage network, roads and fields are established. In Unguri peat production site, milled and block peat is produced. The main work phases for milled peat are milling, harrowing and collecting peat with vacuum harvesters. Collected peat is stored in stockpiles. Block peat is produced by cutting peat with extraction cutting box. Peat blocks are left drying on the surface of the field overwinter. When block peat is dried to required moisture content, peat blocks are stored on wooden pallets and covered. Peat production period lasts usually from May to September.

Monitoring and mitigating plan was made according to the requirements in the mining permit AP23ZD0044, Gauja Nature Area protection plan (2023-2035) and Steiger Engineering fieldwork (07 – 09.11.2022) results.

Ungurs lake and protected mire habitats are the emphasis of the mitigation measures and the monitoring plan. Mitigation measures such as closure of unnecessary ditches, construction of sedimentation ponds and so on are proposed and respective water level, water quality, forest growth and vegetation monitoring is proposed with locations. The engineering of mitigation measures should be done as part of after-use technical engineering and must include detailed survey of ground height.

1. MONITORING PLAN

Monitoring of Unguri peat production site includes monitoring of water levels, water quality, vegetation composition and remote monitoring of tree cover. Such monitoring network is needed to ensure that the peat production on Unguri peat production site reduces the impact to the surrounding high nature-protection areas (mainly raised bogs, peatland forests and Ungurs lake) in Gauja National Park and determine the efficiency of the mitigation measures and need for new mitigation measures.

1.1. Monitoring of water levels

To determine the extent of the cone of depression of the water table around the Unguri peat production site, four peat water level monitoring profiles must be established extending from peat production site to the undisturbed part of the bog. All profiles consist of nine monitoring wells. The monitoring considers the guidelines by Silamiķeles et al (2019), where applicable to the conditions of the Unguri peat production site. Monitoring wells must be established to 2 m, 10 m, 50 m, 100 m, 150 m, 200 m, 250 m, 350 m and 450 m distance from the outermost collection ditch of the peat production site. The length of the monitoring transects (WV-1 up to WV-4) vary between 50 – 450 m and in addition to monitoring transects there are several separate locations of water level measurement points (WV-5 up to WV-11). On shorter transects, there are less measurement points. Locations of measurement points are brought in figure 1 and coordinates of the monitoring locations in table 1. Water level transects start from the edge of the peat production site and stretch until the more natural high-value peatland habitats (figures 2-5).

Monitoring well (piezometer) consists of two or three 1 m long plastic pipes connected with each other from the top. The depth of the piezometer should consider the water level depth on site, which is influenced by the distance of the ditch and other environmental parameters. The lower pipe is perforated. The piezometers and their construction is described in detail in Silamiķeles et al (2019). Piezometer (suggested inner diameter of 25 mm) is inserted vertically to the peat. Piezometer is closed with a cap to keep the precipitation out of the pipe. The piezometers are anchored to the mineral soil via metal rods so that the top of the piezometer does not change its absolute height with peat oscillations (due to weather and hydrological conditions). During the insertion of the monitoring points, exact GPS coordinates and absolute height of the top of the monitoring well must be taken.

Table 1. Water level and vegetation monitoring points

Monitoring point	X	Y
WV-1-0	564430	564430
WV-1-1	564412	353011
WV-1-2	564406	353016
WV-1-3	564370	353035
WV-1-4	564328	353058
WV-1-5	564284	353080
WV-1-6	564241	353104
WV-1-7	564197	353126
WV-1-8	564113	353172
WV-1-9	564014	353225
WV-2-1	564284	352358
WV-2-2	564272	352357
WV-2-3	564233	352357
WV-3-1	566547	351558
WV-3-2	566547	351550
WV-3-3	566548	351511
WV-3-4	566550	351459
WV-3-5	566552	351360
WV-3-6	566556	351220
WV-4-1	567383	351614
WV-4-2	567392	351613
WV-4-3	567431	351614
WV-4-4	567479	351614
WV-4-5	567533	351614
WV-4-6	567586	351614
WV-5	564931	354156
WV-6	564439	353067
WV-7	564110	352355
WV-8	564250	352334
WV-9	564597	350741
WV-10	564544	350631
WV-11	567274	351454

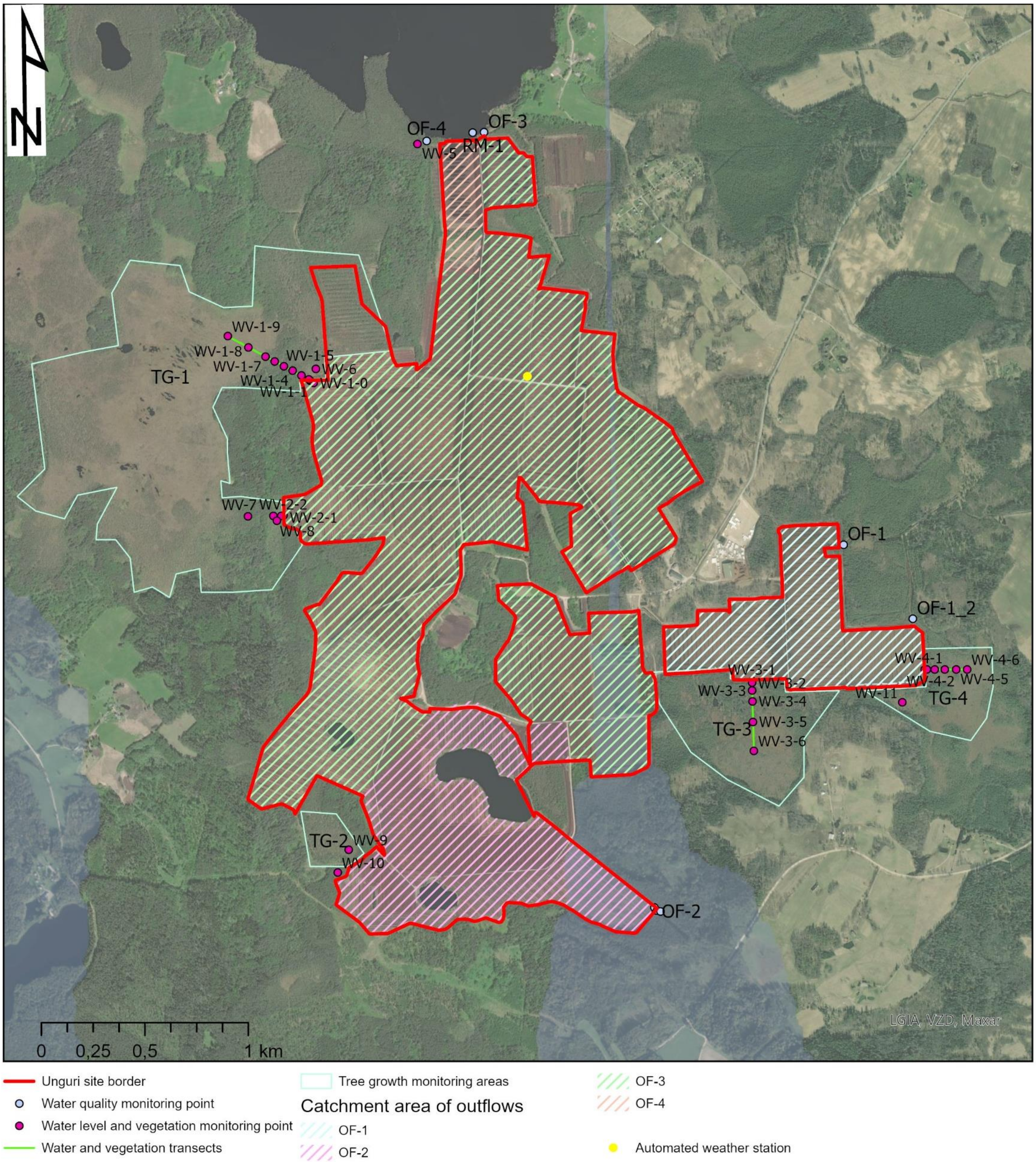

Figure 1. Monitoring locations in Unguri bog.

Water levels must be measured in all the monitoring wells. During every monitoring campaign, height of the top of the monitoring well from the peat surface, and the water table depth inside the monitoring well from the top must be measured, as during drainage, peat layer mineralizes and amount of water in the peat layer changes during the drier and wetter periods (peat oscillates). Measurements must be made at least once a month during freeze-free period. According to this data peat oscillations, water level (relative and absolute) can be quantified.

Figure 2. Well preserved raised bog habitat on water level and vegetation monitoring transect no 1 (Steiger Engineering Bureau, 08.11.2022)

Figure 3. Well preserved raised bog habitat with bog pools and mudbottoms on water level and vegetation monitoring transect no 2 (Steiger Engineering Bureau, 08.11.2022)

Figure 4. Swamp forst on water level and vegetation monitoring transect no 3 (Steiger Engineering Bureau, 08.11.2022)

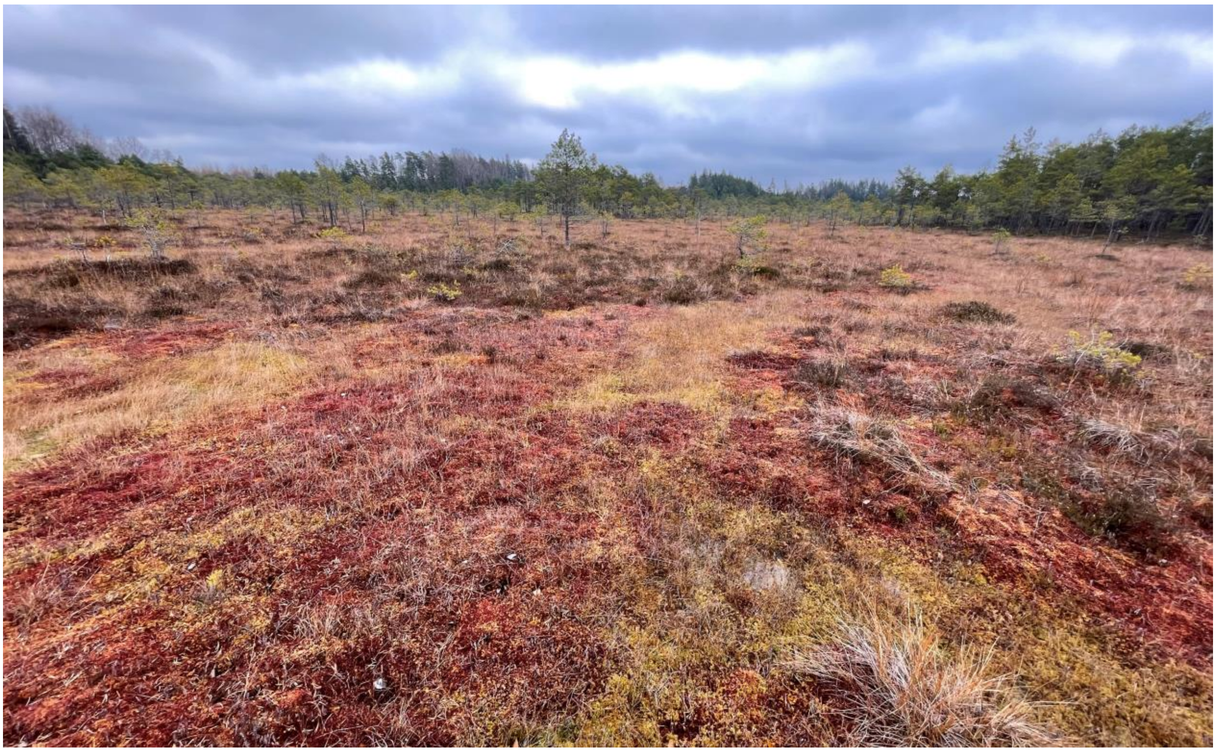

Figure 5. Well preserved raised bog habitat in water level and vegetation monitoring transect no 4 (Steiger Engineering Bureau, 07.11.2022)

1.2. Surface water quality and quantity monitoring

Drainage water consists of precipitation and snow melt water and is affected by the environmental and geological conditions of the peat production site. Drainage water from Unguri peat production site is directed to streams Melnupīte (flowing to Raiskuma lake; OF-1 (will be replaced with OF-1_2 after the redirection of the drainage water as mitigation measure has been concluded (ditch flowing from OF-1_2 reconstructed and settling pond constructed before the OF-1_2), Ederīte (flowing to river Gauja; OF-2) and to lake Ungurs (two outflows; OF-3 and OF-4). Water quality monitoring is done by SIA Unguri in 4 outflows 4 times per year (figure 1; table 2; OF-1 until OF-4) and in Ungurs lake as the recipient (RM-1). Amount of suspended solids, total nitrogen, total phosphorus, pH, water colour and biological oxygen demand in 7 days (BOD7) must be analysed in the accredited laboratory. The water quality monitoring should be done in the outflows to show if water quality meets the requirements set in the Regulations Regarding Discharge of Polluting Substances into Water (Republic of Latvia Cabinet, Regulation No. 34 Adopted 22 January 2002), Regulations Regarding the Quality of Surface Waters and Groundwaters

(Republic of Latvia Cabinet, Regulation No. 118 Adopted 12 March 2002) Otherwise, the use of additional mitigation measures (e.g. sedimentation ponds) is necessary. These limits apply for the drainage water outflows of Unguri peat production site (OF-1 (will be closed after OF-1_2 will be reconstructed); OF-1_2; OF-2; OF-3; OF-4).

Table 2. Water quality monitoring points

Monitoring point	X	Y
OF-1	566989	352217
OF-1_2 (afterthe ditch is cleaned and drainage wate redirected from OF-1)	567324	351858
OF-2	566082	350447
OF-3	565252	354212
OF-4	564974	354169
RM-1	565198	354210
Frequency of sampling	Once in Quartal (4 times a year)	
Analysed variables	pH, colour, Suspended solids (mg/l), N_{tot} (mg/l), P_{tot} (mg/l), BOD_7 (biological oxygen demand in seven-day period), water quantity in outflows (continuous; based on calculations)	

The Methodology for evaluating the ecological quality of water bodies of rivers and lakes (Upju un ezeru ūdensobjektu ekoloģiskās kvalitātes vērtēšanas metodika) gives limits for assessing the water body quality. These water quality indicators refer to natural surface water bodies (not drainage water of the peat production site which is regulated as “waste water”). For monitoring the impact of peat production in Unguri peat production site on Ungurs lake, these quality indicators should be considered in recipient monitoring point (RM-1) to assess the ecological quality of the Ungurs lake (type 8 lake) and Vides Risinājumu Institūts (2018) results should be used for comparison purposes and additional information. The monitoring point no 13 in Vides Risinājumu Institūts (2018) responds to RM-1 in this monitoring plan.

The water quantity monitoring needs to be estimated in each outflow for each Quartal. The amount of the drainage water should be calculated based on the rainfall of the area, as the peatland is largely precipitation-fed. To calculate the amount of runoff (Q; figure 6) from the peat production area, we multiply the area of the catchment area of the peat production area or production field (A; figure 1) by the average amount of the precipitation (P) that falls on it in a specific time-period (1 quartal). Evaporation (E), if the data is available, is subtracted from precipitation. If there is no data of evaporation, the value is 0. If the influence radius (L) of collecting ditch is known or can be estimated, the influence area of the collecting ditch outside the production field should be included to the catchment area of the peat production area (A).

$$Q = A \times (P - E)$$

Q - Outflow
A – Catchment area/drainage affected area
P - Precipitation
E - Evaporation

The company has an SoilTech automated weather station on site (location of figure 1), measuring temperature, dew point, humidity, pressure, wind and precipitation with half-hour intervals. Based on that data, also evaporation (E) is being calculated.

The influence radius of the peat production area can be estimated based on the results of the water level monitoring. Alternatively, the influence radius (L) of the ditch can be calculated as follows (Mioduszewski et al. 2013; figure 7).

$$L = \sqrt{\frac{2 \times k \times m \times h}{W}}$$

k – hydraulic conductivity (m/d)
m – thickness of the peat layer (m)
h – difference between initial water level in natural mire and water level in drainage ditch (m)
W – amount of the precipitation in 24 hours (m) recharging the peat deposit

These calculations should be done separately for each outflow, as the recipients differ by the outflows.

Alternatively, an automatic flow meter can be installed to the each outflow of the peat production area to get the continuous data about the water volumes in the outflow.

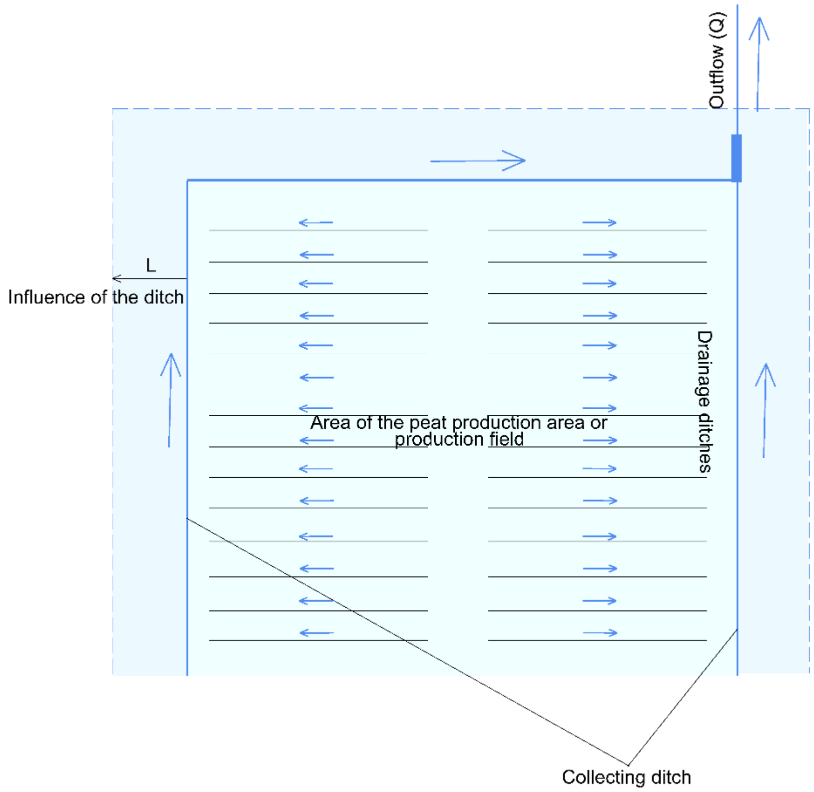

Figure 6. Outline of the peat production area

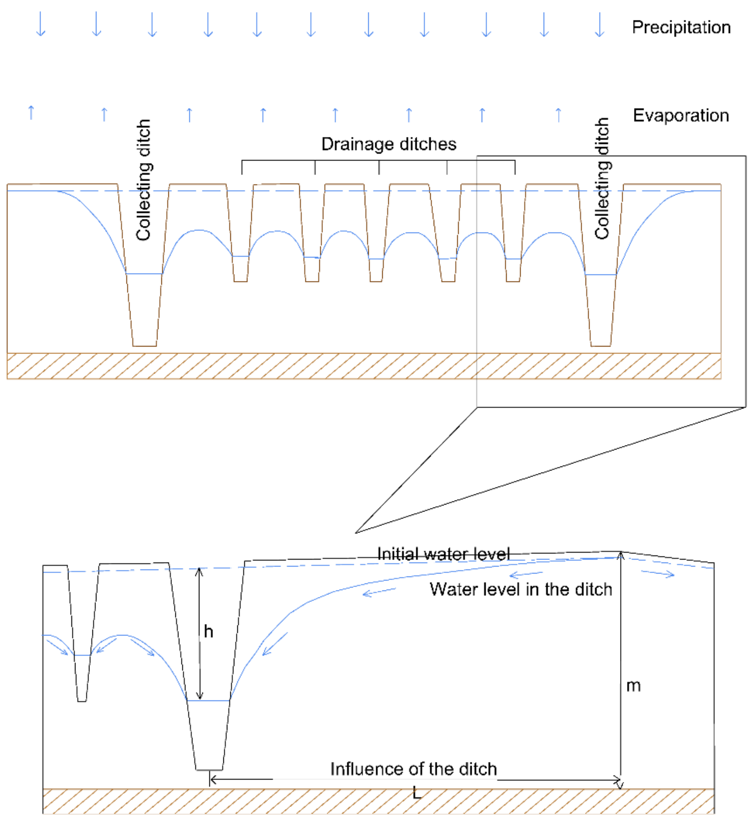

Figure 7. Vertical cross-section of the peat production area

1.3. Vegetation monitoring

Vegetation analysis on permanent plots in protected habitats should be done to assess the impact of the peat production on habitats and vegetation, the vegetation monitoring will be done in 31 permanent plots that will be constructed close to the water level monitoring wells by the company doing the vegetation monitoring. The vegetation monitoring should be done once in three years since the summer of 2023, as the main peatland habitats in the surrounding areas of Unguri peat production site are 7110* (active raised bogs) and 7120 (degraded raised bogs still capable of natural regeneration). Wherever possible, guiding principles from Silamiķeles et al. (2019) should be used.

To assess the drainage impact of Unguri peat production sites on surrounding vegetation, vegetation must be evaluated on the water level monitoring profiles (described in chapter 1.1) and points (figure 1), so it would be possible to relate changes between peat water levels and vegetation. The size of the vegetation monitoring plot is 4×4 m, centred around water monitoring well. It is suggested to make smaller (e.g., 0,5×0,5 m) squares (four) inside the larger monitoring plot. Small squares should not be around or bordering the water level monitoring well to reduce the impact of trampling (figure 8). The border points of the squares would be marked with wooden or plastic stakes. Vegetation monitoring points must be established around all the water monitoring wells to ensure that the water level monitoring and vegetation results are comparable and surrounding areas of the water level piezometers are covered equally. Due to spatial heterogeneity of the surrounding areas of the Unguri peat production site, the construction of vegetation monitoring points further away from the piezometers could result in significant mismatch between the vegetation and water level results.

Although Latvian mire monitoring guidelines (Silamiķeles et al. 2019) propose using round plots with 2 m radius, then the area of such plots is about 1/3 smaller than in the square plots proposed in this monitoring plan, and could underestimate the tree layer, which is one of the significant drainage impact indicators in bog ecosystems. The larger plots proposed in these studies are best suitable for treed peatlands (e.g. peatland forests) as support the more detailed tree cover measurements, same time not yielding in suitability for open peatland. The same plot design is used in many Responsibly Produced Peat (RPP) certification sites in Europe, supporting the large-scale international comparison.

Figure 8. Set up of vegetation monitoring points

On the large plots, tree cover, tree height and number of trees with at least 1 m height must be determined. Also, the cover of dominant plant species and functional groups must be estimated. On the small plots, the cover of vascular plants (shrubs and herbs) and moss layer must be analysed on the species level. Vegetation monitoring must be conducted by person with relevant botanical knowledge, preferably experienced with peatland plants. Monitoring must be conducted on all plots at least once per three-year period and monitoring must be conducted during in the middle of the growing season (early June to late August).

1.4. Remote sensing of tree growth

The density and height of the trees growing on peatland areas adjacent to Unguri peat production site can be estimated by remote sensing. There are four major nearly natural bog areas adjacent to the Unguri peat production site that can potentially be impacted by the drainage network (figure 1). To assess the effect of drainage, mitigation measures and further restoration activities, monitoring of the tree growth (density and height increment) is suggested. For that, the digital surface model (LiDAR) is available from the Latvian Geospatial Information Agency (figure 9).

According to the magnitude of the tree growth speed and the accuracy of the LIDAR data, the remote sensing for the tree growth monitoring should be conducted once every ten years. At each time, the newest available dataset for the monitoring area is derived. The resolution of the dataset must be at least 1 m.

The change in tree growth (density and height increment) is conducted by comparing up to date LiDAR raster layers with the LIDAR layer from the previous period in a GIS software, and comparison with the reference areas within the monitoring area further away from the drainage impacts. The monitoring of tree layer must be done once in a ten-year period. The tree density of the area is calculated by computing the binary fields (tree crown cover/open area) for both layers and comparing them by cover percentage (tree crown cover change). Hight increment of the trees is similarly computed by subtracting the height values of the older layer from the ones of the newer layer. By comparing the average values of the zones at the transect retreating from the border ditches, the effect of the drainage is assessed.

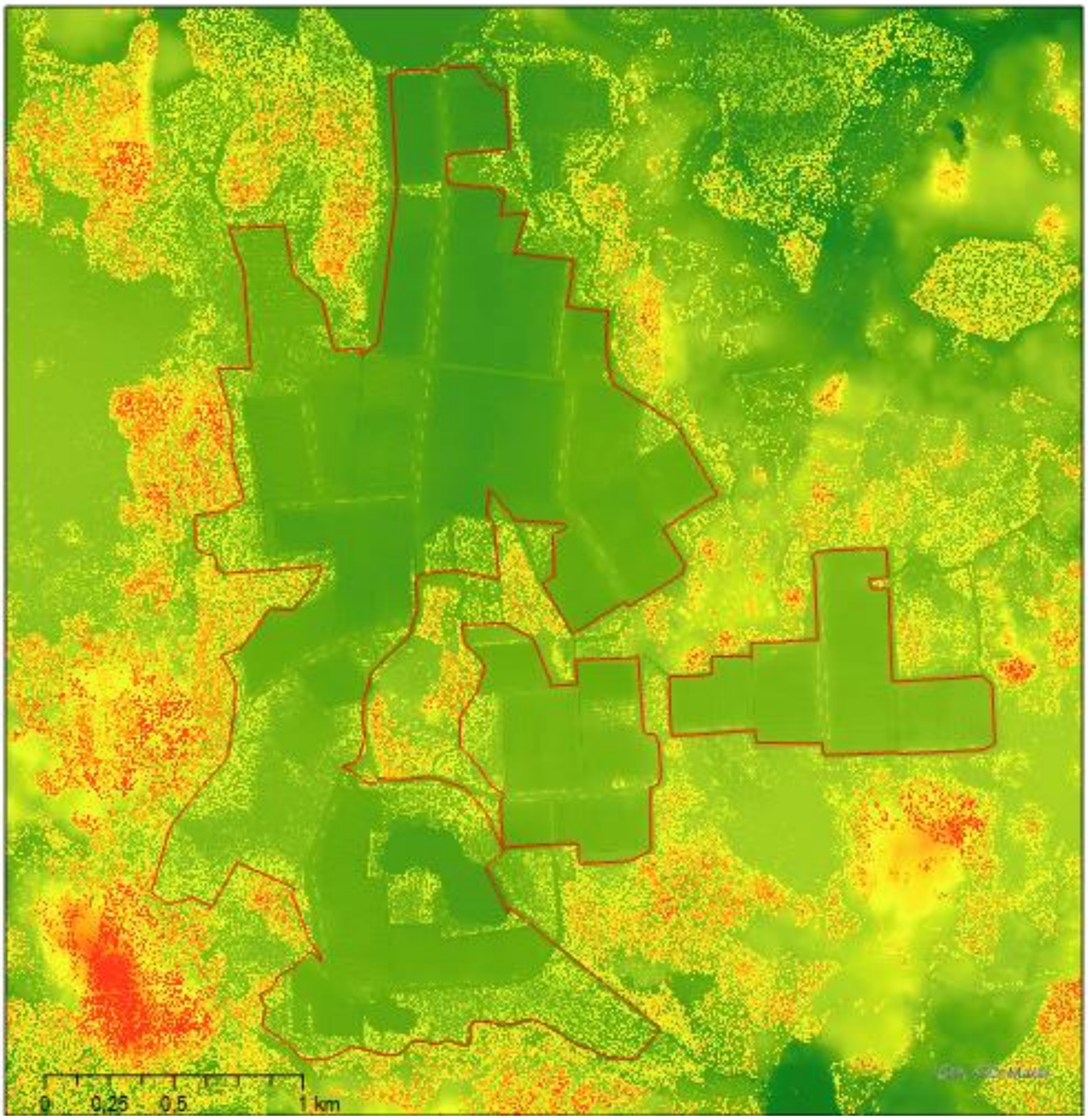

Figure 9. Lidar height model of the Unguri bog in 2014. Dark green colours indicate lower (minimum value 59.14 m) areas and red areas indicate higher (maximum value 145.11 m) areas (data from Latvian Geospatial Information Agency, 2023).

2. MITIGATION MEASURES

To mitigate the possible drainage impacts of Unguri peat production site on surrounding valuable habitats and water bodies, certain measures should be applied. Efficiency of the mitigation measures is determined by the monitoring described in chapter 1. The technical design of the mitigation measures could be done within mining project of the peat production site, as an separate mitigation project or as part of technical engineering of after-use. In this case technical engineering of the mitigation measures (e.g. peat dams, closure of ditches, additional sedimentation ponds) and respective geodetic measurements should be done as part of the technical engineering of the after-use. During the technical engineering, when planning the exact locations of the mitigation measures, then these mitigation measures should be planned within the rental borders of the Ungurs peat production site to reduce the construction impact on surrounding areas. Also, it must be considered that the application of mitigation measures may also affect the surrounding areas. This may be significant consideration if the site is surrounded by the protected objects and/or private lands. For determining the need for mitigation measures, information from field visit and LIDAR data (year 2014; figure 7) was used.

2.1. Drainage mitigation

The effect of drainage on the surrounding peatland habitats can be mitigated through decreasing water inflow from surrounding area to collection ditches (e.g. dams, closing unnecessary ditches) and reducing the effect of the ditch (peat compaction or stabilization, damming) but also through tree-layer reduction (so decreasing the evapotranspiration through tree layer and reducing habitat overgrowth).

Firstly, it is necessary to stop water inflow from natural mire habitats into the drainage system of Unguri peat production site (e.g. figure 10). For this, several damming areas with peat dams are proposed in figure 11. Those dams should be constructed on the outer bank of the collection ditch (between the natural area and collection ditch) and should be designed considering the surrounding ground height and water flow. It is advisable to use compacted peat for the dams, but other alternative methods could also be considered. The exact locations, dimensions and materials should be determined during the designing process. Similar, but larger peat dam is present in the western part of the Unguri peat production site, where it provides according to the visual assessment, significant mitigation against drainage impact (figure 11). Also, these kinds of dams are used to elongate the retention time of the water on the peatland restoration sites, where they have been proved to be effective.

Figure 10. Examples of flowpaths flowing from the protected raised bog (7110*) habitat on Gauja Natioanl park to the collector ditches of the Unguri peat production site (SE part of the peat production site; coordinates of the photos left picture X=567 336; Y =351 535; right picture X=567 384; Y =351 558). (Steiger Engineering Bureau, 07.11.2022)

Figure 11. Compacted peat dam used astransport road in Unguri peat production site (W part of the peat production site; coordinates of the photo X=564 487; Y =353 113). In the natural bog water level is close to the peat surface and in the production site, the water is in the bottom of the ditch (Steiger Engineering Bureau, 08.11.2022)

Another suggested measure for mitigating the drainage impact of the Unguri peat production site to surrounding natural areas is to close unnecessary ditches in eight locations (figures 12, 13). Some of these ditches direct also water from the pristine areas to the drainage network of Unguri peat production site, and so drain the surrounding areas. Unecessary ditches could be closed by peat dams or filling in the ditches. Exact methods for closing ditches must be designed in Unguri peat production site recultivation project or another similar technical project (e.g. mining project or separate technical project).

To further reduce the drainage impact of the peatland habitats near OF-1 (figure 1) it is suggested to move the OF-1 away to proposed location OF-1_2 (further away from the peatland habitats), create there new outflow with sedimentation pond (OF-1_2 in figure 1 and also see figure 11), reconstruct the ditch flowing to the Melnupīte river and to Raiskuma lake. This does not change significantly the water pathway to Raiskuma lake. After the new outflow IF-1_2 is operation the outflow OF-1 in its current location can be closed with peat dams to mitigate the drainage impact to peatland habitats. During the preparation of the new outflow OF-1_2, the material from the new ditch should be placed on the left bank of the ditch to reduce the surface flow and drainage impact of the ditch related to the new outflow on the peatland habitats. The exact location of the new ditches and sedimentation pond would be determined during the technical engineering.

Figure 12. Unnecessary ditch and peat material lifted outside of the ditch in Unguri peat production site (W part of the peat production site; coordinates of the photo X=564 598; Y = 350 668; Steiger Engineering Bureau, 08.11.2022)

Additional possibility to further reduce drainage impact is through removal of trees and bushes from the edges of the collector ditches (especially near the open peatland habitats 7110* and 7120) to reduce the water evapotranspiration through the trees. Only pines and spruces should be removed, as birches give root shoots, which increase their growth after cutting of those trees. The removal of the trees could be done once in a ten-year period from the edges (10 – 20 m distance) of collector ditches and only larger pines and spruces should be removed. The cut trees should be removed from the site and used e.g. for wood chips production.

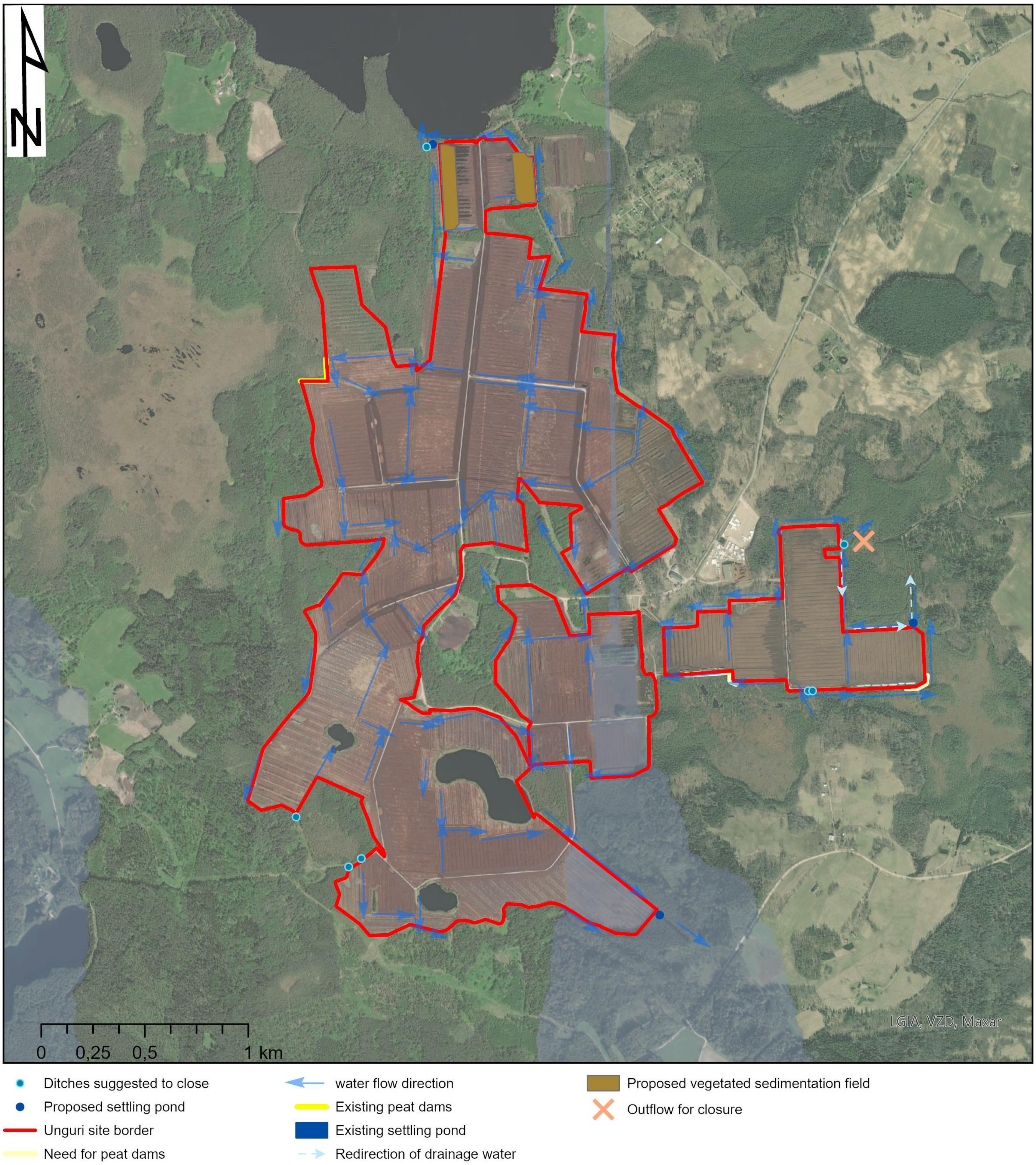

Figure 13. Mitigation locations in Unguri bog.

2.2 Water quality mitigation

According to the study conducted in Estonia, water quality of drainage water of peat production sites generally meets the requirements set in legislation, few exceeding's of set levels are related mostly to the content of suspended solids (SS) and biological oxygen demand in seven days (BOD_7; Uppin & Purre, 2021). Water quality mitigation measures are related to building of additional sedimentation ponds (OF-1, OF-2, OF-4; figure 1) and cleaning existing sedimentation pond in OF-3 (figures 13 and 14). It has been previously shown that the use of sedimentation ponds significantly reduces the content of suspended solids, total phosphorus and BOD7 (Kløve, 2000; Uppin & Purre, 2021). Sedimentation ponds need regular cleaning (at least once a year) to work efficiently. The results of the activity of beavers (branches etc.) should be removed more often, according to necessity. The suspended solids settled in the pond and removed during cleaning can be drained and then mixed with produced peat to reduce waste.

Figure 14. Existing sedimentation pond with overflow (a; coordinates X = 566 283; Y = 354 180) and cleaning net (b; coordinates X = 566 260; Y = 354 198) affected by the beaver activity in OF-1 of Unguri peat production site (Steiger Engineering Bureau, 08.11.2022)

Another possibility to mitigate drainage water quality related to the peat production in Unguri peat production site is using sedimentation fields for water cleaning. Although such mitigation measures are very efficient for reducing the amount of SS, BOD_7, N_{tot} and P_{tot} (Kløve, 2000; Uppin & Purre, 2021), such sedimentation fields need large areas where peat layer is preferably depleted. Such areas are available in the northern part (figure 13) of the Unguri peat production site and should be used as vegetated sedimentation fields to mitigate water quality impacts and support restoration of those fields. As according to the guidelines by Vapo OY, Turveruukki OY and Association of Finnish Peat Industries (2010) the minimum filtration area of the vegetated sedimentation field is 44 m^2/production hectare. So the areas being close to exhaustion in the northern part (6 ha) are sufficient for purifying drainage water flowing from Unguri peat production site to lake Ungurs (also during the snow and ice melt period). For the sedimentation field, natural peatland grasses and vegetation should be used, so supporting the peatland restoration in this area. then the construction of sedimentation fields could be constructed before OF-3 and OF-4. The exact dimensions of the vegetated sedimentation field will be determined in the technical engineering project of the after-use.

It is possible that the quality of the drainage water in Unguri peat production site meets the requirements set in legislation, and this could be confirmed by monitoring. Then as the peat production site is in a sensitive area (Gauja national park belonging to Natura 2000 network), the possible impacts should be mitigated. Therefore, the additional sedimentation ponds should be designed based on the amount of drainage water reaching there and constructed to each outflow. Outflows OF-1 (location OF-1_2 in the future), OF-2 and OF-4 are currently without the sedimentation ponds, and to mitigate the possible effect of the water quality on the protected habitats of lake Ungurs and Gauja river construction of sedimentation ponds or vegetated sedimentation fields are needed.

SUMMARY

This document includes monitoring (chapter 1) and mitigation plan (chapter 2) of Unguri peat production site. Summary of monitoring parameters, measurement points and measurement frequencies are in table 3 and monitoring locations are brought in figure 1. Monitoring results should be presented to the Latvian Nature Conservation Agency. If any circumstances related to the monitoring and mitigation plan change, then monitoring plan must be changed accordingly. If monitoring shows that peat production causes exceeding of the set levels or significant impact on surrounding environment, additional mitigation measures must be applied. The mitigation measures described in chapter 2 include mitigation of drainage impact on surrounding habitats (peat water levels), water bodies (water quality).

Table 3 Indicators measured during monitoring, time, and frequency of monitoring

Monitoring parameter	Location of monitoring	Measured indicators	Frequency
Water quality (outflow and recipient)	Figure 1, table 2	pH, Suspended solids (mg/l), Ntot (mg/l), Ptot (mg/l), BOD_7, colour, quantity	Quarterly
Peat water level	Figure 1, table 1	Water level in the monitoring well, absolute height of the ground and monitoring post	1 x month, from during unfrozen period
Vegetation	Figure 1, table 1	Cover of vegetation (species level), tree height, cover of litter and bare peat	1 x during 3-year period, during summer season
Tree growth (remote sensing)	Figure 1	Tree height and density	1 x during 10-year period, during summer season

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