TALLINN UNIVERSITY OF TECHNOLOGY
SCHOOL OF ENGINEERING

Department of Civil Engineering and Architecture

GROUNDWATER ACTION PLAN FOR THE YEARS 2018-2019 FOR IMPLEMENTING PROGRAMME OF MEASURES OF RIVER BASIN MANAGEMENT PLANS

Vesikondade veemajanduskavade meetmeprogrammi rakendamise tegevuskava põhjavee osas aastateks 2018-2019

MASTER THESIS

EA70LT

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AUTHOR'S DECLARATION

Hereby I declare, that I have written this thesis independently.
No academic degree has been applied for based on this material.
All works, major viewpoints and data of the other authors used in this thesis have been referenced.

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TASK FOR THE FINAL THESIS

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Groundwater Action Plan for the Years 2018-2019 for Implementing Programme of Measures of River Basin Management Plans

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Environmental Permit's Information System
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Contents of the final paper:

- Overview of the programmes of measures and action plan, included legal bases
- Status of Estonian groundwater bodies
- Analysis, materials and methods for preparing groundwater action plan
- Activities fulfilling the administrative measures
- Activities fulfilling the advisory measures
- Planned surveys

Explanation letter:

Thesis is based on the explanation of importance and contents of Groundwater Programme of Measures of River Basin Management Plans and its implementation thought the Groundwater Action Plan basis on the status of Estonian groundwater bodies and pressures that are threaten or causing the poor status of groundwater bodies or being at risk to fall in poor status. The aim is to analyse what Environmental Board as the compiler and promoter of Action Plan may improve in daily tasks to achieve the good status of groundwater bodies being at risk or assessed as in poor status. Thesis provides recommendations for effective implantation of Groundwater Action Plan. For the getting better overview about the potential risks coming from the ground that may affects the quality of the groundwater, were prepared in ArcGIS maps that are useful tools for the specialists' everyday work.

Resümee eesti keeles:

Käesoleva töö eesmärgiks on selgitada veemajanduskavade põhjavee meetmeprogrammi olulisust ning selle rakendamist läbi kavandatava põhjavee tegevuskava, mis põhineb põhjaveekogumite seisundil ja reostusallikatel, mis ohustavad või põhjustavad põhjaveekogumite halba seisundit või ohustatus langeda halba seisundisse. Töö eesmärgiks on analüüsida, mida Keskkonnaamet kui tegevuskava koostaja ja elluviija võiks tõhustada oma igapäevases töös saavutamaks põhjaveekogumite hea seisundi, mille seisund on hinnatud halvaks või ohustatuks. Magistritöö eesmärgiks on tuua välja soovitused põhjavee tegevuskava efektiivseks täitmiseks. Parema ülevaate saamiseks on koostatud ArcGIS tarkvaras kaardid kõikide põhjaveekogumite kohta, kuhu on märgitud potentsiaalsed reostusallikad, mis

mõjutavad ennekõike maapinnalt esimeste põhjaveekogumite seisundit. Kaardikihid on ühtlasi abivahend spetsialistide igapäevaks tööks.

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Supervisor: **Karin Pachel**

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1 Introduction

1.1 Background

All EU Member States have common coal to achieve good status of groundwater bodies. For that responsibility all member states is creating a Program of Measures in order to reach environmental objectives; for instance in groundwater the aim is to achieve good chemical and quantitative status. Environmental Board shall prepare an action plan for implementation of the programme of measures for each river basin.

1.2 Problem description

It is clear that Estonia will not achieve a good status of majority from the eight groundwater bodies that are assessed as being in poor statues, but at least it is needed to move towards improvement of groundwater quality and prevent deterioration of the present situation.
For the achieving good status of groundwater bodies, the pressures causing poor status shall be eliminated. Groundwater renewal process in also taking more time than one period of River Basin Management Plan, i.e. 6 years. In real life there is also playing role in additionally to pollution sources, geological and hydrogeological conditions, economic and social pressures. Therefore achievement of the good status is a long process that takes long time, requires unpopular decisions, involvement of different parties, increase the awareness of potential polluters.

1.3 Aim of the thesis

The aim of the thesis is to give an overview of the present situation of issuing the permits, compose the data layers and thematic maps in ArcGIS software for each groundwater body being at risk or in poor status, where will be added potential sources of pollution. Data for composing maps for all groundwater bodies at risk or in poor status, originates from the Environmental Permit's Information System, Environmental Register, Estonian Agricultural Register and Information Board and Estonian Nature Database (Figure 1). Maps are informative tools that were used for the describing implementation of administrative and advisory measures and what should take into account ordering the surveys in next years.

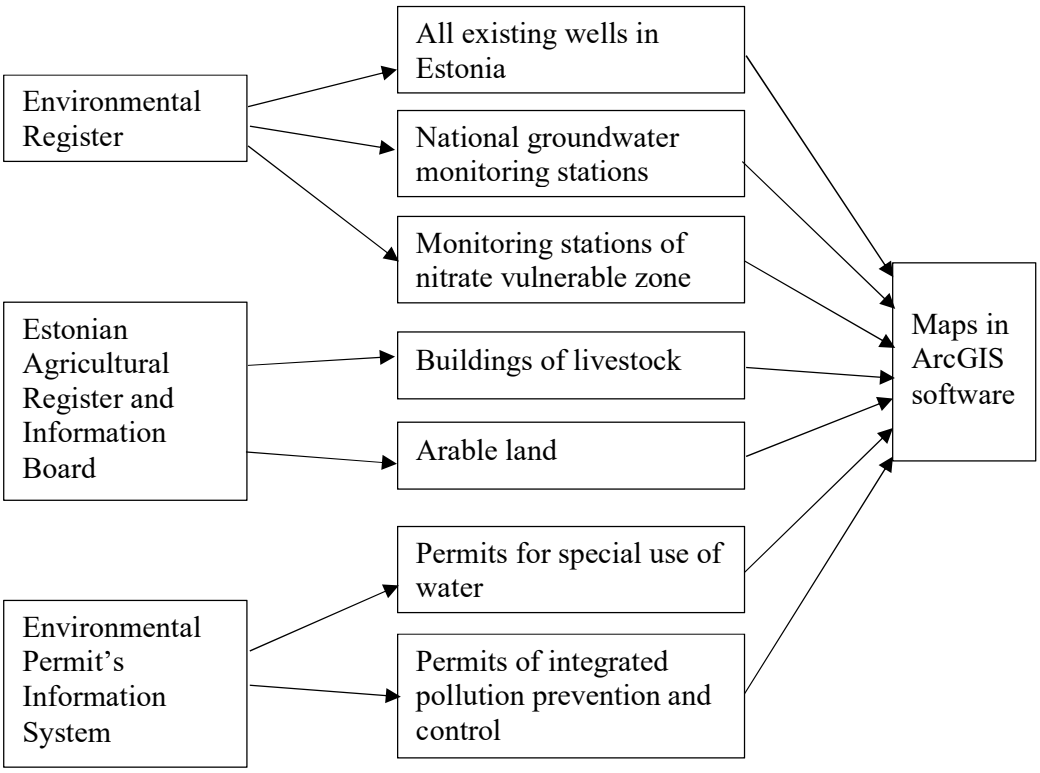

Figure 1. Databases and information used for composing maps in ArcGIS software

2 Programme of Measures of River Basin Management Plans

2.1 Legal Basis of Composing Groundwater Programme of Measure of River Basin Management Plans

2.1.1 EU Water Framework Directive and EU Groundwater Directive

The EU Water framework Directive WFD was adopted in 23rd October 2000 with the purpose of establishing a framework in the field of water policies. The WFD includes groundwater policies that are addressed to groundwater bodies with the purpose of planning programs, monitoring and analysing impacts.

In 29 December 2009, the government of Estonia took over the groundwater directive from the European Commission (2006/118/EC) that set all the requirements that EU members need to follow in terms of quality standards, methodologies and limit values, this in order to set up the right criteria for assessing chemical status in groundwater. The aim of this directive is to get a good level status of groundwater bodies by the end of 2015. Member States that avail themselves of an extension beyond 2015 are required to achieve all WFD environmental objectives by the end of the second and third management cycles, which extend from 2015 to 2021 and 2021 to 2027 respectively.

2.1.2 Estonian Water Act

The paragraph 3^{14} of this act, establish the creation of a programme for environmental measures aiming the use and protection of surface water and groundwater. These measures must be taken into account by all local governments during the creation of their local plans for public water supply and sewerage.

A dedicated program of measures must be created for each river basin within the Estonian territory and transboundary rivers.

The preparation of such measures will be organized by the Ministry of Environment and must be approved by the Government of Estonia. For transboundary rivers there should be a

coordination work prior approval between the competent authorities from the governments of Estonia and Latvia.

2.2 Content of Programme of Measures

The paragraph 3^{15} of this act, establish measures for Groundwater Programme of Measures that are as follows:

1) prevent further deterioration in the status class of groundwater bodies;
2) prevent exceeding the environmental quality standards and plan activities in the event of exceeding the standards,
3) reverse any significant and sustained upward trend in the concentration of any pollutant in groundwater if the concentration of the pollutant amounts to 75 percent of the groundwater quality standard or the threshold value for the pollutant in a body of groundwater;
4) terminate emissions of priority hazardous substances and reduce emissions of other pollutants;
5) prevent direct discharge of pollutants into groundwater or restrict discharge of pollutants into groundwater;
6) protect such bodies of water that are or will be used in the future as drinking water intakes in order to reduce the level of purification treatment required in the production of drinking water;
7) ensure the safety of drinking water and bathing water in accordance with the Public Health Act;
8) protect wild bird species and natural habitats in accordance with the Nature Conservation Act;
9) promote efficient and sustainable water use, including ensure recovery of costs for water services;
10) ensure that good environmental practice is followed.

In addition to the measures provided previously, shall be established measures for reversing any significant and sustained upward trend in the concentration of any pollutant if it amounts to 70 percent of the threshold value for the pollutant in a body of groundwater or of the groundwater quality standard if these measures prevent most cost-effectively, or at least

mitigate as far as possible, any significant detrimental changes in the chemical status of groundwater.

The Program of Measures will have planned activities to implement the subsections (1) and (2), for instance:

1) Ensure safety of enterprises that can be affected by accidents in relation with the Chemicals Act and prevent or control the pollution originated from environmentally hazardous activates in relation with the Industrial Emissions Act.

2) Assess environmental impact and prevent environmental damage in regards of the Environmental Impact Assessment and Environmental Management System Act.

3) Reduce the impact of sewage on the environment in regards of the Waste Act.

4) Reduce the environmental impact originated from wastewater and reduce the pollution hazard caused by nitrates.

5) Reduce the environmental impact originated by the use of plant protection in relation with the Plant Protection Act.

6) Reduce the impact of pollution from point sources as banning the discharge of pollutants into the water or establishing the conditions for such discharge in regards of this Act ant the Industrial Emissions Act.

7) Prevent extensive leakage of pollutants from utility works and reduce their impact that due to an accidental pollution caused by floods.

8) Reduce the pressure on the basis of the Water Act if this represents a risk or affect the status of water.

Following the Water Act §3[28], the Ministry of Environment will prepare a description for each body of groundwater that may be at risk and evaluate its risks in case of poor status including the reasons for such poor status. The Ministry will also use the Programme of Measures to reach the environmental objectives for groundwater bodies.

According to the Water Act § 26^3 (12) an action plan has to prepared in order to reduce the effect of pollution that may arise from agricultural production on surface water and groundwater, this also includes an action plan for nitrate vulnerable zone.

2.3 Description of the programme of measures

They are based on the assessment of groundwater bodies made in 2014 for bodies that are or may be at risk:

- Changes occurred on groundwater bodies compared to the last assessment made in 2010.
- Main pressures causing the poor status of groundwater or that may threat their good status.
- Activities planned for the period 2016-2021 and their implementation schedule.
- Those in charge of the implementation as the Environmental Board, Ministry of the Environment, local governments, owner, Environmental Inspectorate).
- Cost of the activities and funding sources.
- Effectiveness regarding the implementation of the activities.

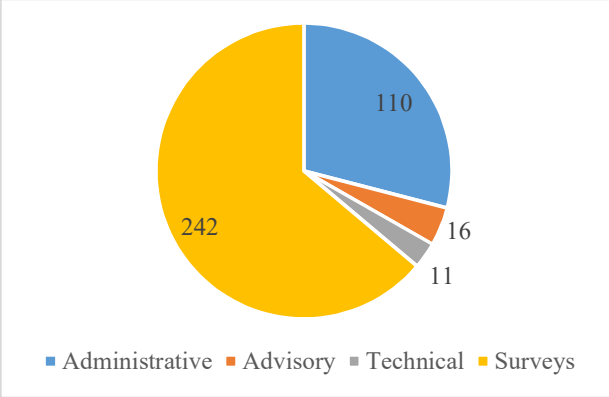

Figure 2: Activities of programme of the measure

In total, there are 379 activities in the programme of measures (Figure 2) that are divided between different institutions or owners.

3 Action Plan

According to Water Act § 3[16] the implementation of a programme of measures shall be organised by the Water Management Committee. The Environmental Board shall prepare an action plan for implementation of the programme of measures for each river basin. The action plan shall be approved by the minister responsible for the area on the proposal of the water management committee.

During the cycle of River Basin Management plan (RBMP) (2016-2021), there will be composed three action plans for the years 2016-2017, 2018-2019, and 2020-2021. The goal of

the action plan is to implement measures of the Programme of Measures (PoM) by stages, in order to enhance the status of groundwater bodies and to achieve the environmental objectives.

3.1 Main principles for compiling action plan

The main principles for composing action plans are following:

1) An Action plan is composed for two years, containing those measures that are planned in PoM of RBMP and if needed there can be additional measures, for example, chemical composition of groundwater has been deteriorated;

2) During the compiling action plans there must be taken into account results of last groundwater analysis, studies and other trustable information that the Environmental Board should be aware, or other research overviews that are presented to Environmental Board by December of the previous year;

3) Information has to be presented by the river basin district (Eastern Estonia, Western Estonia and Koiva) and bounded by groundwater bodies. In the same principle, there shall be presented groundwater body characteristics, pressures, status, measures and time for implementation, cost, funding source, exploiter and other important information. Costs must be presented in case of researches, consultations and technical measures;

4) Measures in action plan are divided between activities related with surface water and groundwater bodies;

5) Action plan contains measures for bodies of groundwater in poor status or at risk, with the aim to achieve environmental objectives set up in RBMPs. In case of need there must be set up measures to conserve environmental objectives of the groundwater bodies in ‘good status’;

6) Measures are divided according to WFD into basic measures and supplementary measures. Basic measures are those needed to implement existing policies and legislation. Supplementary measures are needed to achieve good status of groundwater bodies or conserve their good status if basic measures are not sufficient;

7) Measures are divided administrative (permit issues, inspection, legal framework), technical (construction, operational activities), advising activities (consulting, educating), research (scientific research and/or applied research);

8) In composing and implementing the action plan, it must take into account annual national groundwater monitoring results and other assessments like groundwater monitoring in nitrate vulnerable zone. In the action plan there must be named groundwater bodies which

chemical composition of groundwater that have been deteriorated and the reason(s) must be explained. In case the reason is unknown there is a need to plan measures to find it out;

9) If a measure named in the PoM or a supplementary measure assumes preparatory activity, like research, composing the plan, inventory etc., then it must be provided in the action plan;

10) There shall be explained essential modifications in river basin districts and in groundwater bodies (improvement of chemical composition of groundwater in groundwater bodies, decreased pressure etc.) and in case of need it will be planned additional measures;

11) Action plan must be discussed through with exploiters and with other target groups, including public display in the webpage of Environmental Board and Ministry of the Environment by recommendation at least one month. Different parties must be announced about the public display. Review about public display with the proposals and considers about taking account or discount them must be presented to water management committee with the draft of the action plan.

4 Status of Estonian groundwater bodies

In Estonia, there are 39 groundwater bodies distinguished. In 2014 and 2015, status of the bodies of groundwater was evaluated according to the guide "Criteria and Methodology to determine status classes for the bodies of groundwater", that is based on the assessment criteria provided on WFD 2000/60/EC and groundwater directive 2006/118/EC. For the groundwater body assessment is worked out five test for the chemical and four test for the quantitative status. Final assessment is given on the assumption that one-out-all-out principle that means the worst result of test is given as the status class.

Status can be assessed as good or poor. Groundwater body status is assessed poor, if its chemical or quantitative status is poor. Chemical status shows changes in the chemical composition conditioned by human activity, whereas quantitative status indicates effect of water abstraction to the groundwater body. For evaluating status of groundwater body, it has to be taking into account the influence of human activity and hydrogeological conditions including groundwater protection and state of ecosystems that depend on groundwater. Groundwater body is at risk in case if human activity may cause the degradation of groundwater body.

4.1 Assessment of groundwater body quantitative status

A quantitative indicator to assess groundwater body quantitative status is the groundwater level that depends on the groundwater body recharge and the abstraction of groundwater.

Quantitative status of groundwater body is good, if the following conditions are met:

1) average groundwater abstraction per year is less than confirmed groundwater resource;
2) changes in groundwater flow direction caused by changes in groundwater level do not cause saltwater intrusion into the groundwater body;
3) no changes in the groundwater level caused by human activity that would result in a significant deterioration of groundwater chemical or quantitative status;
4) no changes in the groundwater level caused by human activity;
5) no lowering of the groundwater level and the trend of saltwater intrusion , which would cause significant deterioration of groundwater dependent ecosystems;
6) in groundwater body quantitative status monitoring network observation points, there is no such lowering of groundwater level caused by human activity that would cause groundwater significant decrease.

4.2 Assessment of groundwater body chemical status

The groundwater body chemical status is assessed at the different monitoring wells by counting the average values of pollutants per year.

Chemical status of groundwater body is assessed as good when at least in 80 % of monitoring wells concentration of the pollutant does not exceed the threshold value, groundwater quality limit or other chemical status indicator value. In case the concentration of the pollutant at one or more monitoring wells of the groundwater body exceeds pollutant threshold value or groundwater quality limits, the chemical status of groundwater body will be assessed as good, in case if groundwater monitoring data, computational prognosis and taking into account the concentration of pollutant, quantity, influence to the groundwater body and ecosystems that depend on groundwater body, might be concluded that:

1) concentration of the pollutant does not threaten the groundwater body’s good chemical status or this achievement nor pose a significant risk to the environment;

2) other indicators of groundwater body chemical status corresponding to the values of good chemical status;
3) Concentration of the pollutants does not significantly impair the use of groundwater for human activity.

Groundwater body chemical status is good, if at least in 80% of monitoring wells threshold values and quality indicator values are meeting the following requirements:
1) concentration of chlorides, sulphates and conductivity do not indicate growth trend which would refer to human activity pollution or salt water inflow;
2) pH is in the range of 6-9;
3) dissolved oxygen does not show downward trend caused by human activity or chemical oxygen demand is $\leq$5 mg/l O_2 or in case the quality indicator value is exceeded, it is proven the natural origin of dissolved oxygen in groundwater;
4) concentration of ammonium does not exceed in naturally aerobic groundwater 0.5 mg/l, neither exceed in naturally aerobic aquatic environment 1.5 mg/l or in case the quality indicator value is exceeded, it is identified its natural origin;
5) there are no hazardous substances, including arsenic, cadmium, lead, mercury, trichloroethylene, tetrachloroethylene, concentration of synthetic substances or their concentration does not exceed groundwater quality limit values. In case of presence have been identified their natural origin;
6) the concentration of pollutants in the groundwater body does not impede the achievement of the environmental objectives for associated surface waters, do not cause significant damage to the ecological and chemical status of surface waters or directly dependent on groundwater storage in terrestrial ecosystems.

Groundwater threatening pollutants and their threshold values (Table 1) according to the regulation of the Minister of the Environment No. 75 adopted in 29th December 2009 "Procedure for the establishment of groundwater bodies and the list of those groundwater bodies which status class has to be determined, groundwater bodies status classes, quality indicator values corresponding the statues classes and conditions of quantitative indicators, the list of pollutants threating groundwater and their threshold values and quality limit values in groundwater, the methodology for determining the level of the background and procedure of determining statues classes of groundwater bodies" that are taking into account in the assessment of groundwater body chemical status are as follows:

Table 1. Threshold values of pollutants establish for the groundwater bodies

Pollutant	Unit	Threshold value in groundwater	Number of groundwater body for which applies a threshold value
Monophenols	µg/l	1	5, 6, 7, 27, 28, 29, 38
Petroleum product	µg/l	20	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39
Benzene	µg/l	1	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 38
Sum of polycyclic aromatic hydrocarbons (PAH)s	µg/l	0,1	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39
Sulphates (SO_4)	mg/l	250	5, 6, 7, 27
Chlorides (Cl)	mg/l	250	2, 3, 8, 9, 12, 19, 20, 28, 29, 31, 35, 36, 38
Chlorides (Cl)	mg/l	350	1

For the assessment of groundwater chemical status it is taken into consideration quality limit values (Table 2) accordingly to the regulation of the Minister of the Environment No. 75 adopted in 29th December 2009 for pollutants that are establish commonly for all the member states are as follows:

Table 2. Quality limit values

Pollutant	Quality limit value
Nitrates	50 mg/l
Pesticides	0,1 µg/l

4.3 Characterization of groundwater bodies at risk or at poor status and main pressures

According to the results of groundwater bodies' assessment (Table 3), there are 8 groundwater bodies in poor status and 10 groundwater bodies at risk. To Eastern Estonian river basin district belongs totally 15 groundwater bodies, one of them has status class poor and at risk has evaluated five groundwater bodies. To Western Estonia river basin district belongs totally 21 groundwater bodies, seven of them has status class poor and at risk five. In Koiva river basin district are three groundwater bodies that all are in good status class.

Characterization of groundwater bodies at risk and in poor status is given in Annex 4.

Table 3. Groundwater bodies at risk or at poor status [3]

No.	Name of groundwater body and the number	Belonging to river basin district	Chemical status class	Quantitative status class	Final status or at risk
1.	Cambrian Vendian Gdovi (No. 1)	Eastern Estonian	Good	Good	At risk
2.	Cambrian Vendian Voronka (No. 2)	Eastern Estonian	Good	Good	At risk
3.	Cambrian Vendian (No. 3)	Western Estonia	Good	Good	At risk
4.	Ordovician Cambrian GWB in Eastern Estonia river basin district (No. 5)	Eastern Estonian	Good	Good	At risk
5.	Ordovician Eastern Viru (No. 6)	Eastern Estonian	Poor	Good	Poor
6.	Ordovician East-Viru oil shale basin (No. 7)	Eastern Estonian	Poor	Poor	Poor
7.	Silurian-Ordovician Harju (No. 10)	Western Estonia	Good	Good	At risk
8.	Silurian-Ordovician Matsalu (No. 11)	Western Estonia	Good	Good	At risk
9.	Silurian-Ordovician Pärnu (No. 12)	Western Estonia	Good	Good	At risk
10.	Silurian-Ordovician GWB in East-Estonia river basin district (No. 13)	Eastern Estonian	Good	Good	At risk
11.	Silurian-Ordovician Pandivere GWB in West-Estonia river basin district (No. 14)	Western Estonia	Good	Good	At risk
12.	Silurian-Ordovician Pandivere GWB in East-Estonia river basin district (No. 15)	Eastern Estonian	Poor	Good	Poor
13.	Silurian-Ordovician Adavere-Põltsamaa (No. 16)	Eastern Estonian	Poor	Good	Poor
14.	Quaternary Vasavere (No. 27)	Eastern Estonian	Poor	Good	Poor
15.	Quaternary Meltsiveski (No. 28)	Eastern Estonian	Poor	Good	Poor
16.	Quaternary Männiku-Pelguranna (No. 29)	Western Estonia	Poor	Good	Poor
17.	Quaternary Elva (No. 35)	Eastern Estonian	Good	Good	At risk
18.	Quaternary Võru (No. 38)	Eastern Estonian	Poor	Good	Poor

4.3.1 Cambrian-Vendian Gdov groundwater body (No. 1)

Cambrian-Vendian Gdov (Cm-V2gd) groundwater body is formed from Gdov's aquifer. GWB is located in East-Viru and West-Viru Counties, spreading from Loksa until Sillamäe eastern part. GWB is covered by the clays of Kotlin Formation that forms aquitard. Aquifer is set up by silt- and sandstone. Groundwater natural flow direction is towards to Gulf of Finland. Groundwater pressure level depends mainly from the groundwater abstraction. [7]

Gdov's aquifer is fed by the Voronka aquifer through the Kotlin Formation and from the ancient buried valleys that are filled with Quaternary sediments [8]. Chemical type of Gdov's groundwater is Cl-HCO_3-Na. GWB is not connected with surface water bodies or terrestrial ecosystems [8]

The main pressure on Cm-V2gd GWB is water abstraction for the public water supply that has caused extensive cone of depression and change of groundwater flow direction from the Gulf of Finland. Intensive water abstraction may cause increase of concentration of chlorides and barium from the crystalline base. [7]

4.3.2 Cambrian-Vendian Voronka groundwater body (No. 2)

Cambrian-Vendian Voronka (Cm-V2vr) groundwater body is formed from Voronka' aquifer. GWB is located in East-Viru and West-Viru Counties. GWB is covered by the Lükati-Lontova aquitard. Aquifer is composed from silt- and sandstone. Natural groundwater natural flow direction is from the south to the north. [7]
Voronka aquifer is fed by Ordovician-Cambrian aquifer groundwater that infiltrates through the Lükati-Lontova aquitard and from the precipitation water that infiltrates from the ancient buried valleys that are filled with Quaternary sediments [8].
Chemical type of Gdov's aquifer's water is Cl-HCO_3-Na-Mg. GWB is not connected with surface water bodies or terrestrial ecosystems. [7]

The main pressure on Cm-V2gd GWB is water abstraction for the public water supply that has caused extensive cone of depression and due to that risk for seawater intrusion and increase of concentration of chlorides. Risk to seawater intrusion is especially in regions of Sillamäe and Narva-Jõesuu [7]

4.3.3 Cambrian-Vendian groundwater body (No. 3)

Cambrian-Vendian Voronka (Cm-V2vr) groundwater body is formed from Cambrian-Vendian aquifers. GWB is situated in territories of Harju, Rapla and Lääne Counties, from Loksa to Matsalu natural preserve. GWB is covered with Lükati-Lontova clay and siltstone that forms aquitard. Aquifer is composed from silt- and sandstone. Natural groundwater flow direction is with direction to Gulf of Finland [7]
GWB is fed by the precipitation water that infiltrates from the ancient buried valleys that are filled with Quaternary sediments [8].

Chemical types of Cm-V groundwater is HCO_3-Cl-Na-Ca or Cl-HCO_3-Na-Ca. GWB is not connected with surface water bodies or terrestrial ecosystems. [7]

The main pressure on Cm-V GWB is water abstraction for the public water supply, especially in Tallinn, Paldiski, Keila, Maardu and Viimsi regions. This has caused extensive cone of depression and due to that risk for seawater intrusion or intrusion of saline water from the crystalline base, which in turn will increase of concentration of chlorides [7].

4.3.4 Ordovician-Cambrian GWB in East-Estonia river basin district (No. 5)

Ordovician-Cambrian GWB in East-Estonia river basin district (O-Cm_Ida) is formed from Ordovician-Cambrian aquifer. GWB is situated in territories of Western Viru, Eastern Viru, Järva, Jõgeva ja Tartu counties. GWB's north part is covered with kerogenous shale. Aquifer is composed from quartz sandstone. Groundwater natural flow direction is from Pandivere upland radially to all directions. GWB is fed by the water that infiltrates through the Silurian-Ordovician aquifer regional aquitard and from the precipitation water that infiltrates from the Purtse and Vasavere ancient buried valleys that are filled with Quaternary sediments. [7]
In northern part of GWB there is HCO_3-Mg-Ca or HCO_3-Ca-Mg type of groundwater and in southern part, there is Cl-HCO-Na or Cl-Na type of groundwater. GWB is not connected with surface water bodies or terrestrial ecosystems. [7]

The main pressure to GWB is groundwater abstraction. Bigger groundwater intakes are in Rakvere region and in Tartu. There is a risk for saline groundwater intrusion in Tartu and Jõgeva counties and Northern Estonia coastal areas [4]. GWB is very sensitive about water intake [7].

4.3.5 Ordovician East-Viru groundwater body (No. 6)

Ordovician East-Viru groundwater body (O_viru) is formed from Ordovician aquifers. GWB is located in East-Viru County, around oil shale mining area. GWB is not covered with the clear-cut aquitard. Aquifer is composed from limestones and dolomites. GWB is fed by the precipitation water that is filtrated though the soil. Groundwater flow direction is towards to Ordovician East-Viru oil shale basin groundwater body until groundwater pumping will

continue due to the need to lower groundwater level because of mining activity. Part of the groundwater flow goes to Vasavere groundwater body. Groundwater type is HCO3-Ca-Mg [7]. GWB groundwater regime depends from natural factors like precipitations, evaporation etc and mining drainage of Estonia underground mining and Narva open-cast mining. Part of water that is pumped out from mining is infiltrating back to groundwater body. In deeper aquifers pressure drop reaches until 13 km from the mining. Impact of human activities will increase with the new Uus-Kiviõli mining. Other important pressures on GWB are diffuse source inputs, like agriculture, domestic wastewater, leakages from polluted areas, leakages from waste storage sites, leakages from oil production industry infrastructures. Once if underground mining will be filled with a groundwater after closing, polluted groundwater with a phenols and petroleum products may spread to Ordovician Eastern Viru groundwater body [7].

4.3.6 Ordovician East-Viru oil shale basin groundwater body (No. 7)

Ordovician East-Viru oil shale basin groundwater body (O_pkivi) if formed from Ordovician aquifers. GWB is located in the middle of East-Viru County. GWB is not covered with the clear-cut aquitard. Aquifer is composed from limestones and dolomites. GWB groundwater regime depends on natural factors like precipitations and evaporation and also from the mining activities in Estonia underground mining and Narva career due to what is needed groundwater drainage. There is an extensive cones of pumping depression around Estonia underground mining. In Nabala-Rakvere aquifer cone of pumping depression reaches until 2 km from the mining and in Keila-Kukruse aquifer until 7 km. In deeper aquifers pressure drop reaches until 13 km from the mining. GWB is little bit associated with surface and terrestrial ecosystems. Type of groundwater is mainly HCO_3-Ca-Mg [7].

Due to mining activity the GWB is perspectiveless as drinking water resource. Main pressures that jeopardise GWB is diffuse pollution from the areas that are not connected to wastewater collection systems, but as well from point pollution sources like leakages from the polluted areas, pollution that arrives to groundwater from the mining, leakages from the landfills (mountains of gangues, semi-coke hills, hills of ashes produced by power plants) leakages from the oil industry infrastructures and drainage from mining where water is polluted [4].

4.3.7 Silurian-Ordovician Harju groundwater body (No. 10)

Silurian-Ordovician Harju groundwater body (S-O_Harju) is formed from the Silurian-Ordovician aquifers and it spreads in Harju and Rapla Counties. GWB is not covered with the clear-cut aquitard. Aquifer is composed from homogeneous limestone and dolomites that varies with layers of marl. Close to ground, rocks are karstic and cracked. From the Pandivere upland groundwater flow direction is towards to north-west and north. Feeding of GWB and natural regime depends on precipitation and temperature. Most common groundwater type is HCO_3-Ca-Mg. [7]

The main pressure on groundwater comes from agriculture, especially usage of fertilizers, and livestock raising. Other diffuse pollution sources are cesspools, wastewater drains, especially in areas where groundwater is not protected with an aquitard, but as well as leakages from the polluted areas (Tapa and Ämari airfields, Keila-Joa missile base, Tapa wagon depot, Maardu industrial area etc). Point pollution comes mainly from landfills, wastewater treatment plants and the discharges of wastewater [7], [5]

4.3.8 Silurian-Ordovician Matsalu groundwater body (No. 11)

Silurian-Ordovician Matsalu groundwater body (S-O_Matsalu) is formed from Silurian-Ordovician aquifers. GWB is located partly in northern part of Pärnu County and southern part of the Harju County. GWB is not covered with the clear-cut aquitard. Aquifer is composed from homogeneous limestone and dolomites that varies with layers of marl. Groundwater flow direction is from the North-Estonian plateau to west, towards to West-Estonian lowland. Feeding of GWB and natural regime depends on precipitation and temperature. In northern part of the GWB, groundwater type is HCO_3-Ca-Mg, in western part closer to sea type changes - HCO_3-SO_4-Ca-Mg-, HCO_3-Cl-Na-Mg-Ca- or even Cl-HCO_3-Na-Mg [7].

The main pressure on groundwater comes from agriculture and pollution range depends on annual precipitations and usage of fertilizers, especially where groundwater is weakly or not protected. Other diffuse pollution sources are areas that are not connected to wastewater collection systems. Point pollution is coming mainly from the polluted areas, for example Haapsalu and Raiküla asphalt concrete plants, and from the landfills. The wastewater treatment

plants and the discharges of wastewater are also notable point pollution sources. Less pressure on groundwater are giving drainages of mining and groundwater abstraction for the public water supply [7], [5].

4.3.9 Silurian-Ordovician Pärnu groundwater body (No. 12)

Silurian-Ordovician Pärnu groundwater body (S-O_Parnu) is formed from Silurian-Ordovician aquifers. GWB spreads in Pärnu, Lääne, Rapla, Viljandi and Järva Counties. GWB is not covered with the clear-cut aquitard. Aquifer is composed from homogeneous limestone and dolomites that varies with layers of marl. Groundwater flow direction is from the Pandivere upland to South-West, towards to Gulf of Riga. Feeding of GWB and natural regime depends on precipitation and temperature. During the low water-level time in summertime, rivers are fed by groundwater. Groundwater chemical type in the western part is HCO_3-Ca-Mg, but closer to Gulf of Riga concentrations of chlorides are increasing and due to that the type of groundwater is changing as well - HCO_3-Cl-Na-Mg-Ca-, Cl-HCO_3-Na-Mg- or even Cl-Na-Mg [7].

Very important pressure on groundwater is related with groundwater abstraction for the public water supply, especially in coastal area, because of seawater intrusion. From the diffuse pollution, biggest pressure comes from agriculture that depends on annual precipitations and usage of fertilizers, especially where groundwater is weakly or not protected. Other diffuse pollution sources are areas that are not connected to wastewater collection systems. Point pollution is coming mainly from the polluted areas, for example Sillaotsa asphalt concrete plant, Pärnu oil base etc. The discharges of wastewater treatment plants are also adding pressure on groundwater quality. Less pressure on groundwater are giving drainages of mining, like Rõsta and Anelema careers [5], [3].

4.3.10 Silurian-Ordovician groundwater body in East-Estonia river basin district (No. 13)

Silurian-Ordovician groundwater body in East-Estonian river basin (S-O_I) is formed from Silurian-Ordovician aquifers. Administratively groundwater body is located in West-Viru and

partly in Jõgeva Counties. GWB is not covered with the clear-cut aquitard. Aquifer is composed from homogeneous limestone and dolomites that varies with layers of marl. Groundwater flow direction is radially from the Pandivere upland to the north, east and south. Karstic areas have an important role in formation of groundwater reserves and GWB is fed by precipitations. Natural groundwater chemical type is HCO_3-Ca-Mg [7].

The main pressure on groundwater body comes from the agriculture that depends on annual precipitations and usage of fertilizers. Vulnerable are areas where groundwater is weakly or not protected. The second important diffuse pollution sources are leakages from the polluted areas, mainly from the previous asphalt concrete plants, like Laekvere, Lasila, Viruvere etc. Also areas that are not connected to wastewater collection systems are playing, but mainly in areas, where groundwater is vulnerable from the pollution coming from the ground. Main point pollution comes from the discharges of wastewater treatment plants [7], [3].

4.3.11 Silurian-Ordovician Pandivere groundwater body in West-Estonian river basin district (No. 14)

Silurian-Ordovician Pandivere groundwater body in West-Estonian river basin district (S-O_PandivereL) is formed from Silurian-Ordovician aquifers. GWB spreads in West-Viru and Järva Counties. Aquifers are composed from homogeneous limestone and dolomites that varies with layers of marl. Groundwater is weakly or not protected and flow direction depends on the shape of Pandivere upland and moves towards to river Pärnu and its tributaries. Feeding of GWB and natural regime depends on precipitation and temperature. During the low water-level time in summertime, rivers are fed by groundwater. The type of groundwater is HCO_3-Ca-Mg [7].

The main pressure on groundwater body comes from the agriculture that depends on annual precipitations, usage of fertilizers and pesticides. There are evolving areas with the intensive agriculture. The second important diffuse pollution sources are areas without connection to wastewater collection systems, but also leakages from the polluted areas, like Tapa aviation field, Tapa locomotive depot etc. Main point pollution comes from the discharges of wastewater treatment plants [7], [3]

4.3.12 Silurian-Ordovician Pandivere groundwater body in East-Estonian river basin district (No. 15)

Silurian-Ordovician Pandivere groundwater body in East-Estonian river basin district (S-O_PandivereI) is formed from Silurian-Ordovician aquifers. GWB spreads in West-Viru and Järva Counties. Aquifer is composed from homogeneous limestone and dolomites that varies with layers of marl and groundwater is weakly or not protected. Flow direction depends on the shape of Pandivere upland and groundwater moves radially to the north, east and south. Karstic areas have important role in formation of groundwater resources. Natural groundwater chemical type is HCO3-Ca-Mg [7].

Biggest problem with the groundwater body is the concentrations of nitrates that has been increasing since 2007 in the areas of intensive agriculture. 54% of the land is agricultural land. The main pressure on groundwater body comes from the agriculture that depends on annual precipitations, usage of fertilizers and pesticides. Notable danger to groundwater quality are big stock-rising complexes that are missing dung pits that are meeting the requirements. The second important diffuse pollution sources are areas without connection to wastewater collection systems, but also leakages from the polluted areas, like previous Rakvere oil terminal, E-Betoonelement factory in Tamsalu etc. Main point pollution comes from the discharges of wastewater treatment plants [7], [3]

4.3.13 Silurian-Ordovician Adavere-Põltsamaa groundwater body (No. 16)

Silurian-Ordovician Adavere-Põltsamaa groundwater body (S-O_AdavereP) is formed from Silurian-Ordovician Silurian-Ordovician aquifers. Administratively groundwater body is located in Jõgeva County. Aquifer is composed from homogeneous limestone and dolomites that varies with layers of marl and groundwater is weakly or not protected. Groundwater level is just 2-6 m from the ground. Groundwater flow direction is determined by local river grid. From the main supply area, which is Pandivere upland, groundwater flow direction is to south. Feeding of GWB and natural regime depends on precipitation and temperature. There are rivers that are fed by groundwater and ditches and streams that are drying in low water periods. Natural groundwater chemical type is HCO3-Ca-Mg [7].

Agricultural diffuse pollution is the main pressure on groundwater quality, depending on annual precipitations, usage of fertilizers and pesticides. Notable danger to groundwater quality are big stock-rising complexes that are missing dung pits that are meeting the requirements. Second important diffuse pollution sources are densely populated areas without connection to wastewater collection systems. Other diffuse pollution sources are leakages from the previous polluted industrial areas, for example Põltsamaa asphalt concrete plant.

4.3.14 Quaternary Vasavere groundwater body (No. 27)

Quaternary Vasavere groundwater body (Q_Vasav) is formed from the aquifer with the fluvious-glaciogenic sediments in Kurtna kame field and Vasavere buried ancient valley. Administratively GWB is located in East-Viru County, in Illuka parish. An aquifer is not protected from the pollution coming from the ground. From the upper sandfields in kame field groundwater flows to west and to east, but also in direction of Vasavere water intake. Groundwater is fed by local precipitations, but also from the water of Ordovician East-Viru oil shale basin groundwater body and surface water. Natural groundwater chemical type is HCO3-Ca-Mg [7].

Main pressure on groundwater body is water intake for the public water supply. The second pressure factor is mining activity, because GWB is impacted by the Estonia mining, Narva career and closed Ahtme mining. In case of further intensive groundwater abstraction, intrusion of polluted groundwater, mainly with the sulphates from the mining, may take place. [7], [3]

4.3.15 Quaternary Meltsiveski groundwater body (No. 28)

Quaternary Meltsiveski groundwater body (Q_Meltsiv) is formed from the aquifer with the fluvious-glaciogenic sediments of Raadi-Maarjamõisa buried ancient valley. GWB is situated in Tartu city. An aquifer is not protected from the pollution coming from the ground. Groundwater body is fed by precipitations and from the groundwater arriving from the Middle Devonian GWB as transit flow. Feeding of GWB and natural regime depends on precipitation and temperature. In summertime groundwater level is low because of evaporation and plants growth. Natural groundwater chemical type is HCO3-SO4-Cl-Ca-Mg [7].

Main pressure on groundwater body is related with the location in the city. Present sanitary protection zone does not ensure the preservation of groundwater quality. It is needed to preserve green areas, fix drainage and to ensure readiness to liquidate fast environmental incidents in Meltsiveski groundwater intake area. Principal pressures on groundwater are storm water overflows and other polluted water drains, leakages from the previous polluted industrial territories, like Raadi airfield and pressure coming from the areas that are not connected to the wastewater collection systems. Also groundwater abstraction is a considerable pressure on the GWB as well as point pollution from the discharges of wastewater treatment plants. Smaller, but still notable pressure comes from the public transportation [3].

4.3.16 Quaternary Männiku-Pelguranna groundwater body (No. 29)

Quaternary Männiku-Pelguranna groundwater body (Q_Manniku-Pelguranna) is formed from the aquifer with the fluvious-glaciogenic sediments. GWB is situated in Tallinn and parishes of Saku, Kiili and Rae. An aquifer is mainly not protected from the pollution coming from the ground. Aquifers are composed principally from the sand and gravel. Groundwater flow direction is from the Nõmme-Männiku sand fields towards to Kopli and Kakumäe Bay. Feeding of GWB and natural regime depends on precipitation and temperature. Groundwater formed in Nõmme-Männiku sand fields is feeding Lakes Raku and Ülemiste and Bog Pääsküla. Groundwater type is mainly HCO3-Ca-Mg. [7]

Main pressure on groundwater body is related with the location in the city. Present sanitary protection zone does not ensure the preservation of groundwater quality. Principal pressures on groundwater are storm water overflows and other polluted water drains from the urban areas, caused by the transport, usage of salt for snow prevention, floods caused by overflows from the sewage pits and the pollution arriving to the groundwater from the careers. Point pollution sources are leakages from the previous industrial territories and leakages from the storages of the waste. [3]

4.3.17 Quaternary Elva groundwater body (No. 35)

Quaternary Elva groundwater body (Q_Elva) is formed from the aquifer with the fluvious-glaciogenic sediments. GWB is situated in Tartu County in Elva city and in parishes of Konguta ja Nõo. An aquifer is not protected from the pollution coming from the ground and it is composed principally from the sand and gravel. Groundwater flow direction is towards to rivers of Elva and Rõngu. GWB is fed locally, where groundwater flow is directed to the deeper areas. Feeding of GWB and natural regime depends on precipitation and temperature. In summertime rivers of Rõngu and Elva are getting additional water resource from the GWB. Groundwater type is mainly HCO3-Ca-Mg. [7]

Principal pressures on groundwater are storm water overflows and other polluted water drains from the urban areas, like usage of salt for snow prevention and floods caused by overflows from the sewage pits. Other important diffuse pollution sources are agriculture, pressure from the areas without connection to wastewater collection systems and leakages from the previous polluted industrial areas, but also transport. Notable point pollution comes from the discharges of wastewater treatment plants [3]

4.3.18 Quaternary Võru groundwater body (No. 38)

Quaternary Võru groundwater body (Q_Voru) is formed from the aquifer with the fluvious-glaciogenic sediments. Administratively groundwater body is situated in Võru parish. An aquifer is mainly not protected from the pollution coming from the ground and it is composed principally from the sand and gravel. Groundwater flow direction is to the north-west, towards to the lakes of Vagula and Tamula. GWB is fed locally, where groundwater flow is directed to the deeper areas. Feeding of GWB and natural regime depends on precipitation and temperature. In summertime, lakes of Tamula and Vagula are getting additional water resource from the groundwater. [7]

Main diffuse pollution sources are agriculture, pressure from the areas that are not connected to the wastewater collection systems, storm water overflows and other polluted water drains from the urban areas. Principal point pollution comes mainly from the discharges of wastewater treatment plants and leakages from the storages of the waste. [3]

5 Analysis, materials and methods for preparing groundwater action plan for implementing the programme of measures

Environmental Board is mainly responsible for the administrative activities that are related with the issuing Integrated Pollution Prevention and Control permits (IPPC) permits and permits for special use of water. Therefore it was necessary to take a look how permits being valid, are fulfilling the objectives of the administrative measures. For that was chosen randomly approximately 5% of the valid permits (25 permits) for special use of water. Results are given in annex 2.

Firstly, it is need to control in permits for special use of water to which groundwater body some well related with permits are bounded, because from this depends which measures is needed to apply. There was done an excerpt from the Environmental Permits' Information System. The results are given about the Cambrian Vendian Gdov (No. 1) groundwater body (Figure 3), where lot of wells are belonging by mistake to the Cambrian Vendian (No. 3) groundwater body. The same problem appears with many others permits in Cambrian-Vendian groundwater body, Silurian-Ordovician Harju groundwater body, Silurian-Ordovician Matsalu and Pärnu groundwater body.

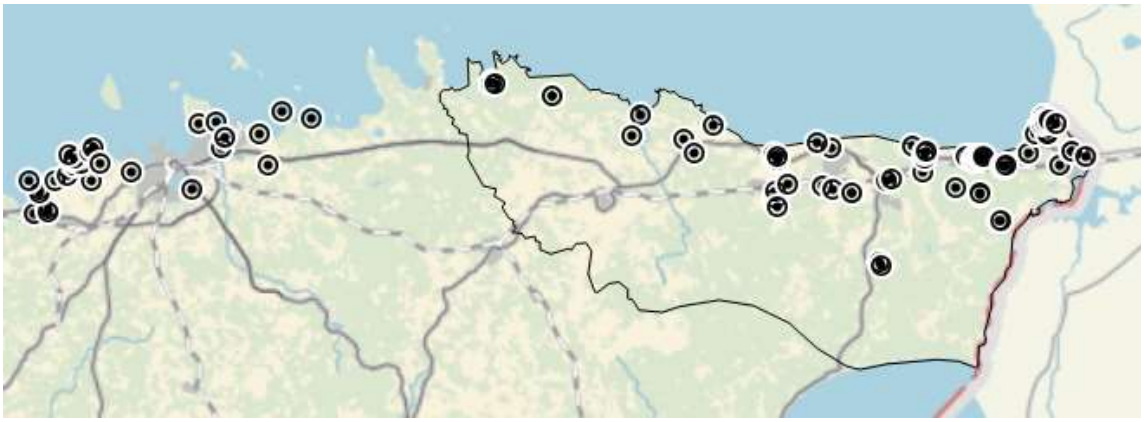

Figure 3. Cambrian Vendian Gdov's groundwater body and wells that are related with the permits for special use of water

Secondly, in monitoring conditions in permits, it is not common to take into account the real pressures on some specific groundwater body. For example, if water abstraction is the only and main pressure on groundwater quality and quantity, it is not enough to measure groundwater

level once in 5 years or when pump is broken or will be changed out. Also is not common to guide from the principle 'polluter pays' and set the monitoring conditions in compliance with the risk that activity of owner of permit might constitute to groundwater (agriculture, usage of hazardous substances). From the randomly made selection stands out that the most commonly set monitoring conditions are based on regulation of Ministry of Social Affairs No.1 "Requirements of the control and quality of the surface water and groundwater being at use or planning to use for the drinking water production".

In assessment of status groundwater bodies, it is taken into account as well the results of analysis that are done by the owners of permits, in addition to national groundwater monitoring and researches. Therefore the result of analysis shall provide necessary input.

For the better overview of the problematical areas of each groundwater body and for the planning activities that will to be implemented in 2018-2019, there was composed data layers and thematic maps in ArcGIS programme all groundwater bodies being at risk or which statues has been assessed as poor. Information for the maps was taken from the Environmental Register, where is provided reliable environmental information for Estonian decision-makers and wider public, like wastewater discharges, waste management facilities, wastewater collection areas with more and less than 2000 people equivalent, groundwater wells, groundwater monitoring stations and borders of groundwater bodies. While lot of activities are related with environmental permits, within the thesis was compiled tables and map layers for each groundwater body's permits for the special use of groundwater and IPPC permit provided by Environmental Permits' Information System (EPIS). Significant information about livestock buildings and arable land in obtained from the Estonian Agricultural Registers and Information Board (ARIB).

In order to find solutions for the effective activities, best practices from the other counties were analysed in connection with the scientific articles.

6 Groundwater Action Plan for the Years 2018-2019 for Implementing Programme of Measures of River Basin Management Plans

According to Water Act § 3[16] the implementation of a programme of measures shall be organised by the water management committee. The Environmental Board shall prepare an action plan for implementation of the programme of measures for each river basin. The action plan shall be approved by the minister responsible for the area on the proposal of the water management committee.

During the one river basin management plan cycle (2016-2021) that extends six years there will be compiled three action plans (2016-2017, 2018-2019, and 2020-2021). The goal of action plan is to implement measures of programmes of measures by stages to enhance the status of groundwater bodies and to achieve the environmental objectives.

Groundwater Action Plan is in Annex 1.

6.1 Activities of administrative measures

In programme of measures is planned total 110 administrative measures. Majority of measures are continuous during the RBMP period 2016-2021. Measures are mostly divided between Environmental Board and Environmental Inspectorate as shown in Figure 4.

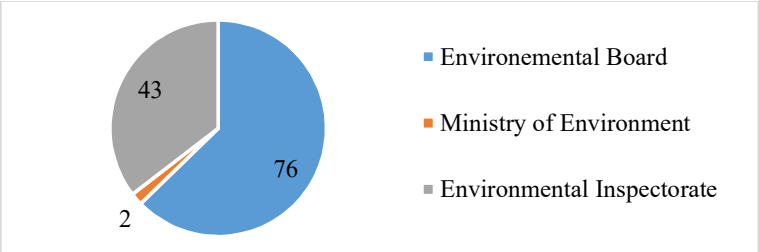

Figure 4. Administrative measure divided between promoters given in percentage

The measures, which is the responsibility of the Environmental Board are all related with a permits – IPPC permits and permit for special use of water and are applying for all the groundwater bodies.

Common measures are following that are applying for the groundwater bodies indicated in Table 4. Rest of administrative measures are similar.

Table 4. Common administrative measures for applying in groundwater bodies

Administrative measure	GWB, where measure will be applied
Review the conditions of permit for special use of water and in case of need, roughen the requirements of groundwater chemical composition monitoring, measuring the water level and water abstraction	3, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 27, 28, 29, 35
Setting an additional environmental requirements to special user of groundwater about those chemical indicators, which has assigned threshold values or quality limit value, if concentration has been growing more than 75% of the threshold value and the upward trend is significant and sustained	1, 2, 3, 7, 10, 11, 12, 13, 14, 15, 16, 29, 35, 38
Setting an additional environmental requirements before issuing the permit for special use of water, like groundwater investigation, expert rating, hydrogeological surveys, in case if in region some threshold value or quality limit values has been exceeded or there are existing growing trends of those values	2, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 27, 28, 29, 38
Establish requirement for groundwater monitoring for the farms owning the IPPC permit	6, 10, 11, 12, 13, 14, 15, 16

For reviewing existing permit or issuing the new permit, there is needed to keep in mind that the purpose of setting monitoring conditions in permit is to find out how special user of water user is affecting with his activity the quality or quantity (groundwater level) of the groundwater. Here applies the principle 'polluter pays'. In additionally is necessary to issue from the purpose of groundwater abstraction and proceed from the regulation of the Minister of Social Affairs No.1 adopted in 2nd January of Ministry of Social Affairs "Requirements of the control and quality of the surface water and groundwater being at use or planning to use for the drinking water production" and from the regulation of the Minister of the Environment No. 75 adopted in 29th December 2009 "Procedure for the establishment of groundwater bodies and the list of those groundwater bodies which status class has to be determined, groundwater bodies status classes, quality indicator values corresponding the statues classes and conditions of quantitative indicators, the list of pollutants threating groundwater and their threshold values and quality limit values in groundwater, the methodology for determining the level of the background and procedure of determining statues classes of groundwater bodies".

By the recommendations of the members of groundwater commission, it is recommended to consider the potential impact on groundwater intake water with the approximately radius 200

m around the well is getting groundwater from shallow aquifers. In case well is using a groundwater from pressurized aquifer, there is recommended to issue from the results of closest national groundwater monitoring that opens the same aquifer.

It is needed to review self-monitoring results and closest national groundwater monitoring station results. In case some water quality indicator is exceeding threshold value or quality limit value or concentration has been growing more than 75% of the threshold value and the upward trend is significant and sustained, more rigid quality indicator monitoring requirements has to be added to the permit accordance with the regulation of the Minister of Environment No. 25 adopted in 6th April 2011 "Requirements for the water monitoring programs in river basin districts". In case the groundwater level shows downward trend, more frequent measuring the water level is required and referring groundwater abstraction more or less equably during the year.

Environmental Board shall use more often the right coming from the regulation of the Minister of the Environment No. 18 adopted in 26th March 2002 "Procedure of issuing the permit of water special use or temporary permit of water special use and revocation, the list of materials needed for pursue a permit and permit forms" to involve expert assessment to find out how the groundwater intake may affect the movement of pollutants in case of bigger groundwater abstraction (for example more than 100 m3/d) if in the region has been discovered heightened concentrations of pollutants.

Environmental Board will work out short guide for special users of water how to measure groundwater level manually. The guide should provide short and easily understandable information about the measuring the groundwater level and will be uploaded on the Environmental Board's webpage.

In case the results of groundwater quality are indicating to the pollution, especially in case of deeper aquifer, it is needed to take supplement analyses. If results are still showing a pollution, it is possible to control a condition of the well by the video survey. From the video is possible to see the condition of casing pipe and joints between them. Other possibility is for controlling the technical condition is borehole geophysics with gamma logs, fluid-resistivity logs, electromagnetic-induction log, etc.

The best overview for setting monitoring conditions in permits are giving following maps about all groundwater bodies and tables where are brought out monitoring wells where is identified higher concentrations of polluters or upward trends. Setting a monitoring conditions there is a need to take into account the main pressures causing the poor status of groundwater or that may threat their good status.

The result of groundwater monitoring stations where established threshold values or quality limits are exceeded are given in annex 3.

Generally, Environmental Board shall review a permit conditions related with wells that are situating close to the groundwater monitoring stations where threshold values or quality limit values has been exceeded or there is a significant upward trend in concentration of pollution. It is recommended to issue from the existing reports of the environmental impact assessment, water intake sanitary zone assessment, the assessment of groundwater resources and feeding area of the water intake.

6.1.1. Cambrian-Vendian groundwater bodies (No. 1, No. 2, No. 3) and Ordovician Cambrian GWB in Eastern Estonia river basin district (No. 5)

All Cambrian-Vendian aquifers are well protected from the pollution coming from the ground, the only way how pollution arrives to aquifer is through the abandoned well or through the well that is technically defective, in additionally through the ancient buried valleys. The main pressure on those groundwater bodies is groundwater abstraction, but accordingly to the national groundwater monitoring results in 2016, the groundwater level of aquifer has been increasing in all groundwater bodies. Chemical composition has been stable

As it is shown in the figures 5, 6 and 7 the main problems with higher concentrations of chlorides are in bigger towns like Kunda, Aseri, Toila, Sillamäe, Narva-Jõesuu, but also in Narva, Voka, Oru, Jõhvi, Kohtla-Järve, Kiviõli, Rakvere and Tallinn especially in coastal areas, groundwater abstraction is causing salty water intrusion from the crystal base or from the sea that results with higher concentration of chlorides. It is recommended to set limiting conditions for the groundwater intake according to the real water abstraction and to try to divide water abstraction equally during the year.

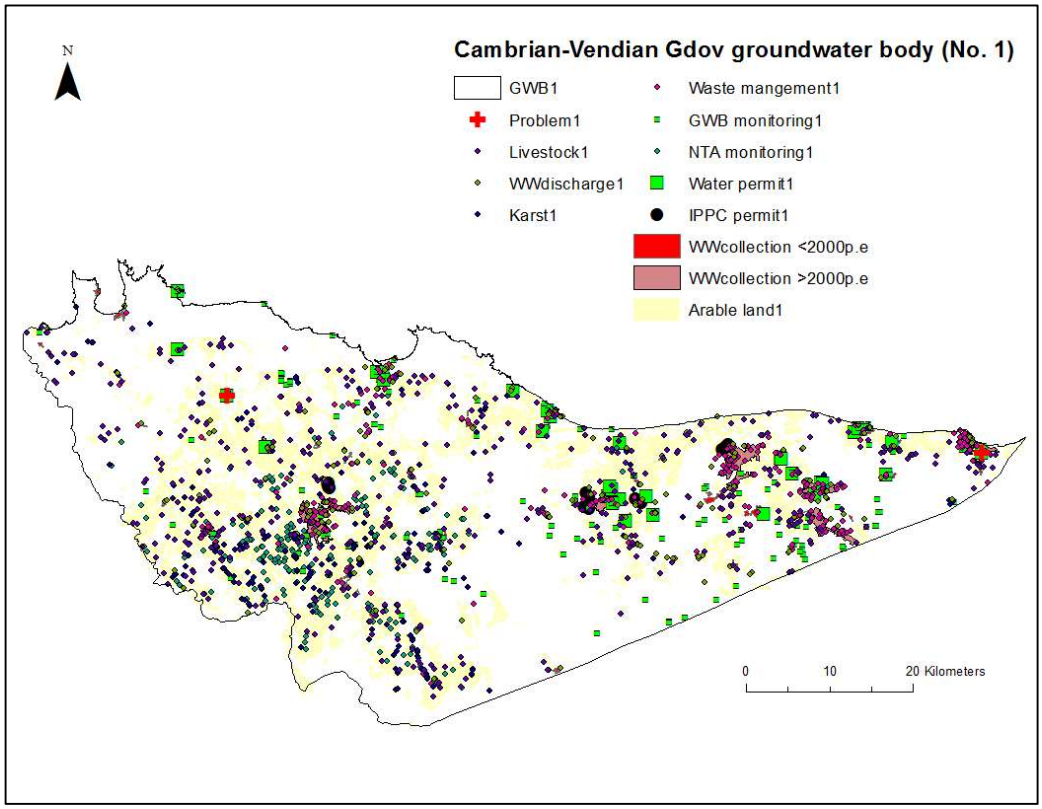

Figure 5. Cambrian-Vendian Gdov groundwater body (No. 1)

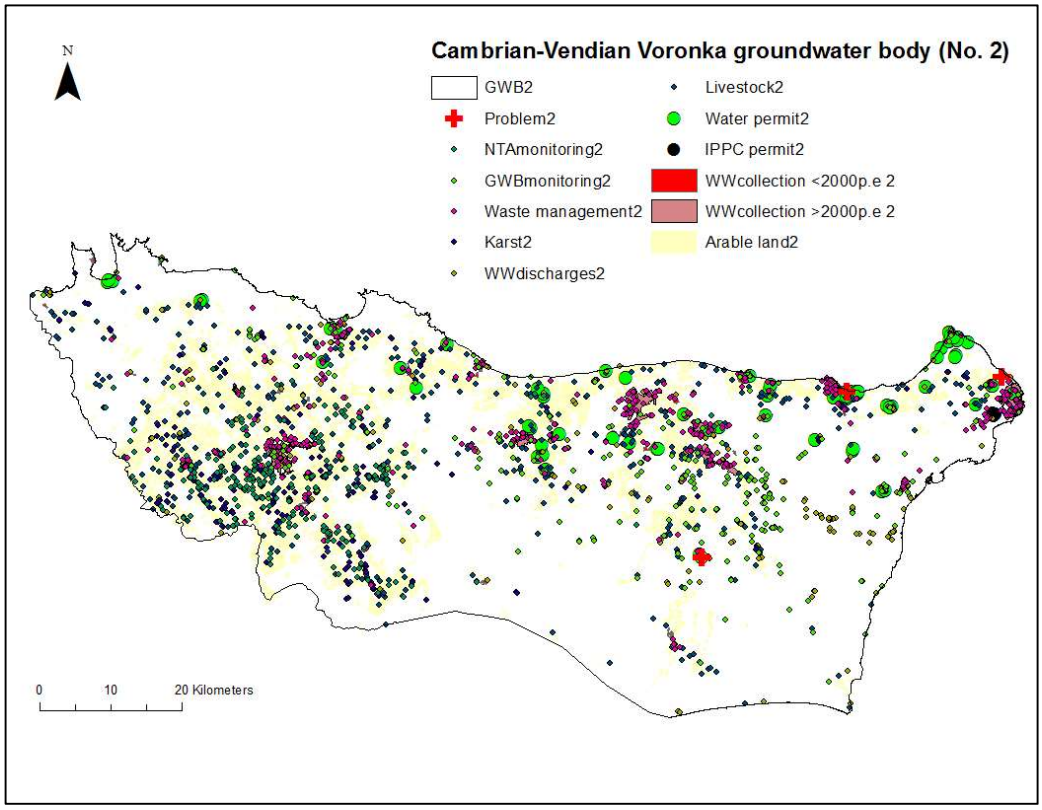

Figure 6. Cambrian-Vendian Voronka groundwater body (No. 2)

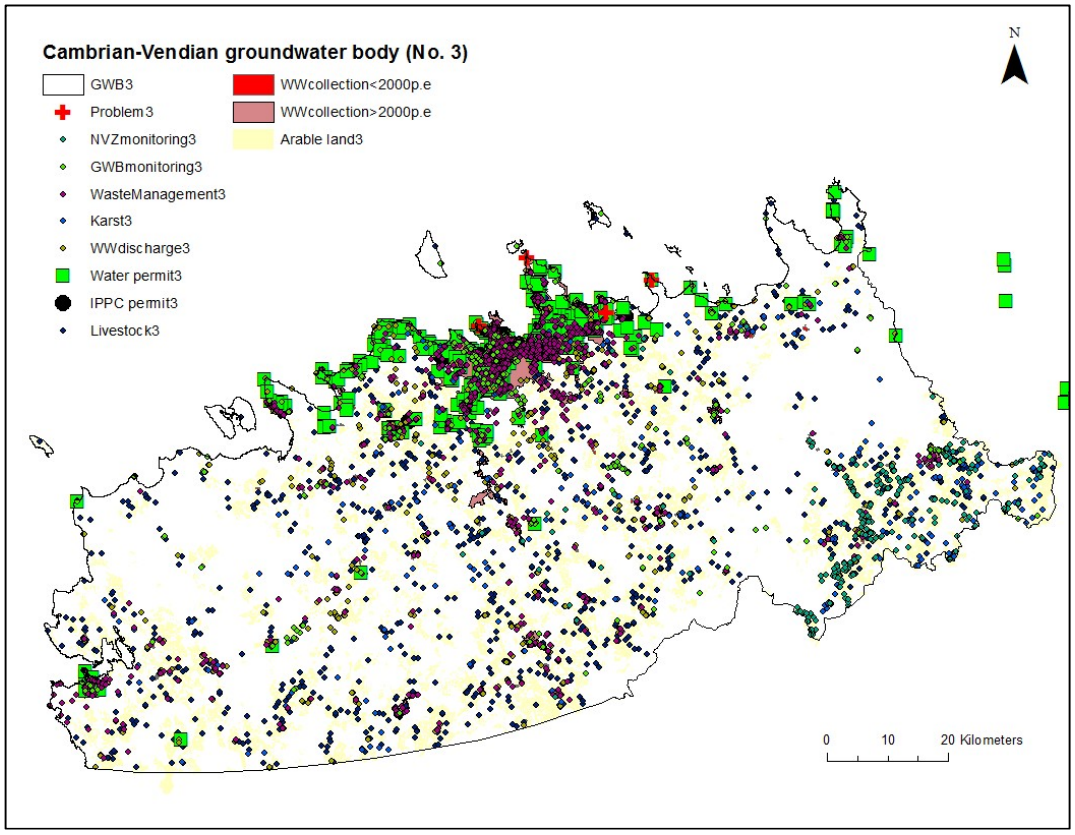

Figure 7. Cambrian-Vendian groundwater body (No. 3)

6.1.2 Ordovician Cambrian GWB in Eastern Estonia river basin district (No. 5)

Ordovician Cambrian GWB in Eastern Estonia river basin district (No. 5) is very sensitive about groundwater abstraction and in the North-East Estonia, the water level is affected by the drainage. Due to the drainage of upper aquifer – Ordovician, feeding of the groundwater body has been decreased accordingly to the national groundwater monitoring results in 2016. Chemical composition has been stable. Groundwater body is depicted on figure 8.

Reviewing the real groundwater abstraction by the special users of water (water abstraction >5 m3/d) in order to find out if groundwater abstraction exceeds or falls below 500 m3/d, which depends on the need to for the hydrogeological survey for the assessment of groundwater reserves. Environmental Board will send to companies a reminder, bringing out the main problems related with the area of groundwater body taking into account state monitoring data and additional requirement that should be surveyed.

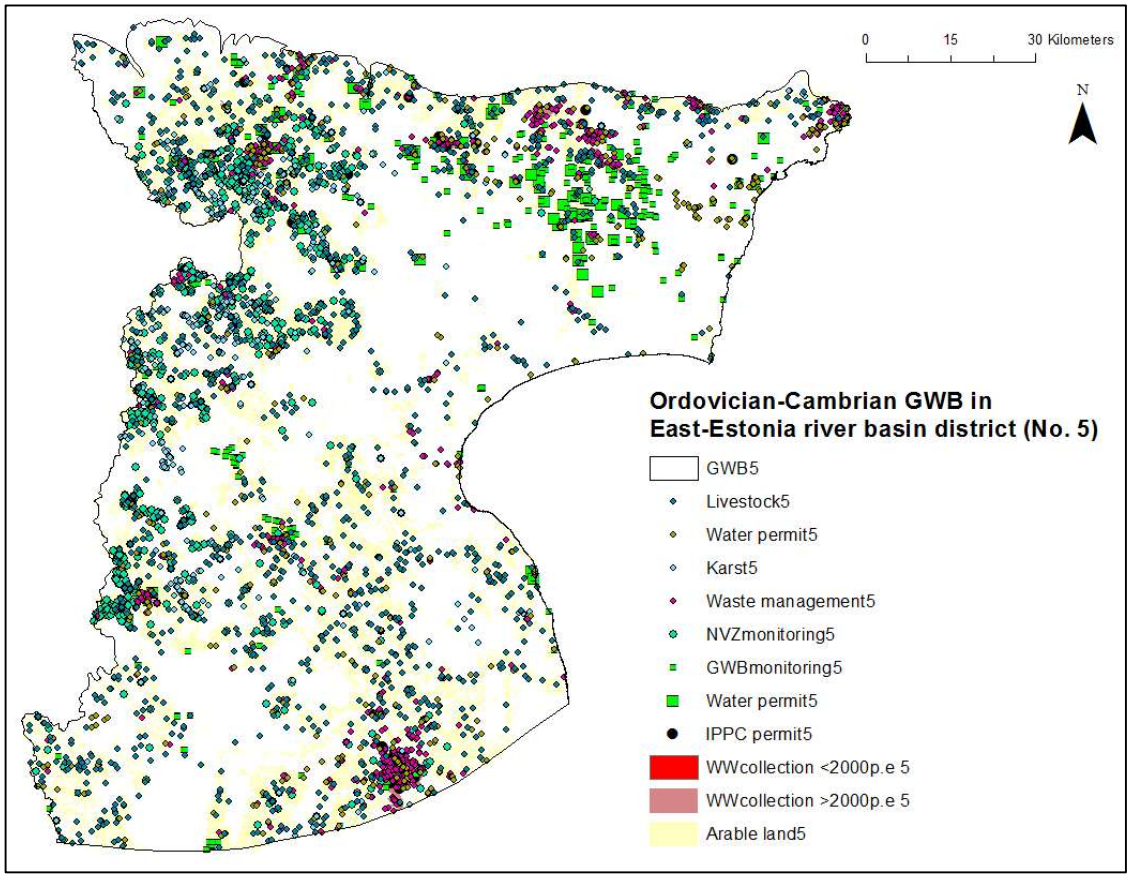

Figure 8. Ordovician-Cambrian groundwater body in East-Estonian river basin district (No. 5)

6.1.3. Ordovician East-Viru and Ordovician East-Viru oil shale basin groundwater bodies (No. 6 and 7)

Groundwater bodies are affected by the mining activity. Ordovician East-Viru groundwater body exchange with a Groundwater exchange oil shale basin groundwater body is causing a poor status of groundwater body [6]. Groundwater of both groundwater bodies contain at times heighten concentrations of manmade pollution – monophenols, petroleum products, sulphates, benzene and PAHs. Higher concentration of sulphates and hazardous substances are arriving to the groundwater from the mining. Monophenols are derived from the residual pollution sites like from the mine wastes, semi coke deposits, as well as sum of polycyclic aromatic hydrocarbons (PAHs) concentration is increasing with the ageing. In additionally, concentration of Ag, Mn, Sr, Zn increases during the deposition of semi-coke. [19] Petroleum products are arriving to groundwater from the deposits of oil shale ash and oil base.

There are no mining scenarios that would change the status of groundwater body for good according to the allowed volume – 15, 20 and 25 tons of oil shale per year [9]. In addition, change of groundwater level leads to a favourable environment for chemical reactions that are causing groundwater pollution with the hazardous substances and sulphates. Significant local improvement in groundwater quality may appear with the organizing the landfills and liquidating the residual pollution sites [10].

Groundwater bodies and their pressures are shown on figures 9 and 10.

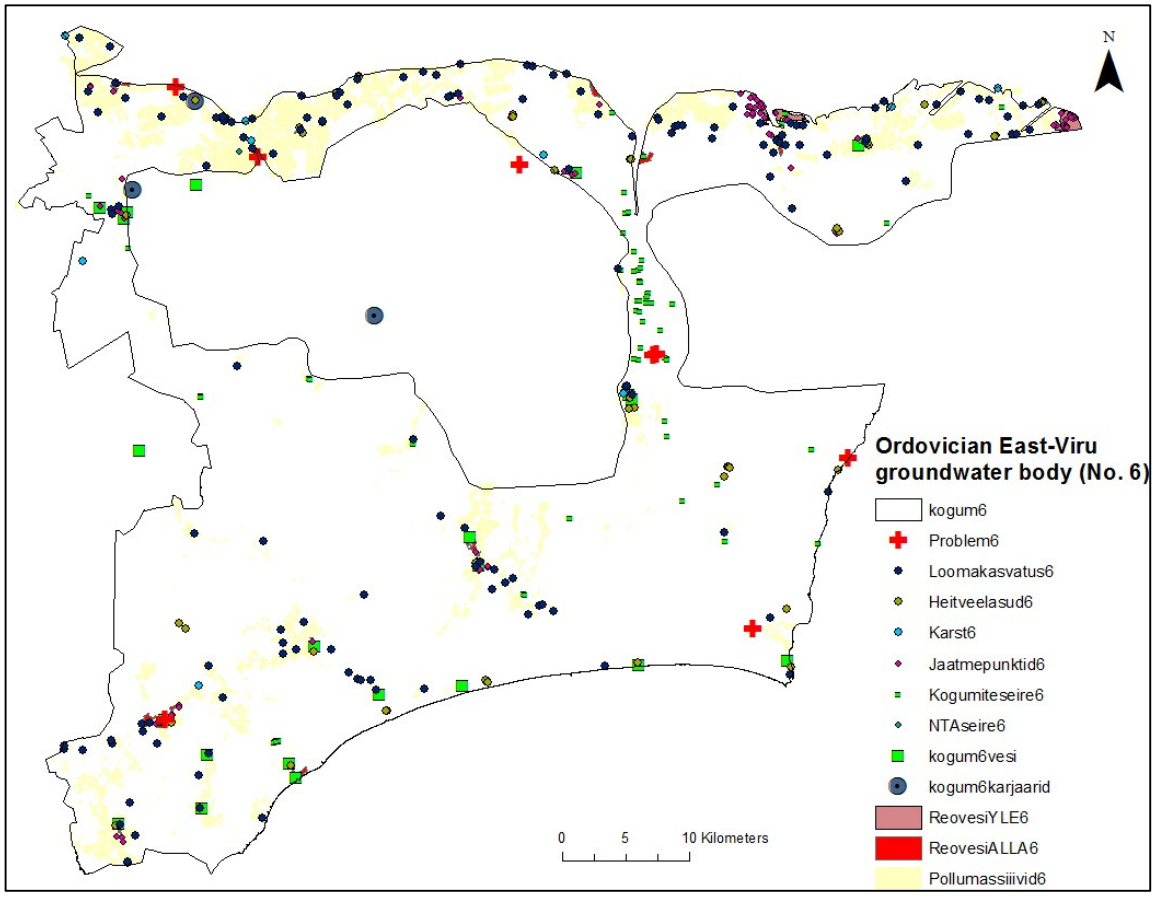

Figure 9. Ordovician East-Viru groundwater body (No. 6)

According to the national groundwater monitoring results in 2016, groundwater level in Ordovician East-Viru groundwater body has not been changed remarkably, but groundwater level in Ordovician East-Viru oil shale basin groundwater body has been decreasing since 2010. 54% of the analysis of monophenols, 25% of the analysis of benzene and 14,3% of analysis of PAHs are exceeding the threshold values establish by the regulation of Minister of the

Environment No. 75 adopted in 29th December 2009 “Procedure for the establishment of groundwater bodies and the list of those groundwater bodies which status class has to be determined, groundwater bodies status classes, quality indicator values corresponding the statues classes and conditions of quantitative indicators, the list of pollutants threating groundwater and their threshold values and quality limit values in groundwater, the methodology for determining the level of the background and procedure of determining statues classes of groundwater bodies”

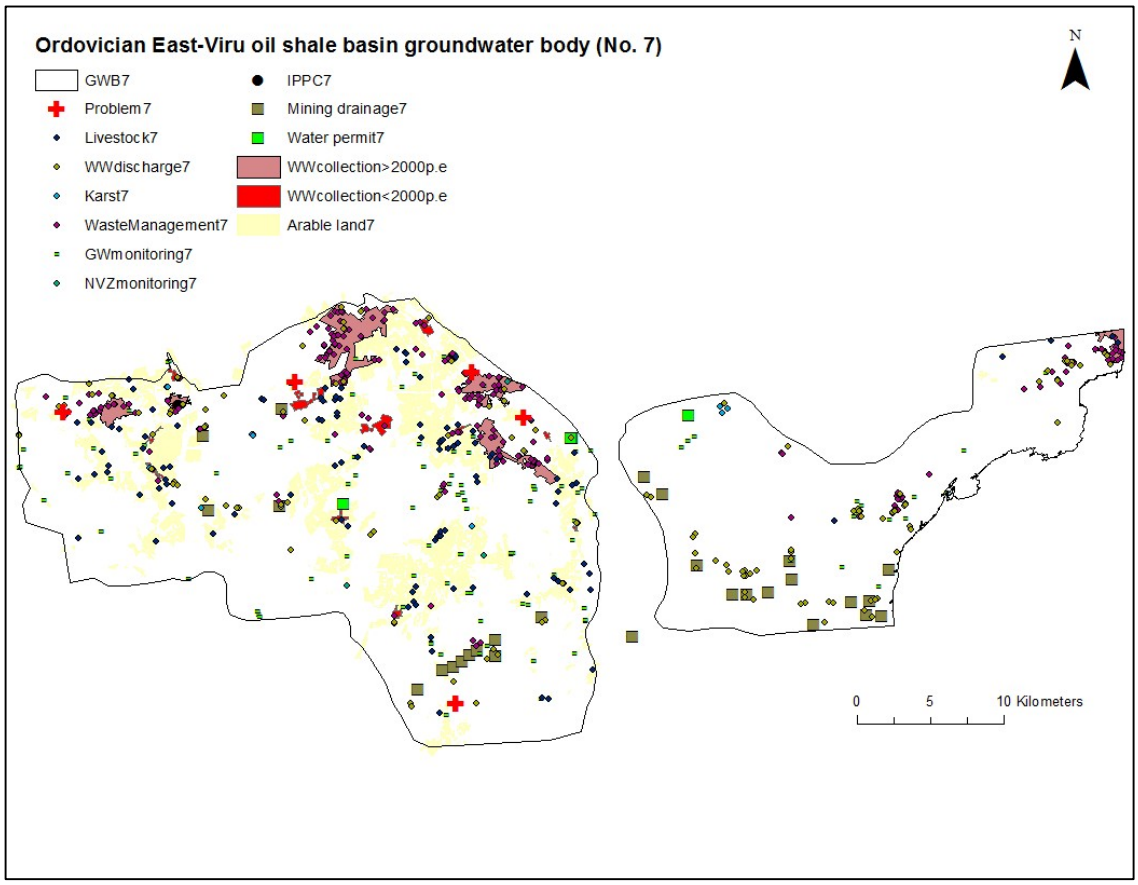

Figure 10. Ordovician East-Viru oil shale basin groundwater body (No. 7)

With the extraction permit Environmental Board should require the organizing of mined areas by the stages or during the issuing the modification of mining to avoid the forming of large underground lakes in mined areas.

Other common method for avoiding formation of large underground lakes in mined areas is to use backfilling. For backfilling can be used limestone that is not usable in road building or civil engineering. [18]

Environmental Board should cooperate with the MoE and with the Technical Regulatory Authority who is exercise supervision over compliance of the requirements in plan of mining to involve the geologists to develop the best available technologies taking into account geological and hydrogeological conditions and environmental objectives.

Mining activity has an impact on all Ordovician aquifers in Ordovician Eastern Viru oil shale basin groundwater body. Mainly is affected Keila-Kukruse aquifer, where cone of pumping depression arrives until 2 km from the mining in areas with not pressurized aquifer. In case of pressurized aquifer cone of pumping depression spreads even 7 km from the mining. In pressurized Lasnamäe-Kunda aquifer even until 20-25 km from the mining, because of the drainage of the oil shale layer that locates even in 60 meters depth. [3]

One of the measures from the programme of measures is installation of bulkheads between careers that would allow to regulate groundwater level independently from each other. Environmental Board should require this in the extraction permit finding out how reasonable it is economically. There are several possibilities: establishing the wall inside the ground, settle the clay on the slope of career, installing membrane on the bottom of the settling basin or establishing the infiltration basins.

Other measure is using a geomembrane in river basin for isolating negative impact of surface water infiltration in karstic areas that shall be set as an additional requirement in water permit taking into account the location of water pump and water quantity.

Review all permits related with the discharges and the results of self-monitoring by the mining companies and if concentrations are exceeding the limits establish by the regulation of Minister of Environment No. 99, adopted in 29th November 2012 “Requirements for the wastewater purification and recipient to where a wastewater or storm water is discharged and limits of the pollutants in wastewater and storm water and the measures of controlling compliance of verification” setting a tighten requirements.

6.1.4. Silurian-Ordovician Harju groundwater body (No. 10)

Main pressure on groundwater body comes from agriculture to threatened aquifers close to ground. There are no very important pressures accordingly to PoM and therefore related measures.

Taking into account that GWB is mainly not covered with aquitard, it is important to consider in which purpose the water is used and how the special user of water is polluting groundwater, including only with the groundwater abstraction. For example if special user of water who has an arable land and he uses pesticides and phosphorus fertilizers, requirement of monitoring concentration of pesticides and phosphor shall be added on the permit. It is needed to take into account, or consider all existing reports made by expert about the area and given recommendations about the impact on the groundwater or monitoring, especially in areas with the confirmed groundwater resource.

Forbid the utilization of the fertilizers and pesticides and other threaten activities that may affect groundwater quality around the springs and karstic features closer than 10 m and direct attention of persons engaged in agriculture during the authorization process on Water Act in § 26’1 that regulates protection of catchment areas related with usage of manure, fertilizers, sewage sludge.

Main pressures of the Silurian-Ordovician Harju groundwater body is shown on figure 11.

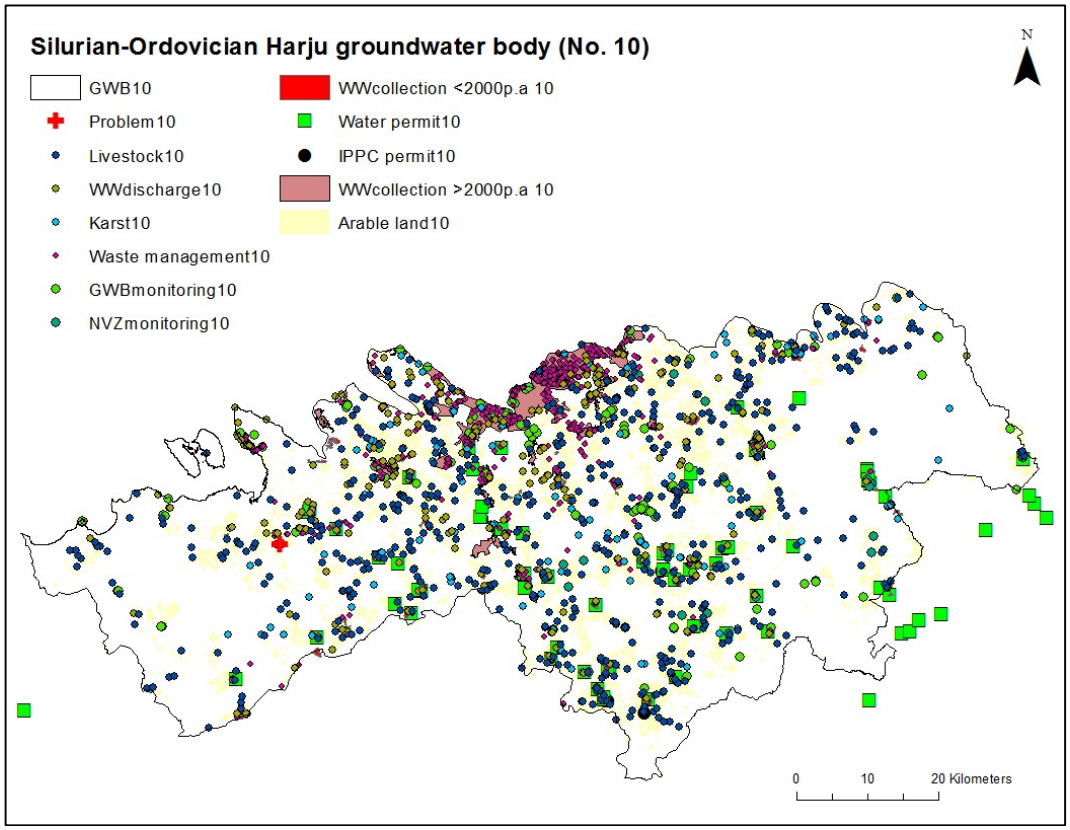

Figure 11. Silurian-Ordovician Harju groundwater body

According to the national groundwater monitoring groundwater level has been stable in whole groundwater body. Chemical composition indicates stability.

6.1.5. Silurian-Ordovician Matsalu and Pärnu groundwater bodies (No. 11 and 12)

The main pressure on groundwater comes from agriculture and pollution range depends on annual precipitation and usage of fertilizers, especially where groundwater is weakly or not protected. Other diffuse pollution sources are areas that are not connected to wastewater collection systems. Point pollution is coming mainly from the polluted areas, for example Haapsalu and Raiküla asphalt concrete plants, and from the landfills. In case of Pärnu groundwater body, very important pressure on groundwater is related with groundwater abstraction for the public water supply, especially in coastal area, because of seawater intrusion. From the diffuse pollution, biggest pressure comes from agriculture that depends on annual precipitation and usage of fertilizers, especially where groundwater is weakly or not protected.

There are no very important pressures according to PoM and therefore related measures.

In coastal areas GWBs' water quality is vulnerable about the groundwater abstraction, therefore is needed to define the additional conditions to IPPC permit and to permit for special use of water about measuring regularly groundwater level and assign the concentration of chlorides.

National groundwater monitoring results are indicating similarity in groundwater level since 1990 in both groundwater bodies. There is no any problem with a chemical composition of the groundwater in Silurian-Ordovician Matsalu groundwater body. In Pärnu groundwater body, only coastal area shows increased concentration of chlorides that are caused by the seawater intrusion.

Main pressures of the Silurian-Ordovician Matsalu and Pärnu groundwater bodies is shown on figure 12 and 13.

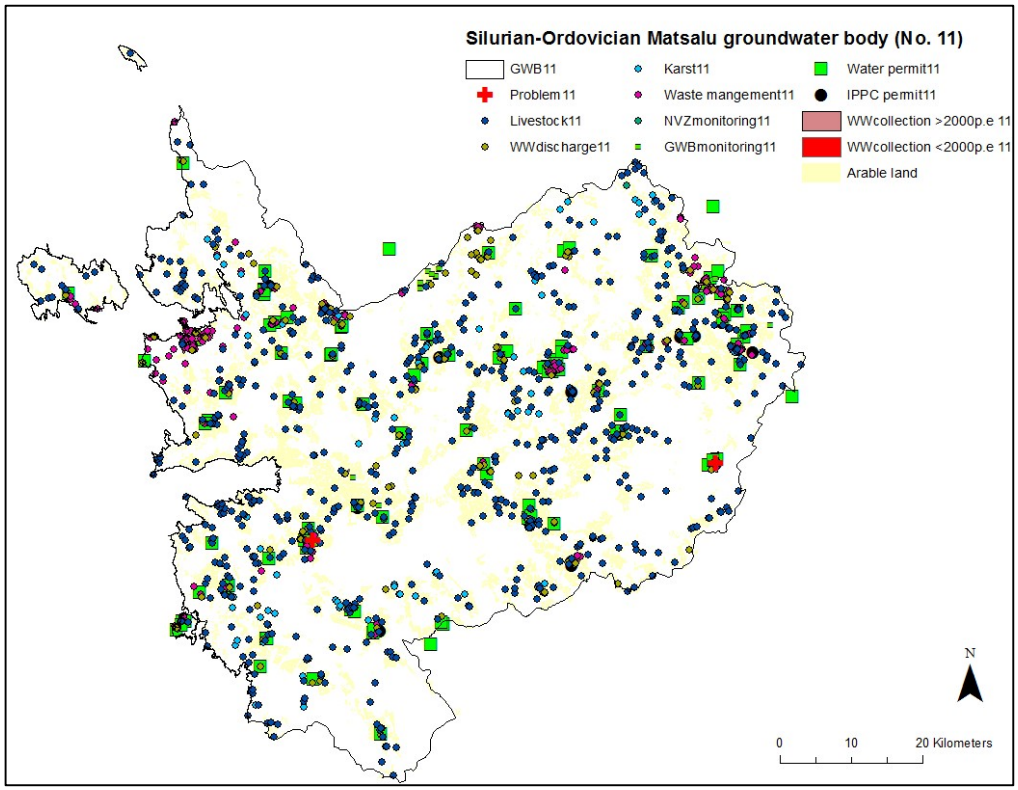

Figure 12. Silurian-Ordovician Matsalu groundwater body

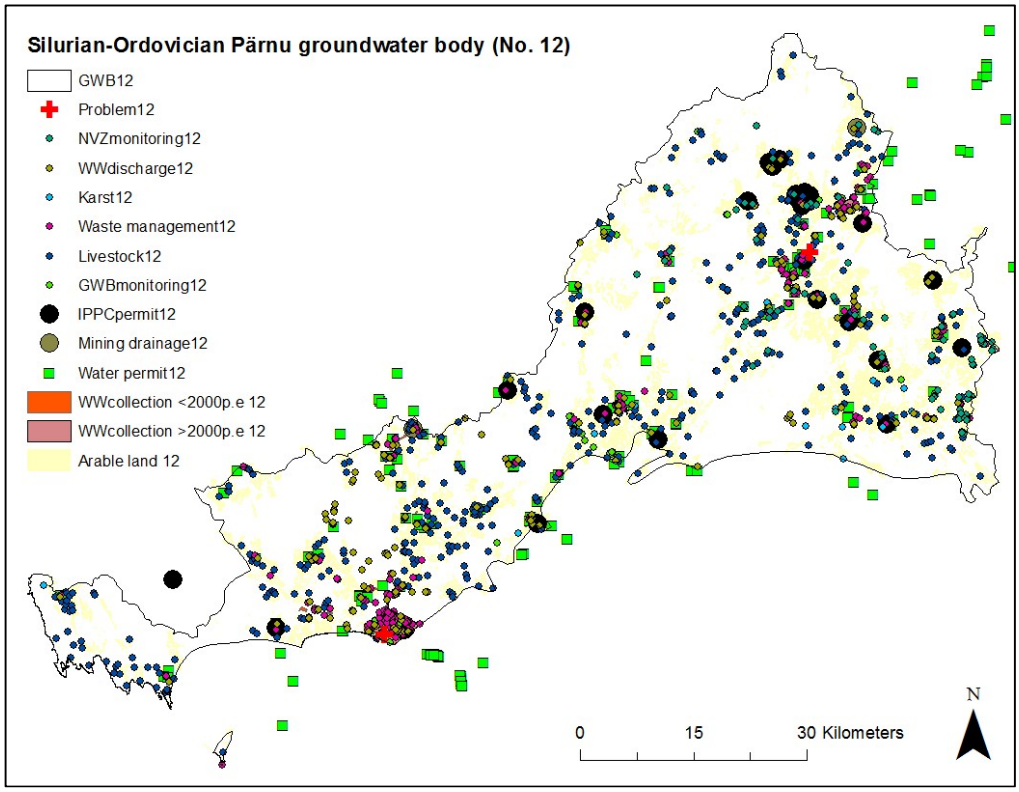

Figure 13. Silurian-Ordovician Pärnu groundwater body

6.1.6. Silurian-Ordovician groundwater body in Eastern Estonia river basin district (No. 13), Pandivere groundwater body in West-Estonia and East-Estonia river basin districts (No. 14 and 15) and Adavere-Põltsamaa (No. 16) groundwater bodies (No. 16)

The main pressure on groundwater bodies comes from the agriculture that depends on annual precipitation, usage of fertilizers and pesticides. There are evolving areas with the intensive agriculture.

Pursuant to the national groundwater monitoring in nitrate vulnerable zone, in 2016 the concentrations of nitrates has been increasing in whole nitrate vulnerable zone 68% and decreased in 10% of monitoring wells. In Pandivere region concentrations have been increasing 85% and deceasing only in 10% of monitoring stations. In Adavere region concentrations have been increasing 36% and decreased 46%. In 2016 was found pesticide residues in 31 monitoring stations, 8 of them exceeded quality limit (0.1 µg/l). In 2015 was found pesticide residues in 29 monitoring wells and quality limit was exceeded by the 7 monitoring station.

Taking into account that GWB is mainly not covered with aquitard, it is important to consider in which purpose the water is used and how the special user of water is polluting groundwater, including only with the groundwater abstraction. For example if water special user who has an arable land and he uses pesticides and phosphorus fertilizers, requirement of monitoring concentration of pesticides and phosphorus shall be added on the permit. It is needed to take into account, or consider all existing reports made by expert about the area and given recommendations about the impact on the groundwater or monitoring, especially in areas with the confirmed groundwater resource.

Forbid the utilization of the fertilizers and pesticides and other threaten activities that may affect groundwater quality around the springs and karstic features closer than 10 m and direct attention of persons engaged in agriculture during the authorization process on Water Act in § 26^1 that regulates protection of catchment areas related with usage of manure, fertilizers, sewage sludge.

Main pressures of the groundwater bodies is shown on figure 14, 15, 16 and 17.

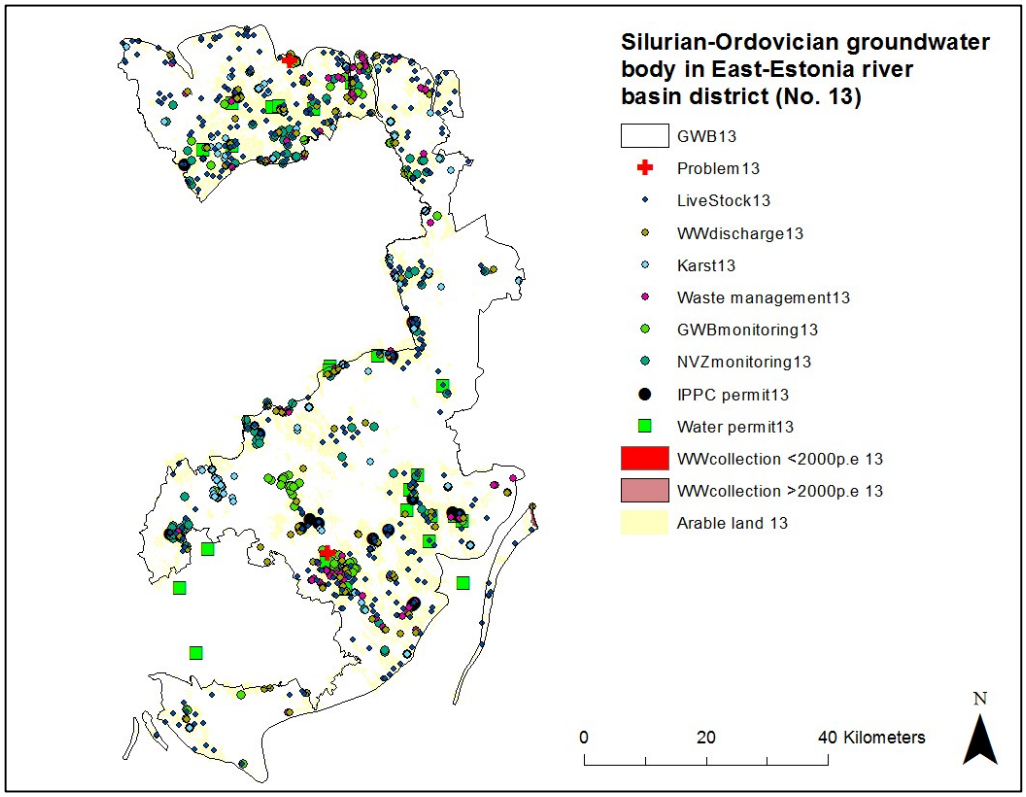

Figure 14. Silurian-Ordovician groundwater body in Eastern Estonia river basin district

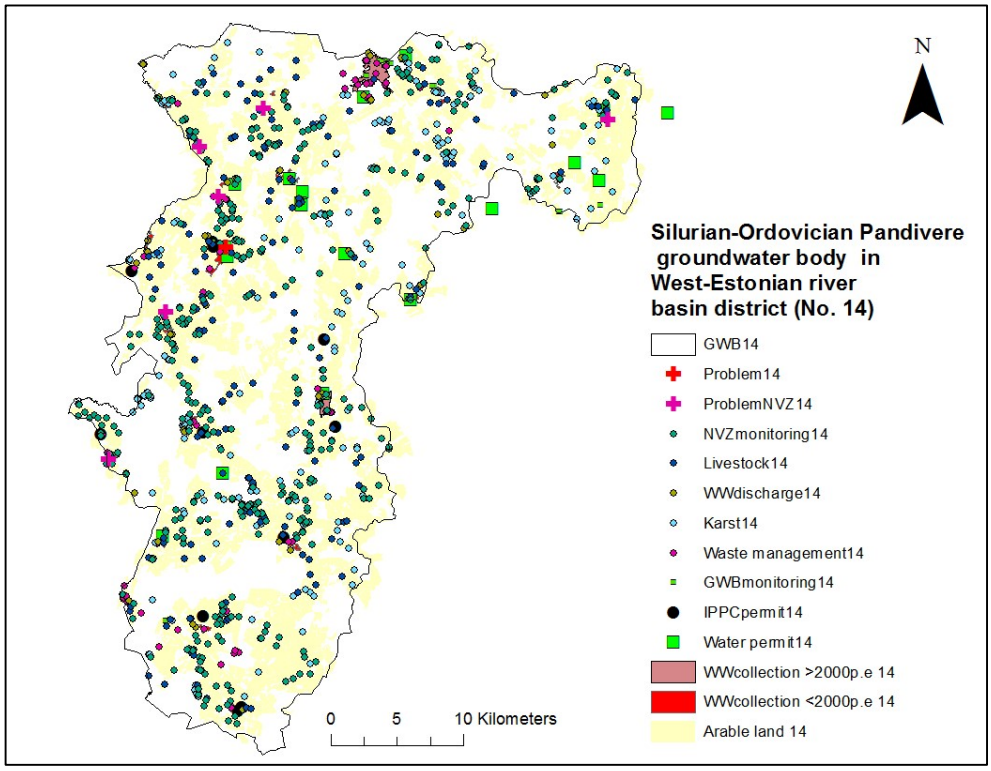

Figure 15. Silurian-Ordovician Pendivere groundwater body in West-Estonian river basin district

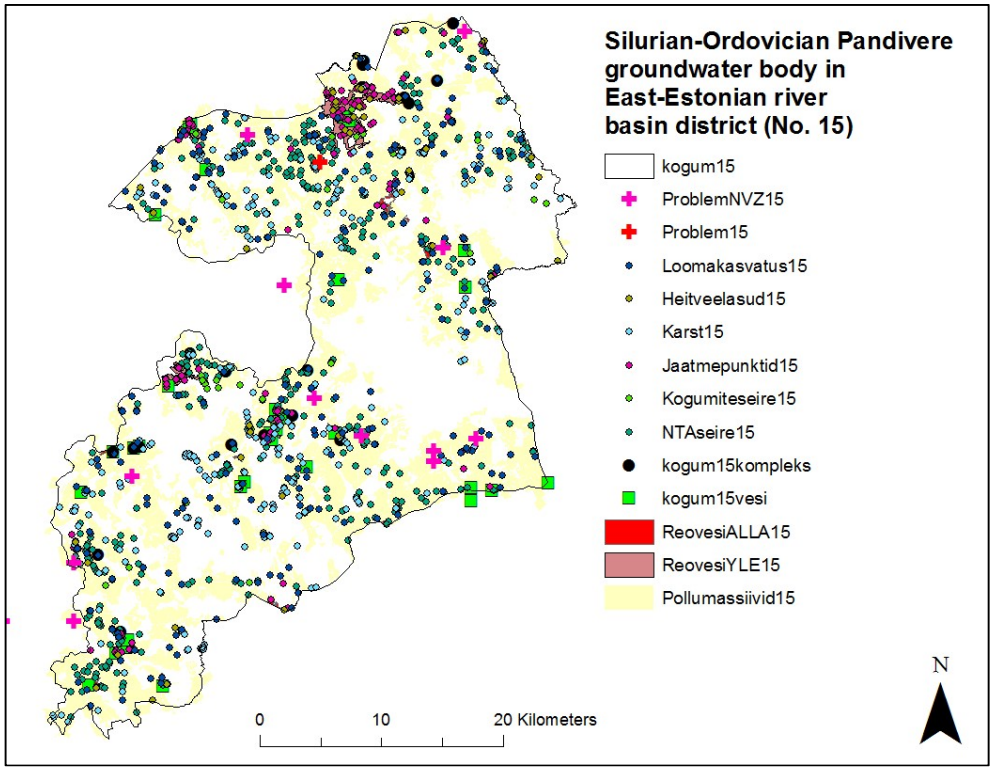

Figure 16. Silurian-Ordovician Pandivere groundwater body in West-Estonian river basin district

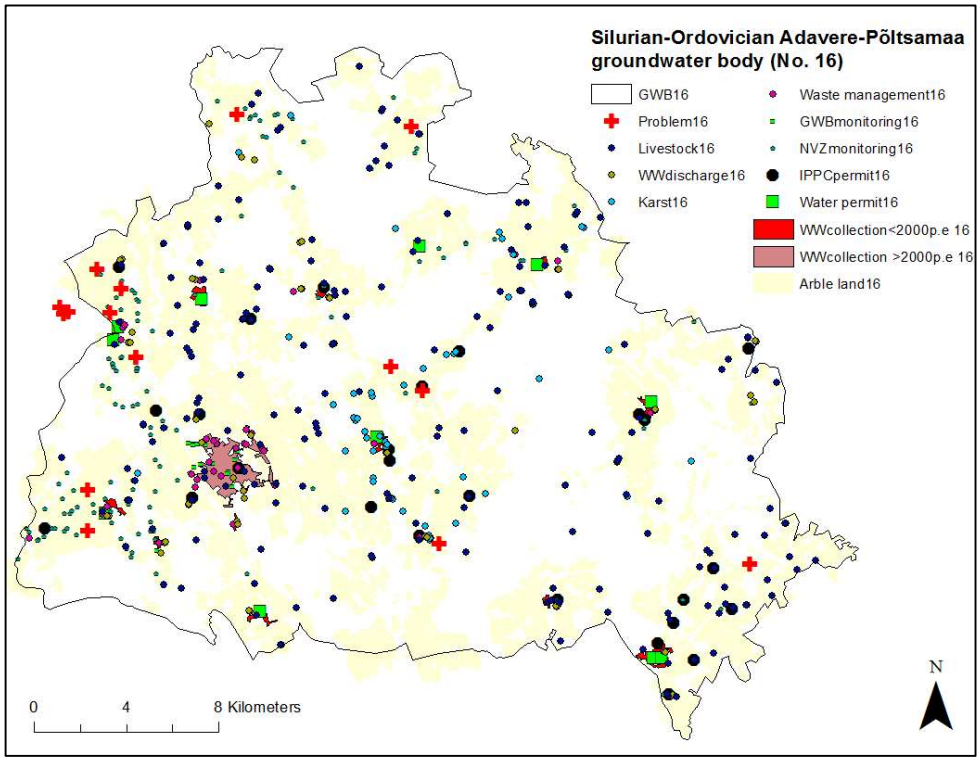

Figure 17. Silurian-Ordovician Adavere-Põltsamaa groundwater body in West-Estonian river basin district

6.1.7. Quaternary Vasavere (No. 27), Meltsiveski (No. 28), Männiku-Pelguranna (No. 29), Elva (No. 35) and Võru (No. 38) groundwater bodies

Quaternary Vasavere groundwater body locates in extent of the impact of the Estonia mining and Narva career. There is important not to allow further increasing groundwater abstraction, because of decrease of the groundwater level that in turn may cause the intrusion of polluted mining waters.

Accordingly to the national groundwater monitoring results groundwater level had been stable until 2013 when was opened a new Ahtme drinking water treatment plant, but since 2016 groundwater level has upward trend. One of the monitoring wells from the five, has been ascertained little bit higher concentrations of phenols – 1.8 µg/l (threshold value – 1 µg/l).

Meltsiveski and Männiku-Pelguranna groundwater bodies are both located partly in town (Tallinn and Tartu) and thus very vulnerable from the pollution of transport and in winter time road maintenance while is used chlorides.

In Meltsiveski groundwater body on PAHs have heighten concentration – 0.12 µg/l. If concentrations of petroleum products and chloroform have been remaining stable, then benzene and monophenols are indicating to downward trend. Only concentrations of PAHs and trichloroethane are increasing.

Quaternary Elva and Võru groundwater bodies are sensitive about polluted storm water and therefore is needed to find solutions to avoid polluted storm water to absorb to the ground.

In Männiku-Pelguranna groundwater body concentration of chlorides is not exceeded the threshold value, but it indicates on the impact of road maintenance in winter time. In 2016 505 of the monitoring wells from the 7 are exceeding PAHs' threshold value and 16.7% of wells monophenols.

In Elva and Võru groundwater body is monitored only by one monitoring station. In Elva groundwater body groundwater level has been always stable and in 2016 there has not being discovered any established threshold value by the pollutants.

In Võru groundwater body there has not been taken analysis already two years. Therefore is not possible to describe trends or changes in concentrations of pollutants.

Pressures of mentioned groundwater bodies are figured out on the figures 18, 19, 20, 21 and 22.

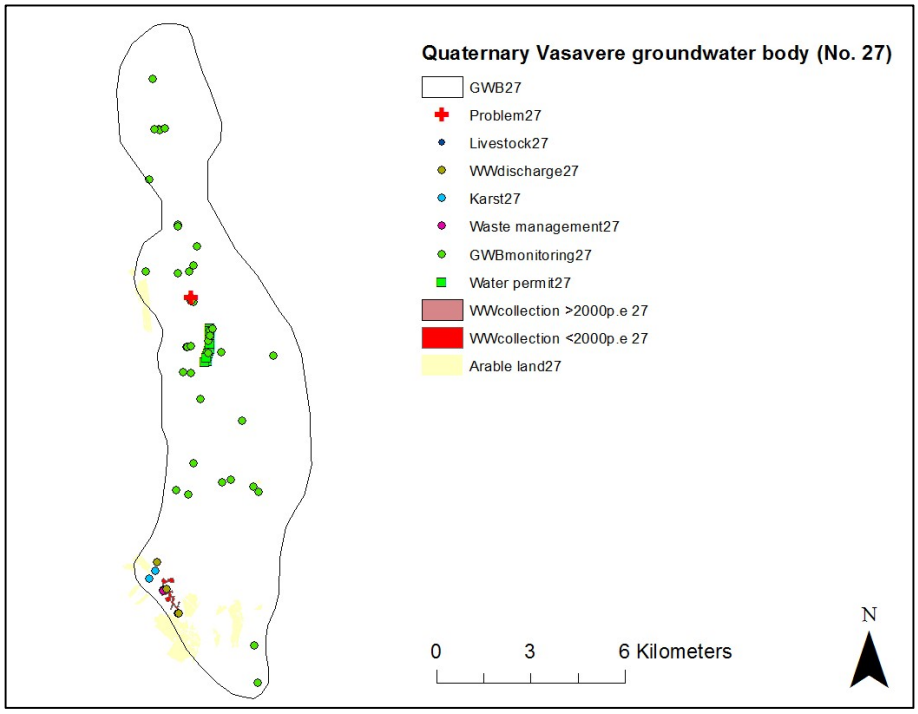

Figure 18. Quaternary Vasavere groundwater body

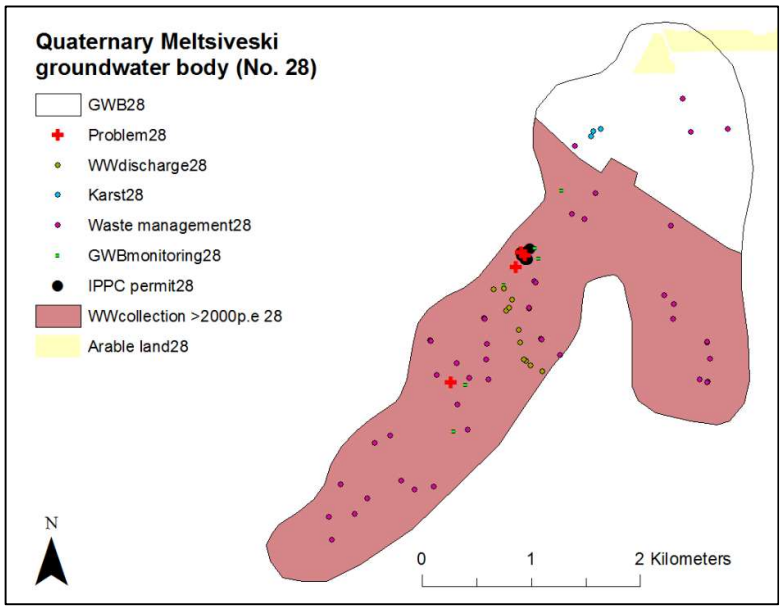

Figure 19. Quaternary Meltsiveski groundwater body

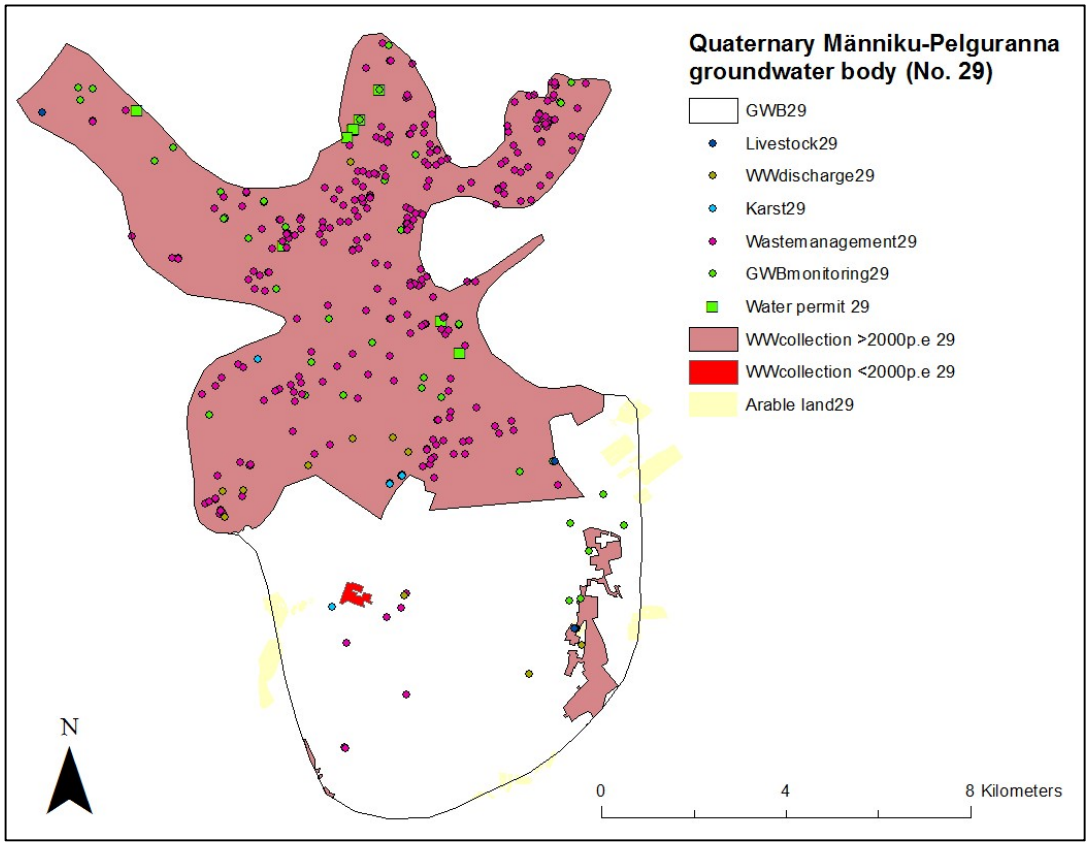

Figure 20. Quaternary Männiku-Pelguranna groundwater body

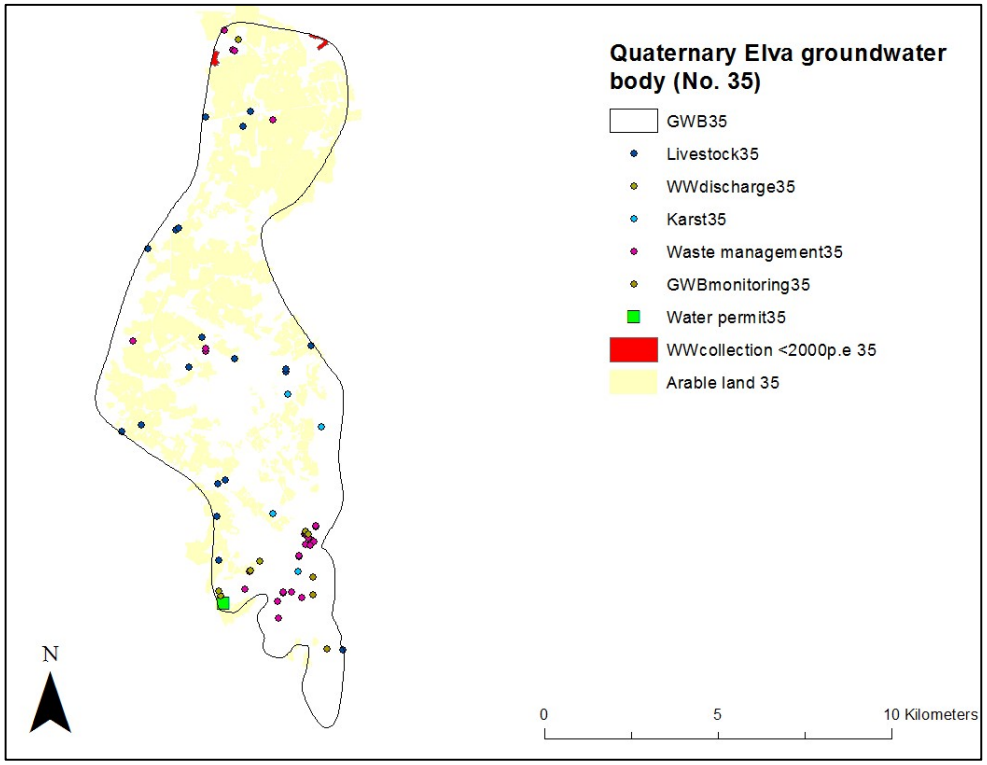

Figure 21. Quaternary Elva groundwater body

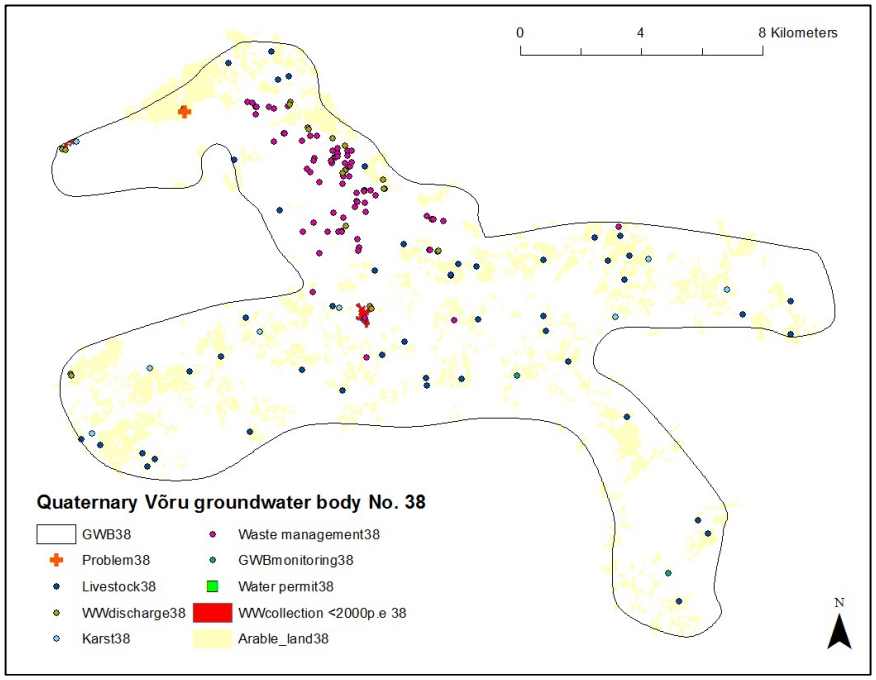

Figure 22. Quaternary Võru groundwater body

6.1.8 Other groundwater bodies that were not assessed as being at risk or in poor quality, but need more attention

There are two groundwater bodies, which has been assessed as being in good status, but according to the national groundwater monitoring, that is done based on data of one monitoring station per groundwater body.

In Quaternary Sadala groundwater body (No. 32) the chemical composition of groundwater well No. 11875 has been stable, but in 2016, there was found pesticides in groundwater that are exceeding quality limit (0.1 µg/l) and in Quaternary Piigaste-Kanepi groundwater body in monitoring well No. 21269, the concentration of chlorides has been increasing almost five times, as well as concentration of sodium. Also the concentration of ammonium was indicating to heighten concentration.

Therefore the monitoring conditions of closest wells that are related with permits needs more attention.

6.2 Activities of advisory measures

Completing advisory measure is the role of Environmental Board. The goal is to reduce the pollution caused by the nutrients coming from the agriculture. There two kind of common measures that are applying mainly for the groundwater bodies that are weakly protected or not protected about the pollution coming from the ground.

Table 5. Advisory measures for applying in groundwater bodies

Advisory measure	GWB, where measure will be applied
Consulting farmer about decreasing pressure on groundwater coming from nitrogen	10, 11, 12, 13, 14, 15
Increasing awareness of farmer about groundwater protection in their region and results of national groundwater monitoring	10, 11, 12, 13, 14, 15

Environmental Board will prepare every year an overview about problematical areas that are affected by the agriculture, where concentrations of pollutants, like nitrates and pesticides are over the threshold values (NO_3 – 50 mg/l, pesticides – 0.1 µg/l) accordingly to the national groundwater monitoring and where groundwater is weakly or not protected. EB will send the prepared information of owners of IPPC permit and permit for special use of water.

Best available technology standard should be applied to agricultural and use, especially for high-input-farms. If the BAT standard would be obligatory for applying to agricultural land use, farmers would be obliged to use those techniques and farming methods most efficient and advanced in terms of reducing environmental emissions and most effective in achieving a generally high level of protection for the environment as a whole. [21]

6.3 Planned surveys

Significant amount of activities (34%) that should be finished during the RBMP by 2021 are mainly related with hydrogeological surveys for the assessment of groundwater reserves that will be done by the owner who consumes the groundwater more than 500 m^3/d. Second notable amount of activities (32%) are related with residual pollution.

For the third part (19%) is responsible Ministry of Environment (Figure 23) and those measures are related with different surveys about finding out the spreading and reason of pollution.

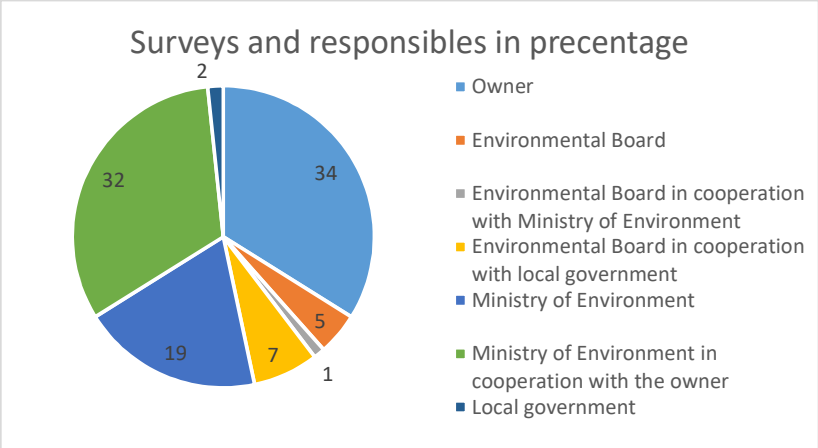

Figure 23. Administrative measure and responsible

Environmental Board is responsible or jointly liable for the 13% of the measures connected to the surveys. However, in order to procure hydrogeological survey about some monitoring station, where concentrations have been increasing the quality limit values or threshold values, is needed to find out what kind of information we have about some certain region of studying. Information can provided by the national groundwater monitoring results or by the self-monitoring results ordered by the owners of permit that are related with a wells staying in the region. All hydrogeological surveys will be conducted by the person owning licence performing hydrogeological works.

6.3.1 Surveys in Ordovician Eastern Viru groundwater body (No. 6)

In Ordovician Eastern Viru groundwater body (No. 6) these surveys supposed to raise the level of knowledge for solving the problems related with the increased concentrations of monophenols, petroleum products and other hazardous substances:

1) Hydrogeological survey of finding out the reasons, origin and diffusion process of phenols in groundwater monitoring well No. 3862 and No. 3875;
2) Hydrogeological survey of finding out the reasons of increased concentrations of sulphates in the region of new national monitoring well No. 26251.

6.3.2 Surveys of Ordovician East-Viru oil shale basin groundwater body (No.7)

In Ordovician Eastern Viru oil shale basin groundwater body (No. 7) Environmental Board is involved in following surveys:

1) Inventory of the regions that are not connected to the wastewater treatment systems and creation of the database and according to the database plan the measures first of all in the areas with weakly protected or not protected groundwater.

Activity: Inventory will be procured in 2018 choosing a pilot area what to study. Choice will be done according to the impact of waste water treatment systems on the groundwater in weakly protected or not protected area and outside of waste water collection area, but where the impact of the local population is still high taking into account the density of local population.

2) Assessment of the Lasnamäe-Kunda aquifer as the drinking water resource in ca 10 housekeeping wells in Erra-Liiva village and in Uhaku karstic area.

3) Assessment of Lasnamäe-Kunda aquifer as the drinking water resource in Lügnuse village and summer cottages' area and in private houses area in Roodu village.

4) Survey of the groundwater quantity and quality from the self-flowing outlets related with the mining activity in the river Purtse basin four times per year during 2-3 years.

Activity: set the requirement to the mining company in the permit for special use of water, latest in 2018 for starting with a monitoring from 2019. It is necessary the find out how much discharges from mining affecting the quality of the groundwater.

5) Assessment mining aftereffects Northern Kiviõli career through the monitoring

Activity: Environmental Board shall send to the mining company official letter with pointing out the problems in region referring to the national groundwater monitoring results.

6) Planning the groundwater monitoring in New Kiviõli mining at least in the monitoring stations No. 4025, 4026 and 4002 starting latest 2-3 years before mining activity.

Activity: setting requirements in the excavation permit.

6.3.3 Surveys of Silurian-Ordovician Harju groundwater body (No. 10)

In Silurian-Ordovician Harju groundwater body (No. 10) Environmental Board is responsible or jointly liable about following surveys that are related with solving the problems:

1) Hydrogeological survey to identify the reasons of significant upward trend in concentration of chlorides and sodium in monitoring station No 266.
Activity: order survey in 2018 from the person owning licence performing hydrogeological works to find out if changes of concentrations of chlorides and sodium are taking place only in that particular well or the problem wider in that region. Concentration of chlorides have been in 2013, 2014 and 2015 respectively 92.5 mg/l, 94.3 mg/l and 103.2 mg/l, upward trend has been since 2009 starting from the level – 55.7 mg/l. Concentration of sodium has been in 2013, 2014 and 2015 respectively 42.5 mg/l, 42 mg/l and 45.7 mg/l, upward trend has been ongoing since 2009 starting from the level 18.9 mg/l.

2) Hydrogeological survey to identify the reasons of existence and extent of the spreading of petroleum products in the region of the monitoring station No. 9419.
Activity: order survey in 2018 from the person owning licence performing hydrogeological works taking into account that accordingly to the national monitoring results of concentrations have been following: 2010 – 30 µg/l, 2011 - <20 µg/l, 2014 - <170 µg/l, 2015 - <20 µg/l.

6.3.4 Survey of Silurian-Ordovician Pandivere groundwater body in West-Estonia river basin district (No. 14)

Environmental Board is involved or responsible about the hydrogeological survey to identify the reasons of heighten concentrations of petroleum products and hazardous substances and spreading of pollution in area of the monitoring well No. 7553.

6.3.5 Survey of Silurian-Ordovician Pandivere groundwater body in East-Estonia river basin district (No. 15)

About Silurian-Ordovician Pandivere groundwater body in East-Estonia river basin district (No. 15) Environmental Board is responsible about following surveys:

1) Hydrogeological survey to identify the reasons of heighten concentrations of petroleum products and hazardous substances and spreading of pollution in area of the monitoring well No. 3677

Activity: order survey in 2018 from the person owning licence performing hydrogeological works. In additionally the concentration of monophenols is exceeding the limit 1.0 µg/l establish by the regulation of Minister of the Environment No. 39 adopted in 11th of August 2010 "Quality limitations of hazardous substances in groundwater" with the concentration <2.0 in 2015.

2) Hydrogeological survey to investigate the reasons of heighten concentrations of pesticides and nitrates and extent of spreading

Annual national monitoring of groundwater in nitrate vulnerable zone (NVZ) are indicating the increase of nitrate concentration. In additionally in more wells are found residues of pesticides. According to the report of groundwater monitoring in NVZ, concentrations of nitrates in wells in 2016 have been increasing in 85% of the wells, compared to the average concentrations between 2001 and 2016 and decreased only in 10% of the wells. If in 2015 there was found only in 29 monitoring wells residues of pesticides, than in 2016 already from the 31 wells. During the period of 2012-2015 have been analysed residues of pesticides from 109 monitoring stations, in case of 35% pesticides were found. 22% were increasing the quality limit of 0.1 µg/l. Therefore in this GWB will be chosen pilot region taking into account previous results of the concentrations of the pollutants that will be investigated. During the hydrogeological survey will be chosen around 20 wells that are preferably monitoring wells or related with IPPC permit or with the permit for special use of water. Selection has to done like that: half are lower wells (15-30 depth) and other half deeper – 30-50 meters. It is important to prefer wells with a similar construction and with a working part that opens aquifer that is weakly protected or not protected from the pollution coming from the ground.

From these wells will be taken four times per year analyses to determine the ratio between delta ^{18}O and delta ^{2}H ($\delta^{18}O$/ $\delta^{2}H$) to find out how much precipitations or season is affecting the groundwater quality inside well [17]. This will help to understand water exchange inside the well. In additionally will be taken isotope analysis for determination of ratio between ^{15}N and ^{14}N, to identify the origin of the nitrogen – from atmosphere, fertilizers, manure or from other resources. Finally will be taken groundwater samples for identification the ratio between of

helium and tritium ($^{3}H/^{3}He$) to identify the age of young water with the maximum exactness one year, but not more than 60 years. [15]

These results will help to interpret the age and origin of the pollution. In addition, there will be compiled a model of groundwater to understand better the dynamics of groundwater during the last five years and how will be the situation in future.

In case, the results are indicating the recent pollution of nitrates, there will be need to consider changes in regulations. For example in Netherlands has since 2014 a policy for compulsory manure processing for a fraction of the manure surplus at the farm level that is enforced by the regions and has been getting more strict in 2016 [12].

6.3.6 Survey of Quaternary Võru groundwater body (No. 38)

Environmental Board is responsible for the hydrogeological survey to identify the interdependency between the groundwater body and surface bodies. For that is needed to order a survey in 2018 from the person owning licence performing hydrogeological works and during one year measure the groundwater level of groundwater body and take analysis of groundwater and surface water.

In additionally will be chosen out one region from whole Estonia that is not connected to the wastewater treatment systems in weakly protected or not protected groundwater to accomplish an inventory. During the inventory will be found out where exactly comes to main pressure to groundwater and what are the main polluters. Important is to find out how the pollution spreads in area.

Summary

In order to follow more effectively the implementation of the action plan is needed to assure availability of all needed information for making decisions while issuing the permits.

There is a need to create digital archive where are findable all assessments of experts, reports of environmental impact assessments, reports of assessment groundwater resource etc. Current situation is that some documents are in achieve and the rest are administrated by the specialist and therefore not always easily available.

Important is to have a common groundwater resource balance that is updated in real time and based on the reports of existing hydrogeological assessments of groundwater resources that would be available for all the institutions under the authority of Ministry of the Environment to ensure that different institutions while completing their duties are originating from the data of the same wells. Groundwater resource balance with the map layers about the regions, where available groundwater resource is confirmed, would be an useful tool not only for the Environmental Agency to compile annual report of groundwater source balance based on real groundwater abstraction, but also for Environmental Board issuing the permits that are related with groundwater in regions where available groundwater resource is confirmed. Moreover, this would avoid the situation that by the permits is allowed to consume groundwater over the confirmed resource even if actual groundwater abstraction falls between confirmed available groundwater resource.

Lack of database for the water self-monitoring results that are regularly made by the owners of IPPC permit and permit for special use of water, is also an obstacle analysing effectively results of self-monitoring data for following trends of concentrations of pollutant in time. Today all the data is in pdf-fails.

During the thesis were prepared data layers and thematic maps in ArcGIS for all groundwater bodies that might be the useful tool for groundwater specialists and IPPC specialist in order to get faster overview about potential pollution sources for issuing permits.

Environmental Board will concentrate during the Groundwater Action Plan (Annex 1) period 2018-2019 on the problematical areas where results of national groundwater monitoring or self-

monitoring made by the owner of permit has been identifying heightened concentrations of pollutants or there exists upward trend. Issuing permits has to base more on the activity of the owner of permit and potential risks on groundwater. In addition, it is important to consider real pressures of certain groundwater body and through the permits for special users of water require mitigation measures, in case their activity represents a threat to achievement of groundwater body's good status.

There are no additional supplementary measures planned for the years 2018-2019, because the main attention will be directed to issuing permits with a setting monitoring conditions according to the groundwater bodies' pressures and considering a potential impact that special user of water may cause with his activity. Other activities under increased attention will be ordering surveys with involvement of research institutions and with previous analysis of existing data, included self-monitoring and national monitoring data and information from the researches, which in cooperation with monitoring data and practices of other countries in turn will provide useful information for the next groundwater action plan for the years 2020-2021 for implementation programme of measures of river basin management plans. Also the raising of awareness of the people involved in potential polluting will help to move little by little to achieve environmental objective of water framework directive.

Kokkuvõte

Vesikondade veemajanduskavade meetmeprogrammi rakendamise tegevuskava efektiivseks täitmiseks on esmalt vajalik tagada kogu olemasoleva informatsiooni kättesaadavus vee erikasutuslubade ja kompleksluba de menetlemiseks.

Vajadus on digitaalse arhiivi järele, kust oleks hõlpsasti leitavad seni tehtud eksperthinnangud, keskkonnamõju hindamise aruanded, põhjavee varude hindamiste aruanded, teemakohased uuringud jne. Praeguse olukorra alusel on osa dokumente arhiivis ja ülejäänud spetsialistide hallata ning seetõttu mitte alati kergesti leitav või puudub koguni teadmine nende olemasolu kohta.

Ühtlasi on vajalik reaalajas uuenev põhjavee ressursi bilanss kinnitatud põhjaveega alade kohta, millest Keskkonnaministeeriumi allasutused saaksid lähtuda oma tööülesandeid täites ning tagades, et lähtutakse samadest puurkaevudest. Ühine põhjavee ressursi bilanss koos vajadusel uuendatavate kaardikihtidega kinnitatud põhjaveevaruga alade kohta ei oleks mitte ainult hea töövahend Keskkonnaagentuurile iga-aastase põhjaveebilansi koostamiseks tuginedes tegelikule veevõtule, vaid ka Keskkonnaametile vee erikasutuslubade ja kompleksluba de väljastamisel, mis on seotud puurkaevudega, mis jäävad kinnitatud põhjaveevarude piirkonda. Ühtlasi aitaks see välistada olukorda, kus keskkonnalubade alusel lubatav põhjaveevõtt oletab kinnitatud põhjaveevaruga lubatud veevõtu koguse.

Omaseire andmete andmebaasi puudumine, mille kaudu jõuaksid töödeldavad seireandmed loa halduriteni, kes oma igapäeva töös jälgivad lubadega seotud puurkaevudes saasteainete sisaldusi ning nende languse ja tõusutrende, on samuti segav tegur meetmete efektiivse täitmise juures.

Käesoleva magistritöö raames sai koostatud kaardikihid ArcGIS tarkvaras põhjaveekogumite kohta, mis on ohustatud või hinnatud halvas seisundis olevateks. Põhjaveekihtide abil on kergesti võimalik näha, millised on konkreetses piirkonnas potentsiaalsed reostusallikad, mis on sisendiks seiretingimuste määramiseks keskkonnalubades, ennekõike just maapinnalt esimeste põhjaveekihtide puhul.

Tuginedes käesolevas magistritöös analüüsitud kehtivates vee erikasutuslubades määratud seiretingimusele, järeldub, et 2018-2019 a tuleks enam tähelepanu pöörata piirkondadele, kus riikliku või omaseire andmete alusel on tuvastatud kõrgendatud saasteainete kontsentratsioone ning olulisi ja püsivaid kasvusuundumusi. Lubade menetlemisel tuleb enam lähtuda vee erikasutaja potentsiaalsest mõjust põhjavee kvaliteedile või põhjavee tasemele, võttes seejuures arvesse ka igale põhjaveekogumile iseloomulikke koormusallikaid.

2018-2019. a ei planeerita täiendavaid meetmeid kuna peamine tähelepanu suunatakse nii vee erikasutuslubades kui komplekslubades seiretingimuste ja keskkonnanõuete üle vaatamisele ja vajadusel karmistamisele ning eesmärgi täitmiseks vajalike materjalide ja töövahendite loomisele ja korrastamisele. Lisaks pööratakse varasemast enam tähelepanu uuringute tellimisel teadusasutuste kaasamisele ning seni olemasoleva info analüüsimisele. Ka keskkonnaalase teadlikkuse tõstmise tähtsust ei saa alahinnata, eriti potentsiaalsete reostajate puhul.

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