TECHNICAL ASSISTANCE FOR EXTENSION OF MUUGA PORT ON THE TRANS-EUROPEAN NETWORK

EASTERN EXTENSION OF MUUGA HARBOUR

ENVIRONMENTAL IMPACT ASSESSMENT

Muuga Port Consortium
ILAG-HPC-ESP-TALLMAC

March 2006

TECHNICAL ASSISTANCE FOR EXTENSION OF MUUGA PORT ON THE TRANS-EUROPEAN NETWORK

INSTRUMENT FOR STRUCTURAL POLICIES FOR PRE-ACCESSION (ISPA)
COHESION FUNDS (CF)

2002/EE/16/P/PA/009

ENVIRONMENTAL IMPACT ASSESSMENT

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Port of Tallinn	**Ministry of Economic Affairs and Communications**
M ____________________	**M** ____________________
Date:	**Date:**
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1. INTRODUCTION

1.1. Objective and Necessity of Planned Activity

Port of Tallinn is the largest Estonian cargo and passenger port holding a lead position in the handling of cargo flows between Russia and Western Europe. Port of Tallinn comprises four port regions: Old City Harbour, Muuga Harbour, Paljassaare Harbour and Paldiski South Harbour. Muuga Harbour is situating on the south shore of the Gulf of Finland, on the coast of Muuga Bay and on the territory of 3 municipalities – Viimsi rural municipality, Maardu city and Jõelähtme rural municipality. Due to its favourable location and good railway and road connections with hinterland Muuga Harbour plays an important role in Estonian transit trade. The turnover of transit trade has grown continually and it reached 30.5 million tons in 2004. Currently oil terminals have the greatest percentages, which are locating in the western part of the harbour. Also general cargo, containers and dry bulk cargo pass the harbour.

The western territory of Muuga Harbour has run out of most of its capacity. Further development is possible with the extension of the eastern part and construction of new quays. Development plan of Muuga Harbour foresees to build up the coast area of the eastern part with new harbour constructions. According to the comprehensive plan of Jõelähtme rural municipality the expanding part of the harbour is locating in Jõelähtme rural municipality and the comprehensive plan considers the perspective outline of harbour's extension.

The extension of the eastern part infrastructure covers the area ca 130 ha (both reclaimed land and existing coastal area), which means first of all the construction of the second phase of the container terminal, new cargo and dry bulk terminals, railway connection, road access and utility networks.

The objective of the planned activity – eastern extension of Muuga Harbour – is improvement of efficiency of the harbour and increasing of cargo volume throughput, which assumes the expansion of harbour activity in the occupation borders of the harbour. The expected volume of cargo flows in the new terminals of eastern Muuga Harbour will be approximately 10 million tons (together with the coal terminal 16.6 tons) by the year 2025.

Environmental impact assessment (EIA) of eastern extension of Muuga Harbour has been performed within the technical assistance of Muuga harbour extension (*Technical Assistance for Extension of Muuga Port on the Trans-European Network*) and is co-financed by ISPA measures. Project is executed by the consultant's consortium Inros Lackner / HPC / ESP / Tallmac.

Current report is the second phase of the environmental assessment works of the project and the goal is to assess presumable environmental impacts resulting from the selected option of harbour extension of the technical design. Environmental impact of other actual alternatives is also covered. In the first phase of the project, preliminary environmental assessment was carried out where presumable environmental impacts resulting from three alternative solutions of harbour extension of the preliminary design were analysed and the best option regarding environmental impacts brought out.

The following environmental impact assessment has been prepared based on the *Environmental Impact Assessment and Environmental Management System Act* (State Gazette I, 24.03.2005, 15, 87) and on the program approved by the minister of environment with the letter of 1.08.2005 no 13-3-1/5017-8.

The current EIA report comprises:

- description and analysis of the environmental conditions of the project area, incl. review of protected objects;
- description and comparison of the proposed alternative solutions;
- assessment of the presumed environmental impacts of the project options, incl. assessment of the efficiency of the use of natural resources;
- the measures suggested for avoidance and mitigation of negative environmental impacts;
- environmental monitoring concept.

1.2. Performers

Developer: Port of Tallinn (AS Tallinna Sadam)
Contact: Sadama 25, 15051 Tallinn; contact person: head specialist of quality and environmental management department, Port of Tallinn, Andres Linnamägi, phone 631 8018

Decision-maker: the Ministry of the Environment, the issuer of a development consent (a permit for special use of water)
Contact: Narva mnt 7a, 15172 Tallinn; contact person: specialist of water department, Heidi Káär, phone 626 2990

Supervisor of EIA: the Ministry of the Environment
Contact: Narva mnt 7a, 15172 Tallinn; contact person: specialist of environmental management and technology department, Irma Pakkonen, phone 626 2974

Expert: AS Tallmac
Work group coordinator is environmental expert of AS Tallmac, Rein Ratas, EIA activity license no KMH0066.
Contact: Mustamäe tee 44, 10621 Tallinn, phone 656 2999, fax 656 2855, e-mail: tallmac@tallmac.ee

EIA work group includes the following persons:

- Rein Ratas – workgroup coordinator, environmental expert and auditor;
- Ülle Ambos – project manager of Environmental Service of AS Tallmac, environmental expert, license no KMH0116
- Kalev-August Parksepp – project manager of Environmental Service of AS Tallmac
- Eino Väärtnõu – environmental expert, EIA activity license no KMH0100
- Jüri Kask – scientist of the Marine Systems Institute at Tallinn University of Technology, geologist, environmental expert, EIA activity licence no KMH0059
- Andres Kask –environmental expert, EIA activity licence no KMH0109;
- Robert Aps – head of the Marine Systems Department of Estonian Marine Institute, University of Tartu
- Uno Liiv – technical doctor, expert of hydrodynamics
- Toomas Liiv – expert of hydrodynamics
- Margus Kört – air expert, environmental expert, EIA activity licence no KMH0060

Other consultants and experts: Rein Rannamäe, medical candidate; Anto Raukas, geologist; Meelis Uustal, ornithologist. Student of environmental technics at Tallinn University of Technology, Rita Strandberg was also involved in the work.

Interested parties:
Inhabitants of Jõelähtme rural municipality, especially of Uusküla village
Operators and companies operating in Muuga Harbour
Estonian Railways (AS Eesti Raudtee)
Companies operating in the business of transit trade
Public of environmental protection
General public (in Estonia and abroad)

1.3. Initiation, Programme and Public Disclosure of Environmental Impact Assessment

The Ministry of the Environment initiated environmental impact assessment of the planned activity on 22 April 2004 by the letter No 11-17/2920-3 on the basis of the application for the permit for the special use of water submitted by Port of Tallinn pursuant to § 6 (1) 16) and 17) of the *Environmental Impact Assessment and Environmental Management System Act*, according to which the following planned activity has a significant environmental impact:

- construction of trading ports, piers for loading and unloading connected to land and outside ports which can take vessels of over 1 350 tonnes;
- marine dredging, starting from the soil volume of 10 000 cubic metres, sinking of solid substances into the seabed, starting from the soil volume of 10 000 cubic metres.

The documents reflecting the EIA procedure are presented in Annex 1 to this report.

The decision maker, the Ministry of the Environment, notified of the initiation of the EIA for obtaining the permit for the special use of water in the official publication *Ametlikud Teadaanded (Official Notices)* on 4 May 2005, also the participants in proceedings in writing.

The environmental impact assessment programme has been prepared in compliance with the *Environmental Impact Assessment and Environmental Management System Act* (RK, RT I, 24.03.2005, 15, 87) passed on 22 February 2005. The Ministry of the Environment notified of the public disclosure of the EIA programme in the official publication *Ametlikud Teadaanded* on 10 May 2005 and in the newspaper *Postimees* of 12 May 2005 and the participants in proceedings. It was possible to get acquainted with the programme at the public display in the Ministry of the Environment, in the main building of Muuga Harbour and in AS Tallmac; one could see the programme also in the homepages of the Ministry of the Environment and AS Tallmac. Interested persons could present proposals and objections and ask questions in two weeks from 16 to 30 May 2005. The Ministry of the Environment made essential proposals and delivered opinions about the programme during the public display of the EIA programme.

The public discussion of the EIA programme took place on 30 May 2005 at 15.30 in the main building of Muuga Harbour at the address Maardu tee 57, 74115 Maardu. The minutes of the public discussion and the list of the participants is presented in Annex 1. After the public discussion the programme was amended by the proposals made by the Ministry of the Environment and in the meeting and it was submitted together with the minutes of the public discussion to the Ministry of the Environment for approval. Also the copies of the letters were added, where the acceptance of the proposals and objections presented about the programme in the course of the public discussion are explained. Pursuant to § 17(3) of the EIA Act the following interested persons: Villem Viikholm, Jaak Tamtik and Külliki Hütt were notified of the results of the public disclosure of the EIA programme in writing.

The EIA programme was approved by the Ministry of the Environment by letter No 13-3-1/5017-8 of 1 August 2005. The Ministry of the Environment notified the participants in proceedings and in the official publication *Ametlikud Teadaanded* of 9 August 2005 of the approval of the EIA programme.

The Ministry of the Environment gave notification of the completion of the EIA report, public display and public meeting regarding the EIA report on 8 November 2005 in the official publication *Ametlikud Teadaanded* and on 11 November 2005 in newspaper *Postimees.* The Ministry of the Environment notified also the participants in proceedings of the disclosure of the EIA report.

People could get acquainted with the report at the open display in the Ministry of Environment, on the website of the Ministry of the Environment, in the main building of Muuga Harbour and in AS Tallmac and make proposals, objections and ask questions during 11-29 November 2005. During the period proposals on and objections to the EIA report were made by Jõelähtme Rural Municipality Government, to whose letter Port of Tallinn (AS Tallinna Sadam) has replied.

The public discussion of the EIA report took place in the main building of Muuga Harbour on 7 December 2005. The issues related to railway noise and coal terminal were most acute at the discussion. Port of Tallinn has also notified the persons asking questions at the public discussion (P. Hütt, J. Tamtik and L. Kägo) of the EIA results in writing. The minutes and the list of participants have been added to the report (Annex 1).

On 4 January 2006, a roundtable with the representatives from Jõelähtme Rural Municipality Government, Port of Tallinn, Harju County Environmental Department and AS Tallmac took place in Port of Tallinn, where issues related to the extension of the eastern part of Muuga Harbour and the EIA report were additionally discussed. Based on the roundtable results additional measuring of noise from Muuga railway station was performed in Uusküla and possible measures for the noise level control are treated. Noise study has been added to the EIA report (Annex 15). Taking into consideration the proposals made and objections stated at the gathering and earlier in the course of disclosure, the report has also been upgraded in other issues: a chapter on the impact of dumping on Prangli proposed Site of Community Importance has been added; cumulative impact; best available technique; proposals made on extension possibilities of the harbour.

1.4. Method

The EIA process commonly used in Estonia is applied, which essential stages are the following:

- initiation, setting a task;
- specification of the objective and necessity of the planned activity;
- specification of alternatives;
- specification of interested parties and EIA fields;
- collection of material;
- description of the background;
- assessment of alternatives;

- analysis of the impacts and mitigation measures;
- comparison of alternatives.

In the procedure the stages required in the *Environmental Impact Assessment and Environmental Management System Act* are observed: notification of the initiation of the EIA, preparation and public disclosure of the EIA programme, preparation of the EIA report in compliance with the approved programme and publication of the report.

The following was taken into account in the EIA process:

- experience in the EIA;
- on-the-spot inspections;
- laboratory work;
- expert assessments;
- works performed by the Consultant in the course of this project;
- earlier works, publications, etc.

The work was carried out in sustained co-operation both, with the representatives of Port of Tallinn and the designers (members of the consortium of consultants AS ESP and Inros Lackner AG) and the experts belonging to the EIA work group were consulted. Issues were also discussed in regular technical meetings held in Port of Tallinn. The results of the EIA process are presented in this report.

As for methodological basis the relevant valid Estonian and international legislation and other adequate documents were observed. The main methodological guidance material was:

- Environmental Impact Assessment. Handbook. – Ministry of the Environment. Environmental Investment Centre. Tallinn, 2002.

The mathematical modelling of the hydrodynamic processes of Muuga Bay presented in this study was carried out with four different MIKE 21 models.

Soil samples were taken for the determination of the granulometric composition and pollution components of the bottom sediments of the harbour basin, which analyses were made in the laboratory of OÜ Eesti Geoloogakeskus. The relevant HELCOM recommendation 13/1 was also taken into account upon taking samples.

Environment has been regarded as habitat in the widest sense – both as a natural and anthropogenic environment, which includes also the social and economic sector, proceeding from the environmental impact assessment programme. The assessment of impacts was carried out by a consensus expert method in the way of analysis, conclusion and discussion.

1.5. Initial Materials

The following information sources were used as initial data and materials:

- Feasibility Study. Technical Assistance for Extension of Muuga Port on the Trans-European Network. Muuga Port Consortium. July 2005.
- Preliminary Design Report. Technical Assistance for Extension of Muuga Port on the Trans-European Network. AS ESP. Inros Lackner AG. May 2005.
- Economic Analysis. Technical Assistance for Extension of Muuga Port on the Trans-European Network. HPC Hamburg Port Consulting GmbH. Inros Lackner AG. April, 2005.

- Estonian Marine Institute of the University of Tartu. Marine Environment Monitoring in Muuga Harbour 2004. Final report. Tallinn 2004.
- AS ETP Grupp. Detailed Plan of the Eastern Part of Muuga Harbour 2003.
- OÜ E-Konsult. Job no. E846. Report on the Assessment of the Strategic Environmental Impact of the Detailed Plan of the Eastern Part of Muuga Harbour. Tallinn 2003.
- IPT Projektijuhtimine. Eastern Territory of Muuga Harbour. Geotechnical Investigations. Tallinn 2004.
- IPT Projektijuhtimine. Muuga Harbour Metal Terminal. Report on Additional Soil Investigations. Job no. 03-07-0273. Tallinn 2003.

In the EIA process the relevant valid Estonian and international legal acts are used, incl.:

- *Environmental Impact Assessment and Environmental Management System Act* (passed 22 February 2005; entered into force 3 April 2005)
- Council Directive 85/337/EEC of June 27 1985 *on the Assessment of the Effects of Certain Public and private Projects on the Environment* and 97/11/EC of March 3 1997 Amending Directive 85/337/EEC
- Council Directive 92/43/EEC of 21 May, 1992 o*n the Conservation of Natural Habitats and of Wild Fauna and Flora*
- Council Directive 79/409/EEC of 2 April 1979 *on the Conservation of Wild Birds*
- Council Directive 96/61/EC of 24 September 1996 *concerning integrated pollution prevention and control*

2. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The project site of eastern extension of Muuga Harbour includes narrow and low coastal strip between the shoreline of eastern Muuga Bay and the extension of Muuga railway station (Annex 2). In the north-east the area borders with the coal terminal and in the south-west with the container terminal on Hoidla road.

In general, the area affected by the extension of the eastern Muuga Harbour covers the project site, in case of marine population also the harbour aquatory and its immediate vicinities. The results of marine environment monitoring in Muuga Harbour have indicated that earlier dredging related to Muuga Harbour construction and resulting spreading of suspended matter have had a moderate to strong impact on benthic fauna and flora of the harbour basin and the marine area bordering directly with the harbour aquatory. Dumping of the dredged material not suitable for filling will take place into the dumping site north-east of Aksi island. Dumping may have an impact on fish spawns in the coastal waters of Prangli island and shallow waters surrounding Aksi. The impact of noise level (above all railway noise) increasing due to an increase in the cargo volume accompanying harbour expansion extends outside of the project area, i.e. to the nearest residential buildings.

2.1. Geological Setting of the Muuga Bay Area

The results of different geotechnical investigations have been used on composing the review of geological setting of the area (Sedman 2000; Luht 2003; Helm, Luht 2003; Helm, Talviste, Luht 2003; Sedman 2004).

2.1.1. Inner Part of Muuga Bay

The geological setting of Muuga Harbour area is variable. The layer on which the foundations of the hydrotechnical constructions of the harbour have been established lies at very changeable depth. Therefore, thorough geotechnical investigations and computations have been performed for each quay established up to now. The settlements of a number of previously constructed quays still continue and additional supporting works are carried out to decelerate these processes.

The bedrock is formed from Lower Cambrian sedimentary rocks. On the eastern and western coast of the bay the blue clay of the Lontova Formation, Lower Cambrian crops out, while inside the bay its upper surface lowers down to an elevation of -5 m in shore zone to -46 m in the central part. The clay is variegated (greenish-blue with purple blots). Its consistency is hard and it contains layers of silty sand or sandstone.

The Quaternary deposits are represented by glacial (loam / sandy loam till), glaciolacustrine (varved clay) and marine (silt, sand) deposits. Their thickness is variable, decreasing in the western and eastern part of the bay and reaching approximately 40 m in its central part (along the axis of an ancient buried valley).

2.1.2. Project Site

The description of the site's geological setting is based on the investigation reports compiled by IPT Pojektijuhtimine. The review is systemized on the principle that it would be possible to create a link between the terms used in geotechnics and geology. Terms used in geology are shown in italic. Generally, the nomination of a deposit is provided on the grounds of its grain-size distribution, which controls also the geotechnical properties. Besides, the grain-size distribution is directly connected with hydrodynamic processes, which relocate deposits on the shore.

Table 2.1. Geological setting of project site

Layer 1	Mud (*silt and sand with organic matter*)	
	The topmost portion of the seafloor is represented by up to 0.90 m thick layer of sea mud (Helm, Luht, 2003). This layer is missing on the nearshore, where sediment transport is active due to the activity of waves and currents. The mud's mineral part consists of silty clay or clayey silt, rarely of sand or silt. Due to the presence of colloidal organic matter, the mud is dark grey by colour; in places contains shells of molluscs. The layer is water-saturated and therefore generates lot of suspended matter when dredged.	
Layer 2	Fill: fine sand (*fill*)	
	The fill occurs on the beach. The layer is represented by fine sand. The flotation sand was used as filling material approximately 5 years ago. Thickness of the layer is 3–4 m.	
Layer 3	Silty fine sand, (*yellowish brown silt or fine sand*)	
	Silty fine sand is spread directly on the seafloor at an elevation of -10.80–-13.30 m. The layer is 0.30–1.90 m thick in the area under discussion. In the beach side part the silty fine sand is overlain by mud. Regarding the grain-size distribution, 74.5% of the material is represented by 0.06–0.2 mm fraction, the share of pelite (grain of <0.002 mm in diameter) is 3.5%. The sand is dark grey by colour, water-saturated. In the land area (on the beach) the layer of silt is 1.60–4.80 m and the layer of sand – 4.20–6.60 m thick. Sand's upper surface lies at a depth of 3.00–3.90 m (elevation -0.95–+0.15 m (average -0.40 m), directly under the fill. **Based on the grain-size distribution of the material, it can be used as fill. Therefore, when planning the dredging works, it is should be considered to separate this material from the rest of the layers to be dumped into the sea.**	
Layer 4	Silt	(*silt and sand with organic matter*)
Layer 5	Clayey silt with abundant sand, of low plasticity	
Layer 6	Silty clay, of medium plasticity	
Layer 7	Silty clay with abundant sand, of low plasticity	
	The diameter of soil particles decreases towards the base. At an elevation -11.90–-13.80 m sand occurs, under which loose silt lies. The layer is 0.50–1.70 m, in places more than 3 m thick (Layer 4). The silty clay (Layer 7) and clayey silt (Layer 5), both with abundant sand, were deposited during the ice lake stage and the following stages of sea development. They contain lot of sand (50–55%). The clayey silt of marine origin (Layer 5) occurs as 7.80-13.00 m thick layer and spreads to a depth of 10.20–12.80 m below ground surface (elevation -7.55–-9.60 m).	
Layer 8	Clayey silt with abundant sand, of low plasticity	(varved clay)
Layer 9	Silty clay, of low plasticity	
Layer 10	Silty clay, of high plasticity	
	Sand and silt are underlain by a complex of clayey soils, which begins at an elevation of -11.40–-14.40 m. The complex comprises soils of different geotechnical properties – clayey silt (Layer 8) and silty clay (Layer 9 and 10),	

	which occur to an elevation of -17.00 m. In the lowermost portion of the complex fine-grained material prevails; higher, the share of clay particles in silty clay decreases. The upper portion of the complex (thickness 0.90–2.60 m) is represented by clayey silt with abundant (>50%) sand (Layer 8), containing 7.7% of clay fraction. Thickness of the lower part (silty clay) is 3.80–6.00 m.
Layer 11	Clayey sand till with small amount of gravel (*loam and sandy loam till*)
	The bedrock is overlain by 3.80 m thick layer of till. Its upper surface lies at a depth of 30.80–35.40 m below ground surface (elevation of -27.40–-32.75 m). The layer is thicker closer to the shoreline and wedges out in the southern direction. The bluish grey till consists of clayey sand with small amount of gravel.
Layer 12	Weathered blue clay (*weathered blue clay* of hard consistency)
	Weathered blue clay is of hard consistency. The thickness of weathering crust is variable, 0.8…2.2 m in the seaward part of the planned area; in the southern part it is absent. The layer lies at an elevation of -28 m.
Layer 13	Blue clay
	The Cambrian blue clay lies at a depth of 31.60–38.60 m below ground surface (elevation -28.40–-35.75 m).

2.1.3. Bottom Sediments

Granulometric Composition

In order to characterise bottom sediments 21 samples were taken for the analysis of the granulometric composition (Annex 3, figure 1). The analyses of the granulometric composition were made in the laboratory of OÜ Eesti Geoloogiakeskus (Geological Survey of Estonia). Sieves (mesh size mm): 10; 5; 2.5; 1.25; 0.63; 0.315; 0.16; 0.05 were used upon the analysis of the granulometric composition of sand. It appears from the results of the analysis of bottom sediments that there is mostly superfine sand (maximum fineness modulus 0.99) (Annex 4, table 1, figure 1). It appears that most fractions are 0.16-0.05 mm and <0.05 mm. From the abovementioned fractions the content of the first one is bigger in the bottom sediments of the south-western part of the planning area. The ratio of clay fraction (<0.05 mm) is bigger in the north-eastern part of the planning area dredged earlier and in the deeper part of the sea. This can be explained by the fact that in the course of earlier dredging the part of bottom sediments was taken out and the seabed is covered by a complex of glaciolacustrine sediments like in the old part of Muuga Harbour.

Concentration of Pollution Components

Samples of bottom sediments were taken from 21 points for the analysis of pollution components (Annex 3). Samples were taken from the upper 0.5 m thick layer of the bottom sediments. The analysis of oil products and heavy metals were made in the laboratory of OÜ Eesti Geoloogiakeskus (Manager M. Kalkun), which is a testing laboratory accredited by the Estonian Accreditation Centre with the registration number L093. The data presented in earlier studies have also taken into account in the discussion of the content of heavy metals and oil products.

The samples were dried and the relevant weighed portion was taken in the laboratory. Cadmium, copper, chromium, nickel and lead were determined in aqua regia extract by the atomic absorption method. Since the target value of cadmium in soil is 1 mg/kg, a method, which minimum determination limit is 1 mg/kg, is used for the determination of this element. For the determination of oil products the samples were extracted in hexane and the content was obtained by gravimetric analysis. The results of the analysis (Annex 5, tables 3-5) were compared to the maximum limits established by the Regulation of the Minister of the

Environment No. 12 of 2 April 2004 *Maximum Limits for Dangerous Substances in Soil and Groundwater*. Pursuant to the Regulation the maximum limits for dangerous substances are expressed as reference values and target values for these substances.

- A target value is a concentration of a dangerous substance in soil at or below which the condition of the soil is good, that is, safe for humans and the environment.
- A reference value is the concentration of a dangerous substance in soil above which the soil is polluted and dangerous to human health and the environment.
- The condition of soil is satisfactory, if the concentration of dangerous substances is between the reference values and target values for soil. Depending on the purpose of land use, different reference values shall be implemented for industrial and residential zones. Since in the given case it is an industrial zone (§2(5) and (6) of the Regulation), the concentration of pollution components in soil (bottom sediments) shall not exceed the reference value in the industrial zone.

The maximum concentrations of *cadmium, chromium, mercury* and *nickel* in the samples are significantly below the relevant target values. As for the concentration of the abovementioned elements, the condition of bottom sediments is good, that is, safe for humans and the environment.

The maximum concentration of *copper* is 208 mg/kg in sample AG6. The concentration of copper in samples AG4, AG5, AG6 and AG7 is between the reference value of the residential zone (150 mg/kg) and the industrial zone (500 mg/kg). These samples have been taken from the eastern pier of Muuga Harbour. In the areas of the samples AG8, AG10 and AG12 the concentration of copper is between the target value and the reference value of the residential zone. In the area, where the abovementioned samples were taken, the bottom sediments are in a satisfactory condition as for the concentration of copper. In other samples the concentration of copper is below the target value and the condition of bottom sediments is good, that is, safe for human health and the environment.

The concentration of *lead* is the biggest in samples AG4 and AG5. The maximum concentration of lead and the concentration of lead in samples AG6 and AG7 are between the target value (50 mg/kg) and the reference value of the residential zone (300 mg/kg). In the area, where the abovementioned samples were taken, the bottom sediments are in a satisfactory condition as for the concentration of lead.

The concentration of *zinc* in samples AG4, AG5, AG6, AG7, AG8 and AG10 is between the target value (200 mg/kg) and the reference value of the residential zone (500 mg/kg). The maximum concentration of zinc is 363 mg/kg in sample AG4. In the area, where the abovementioned samples were taken, the bottom sediments are in a satisfactory condition as for the concentration of zinc.

The maximum concentration of *oil products*, which is equal to the target value (100 mg/kg), is in sampling point PA11 between 3.80-4.00 m. In other samples the concentration of oil products is below the target value. In the area, where the abovementioned samples were taken, the bottom sediments are in a good condition as for the concentration of oil products, that is safe to human health and the environment.

Thus, it can be concluded on the basis of the analysis of pollution indicators that suitable soil may be used for the filling of the terminals' area, since it is production land, which belongs to the industrial zone.

2.1.4. Coastal Processes

In Muuga Bay the waves from E-NE and NW affect the sediment transport and erosion of the beaches (Annex 6 photo 1). From these directions the wave length is the longest and therefore the energy of the reaching wave the greatest. The current and waves generated by E-NE winds carry the sedimentary material along the eastern coast of the bay towards Muuga Harbour. The coal terminal hinders the sediment transport, therefore in SW of the terminal the shore may be damaged due to the sediment deficiency. The damages are caused by the storm waves generated by strong NW winds.

The project area includes the shore section ca 2000 m from the coal terminal to the north-easternmost berth of the harbour, where mainly sandy beach occurs, with few sections where cobbles and boulders are also found. The distribution of bottom deposits in this region has been influenced by human activity (filling). Besides, in a number of places the shore has been affected by the storm waves and high water stand of January 2005. The erosion has been more intense in the shore section near the coal terminal. The eroded material has been carried to the shallow sea and to the sandy beach near Kroodi Creek. The sand dumps near the coal terminal have been partly carried to the sea, in result of which the sea has become shallower in this area. There is a shore protection structure made of boulders near the coal terminal.

The sandy beach of variable appearance continues up to the mouth of Kroodi Creek, there can be found a small sandy cape, abrasion scarp and dumps (Photos 2, 3).

To characterise the coastal deposits, samples were taken from the area of sand dump in SW of the coal terminal. From these 62 % were fine sand, 28 % – very fine sand, 5 % – medium sand and 5 % – extra fine sand.

The gently sloping sandy beach is modelled by the water of the ditches which flow out from below the railway embankment and fall into the bay (Photo 4). In the vicinity of the Kroodi Creek, spreads vegetated overmoist area in the landward part. Seaward of it a vegetated beach ridge occurs (Photo 5), which is not influenced by wave activity. Between the beach ridge and shoreline there is wide low sandy beach.

In the south-westernmost part of the beach, from Kroodi Creek to the eastern pier of Muuga Harbour, there is a shore protection structure made of limestone lumps, with sandy foot (Photo 6).

In the NE of the coal terminal a shore protection structure of cobbles and boulders has been created. Further low vegetated shore begins, where hydrodynamic processes are relatively less active and the appearance of the beach has changed little in the course time. As a result of storm and high water level (8-9 January 2005) the coastal processes has become somewhat more active.

When new quays will be established, the described beach will be filled. As a result, a man-made shore will form, with the quay as its seaward boundary.

2.1.5. Geological Processes in Saviranna Area

Since the problem of the costal processes of Saviranna was raised in the public discussion of the EIA programme, this subject has been discussed in this report, although this region remains farther away from the area affected by the extension of the eastern part of Muuga Harbour.

East from the coal terminal there is a building constructed by the former army of the Soviet Union at the end of the natural coast of Cape Tahkumäe. The coast in front of the building is secured by tetrapods in order to avoid further wear of the coast. From this cape end in the direction of the coal terminal there is a shallow cove, where the coast material is gravel with pebbles and sand. Sand has probably been carried here upon the construction of the coal terminal, when the shallow sea was filled. Coast defences of boulders run along the western side of the cove, which has been erected in the course of the construction of the coal terminal. (Annex 6, photo 7).

100 m east from the end of Cape Tahkumäe there is a coast of blended material (boulders, cobbles, pebbles). In several places on the coast blue clay is revealed, the coast is vegetated in some places. From there on the coastline becomes north-south. The material on the coast is the same as described in the paragraph above. From there on the coastline turns east, where the coast is covered with sand at the extent of approximately 200 m (Photo 8). A bank in Cambrian sediments begins to the east, which extends on a long coastal section at different distances from the boundary of water. In this area there is also the so-called deep-sea outlet harbour, from where approximately 200m east there is a deep-sea outlet pipe. The higher part of the steep rocky coast of Cambrian sediments remains approximately 1 km to the east from the deep-sea outlet. Geologically the upper part of the steep rocky coast is formed by the Cambrian sandstone. Beneath it there is a complex of sandstones with loamy interlayers, which base is formed by blue clay. The lower part of the steep rocky coast has been eaten away actively at some places. Big pieces have fallen down from the upper complex with massive rocks, which form a talus. There is an area between the steep rocky coast and the present coastline, which is covered by the crushed material of the steep rocky coast. In the coastal water there are many boulders of crystalline stones originating from the sediments (moraine) on the steep rocky coast. Cambrian blue clay is revealed in the coastal sea and on the border of water. In some places the coast (from the deep-sea outlet harbour up to Saviranna village) is developing very actively, especially in the periods of high water level and storm waves. The occurrence of landslides is characteristic of some coastal sections in this region, which is caused by the flowing out of surface water and groundwater from the loamy layers forming the steep rocky coast. The coast of Saviranna region was significantly changed by the storm of 8-9 January this year. More crushed material of the steep rocky coast than earlier is found on the coast. The present coal terminal and the quay line to be constructed in the planning area have practically no impact on the development of this coastal section. This is confirmed also by the monitoring carried out by the Estonian Marine Institute of the University of Tartu in 2004 (Orviku, 2004).

It is recommended in the marine environment monitoring report (2004) of Muuga Harbour prepared by the Marine Institute to continue the monitoring of the coastal processes of Saviranna area for timely detection of unforeseeable and undesirable changes and for the development of remedies. Measurements should be repeated at least once a year, and should be continued for at least 6 years after the completion of the construction, since the coastal processes of the coastal section are very active and it is necessary to monitor continuously the further changes in their intensity.

2.2. General Characteristics of Muuga Bay

Muuga Bay is located on the northern coast of Estonia. In the west it borders with Viimsi peninsula, in the east – with Cape Tahkumäe and Aksi island, and in the north – with Prangli island. Estonia’s largest trading harbour is situated on its southern coast. Besides, the Maardu Chemical Plant is also located there, which until 1990 produced mineral fertilizer (superphosphate) and sulphuric acid. There are no major rivers, but only one creek (Kroodi) flows into the bay. The Kroodi Creek carried the untreated wastewaters of the Maardu Plant to the sea.

The coastal slope of the mainland and the islands is relatively steep, which is why the depths from the coast to the sea increase rapidly up to 20 meters. In the middle of the bay there is a shoal Karbi madal with a small area and steep slopes. At the depth of over 20 meters the bottom relief is comparatively plain with a slight inclination towards the northern part of the bay, where there are the biggest depths (70-80 m) of the region. In most part of the bay the depth remains between 20-50 m. The bay is connected with the submarine trenches of the central part of the Gulf of Finland through the deep-water (90 m) syncline between Prangli Island and Viimsi peninsula.

The good connection with the middle part of the Gulf of Finland ensures the entering of the water of the submarine trenches in the Gulf of Finland into Muuga Bay. Upon the intensifying of the stagnation processes at the depth of 60-80 m the oxygen-deficient water of the submarine trenches will inhibit the development of benthic fauna. The content of oxygen dissolved in shallower water is not, as a rule, a limiting factor for the spreading of benthic fauna.

Salinity of near-bottom water of Muuga Bay varies between 5–8‰. In summer the temperature of near-bottom water layers at the depth of 5–10 m is usually 10–18°C. In the maritime areas, which depth exceeds 20 m, the temperature of the near-bottom water stays below 10°C, at the depth of 50–70 m between 2–5°C all the year round.

From the border of water up to the depth of 10 the seabed is covered mainly by clay, gravel, sand and stones. In Muuga Bay phytobenthos has spread only in this depth zone. At the depth of 10-20 m the solid bottoms become soft – sandy clay or muddy clay. At the depth of 20-50 m there are only argillaceous bottoms usually covered by a couple of centimetres thick layer of mud. At the depth between 70–80 m there are mostly muddy sediments.

2.3. Meteorological and Hydrodynamic Characteristics of Muuga Bay

2.3.1. Winds

Western and southern winds dominated on Muuga Bay in 2001-2004 by the data of Muuga harbour observatory (Figure 2.1). First maximum of wind directions recurrence was S (170-190º), second W (250-270º) and third NE (50-70º). Generally can be said that the winds blowing between the southern and western directions dominate on the aquatory of Muuga Harbour, the north-eastern is presented considerably less. The average wind strength of the period was 5,2 m/s.

The windiest months on Muuga Bay, like in the whole Estonian coastal sea, are January, February, November and December, when wind strength is about 10-20 % more than annual medium. About near the average is wind velocity also in March, April, May and October. Summer has 10-20 % less wind. In windy months dominate SW, S and W winds, but in April, May, June and July there are also N or NE winds. Strong storms in Estonian coast are statistically mainly from SW, SSW, W and S directions, seldom from NW and N directions.

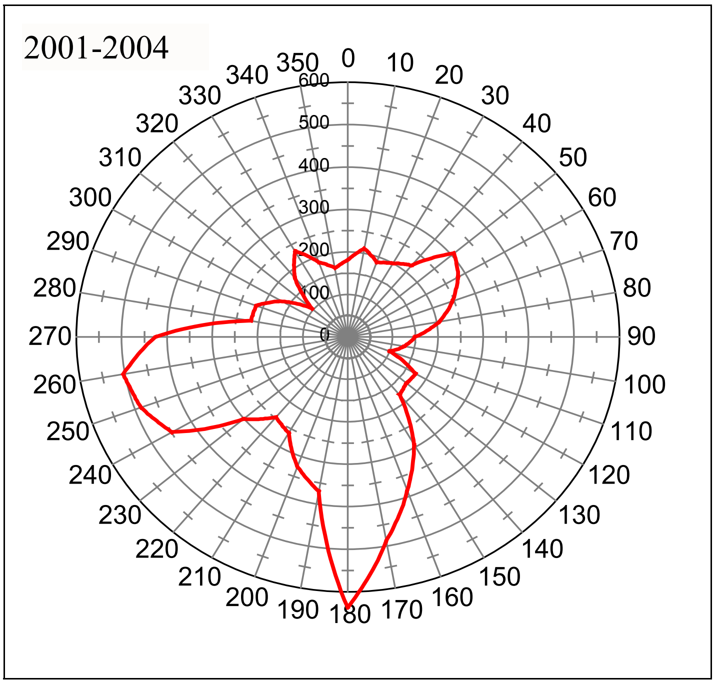


Figure 2.1. Wind rose of 2001-2004 medium in the area of Muuga harbour

Annual maximum wind speed is usually measured in October-November. In these cases the wind speed may reach up to 30 m/s, sometimes even above it. The events, where wind speed is above 13 m/s, are still relatively rare. Strong winds (15-20 m/s) occur more frequently in the winter period. The percentage of relatively weak winds, 3-7 m/s is big and these dominate in more than three fourths of the whole year. The periods of zero wind occur in 10% of all the cases.

Muuga Harbour is situated in the south-eastern part of Muuga Bay and due to the location it is sheltered by the mainland from the winds blowing from the southern directions. The eastern part of the harbour basin is also protected from the winds blowing from the eastern directions by Tahkumäe peninsula.

2.3.2. Waves

In Muuga Bay waves form mainly as a direct result of wind. The maximum wave heights, 3.5...4 m, in the bays of the northern coast have been caused by northerly storms, when the wind speed is above 15...20 m/s. An even wave field with up to 0.5 m high waves forms in the whole Muuga Bay in case of a weak and moderate wind (3-8 m/s). In case of a stronger wind (9-11 m/s) the wave height increases up to 1...2 meters. In the open part of the bay the direction of the waves coincides mostly with the wind direction, closer to the coast the wave field follows the topography of the coastal slope and the wave front becomes parallel to the coastline.

Since Muuga Bay is open from the northern direction and the percentage of northerly winds is small in the division of wind directions, the occurrence of relatively weak waves may be expected in Muuga Bay. The division of wave heights obtained on the basis of visual monitoring (1945-1989) shows that waves with the height below 0.3 m are dominating (52.9%). Waves with the height of 0.3-0.5 m occur with the frequency of 27.5% during the monitored period. The cases, where the wave height exceeds one metre, are relatively rare (below 3%).

In more than half of the cases the direction of the spreading of waves is the sector between north and south-east. The percentage of zero wind is rather big, which shows that relatively weak winds cannot cause waves in Muuga Bay at all. Although the average wave height in Muuga Bay is relatively small, situations may be observed, where the waves increase up to the height of 3.5 m and this especially in case of strong (>20 m/s) northwesterly winds.

Unlike the open sea, the relative closure shall be taken into account in bays, which in case of the prevailing wind directions in Muuga Bay is a good impediment for the formation of strong waves, but at the same time turns out to be a factor intensifying the waves in case of a certain wind direction.

2.3.3. Currents

Two important factors, which control circulation in Muuga Bay, may be pointed out. These are local wind conditions and the topography of the seabed. In most cases the direction of flow in the surface layer coincides with the wind direction in the range of ±45º. Current velocity in the surface layer is mainly 10-20 cm/s, but may reach also up to 40 cm/s in some places.

In the southern part of the Gulf of Finland the dominating currents move along the Estonian coast from the west to the east. Due to the effect of those currents the water masses are carried from the harbour zone in Muuga Bay mainly towards Cape Tahkumäe and Ihasalu peninsula. Only continuous moderate and strong southerly and south-easterly winds may turn the flow into the northerly direction and the easterly winds into the westerly direction. The velocity in the middle part of Muuga Bay is strongly affected by local winds.

There is often a situation, where a convergence zone is formed near Cape Tahkumäe in reference to the flow along the coast, i.e. west from Cape Tahkumäe the current is directed east and east from the cape it is directed west. As a result of it, a strong northerly flow can be observed near the end of Cape Tahkumäe. When moving to the north the current turns west forming cyclonic circulation in the southern part of Muuga Bay.

Current velocity in the whole liquid column remains between 5-10 cm/s, whereas there is no direct connection between momentary wind and flow velocity, which refers to a certain delay of circulation in case of the change of atmospheric conditions.

2.3.4. Ice Conditions

In normal winters the ice conditions in the area of Muuga Bay are relatively easy as compared to the eastern part of the Gulf of Finland or the Gulf of Bothnia. The reason for this is the winter circulation scheme of water masses in the Gulf of Finland, according to which the warmer (and also saltier) water masses from the open part of the Baltic Sea move along the Estonian coast to the east and the colder (and also less saltier) water masses along the northern coast to the west.

Muuga Bay is totally covered with ice only in exceptional winters, thus, Muuga Harbour may be considered an ice-free harbour. More frequently, once or twice in almost every winter, ice occurs in the bay during a short period of time, mainly in the form of drift ice. In warm winters only relatively narrow ice occurs near the coast. The occurrence of sea ice in different years varies to a relatively big extent and it is connected with the climatic periods.

The earliest date of the formation of ice in the reference period 1920-90 has been 2 November and the latest has been 12 March. In case of a normal winter stable forms of ice occur in Muuga Bay at the end of January and at the beginning of February. However, it is ice, which breaks up from time to time and does not prevent navigation significantly. The drift ice carried into the bay by northerly winds, which may prevent shipping traffic by heaping and hummocking, is an exception and should be taken into account upon the designing and performance of filling works of the harbour area.

Based on observations the average thickness of ice has been 35 cm and the maximum 73 cm. Breakup of ice will start in the end of March or the beginning of April in the open western part of the bay, where fast ice is formed later than in the eastern part of the bay. Breakup will be rapid and will take place on an average of during 10 days. The bay will be ice-free by the beginning of April (on an average by April 4). Based on observations (1920-90) ice has broken on January 9 at the earliest and on May 14 at the latest.

2.3.5. Water Level

Water level in Muuga Bay is affected to a considerable extent by the water level in the whole Baltic Sea. The variability of the sea level both, in the Baltic Sea as a whole and at the coast of Estonia is caused by the impact of the local influencing factors. The most important of them are velocity, direction and duration of the wind, changes in air pressure, inflow of rivers and the intensity of water exchange through the Straits of Denmark. In Muuga Bay, like in most part of the Estonian coast (except closed bays or estuaries) the amplitude of the fluctuations of water level is ca 2.5 m as difference between the absolute maximum and minimum water level (in Muuga Bay +126 and –90 cm from the Kronstadt zero).

The daily amplitudes of the fluctuations in water level are bigger in autumn and spring and smaller in summer. In winter the daily amplitude is influenced by ice, which prevents the impact of wind from reaching the water masses by suppressing the fluctuations in water level.

2.4. State of the Environment in Muuga Bay

Human activity changes the indicators of the marine environment, which in its turn causes changes in the biota. Bioindication method has been used successfully for the assessment of the intensity of human activity. The bioindicators used often are big invertebrates living in the bottom of the sea i.e. benthic fauna. The biotic communities of benthic fauna indicate especially clearly the long-term changes of environmental state taking place from months up to decades. This is due to the peculiarities of the spreading and lifestyle of the given group of animals. Negative changes in the chemical composition of sediments and seawater are expressed in the disappearance of some species and the increase of the numbers of other species. Benthic fauna may become extinct in case of certain critical conditions.

Quantitative samples of the benthic biota have been collected from the investigation area of Muuga Harbour since the 1960-ies. Long-term data rows enable to differentiate natural processes from the anthropogenic ones, including to point out the changes in the biota caused by dredging and dumping. The bay has been surveyed regularly in the course of the monitoring of Muuga Harbour since 1996. Since the waters of the harbour area are carried by the dominating currents towards Cape Tahkumäe, the sea area to be dredged near the harbour and Tahkumäe region have been selected as a traditional area for the investigation of benthic biota. The aim of the monitoring of benthic fauna is to assess the possible impact of the activity of Muuga Harbour to the state of the marine environment.

During last 40 years, considerable changes have occurred in the structure of zoobenthos of Muuga Bay, all of them directly caused by human activity. The zoobenthos has been affected by two main factors: wastewaters of the Maardu Chemical Plant and dredging works carried out in Muuga Harbour. The influence of human activity is expressed mainly in the littoral zone of the bay, i.e. in the areas with water depth between 0.5 and 30 m.

The biota of Muuga Bay has been influenced by the effluents of Maardu Chemical Plant for decades. In the years 1960-1980 there was no benthic fauna in the southern part of the bay and the biotic communities were very poor in species up to the depth of 30 m.

In the years 1980-1985 the extensive dredging operations connected with the construction of the new harbour had a strong impact on the biota of the bay. The coastal region was filled by excavated bottom sediments, as a result of which part of the coastal waters was left under land in the southern part of Muuga Bay. The amount of suspended solids in seawater increased considerably as a result of dredging.

The population diversity of zoobenthos increased in 1990-ies, after the closing of Maardu Chemical Plant. From 1994 up to 2003 the communities of zoobenthos in Muuga Bay were similar to those of the neighbouring areas. The communities of zoobenthos, which characterise the area of the middle part of the Gulf of Finland open to the sea and under the influence of strong waves and currents, are typical of Muuga Bay.

From the autumn of 2003 and during 2004 large-scale dredging and filling works were carried out in connection with the construction of the coal terminal. In 2004 also the harbour basin was dredged at the 14th and 15th pier.

The results of marine environment monitoring in Muuga Harbour have shown that the previous dredging works performed in connection with construction activities on the harbour territory and the resulting spreading of suspended matter have moderately to strongly affected the benthic fauna and flora of the seafloor directly bordering with the harbour. These changes are of reversible character and the situation will likely stabilise in 3–4 years (maximum 10 years, depending on the volume of dredging) after completion of dredging.

2.5. Marine Flora and Fauna

In relatively narrow and shallow (<15 m) coastal sea area of Viimsi and Tahkumäe peninsula there is very intense water movement due to the effect of currents and waves. Therefore, sediments are well washed and sorted through by currents and waves. From those regions lighter seston is carried from shallow waters to deeper areas. Only in the sea area between the western piers of Muuga Harbour and Viimsi peninsula accumulation processes prevail, to where currents carry partly-decomposed organic material (silt with plenty of decay dominates).

Eastern Muuga Bay has typically rocky bottoms in the depth zone of 0-0.5 m and clayey bottoms covered with boulders at 1-10 m. Phytobenthos occur only in this depth zone. In the depths over 20 m strongly muddy-clayey bottoms dominate, where phytobenthos is absent.

2.5.1. Phytobenthos

The general coverage of the flora is relatively stable in the range of the whole investigation area of Muuga Bay by decreasing evenly as the depth increases. The percentage of annual plant species in the shallower part of the sea (0-4 m) is very big, which refers to big natural instability of the marine area. In the western part of Muuga Bay stones suitable as a substrate for the plants occur in the whole range of the habitat and the communities of phytobenthos are relatively diverse.

Green alga *Cladophora glomerata* dominates in the shallower part of the sea (0-3 m), which is replaced by the community of red alga *Ceramium tenuicorne* from the depth of 4 m. The numerous population of *Mytilus edulis* is added from among the fauna. In addition, red algae *Furcellaria lumbricalis*, *Rhodomela confervoides*, brown alga *Pilayella littoralis* and green alga *Cladophora rupestris* can be found in deeper areas (Figure 2.2).

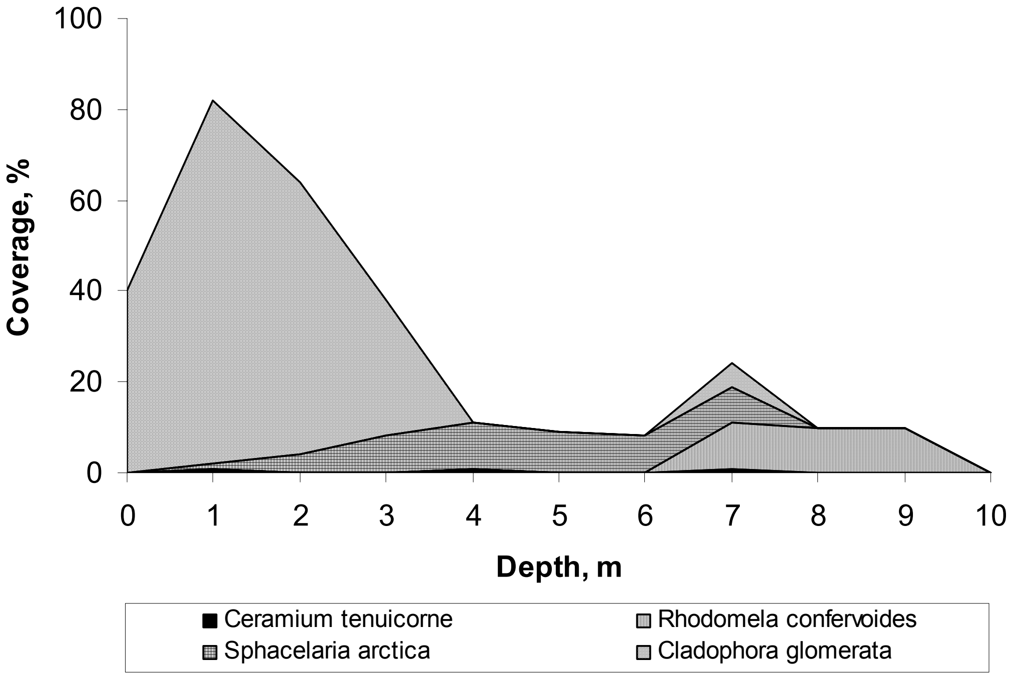


Figure 2.2. Depth distribution of bottom vegetation by species in the eastern part of Muuga Bay in 2003

2.5.2. Benthic fauna

Shallow waters are populated mainly by the benthic fauna fixing to the bottom and moving on the sediments: the community of snails, acorn shells *Balanus improvisus* and mussels *Mytilus edulis*. In the areas with rich vegetation spread phytophilous crustaceans (gammarids *Gammarus salinus* and *Gammarus oceanicus*), Isopoda *Idotea balthica* and *Jaera albifrons*, insect larvae (two-winged *Diptera* and midges *Chironomidae*) and cockles *Cerastoderma glaucum*.

Muddy sandy-clayey bottoms dominate in the waters at the depth of above 20 m and there is no flora. The species composition of benthic fauna is much poorer there than in shallow waters. The most typical species are *Macoma balthica*, *Halicryptus spinulosus*, *Monoporeia affinis* and *Saduria entomon*. The dominating species as for the numerousness and biomass in the deeper zones of Muuga Bay is *Macoma balthica*.

As compared to the biotic community of Ihasalu Bay with a small impact of human activity, the communities of Muuga Bay vary considerably more than the communities of Ihasalu Bay (Figure 2.3). The bigger variation refers to a more extensive instability of the communities, which in case of similar background conditions can be related directly to the impact of dredging and dumping operations. Stable communities are characterised by big-sized individuals, but populations with small numerousness. Disturbed communities are characterised by the small size and a great number of animals. In general, the fauna has been disturbed most of all in the areas at the depth of 10–13 m, i.e. in the areas, where there is active shipping traffic and regular dredging operations are carried out.

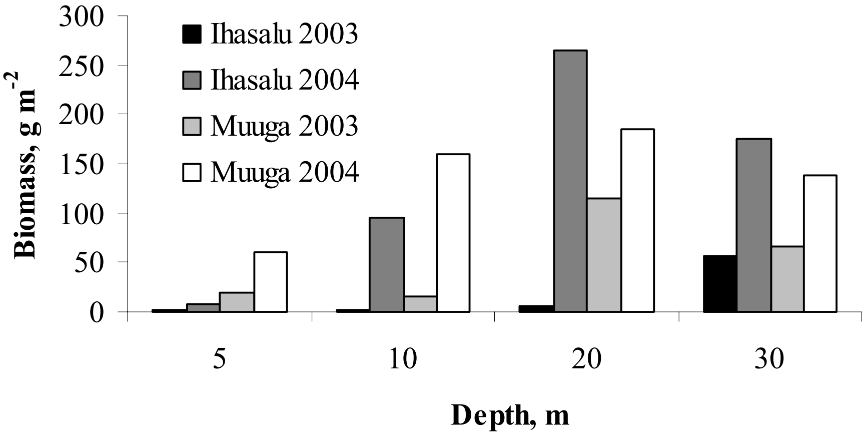


Figure 2.3. Distribution of zoobenthos biomass (g m^{-2}) in the standard monitoring stations of Ihasalu Bay and Muuga Bay in 2003-2004

2.5.3. Fish Fauna

In the NW monitoring site (Tammneeme coastal waters) the number of species occurring in the catches has been relatively stable since 1994. In 2003 and 2004 a number of cold-water sea fish species – sculpins and lumpfish – appeared in the catches, which allows to presume that the quality of seawater is good in Tammneeme area.

Population diversity SE from the harbour, in the area between the eastern pier and Cape Tahkumäe was also relatively similar in the years 1999-2003, only the percentage of carps (roach, bleak) increased a little. However, in 2004 the picture here changed cardinally – the number of species occurring in the catches decreased to 10 and the percentage of carps decreased to minimum. As a result of large-scale hydrotechnical works the given sea waters have lost their natural state of the environment and have become sea waters, where the local fish communities have been preserved to a minimum extent (or are disappearing) and the fishes found in the given sea waters are mainly individuals, who have come there temporarily for eating.

The yield in monitoring nets in 2004, like also in 2003, was relatively small north-west and south-east from the harbour. The relatively big number of lavarets in the autumn monitoring in 2004 attracts attention. The impact of the harbour can be clearly seen in case of those monitoring stations, which are located in the sea waters between the coal terminal on Cape Tahkumäe and the present eastern pier of the harbour, where in addition to the decrease of the number of species, the yield in monitoring nets has also decreased considerably in the last two years.

The number of fish species varies between 15-20 in monitoring catches (Figure 2.4). In the monitoring catches in 2003-2004 there are clear differences in the percentages of fish species (Figure 2.5).

The part of Muuga Bay between Muuga Harbour and Cape Tahkumäe has lost its importance as the reproduction area of fishes for a long time or forever. Phytobenthos has practically died away here. Although hard roe of Baltic herring was not found in the estuarine area of Ihasalu Bay, spawning substrate suitable for Baltic herring and other fish species occurs here to a small extent. It is likely that fish can spawn in the cove of Ihasalu Bay farther away from the harbour and it may also be restored to a certain extent in the estuarine area of the bay (i.e. east from the coal terminal) in future – in 2-4 years after the completion of hydrotechnical works.

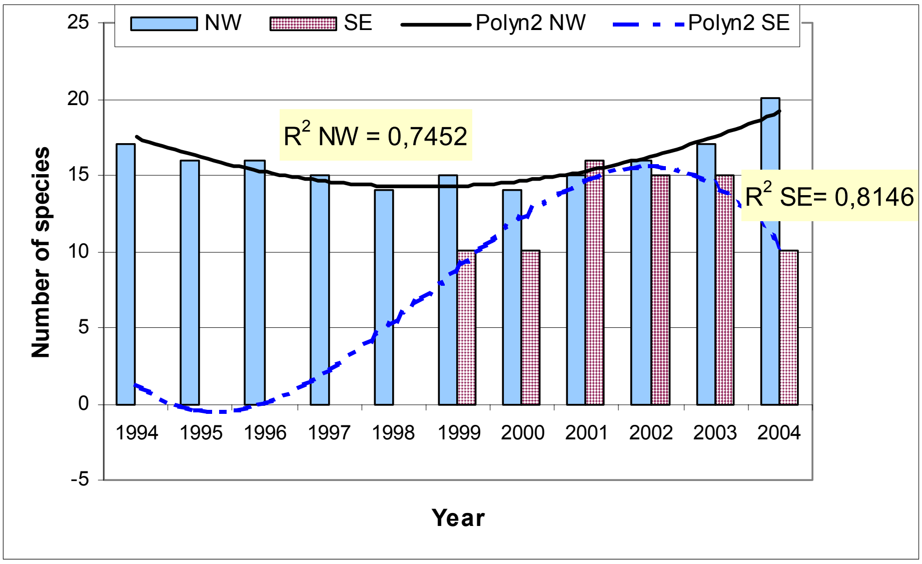


Figure 2.4. Number of fish species in experimental catches in 1994-2004 (NW – Tammneeme, SE – between Muuga Harbour and Cape Tahkumäe)

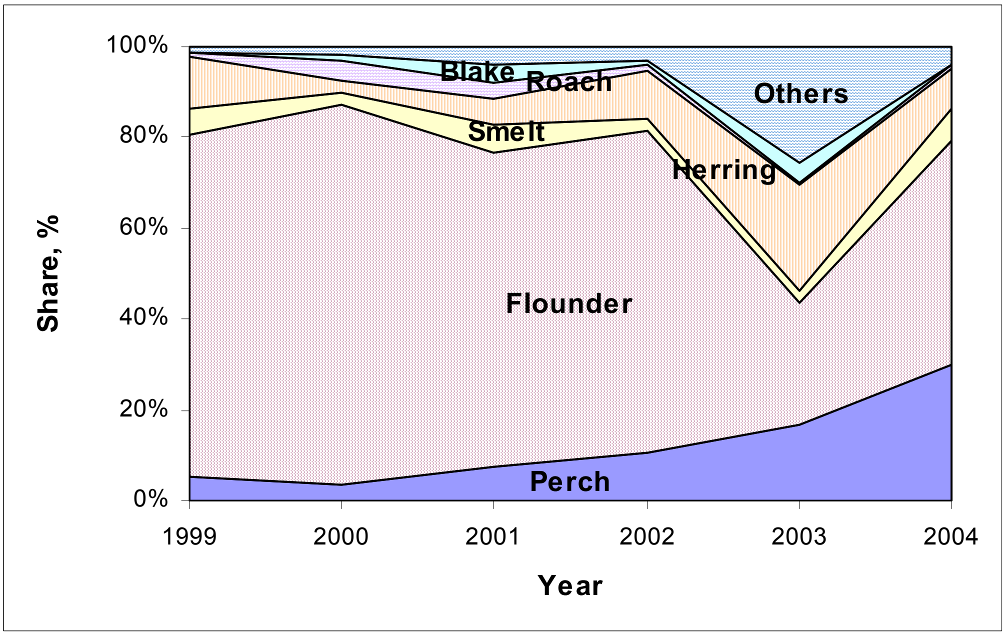


Figure 2.5. Composition dynamics of fish species in experimental catches in Muuga Bay in 1999-2004

2.6. Biota of the Dumping Site

Dredged soil is dumped near Aksi island at the depth of over 70 m. The quantitative composition of benthic fauna depends on the concentration of oxygen in the near-bottom waters. Most of the benthic fauna is formed, as rule, by crustaceans and worms, most of the biomass by bivalve molluscs. The oxygen balance in the submarine trenches is usually not favourable for the development of benthic fauna, which is why the number and biomass of the benthic fauna is very low (number in the years 1996-2001, biomass in the years 1996, 2001) or there is no fauna (2002-2004).

The coastal waters of Prangli and Aksi have preserved their importance as the reproduction areas of fishes (Baltic herring, perch) and it is rather likely that the reproductiveness of the fishes propagating there will be damaged in case the suspended solids generated upon dumping reach shallow sea, up to the depths below 10 m. It is especially likely that damage will be caused in the spring period between the end of April and the beginning of July (in the years with average weather). The given period is specifically connected with the seawater temperature and the period more dangerous for the reproduction of fish is when the seawater temperature is between +6º- +15ºC.

2.7. Surface and Ground Water

The surface water drainage basin of the territory and aquatory of Muuga Harbour is small, covering only 47.25 km², of the eastern territory – 31.59 km². The drainage basins of Võerdla main ditch and Kroodi Creek, which pass the eastern Muuga Harbour, are 7,78 km² and 23,81 km², respectively.

The runoff of minor ditches is hindered by various pipelines, transmission lines etc established parallel to the shoreline. Natural runoff into the sea was stopped by the construction of Muuga railway station. As a result, several land units between the Nuudi road and railway station are overmoist. In the course of the harbour extension Kroodi Creek and ditches will be led into the sea by new channels (p 3.6).

Kroodi Creek is 10.8 km long, it starts from Lake Maardu and falls into Muuga Bay. Its flow rate is controlled by the overfall of Lake Maardu and is on the average 0.5 m³/s. Until the beginning of the 1990's the untreated technological wastewaters of TK Eesti Fosforiit (former Maardu Chemical Plant) reached the sea through Kroodi Creek. In the construction process of Muuga Harbour the area of the mouth of Kroodi Creek has not been dredged. This area will be filled and a terminal will be built instead. Thus, possible contaminated bottom sediments from the area of creek's mouth will not be directly hazardous to the environment and to human health.

Currently, the production of mineral fertilizers in Maardu Chemical Plant has been stopped and therefore the quality of the water in the creek has improved. The creek runs through the territory, where previously intensive industrial activity was carried out and which is contaminated with industrial wastes. Thus, the main sources of pollution for the creek's water are storm water and waste water from the industrial area of Maardu town.

11 enterprises discharge their waste and rain waters, Iru Power Plant also its cooling water (258.9 thousand m³/a year) into Kroodi Creek through purification plants. The total quantity of water discharged into Kroodi Creek is above 900 thousand m³/a year. Significant pollution of Kroodi Creek comes also from the drainage water from the industrial territory of the town of Maardu, which flow rate is rather big and where there is a lot of nitrogen and phosphorus. If adequate measures were ensured for the prevention of pollutants getting into Kroodi Creek, the condition of Kroodi Creek would become good and it would embellish in its own way the industrial landscape of the town of Maardu.

On 13 October 2005 a water sample was taken from Kroodi Creek from the culvert at Maardu road and the following components were determined in its analysis (Annex 10):

Analysed component	mg/l
Cd	<0.0002
Cu	0.0217
Hg	<0.001

Pb	<0.002
Zn	0.180
NH_4	9.12
NO_2	2.99
NO_3	19.33
PHT (mgO/l)	8.73
orto-PO_4	0.40
poly-PO_4	<0.01

On the basis of the results of the analysis it can be concluded that there are few heavy metals in the water of Kroodi Creek – below the permitted limit. However, there is a big amount of nitrogen and phosphorus compounds. The quality of Võerdla main ditch has not been researched, but it can be concluded that there is no pollution in it, since the area has been out of active use previously.

Hydrogeologically, Muuga Harbour is located on the North-Estonian fore-klint lowland, where the Ordovician-Cambrian aquifer system is the uppermost aquifer in the bedrock. The unconfined water of the Quaternary aquifer system occurs in the flotation and marine sands and is in contact with seawater. As for groundwater resources, the water of the Quaternary aquifer system can be used for single objects only. Considering vulnerability, the aquifer is not protected.

The eastern part of Muuga Harbour is located downstream of the water users of this aquifer, which is why the activity in the harbour area does not have an impact on the usage of groundwater resources. However, the measures necessary for the prevention of the pollution of the uppermost aquifer shall be kept in mind upon the construction of harbour facilities in order to avoid pollution of seawater through the water horizon connected with the sea.

Major groundwater resources on the territory of Jõelähtme rural municipality are related to the Ordovician-Cambrian and Cambrian-Vendian aquifer systems. Consumption of the groundwater of these aquifer systems is limited, since Tallinn is the biggest consumer of their groundwater and as a result, a drawdown cone ca 70 km in radius has formed. On the southern coast of Muuga Bay the groundwater of the Cambrian-Vendian aquifer system is well protected by the Lower Cambrian blue clays.

2.8. Landscape and Nature Objects

2.8.1. Meadows and Forests

On the eastern coast of Muuga Bay, east of Kroodi Creek up to Cape Tahkumäe the **meadows**, mainly covered by reed, occur as 100 m wide coastal strip. These meadows will perish due to the harbour extension and in the future in their place there will be harbour facilities (rail manoeuvring yard). In great extent the area between the Muuga railway station and the sea is filled with sand by now. Only narrow coastal section – the project area – is still untouched. There can be observed erosion on the seaside edge of the filled artificial scarp (~3 m high).

Somewhat more of natural landscape has remained in the southern part of the extension area, near the eastern bank of Kroodi Creek, where broadleaved grove with bushes, ponds and reed-bed occur. There downy birch, grey alder, birch and single crack willows, shrub willows grow. North-eastern part of the forest stand is dried.

According to the database of semi-natural meadows (based on the fieldwork carried out in 1999–2000 when ca 6500 meadows all over Estonia were studied) three meadows occurred on the territory of Muuga Harbour expansion. They were located in the near-coast area between Cape Tahkumäe and Võerdla main ditch, bordering with the project site, and partly on the territory of the coal terminal, where they have already been destroyed by construction activity. The areas were partially overgrown with brushes and had not been in use for at least 10 years. Meadows have remained partly in the Cape Tahkumäe.

The **woody plants** on the area of harbour expansion are of variable appearance and value due to their origin and land use. On woodlands the woodland habitat types with bridewort and goatweed-fern ground vegetation prevail. In the project area above-mentioned grove grows, but other natural communities – valuable forest stands and woodland key biotopes adjoin with the given extension area.

An attractive and very valuable oak stand growing in the area between the coal terminal and railway must be preserved as an entirety. Similarly, other valuable forest stands are to be preserved entirely or as large groups of trees. The above oak stands border with valuable forest stands where black alder prevails. On the banks of Võerdla main ditch and between the ditch and the oak grove there are also a number of stands where black alder dominates. These areas form a compact entirety (see scheme in Annex 7). Partly the stands have remained under the construction activity in the territory of the coal terminal and railway leading to the coal terminal and therefore removed.

In the area there are registered 4 **woodland key biotopes**. By Võerdla main ditch, near the railway woodland key biotope no 2 occur and on the other side of the railway woodland key biotope no 3 (database codes 154 002 and 154 003, respectively). The woodland key biotopes no 154 001 and 154 004 occur on the area between the railway and Nuudi road (Annex 7). The key biotope no 2 belongs to I value class. According to the inventory fieldwork sheet this forest stand comprises old oak trees, alder of different age, aspen and birch and it has bird cherry shrub layer. There are very many windfallen trees already decomposed which should not be removed. The forest management and drainage should be avoided. However, according to the detailed planning of the eastern Muuga Harbour, the above woodland key biotope is located on the industrial and transport territory and has been partially perished because of the railway line to the coal terminal. In key biotype no. 3 there are over 100 years old oaks and many old hazels, which refers to wooded meadow origin. The key biotype no. 1 remaining further to the other side of the railway is alder wood of different age with a strong share of oak, where also the number of very old oaks is large; the habitat is untouched by human activity. Also, key biotype no. 4 located near Nuudi Road is primarily made up of oaks.

In the key biotypes there are many dead trees and decayed down timber, which should not be eliminated, also management and draining should be avoided in habitats. In the course of port development construction activity (including the planned Industrial Park) the aforementioned forest stands and key biotypes should be preserved to the extent as large as possible. At the same time original forest areas and forest stands with key biotypes make the technogenetic environment of the port area more vivid.

Protection of a woodland key biotope must be followed according to *Forest Act* (RT I 1998, 113/114, 1872; 1999, 54, 583; 1999, 82, 750; 1999, 95, 843; 2000, 51, 319; 2000, 102, 670; 2001, 50, 282; 2002, 61, 375; 63, 387; 2003, 88, 594; 2004, 9, 53; 38, 258) § 31. By the Act a key biotope is an area which needs protection in a commercial forest and where the probability of the occurrence of endangered, vulnerable or rare species is great; such areas include the vicinity of small water bodies and springs, small marshes, burnt woodlands and bog islands, species-rich forest glades, overgrown former gardens, forest skirts, terraces and parts of virgin forests. In the course of forest management, the key elements which are the prerequisites for the formation of a key biotope such as old trees, shrubs, stone fences and springs shall be maintained.

The obligations for the owner of a forest in protecting a key biotope and the obligations of the state in fostering the protection of the key biotope, are specified by a contract entered into between the Minister of the Environment and the owner of the forest, also obligations upon compensation for damage or payment of additional costs caused by the maintenance of biological diversity and by the restrictions on forest use arising from the contract. There are no given contracts for the aforementioned key biotypes.

Cutting forest stands in the course of harbour development needs to be coordinated with the county environmental department.

Upon logging operations in the surroundings of key biotopes the key biotope should not be cut open from every side, but it would be more correct to form a felling rotation around the key biotope so that it would always be in contact with the forests of different age groups. Also in case of clear cutting the impact of wind shall be taken into account. In case of cutting from near a key biotope natural gaps should be taken into account and a buffer zone should be preserved around the area, if necessary, by leaving the trees more resistant to wind, also the bushes and undergrowth growing there (Palo, A. 2005).

2.8.2. Thematic Planning of Harju County

According to the thematic planning *Environmental conditions guiding the settling and land use* of Harju county planning, on the area bordering with Muuga Harbour in the east on Tahkuneeme cape there is a small green corridor (K9) of county importance, which in Ülgase transfers into a small core area (T9) of regional/county importance(Annex 8). In the above green corridor or in its immediate vicinities woodland key biotopes occur. According to the above thematic planning valuable meadows occur in the area of eastern Muuga Harbour. However, they have been mostly perished for now due to construction works.

A most important aim of any thematic planning is to provide spatial structure which is well-based from the standpoint of nature and environmental protection. Two subthemes of the planning are *Green network* and *Valuable landscapes*. The thematic planning establishes the general utilisation conditions for the green network's basic areas and corridors, which must assure the proper functioning of the network.

In case of plans in the green network area, the fact that green network has to stay should be definitely considered. On support areas and in corridors outside of the borders of the green belt usual economic activity taking into consideration the green network may be developed. In general forest category is commercial forest, except for valuable forests inside the green belt, which proceeding from their tasks and usage load should belong to the category of protection forests. In the area the changing of the intended purpose of state forests shall be avoided. Development activity changing the intended purpose of land or planned constructions (roads, trasses etc.) needs to be coordinated with the county government and environmental department and at the assessment of their environmental impact attention shall be paid to the functioning of the green network.

The closest valuable landscape is the traditional landscape in Kallavere – a traditional village landscape side by side with the panel dwelling houses of the residential quarter of Maardu town. The harbour construction activity remains far away from this site and does not affect the described landscape.

2.8.3. Protected Natural Objects

In the harbour expansion area and in its immediate surroundings there aren't any objects taken under nature protection.

There are no Natura 2000 network areas or potential future Natura 2000 sites in the project area or in the immediate vicinity. The nearest Natura 2000 site – Ülgase Proposed Site of Community Importance – is situated about 4 km east of Muuga Harbour and it is sufficiently far that the eastern extension of Muuga Harbour or operation of Muuga Harbour could have any significant effect on the Natura 2000 site. It is also protected area in the meaning of Estonian *Nature Conservation Act* – Ülgase limestone bank with gateways, 1 km long. In the north-east of it, on the coast of Saviranna, Ülgase-Saviranna special conservation area is located.

Dumping of the dredged soil, which is extracted during the harbour extension, will take place about 1 km east from the eastern coast of Aksi island. Aksi island and part of Prangli island belong to Prangli proposed Site of Community Importance declared to the Natura 2000 Network. The site includes the area of 250 metres around Aksi island – mainly the coastal sea up to 5 metres in depth (for further see p 4.8.1).

2.9. Bird Fauna

A survey of bird fauna was carried out in the area under discussion – the area between Muuga railway station, Kroodi Creek and the coal terminal. Fieldwork was carried out 04.07, 19.08 and 28.09.2005, in addition to this, the data obtained in the fieldwork carried out in spring 25.04 – 27.04.2005 were used. Birds were observed in morning hours between 4.30 and 10.00 o'clock, altogether during 10h 25 min. Binoculars with 8-20x magnification were used upon the observations.

The bird species registered in the area and in the vicinity of the area in the course of the observations were entered into a table, where the status of each bird species (nester, transmigrant, eating visitor, occasional visitor, protection status; see Annex 9) was also specified.

76 bird species were registered in the area between Kroodi Creek, Muuga railway station and the coal terminal and in its vicinity in the period from April to September 2005. 19 protected bird species were registered, from among these 10 species belong to Annex I to the Directive (79/409/EEC) of the European Union (the so-called Birds Directive), which are whooper swan, barnacle goose, marsh harrier, osprey, spotted crake, bar-tailed godwit, dunlin, Caspian tern, artic tern and red-backed shrike.

25 bird species nested in 46 pairs in the area, from among whom the most numerous nesters were little ringed plovers, arctic terns, bank swallows and reed buntings. Most of the birds nested in two groves, in reed-bet and near the ponds. The nesting places of mute swans and shelducks were not found out, since they were probably located on the left bank of Kroodi Creek. From among the species in Annex I to the Birds Directive red-backed shrike and arctic tern nested in the area.

There were 33 transmigrant bird species, the most numerous of them were long-tailed ducks. Meadow and tree pipits, dunlins, curlew sand-pipers and knots, ouzels, siskins and skylarks stay in the region in small groups, numerous long-tailed ducks and a smaller number of common eiders stay at sea. Small flocks of whooper swans and barnacle geese were registered while they were flying over. The most noteworthy transmigrant was osprey belonging to the I protection category, however, he/she may be considered an occasional visitor in this area.

No observations have been carried out in the winter period, but there is a reason to believe that hundreds, even thousands long-tailed ducks, goldeneyes, mergansers and other anatidae may gather in Muuga Bay. This is grounded by intense shipping traffic of Muuga Harbour, which makes the formation of a permanent ice cover difficult, which is why ice-free sections can be found in the bay throughout the whole winter.

The description of the wild birds of the area is presented by regions below.

<u>The area in the north-eastern, eastern and south-eastern part filled with sand and crushed stones</u>

Most of the area observed is covered with sand and crushed stones, which end as a couple of meters high steep at the side of Muuga Bay. The biggest open field in the middle of the area is used by herring gulls and to a smaller extent also by common gulls, black-headed gulls and greater black-backed gulls for staying overnight, from where they fly to Jõelähtme landfill, to the sea and to the surroundings for eating when the day breaks. The total number of the gulls staying on the open field and on the coast may reach up to 3000 individuals starting from August after the nesting period. However, up to a couple of hundred non-nesting gulls stay in the area during the nesting period.

Up to 5 little ringed plover pairs nest in the central and north-eastern part of the filled area. In summer 2005 up to 3 bank swallow pairs nested in the steeps on the coast of the bay and up to 4 arctic tern pairs nested there near-by.

There are also temporary ponds on the coast produced by waves, which attract anatidae and charadriiformes. Charadriiformes eat on the ponds during migration in spring and late summer. The most numerous charadriiformes in 2005 were dunlins, curlew sand-pipers and knots (altogether 65 individuals), curlews (7 individuals), bar-tailed godwits (3 individuals) and ringed plovers (5 individuals). Shelducks (15 individuals), gadwalls and mallards acted in deeper ponds. Little ringed plovers ate in the area during the nesting period.

<u>The grove and ponds in the southern and south-western part of the area between Kroodi Creek and the railway</u>

The grove with bushes, thicket of reeds and ponds is located in the southern part of the area between Kroodi Creek and the railway and it is the richest place in birds in the area. In summer 2005 3 pairs of reed buntings, 2 pairs of crows, chaffinches and sedge warblers and 1 pair of magpies, pond warblers, yellow wagtails and blackbirds nested in the area. Skylarks, meadow pipits, tree pipits, and white wagtails use the surroundings of the ponds as places for eating in spring and in autumn; also spotted crakes are present there in spring.

Several seed-eating passeriformes (siskins, finches, goldfinches) and fieldfares stay in the grove. Shelducks and mallards may have nested in the given area too, but it could not be proved for sure.

<u>Muuga Bay and coast</u>

Muuga Bay and coast is a very good resting, eating and stopping place for several anseriformes and gulls. In 2005 the most numerous were long-tailed ducks (1500 individuals), gulls (up to 2000 individuals) and common eiders (27 individuals). Osprey belonging to the I protection category, who was probably migrating, struck the eye as an unusual occasional visitor. Also mute swans and shelducks keep close to the coast.

The grove in the north-eastern part of the area

2 pairs of fieldfares, chaffinches and icterine warblers, 1 pair of golden orioles, Blyth's reed warblers, red-backed shrikes, etc. nested in the grove near the coal terminal. Flocks of several passeriformes, such as siskins, fieldfares, green-finches, stay here during migration.

Muuga railway station adjacent to the area

From among brooding birds there are 3 pairs of wheatears, 2 pairs of white wagtails and house sparrows, one pair of tree sparrows in the area of the railway station. Wheatears and white wagtails nest in different voids under the railways and in the structures connected with the railway. Sparrows use the voids of the buildings of the railway station for nesting. Since the existing railways and buildings will presumably not be altered significantly, there should be no negative impact to those birds. The construction of new railways and buildings may even improve their nesting possibilities and increase their number.

Next to the railway station there is a thicket of reeds and bushes, where the most interesting species is water rail, who may also nest there. In the nesting period this area is a habitat for passeriformes (reed warblers, hedge sparrows), whose numbers may increase considerably at that time.

2.10. Present Air Status of the Harbour Area

Air pollution emissions from the terminals in the western part of Muuga Harbour are mainly organic hydrocarbons (benzene, toluene, xylene) from the oil terminals and dust from the fertilizer terminal. As liquid fuels are not handled in the eastern part, the development of the eastern part of the harbour will not deteriorate the air quality with the emissions of aromatic hydrocarbons.

At the present time the air pollution source in the eastern part of the harbour is the coal terminal, which impact is expressed primarily by the amounts of coal dust emitted into ambient air. The main emissions are generated upon unloading of coal wagons, crushing of coal, loading coal into heaps, lying in heaps and removing from heaps and loading onto ships (Annex 6 photo 9). It is concluded in the *EIA Report on the Design of the Superstructure Objects of the Coal Terminal in Muuga Harbour* compiled by E-Konsult that the treatment of coal in the coal terminal of Muuga Harbour as a single object does not cause any problems in the field of ambient air protection even when all the five possible sources of pollution are operating. The maximum theoretically possible emissions calculated in the study do not exceed the permissible limits of the level of pollution.

Yet, in reality several corresponding problems have occurred in the coal terminal. Jõelähtme Rural Municipality Government issued a temporary use permit for the coal terminal (operator AS Coal Terminal Operator) for the adjustment and launching of the terminal. As the result of testing, it appeared that the moistening system established in the project did not prove efficient and with strong wind dust spread to the nearest villages. Therefore Port of Tallinn has for several times turned to the coal terminal for the getting of the corresponding explanation and requested the applying of measures for the ending of illegal activity. Based on the complaints of the residents of the surrounding villages, the non-fulfillment of the requirements of the environmental impact assessment report, non-use of the best available equipment, lack of activity licenses also Environmental Inspectorate and Jõelähtme Rural Municipality have set corresponding requirements and precepts to the coal terminal.

By today the procedural process of the operating license and necessary environmental permits has been suspended until measures necessary for ensuring compliance with the air pollution norms are implemented. The coal terminal will implement the following measures: a new moistening system will be constructed, nozzles will be installed to the jibs of coal loaders, which in a duplicating manner enables to restrict the spreading of coal dust, a mobile damping device with the capacity of up to 20 m^3 will be taken into use. Also, environmental protection and maintenance ensuring activity plans have been developed.

In November 2005, Environmental Research Centre performed ambient air measuring on the terminal territory, the result of which did not fix substantial dust concentration, as weather conditions were favorable. By the summer of 2006, plans foresee the installation of the air monitoring station on the terminal border, which will provide continuous information on the concentration of coal dust on the border of terminal territory. A corresponding activity plan will be developed for acting upon the exceeding of the limit concentration.

The main **noise source** in the area of Muuga Harbour is the rail transport and the road transport servicing the harbour. The Muuga railway station servicing Muuga Harbour has a rail connection with Maardu station. The railway runs between the region of Muuga garden houses and the former storage site of sand. The noise from the railway causes disturbances to the owners of Muuga garden houses, also to the land units of Uusküla village adjacent to Muuga railway station.

The performed noise measurements and the problems of noise have been discussed in more detail in chapter 4.11 of the report.

3. DESCRIPTION OF THE PLANNED ACTIVITY AND ITS ALTERNATIVES

3.1. Dredging, Filling and Dumping Works and Use of Dredged Soil

The objective of the extension of Muuga Harbour is increasing of the cargo volume throughput. The extension of the eastern part infrastructure covers the area ca 130 ha. New terminals (metal, general cargo and dry bulk terminals and extension of container terminal) and other infrastructure are planned to establish on the land reclaimed from seafloor (about 90 ha) and partially on existing beach area (about 30 ha).

To guarantee a safe depth for the ships at the entrance and near the quays, the seafloor will be dredged to a depth of water 12–17 m. Different alternatives foresee dredging volume 5.3–7.8 million m³ and filling volume 5.2-6.6 million m³ of material. The alternatives of planned activity are based on different location of the quay line.

Table 3.1. Volumes of dredging and filling works

	Dredged soil, million m³	Material needed for land filling, million m³	Territory to be filled, ha
Alternative 1	6.1	6.6	124.5
Alternative 2 – planned activity	7.8	5.6	113.5
Alternative 3	7.1	5.2	110.3
Alternative 4*	5.3	6.1	112.7

* Alternative nr 4 is the option from the early stages of *Preliminary Design.* The alternative was eliminated from Preliminary Design and Feasibility Study due to many of technical disadvantages:
* the possible terminal areas shall not meet the area requirements;
* needs for separate access channels for each basin shall cause big expenses on dredging;
* construction of the quays will require volumeous additional structures ;
* no future extension possibilities towards the sea (too small terminal backyard areas for additional quays).

From the basin the area of shallow sea and the coastal region from the container terminal on the southern shore of Muuga Bay up to the coal terminal at the end of Cape Tahkumäe is subject to filling. The harbour area to be constructed will be raised up to the height of 2.70 m above sea level by filling works. Upon the construction of the substructures of the terminals it is planned to use a suction dredger for placing the filler material into water in the area to be filled. The reclamation fill should be non-cohesive and organic subsoil, which is compactable in the construction process. The material necessary for filling works will be excavated from Naissaare, Littegrundi, Ihasalu and Hiiu Shallow sand extraction sites.

The topmost layer (mud) spreads in the seaward part (in the western part of the project area) of the dredged basin and is relatively thin. The silt and fine sand occurring below the mud can be used as fill. On the basis of preliminary estimation, it is technologically possible to separate and be yielded for the reclamation works about 200 000 m³ of subsoil, in case of Alternative 2 300 000 m³; with a layer thickness of over 2 m.

The analysis of pollution indicators of bottom sediments in eastern harbour basin indicated that the content of heavy metals and oil products does not exceed the reference value of industrial zone and suitable soil may be used for the filling of the terminals, since it is production land, which belongs to the industrial zone.

Dredging will be performed with a suction dredger. For separating the mentioned subsoil layer it is not possible to use suction dredger, which was also shown when the basin of the coal terminal was dredged. The removal of the sediments was also planned by layers there, because part of the soil was usable for filling works. As selective dredging was not possible due to the lack of equipment and quick implementing of the works, then suitable filling material was carried to the soil dumping place. The experience should be considered for the future dredging works in order to separate suitable soil from the whole dredged material. At dredging either single or several bucket excavator shall be used in accordance with the material to be dredged.

The dredged material not suitable for filling will be dumped in the spoil ground north-east of Aksi island. The borders are set and marked on the marine charts by Estonian Maritime Administration (Annex 14).

The dredging volumes are large, therefore it is important to monitor the dumping place both during the dumping (especially for spreading of suspended matter) and during three years after the completion of dumping. The monitoring will enable to determine how the dumping has affected marine biota in the dumping place and in its immediate surroundings, considering also the HELCOM requirements.

3.2. Quay Line Solutions

The future quay line will be situated at a distance of 250–600 m from the today's waterline.

The new quays to be built (with total length ca 2000 m) allow mooring of ships with the following dimensions:

- Container ship – 50 000 DWT, 266 m x 32.3 m – 13.3 m;
- Bulk carrier – 100 000 DWT, 248 m x 37.9 m – 14.8 m;
- General cargo ship – 20 000 DWT, 170 m x 24.9 m – 10.4 m;

As for the solution of the construction of the quay front the designer has offered different conceptual solutions, which have been altered several times in the course of the preliminary design. The final three alternative solutions were offered in July, from among which Port of Tallinn has preferred (the selection was made in September) the solution with two harbour basins, which is a planned activity in case of this environmental impact assessment. In addition to the planned activity the solutions with the frontal location of the quay line and three harbour basins have been discussed in the report as alternatives.

The general layout **alternative 1** (Annex 11.1) is based on a linear quay line with a length of 1600 m from the south-western to the north-eastern part of the extension harbour area and will provide 6 berths for cargo handling on this line (berth Q21 to berth Q26). In front of this quay line an approach channel and place for moored vessels with a width of 250 m and to an elevation of -14.50 m will be dredged in the harbour basin. A turning circle with a diameter of 550 m (-16.00 m) will be placed on the eastern side of the area in front of the coal terminal. It guarantees the safe access of the vessels to the new berths. At the east side, rectangular to the quay line, an auxiliary quay (berth Q27) with a length of 130 m to be used for tug boats and fire fighting boats will be implemented.

In case of **alternative 2 (planned activity)** (Annex 11.2) two basins will be created, each having a width of 200 m and a length of 300 m, which will be dredged to an elevation of -14.5 m. A linear quay line with a length of 310 m (berth Q26) and an auxiliary quay (berth Q 27) with a length of 130 m (depth of at least -7.0 m) will be built close to the coal terminal. At the south-western end of the extension area another linear quay line (berth Q21) with a length of

300 m will be implemented. Both basins provide two berths on the both sides of the banks – the basin on the side of the container terminal has berths Q22 and Q23; the basin on the side of the coal terminal has berths Q24 and Q25. The landside basin end is aligned parallel to the Muuga railway station. The waterside face of the reclaimed area between the two basins is sloped and will get a permeable revetment protection down to about -4.0 m. Berths could be provided at this location, if future port development should require so.

For the access of the vessels to the berths new approach channels have to be dredged – one channel on the south-western side allowing the vessels to berth at the quays Q21 to Q23 (-14.50 m) and a widening of the coal terminal access channel at the other extension area end to provide a turning circle for the vessels and an approach to the berths Q24 to Q27 (-16.00 m).

The alternative is based on the assumption that:

- the unfavourable wave conditions cause decisive problems to implement a linear quay line;
- the future execution of a breakwater that will protect the whole Muuga Harbour may not be built so soon;
- the coal terminal (probably with an extended breakwater in its area) will protect the eastern extension area against unfavourable wave conditions.

The layout of **alternative 3** (Annex 11.3) is similar to the general layout of Alternative 1, which utilizes a linear quay line from the south-western to the north-eastern part of the harbour extension area, but the quay line is shifted 100 m towards landside. The alternative has the advantage of reducing the amount of necessary land reclamation. However, some more dredging work is involved. As the economized costs for land reclamation exceed the additional dredging costs, the overall costs will be reduced. On the other hand the shifted quay line reduces available terminal area for cargo handling operation.

In the layout of **alternative 4** (Annex 11.4) three separate basins with their own access channel and related terminal areas will be created. Each basin has a width of 200 m and a length of 300 m. Basins will be dredged down to an elevation of -17.00 m.

Generally, the advantage of straight quay line is more flexible utilisation of quays, related terminals and cargo processing, also larger area for terminals and storing. The volumes of construction work and costs are smaller and navigation is simpler. The disadvantage is the pressure of waves and ice on the quays under unfavourable weather conditions, which requires stronger structural design solution of quays. Besides, high waves may endanger ships. Thus, under unfavourable weather conditions the operation time of quays may decrease, because the harbour is unprotected by a breakwater.

The solutions, which foresee harbour basins, require bigger volumes of construction work and are more expensive, but for NW–SE oriented quays somewhat lighter structural design solutions can be used. However, the solution with basins has less flexibility for using the berths and terminal areas.

As a 0-alternative a version (chapter 6, comparison of alternatives), where the development of the eastern part of the harbour does not take place and harbour activity continues in the same limits is treated. Yet, this contradicts the harbour development plan. In the longer perspective harbour development plan foresees the construction of new harbour facilities on the coastal territory of the entire eastern part of harbour territory. With the developing of the eastern part of the harbour the former mostly natural area will become artificial, but this enables to fix up the area.

Taking into consideration the development plan of Muuga Harbour and the purpose of the given area the development of this area as harbour territory is most realistic and suitable, due to which the realization of the 0-alternative is not very likely and at the analyzing of the impact of different fields this has not been thoroughly treated in the report. Also, the development of some other activity in the given territory is unrealistic.

3.3. Terminals

In case of all alternatives dry bulk (fertilizers) terminal, metal terminal, general cargo terminal are planned to be built and extend existing container terminal within the extension area. In the course of the preliminary design experts advised the designer to place the terminals with similar product types close to one another. Proceeding from this the dry bulk (fertilizers) terminal is planned next to the coal terminal and the metal terminal to the south-western part of the extended area. The area of the terminals between them will remain for the handling of other metal goods and general cargo.

It is planned to develop the eastern part of the harbour in stages. In the first stage (by the year 2010) the metal terminal and the dry bulk terminal will probably be built. The area between them will remain for the development in the following stages. However, the whole area to be dredged shall be dredged already in the first stage (in case of alternatives 1 and 3). In case of the solution of the planned activity the metal terminal and the dry bulk terminal will also be built in the first stage of the development, both independently. However, in this case at first half of both harbour basins will be dredged for the access channels, according to the formed territories of the terminals (Annex 11.2).

Table 3.2. Parameters of the terminals (areas) and quays to be constructed in the eastern part of Muuga Harbour

	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**
Terminals (ha)				
Dry bulk	12.4	14.4	11.4	15
Metals	27.9	20.7	23.9	26.5
Metal commodities	25	26 (+ general cargo)	18.9	
Containers	18.0	18.0	17.7	22.6
General cargo	11.9		8.4	13.4 (+ metal commodities)
Port services	3.1	2.6	2	
Number of berths	8*	8*	8*	8*
Length of quay line, m	2050	2085	2050	2300

* 8th quay is an auxiliary quay with the length of 130 m

Container terminal

The Consultant has found that it is more appropriate for the further container handling to extend the existing container terminal on the east side of the Muuga Harbour extension area instead of building an additional new terminal.

Due to the increasing container volumes in the future to be handled by the port, additional terminal area and an additional container berth is needed. The extension will take place by means of filling works behind the existing container berth. On the north-western side of the new terminal area the required additional container berth (berth Q17) will be placed with a length of 300 m. In front of the new berth dredging works will be carried out to ensure the required water depth (-14.50 m) for the container vessels. The reclaimed area related to berth Q17 has a size of about 18.0 ha. The development of the container terminal is recommended to implement in the same way for the all proposed alternatives of the eastern Muuga Harbour extension.

3.4. Cargo volumes

The cargo volumes to be handled on the eastern territory of Muuga Harbour in 2010-2025 are presented in the table below, which is based on the *Economic Analysis. Traffic Forecast Muuga Harbour 2005-2025, medium scenario,* composed by the Consultant.

Table 3.3 Predictable cargo volumes in the terminals of the eastern Muuga Harbour 2010-2025, million tons

	2004*	**2010**	**2015**	**2020**	**2025**
Container terminal	1.00	0.89	1.53	2.31	3.22
thousand TEU	112	77	141	219	310
Metal terminal	0.94	1.29	2.04	2.49	3.02
General cargo terminal	0.49	0.21	0.39	0.50	0.63
Dry bulk terminal (fertilizers)	2.23	1.50	3.00	3.00	3.00
Total	4.66	3.89	6.96	8.30	9.87
Coal terminal	*1.10*	*3.50*	*4.70*	*5.60*	*6.70*
Total	*5.76*	*7.39*	*11.66*	*13.90*	*16.57*

* existing cargo volumes in the terminals named in the table for the whole Muuga Harbour in 2004

In 2004 the total cargo volume of Muuga Harbour was 30.526 million tons (from which liquid bulk 24.376 million tons). Predictable cargo volume in 2025 is over 73.2 million tons per year, from which the throughput of liquid bulk is 50 million tons.

In the cargo volumes railway transport prevails (90-95 %), the remaining part will be delivered by motor transport.

3.5. Structural Design of Quays

The Consultant has proposed two structural design solutions for the quays. Preferred option is a fully backfilled anchored steel sheet pile wall and a deep founded superstructure platform. The concrete construction is 15 m wide and is established on three foundation piles 10:1, the quay construction is penetrated by grouted pile declined at an angle of 45 degrees. Steel face-wall of the quay reaches the depth of 29.90 m (Annex 12.1).

Another investigated option is open quay, where the face-wall consists of steel piles; the concrete construction is 35.40 m wide and is established on concrete piles 10:1, which reach down to -30 m. Open slope in front of the quay has an inclination 1:3 and stone protection (Annex 12.2).

As of bearing capacity for landward of the quays the load of soils is 60 kN/m² near the quays and 100 kN/m² further backward.

Both options have been in use in Muuga Harbour, but the first option has been proved to be more effective due to its lower construction costs.

From the environmental standpoint, the quays with solid face-wall are preferred, because the dredging volumes are smaller and consequently less suspended matter is emitted. In case of accident the movement of sediments and water might complicate the pollution control between the piles of open quay. The disadvantage of sheet-pile wall quay type is reflection of waves from the vertical wall located in the end of the harbour basin that may somewhat hinder berthing in case of bad weather conditions. However, this disadvantage is not decisive due to the lower construction costs and in the case of open quay type the berthing and mooring conditions cannot be improved fundamentally for instance to a reasonable advantage, that a breakwater is not needed anymore due to this construction type. Hence, the construction of a sheet pile wall quay is actually practicable also in relation to environmental impacts.

3.6. Other Infrastructure

In the process of Muuga Harbour expansion existing Muuga railway station is planned to be extended, incl. utility tracks of the station will be extended up to 1500 m (not included in this project, but related to noise the extension of Muuga railway station is covered in the report). By now the area has filled with soil.

On the project area, between the Muuga railway station and the new terminals there will be the rail manoeuvring yard of terminals (site from which new connection routes will be headed to the territories of new terminals), roads and technological pipelines. Access for motor transport to the terminals of the eastern territory is arranged via Hoidla road. New road begins at the end of the existing Hoidla road and goes in parallel with the railway.

Kroodi Creek will be redirected and directed into the sea through the terminals to be constructed. In case of *alternative 2* Kroodi Creek will be directed into the sea along the existing direction (to the basin of the metal terminal). The creek is open, but runs in a pipe under the railway and the roads until flowing into the sea. The flows of other three culverts (incl. Võerdla main ditch) will be joined into an open ditch, which outflow is into the basin of the dry bulk terminal and general cargo terminal. In case of *alternatives 1 and 3* Kroodi Creek will be directed through a closed pipe through the area of the existing container terminal to the sea by the shortest way. The creek is open until it passes from under the railway and the roads. The outflow of other existing culverts has been directed to the basin between the dry bulk terminal and the coal terminal through an open ditch. In case of *alternative 4* Kroodi Creek will be directed into the sea through the first, the metal terminal, basin. The flows of three other culverts will be joined and directed into the sea through the third basin (the basin of the dry bulk terminals and metal terminal).

Drinking water and waste water

The present water consumption in Muuga Harbour is 800-1000 m^3 per day, the extension of the harbour will increase it by approximately 200 m^3 per day (120 m^3 of it is for vessel bunkering). Pursuant to the development plan of the town of Maardu the permissible volume of groundwater resources used for the harbour is 1500 m^3 per day.

Presently, the coal terminal is supplied by the water network existing in Muuga Harbour, but in relation to the development of the eastern part a new bore well /pumping station will be completed in the eastern part of the harbour in 2006, which will be connected to the common harbour water network.

The predicted volume of domestic wastewater from the terminals of the eastern part is 80 m^3 per day. The waste water will be directed through the pumping station to the wastewater plant of Port of Tallinn, from where the effluent will be discharged into the sea through a deep-sea outlet. The rainwater collected from the area of the terminals will be discharged into the sea through the purification facilities.

4. ANALYSIS OF THE EXPECTED ENVIRONMENTAL IMPACT ACCOMPANYING THE PLANNED ACTIVITY AND THE ALTERNATIVES

4.1. Affected Environmental Components

The construction activity of extension of the eastern territory of Muuga Harbour affects likely the following components of the environment:

- Coastal processes – the filling carried out for the extension of the eastern harbour territory significantly alters the coastline on the shore section between the existing container terminal and the coal terminal; the sediments engaged in coastal processes may to some extent be carried to another location during the construction period.
- Transport of sediments and suspended matter – the dredging and filling works carried out in connection with the construction activity forces lot of suspended matter into the water column. As a result of this, the composition of sediments changes and the content of organic matter in the near-bottom water layer increases. The extent of the impact depends on the concentration of the suspended matter in the water column and its transportation outside the area of construction works.
- Marine biota – high concentration of suspended matter in seawater has a negative impact on the phytobenthos communities, and consequently also the communities of zoobenthos and fish.
- Landscapes – perishing of coastal meadows, woodlands and other natural communities, which occur directly in the area of planned harbour constructions.
- Bird fauna – the construction activities affect feeding, resting and nesting conditions of the birds in the area.
- Further use of dredged soils and dumping – the further use of dredged soils depends on their properties and pollution level. Dumping may affect the fishes of the coastal sea of Aksi and Prangli islands related to the distribution of suspended matter.
- State of ambient air – can be affected first of all by the dust emitted from building materials in the process of construction activity, and by transportation and machinery noise.

Operation of the expanded Muuga Harbour affects likely the following components of the environment:

- Transport of sediments and suspended matter, marine biota – intensification of shipping increases the impact of hydrodynamic fields generated by ships’ propellers both in the harbour basin and on the roads, which changes the composition of deposits. Besides, the content of organic matter in the near-bottom water layer increases, which influences also zoo- and phytobenthos and fish.
- Hydrodynamic conditions – dredging and the new quays affect the regime of currents and wave activity, which may lead to activation of sediment transport.
- Impact on water – harbour extension could have an impact on sea water at the getting of chemicals into the sea, whether through rain water or directly at the deposition of chemical (fertilizer dust) into the sea; harbour extension will not have substantial impact on surface and ground water.

- State of ambient air – mainly affected by the possible dust emission related to operation of the future dry bulk (fertilizers) terminal, and noise from intensification of harbour transportation. Dust emissions and noise can be considered as significant factors affecting human health and welfare.

The fields of impact mentioned have been discussed in the following chapters. Since in case of the different options of the extension of the harbour the expression of their impact is different primarily from the point of view of hydrodynamic processes, i.e. waves, currents and the transport of sediment material, the impact of different alternatives has been analysed in case of those spheres of impact. As for other spheres of impact (biota, ambient air, noise, landscape, water) there is no significant difference in the impacts accompanying different alternatives.

4.2. Impact on Geological and Coastal Processes

When the new quayline is created and the beach filled, active development of the shore ceases and artificial shore is formed, with the quay as its seaward boundary. The sediment transport will occur in front of the quayline, but since the water in these areas is more than 15 m deep, this does not affect the surrounding shores.

Water movement and consequently sediment movement is influenced mainly by the situation where the relief of harbour basin is more variable or in case of the option where different areas are being dredged to a different elevation.

In case of alternative 4 the relief of the basin is the most variable. In case of alternatives 1 and 3 the sea bottom is dredged more evenly and the undredged sea area will influence the water movement less than as for the undredged area of alternatives 2 and 4.

During dredging the following sediment complexes will be removed from the seafloor:

- silt and sand containing organic matter (mud);
- yellowish brown silt or fine sand;
- silt and sand containing organic matter (the deposits formed during the earliest stages of the Baltic Sea development);
- varved clay.

The topmost layer (mud) spreads in the seaward part of the basin and is relatively thin. The silt and fine sand occurring below the mud can be used as fill, but for this purpose the dredging works must be carefully planned. It is not possible to use soil pump dredge, which was also shown when the basin of the coal terminal was dredged. The removal of the sediments was also planned by layers there, because part of the soil was usable for filling works. As selective dredging was not possible due to the lack of equipment and quick implementing of the works, then suitable filling material was carried to the soil dumping place. The experience should be considered for the future dredging works in order to separate suitable soil from the whole dredged material.

Dredging works will be performed mainly with a suction dredger, but for separating the different soil layers either single or several bucket excavator shall be used.

Suitable material should be used in possibly large extent for landfilling works in order to minimize the volumes of dumping material, enable waste recycling and sustainable use of natural resources.

In case of **alternative 1** the most of the area to be dredged presents a quadrangle in front of the basin's quay line. The seafloor will be dredged to an elevation of -17 m.

In case of alternative 1 the sediments will not be carried to the dredged basin substantially. In E-NE, which is the main direction of sediment transport, there is the coal terminal, which restrains sediment transport from this direction.

Storm wave coming from NW reaches the quay line unbroken. Erosion of sediments on seafloor is moderate due to relatively great depth. Eroded sediments can accumulate into the corner between planned quay line and the coal terminal due to the influence of near bottom water movement caused by waves. It is erosion material of varved clay. Therefore the sediments can relocate slightly within the basin according to hydrodynamic conditions.

Alternative 2 (planned activity) comprises two basins, each 200 m wide, which will be dredged to an elevation of -14.5 m. For the access of vessels to the berths new approach channels have to be dredged. Sea area between the approach channels will remain undredged, where the seafloor remains to an elevation of -6 to -11 m. The rest of the basin will be dredged to an elevation of -14.5 to -17 m. In case of this option the seafloor sediments from the undredged area will be carried to the dredged areas. This could take place both by the effect of gravity and water movement due to waves and currents.

Breaking of waves is also complicated in case of the dredged seafloor. This is affected by the shallower sea area on the side of the coal terminal, undredged area outside the planned quay line and the new quay line on the side of the harbour. Water movement on seafloor (accompanying with the waves arriving to the harbour area from NW) erodes the seafloor and relocate sediments. It is more active due to the abovementioned undredged area. The need for repeated dredging is somewhat larger, compared to the alternatives 1 and 3. Still, the need for maintenance dredging remains relatively low. For the results of sediment transport calculations see section 4.3.3.3.

Alternative 3 is similar to alternative 1, but the quay line is shifted 100 m towards the land. Therefore the volume of filling works is reduced and the volume of dredging works increased. As the dredged area is also similar to alternative 1, the sediment processes in this case are similar as well.

Alternative 1 and 3 have the advantage that the seaward border of the dredged area is about parallel with isobaths, which disperse the water movement caused by wave energy evenly on seafloor.

In case of **alternative 4**, the seafloor between the access channels of the basins will not be dredged. Considering the geological setting of the area, the channels will be filled with sediments in short period of time. Therefore repeated dredging will be needed more often. In this area thick beds of fine sand and silt occur, which will be forced into movement even when the speed of near-bottom water mass is small (<0.20 m/s). In such cases it does not matter that the heaps between the two channels are gently sloping, because due to gravity the fine-grained deposits fall into the channel. Thus, the disadvantage of this solution is that undredged areas will remain in unfavourable places. Besides, the waves generated by W-NW winds may carry the sedimentary material, which has accumulated in the entrance channels, into the harbour basins. In case of this alternative the need for repeated dredging is the biggest.

4.3. Impact on Waves and Currents – Hydrodynamic Modelling

Modelling of hydrodynamic processes accompanying the eastern extension of Muuga Harbour was carried out within this EIA – distribution calculations of waves, currents, sediment transport and suspended solids during construction. The purpose was to evaluate the changes in wave and current fields due to the harbour extension, compared to existing situation. The aim of modelling of sediment transport was to investigate the impact on erosion and deposition processes in the harbour and to assess the extent of spreading of sediment cloud during the construction works when sand is placed into the water.

The modelling procedures were carried out with four different MIKE 21 mathematical models: wave agitation studies with MIKE 21 NSW (*Nearshore Spectral Wind – Wave Model*), calculation of the current fields in the harbour area with MIKE 21 HD (*Hydrodynamic model*). For calculation of sediment transport two models were used: MIKE 21 ST (*Sediment transport*) for the prediction of sedimentation and erosion processes and MIKE 21 PA (*Particle analysis*) to determine the spreading of the suspended sediment during the construction phases.
MIKE 21 NSW is a wind-wave model, which describes the growth, decay and transformation of wind-generated waves and swell in near shore areas.

4.3.1. Initial Data

Bathymetry data was taken from the map by General Army Headquarters of USSR map no 02534. This map serves as basis for the development of digital bathymetry for MIKE 21 applications. In the course of years, several changes have been made to the map related to the harbour development (coal terminal, container terminal, berths 9A and 10A, etc.).

Offshore wind and wave data was taken from the projects by "Lenmorniiproject". The data given in the project describes a combined data of wind and wave measurements from 1945 to 1984. A shorter review of these projects is also given in work by Corson Consulting no 004, *Existing Information on the Hydrographical Conditions for the Ports of Tallinn* (July 2000). Experience has shown that this data describes the best the hydrographic conditions in Muuga Bay. Figure 4.1 depicts the offshore data points – outside the Muuga Harbour in the dephts of 50 m.

Table 4.1 summarizes the wind and wave data at the offshore points depicted on the figure 4.1. The data corresponds to the storm event with probability of 5% with the return period of 25 years.

The occurrence probability gives the percentage of the event of all possible events during one year. It can be read from the table, that north wind events make 51,919 % of all wind events during one year, the rest 48,081% are either winds from south or calm. Figure 4.2 depicts the situation in graphical form.

Table 4.1. Wave conditions at offshore points

	W	NW	N	NE	E
U_w [m/s]	27	26	26	27	27
H_{mo} [m]	1.92	3.04	3.20	2.72	2.08
T [s]	4.6	6.0	6.0	5.6	5.1
L [m]	33	55	54	49	40
MWD (deg)	290	324	0	39	85
Occurrence probability %	15.727	9.002	6.778	9.638	10.774

The notation in the table is as follows: U_w – wind speed at 10 m above sealevel, H_{mo} – mean wave height, T – wave period, L – wave length, MWD – mean wave direction.

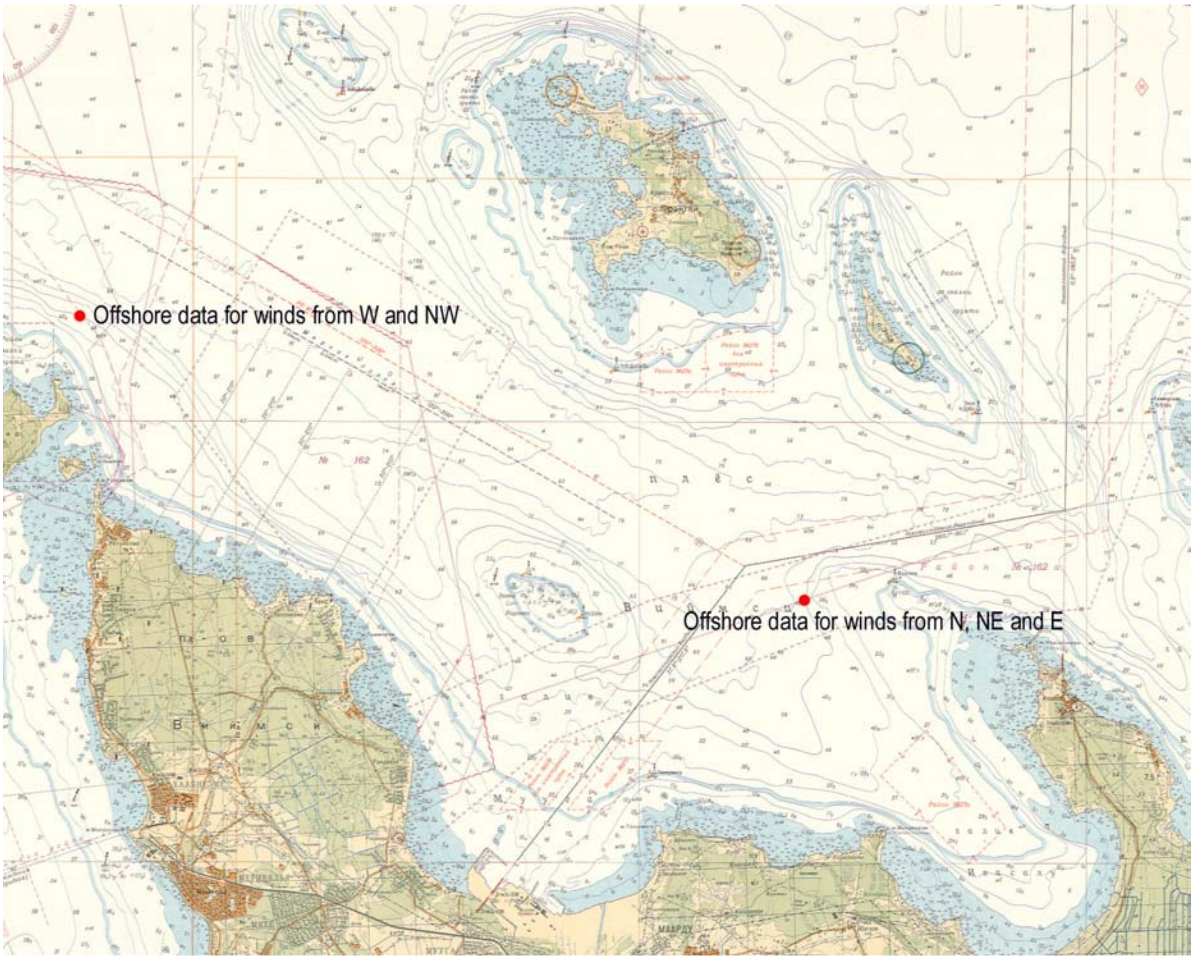


Figure 4.1. Locations of offshore data points

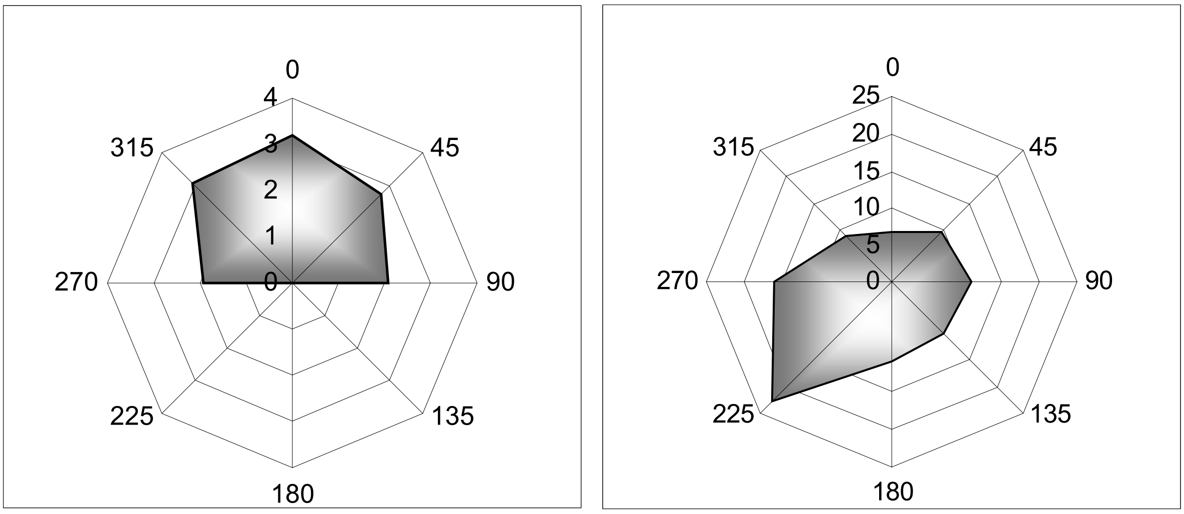


Figure 4.2. Significant wave heights due to northern winds at –50 m and occurrence probabilities of wind events

4.3.2. Procedures of Investigations

In order to investigate the effect of new quays to the wave fields in the Muuga Harbour, 7 locations inside the basin were chosen, where wave data of existing situation and harbour development was compared. Previous investigations (additional investigations of wave parameters and resonance carried out for Inros Lackner AG, which results are included into the Feasibility Study of Eastern Extension of Muuga Harbour), where wave propagation was investigated, have shown that in case of northern and western winds the waves approach the harbour basin mainly under angles of 305 – 330 degrees. It was also found that for winds from north and north-east the area under development is sheltered by the coal terminal and therefore the wave values remain very low. As a result it is possible to generalise the processes in the harbour by merely investigating the winds blowing from NE.

Wave field calculations were basis for the calculation of current pattern. For this case the comparison was also made between the existing and planned situation.

The calculated current pattern was the basis for the sediment transport budget calculations and also spill analysis.

Besides currents an important factor when dealing with sediments is the physical parameters of the sediment. The following sediment properties were used for MIKE ST calculations: mean coarseness of a particle d_{50}=0.09 mm and gradation of sediment particles d_{84}/ d_{16} = 1.4. The calculations made with MIKE 21 PA assumed that the filled material would have the same physical properties as used in land reclamation for the coal terminal case. Therefore the chosen physical properties are: d_{50}=0.1 mm and gradation d_{84}/ d_{16} = 1.1.

However, in the following study describing the spread of suspended matter the diameter of the sand particle under investigation was chosen d=0.063 mm as the smallest particle size in the filled material and is most likely to stay in suspension the longest.

Table 4.2. Settling velocity dependence on the significant wave height H_{mo} = 0,5 m

Significant wave height H_{mo} =0,5 m.			
No.	Water depth H(m)	Orbital velocity on bottom w_0 (m/s)	Settling velocity u_z (m/s)
1	12	0.0073	0.00201
2	10	0.01249	0.00168
3	8	0.02236	0.00129
4	6	0.04201	0.000829

Table 4.3. Settling velocity dependence on the significant wave height H_{mo} = 1,2 m

Significant wave height H_{mo} =0,5 m.			
No.	Water depth H(m)	Orbital velocity on bottom w_0 (m/s)	Settling velocity u_z (m/s)
1	12	0.0909	0.00136
2	10	0.1215	0.000823
3	8	0.1646	0.000614
4	6	0.2282	0.000599

4.3.3. Results

4.3.3.1. Wave Agitation Calculations

Figures 4.3 and 4.4 depict wave heights in Muuga Bay for the existing situation and planned activity. The values describe significant wave heights in Muuga Harbour and nearby. The significant wave height is the average wave height of the one third of the highest waves. In reality it means that the maximum height of a single wave might be twice the significant. Different colours on the figures correspond to different wave heights. The step of the contour lines on the figures is the same allowing the visual comparison of the figures. The vectors on the figures describe wave directions. The length of a vector corresponds to significant wave height.

The model that was set up covered an area of 11.4 x 7.2 kilometres. In order to resolve adequately waves that approach the harbour area, the grid resolution was chosen 3 x 3 meters. This resolution has proven also adequate to resolve the energy loss due to wave penetration through the piled structure at quays 9 and 10. The structure itself is not visible on the model output as the grid spacing is to large to resolve it. The energy loss due to the piles is incorporated into the model mathematically in the boundary conditions.

According to the analysis of the data listed in the previous section the wind from NW with the return period of 25 years and 5% probability, would blow with average speed of 26 m/s. The corresponding significant wave height in the Gulf of Finland at the entrance of Muuga Bay is 3.04 m. Mean wave period is 8.2 seconds. The mean wave direction has already turned from 315° to 324°. This data was used as boundary input data for all four calculations.

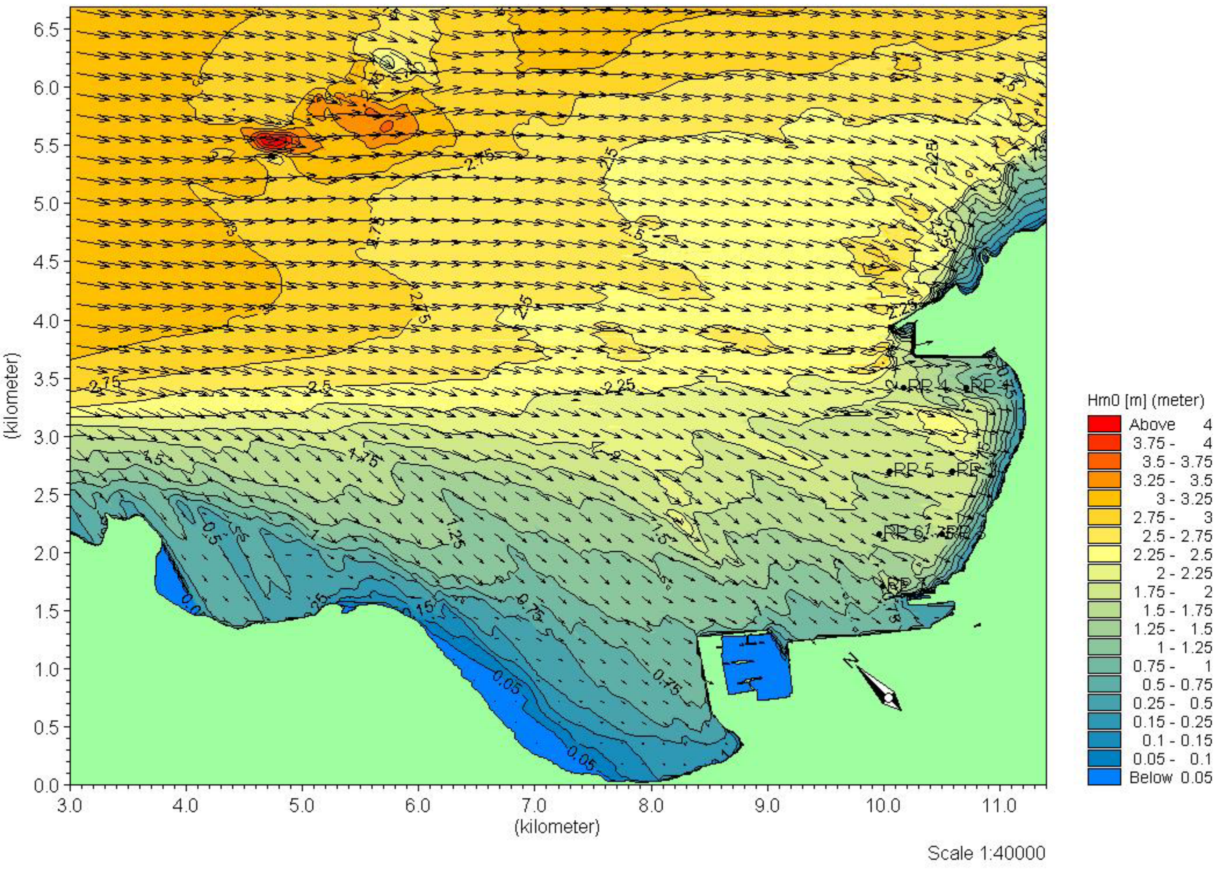


Figure 4.3. Significant wave heights in Muuga Bay (H_{mo} = 3.04 m; T = 7.8 s). Existing situation.

When comparing the existing and proposed situation, it can be seen from the figures that the new quay line and access channels influence the wave values considerably. In order to compare the wave pattern in case of existing situation and planned alternative, 7 reference points were chosen in the harbour. The reference points are depicted on figures and denoted with RP 1-7. Reference points 1-3 were selected along the future quay line, 4-6 are situated further off from the proposed quay line and reference point no 7 is located next to the extension of the container terminal. Table 4.4 compares the wave data at the reference points.

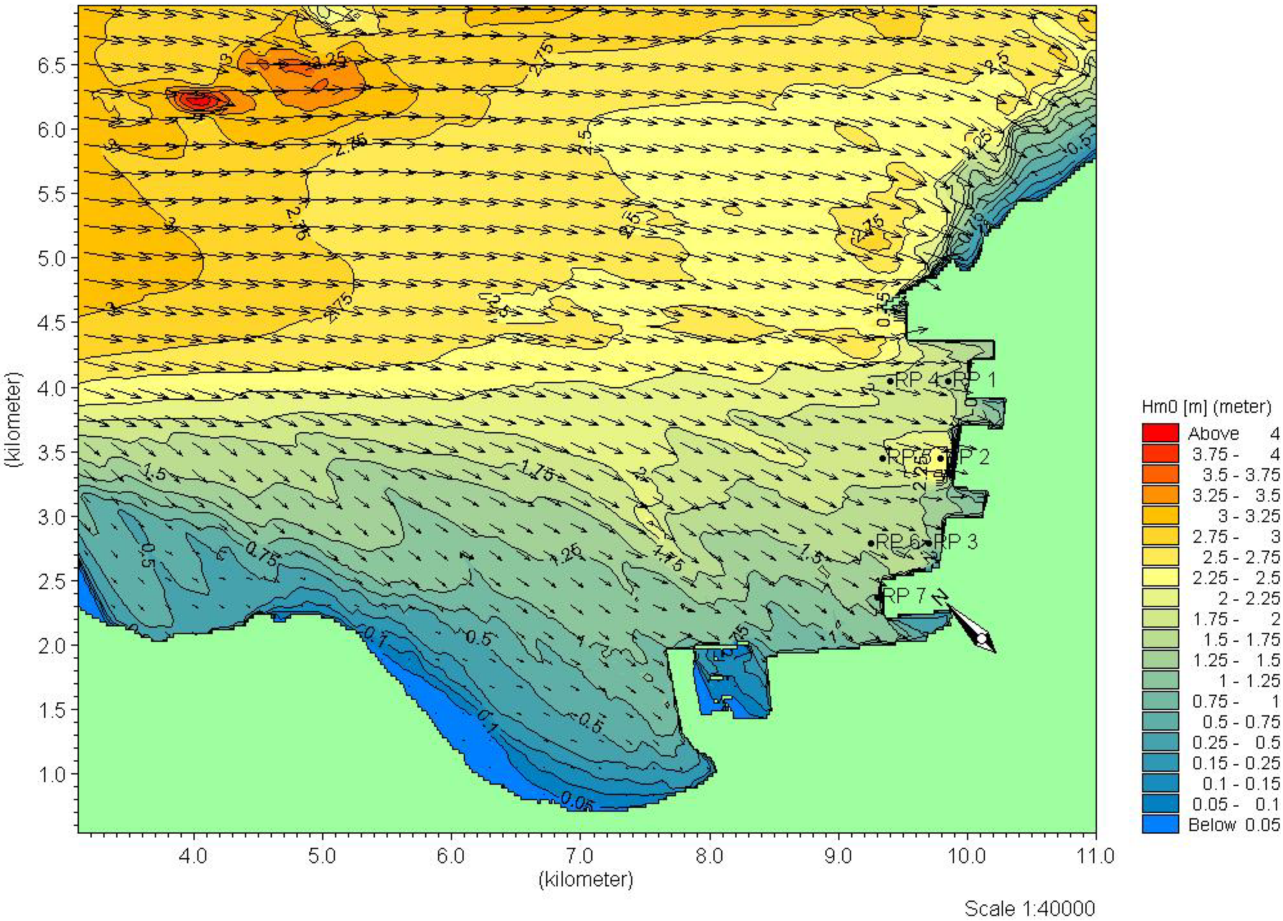


Figure 4.4. Significant wave heights in Muuga Bay (H_{mo} = 3.04 m; T = 7.8 s). Alternative 2 (planned quay line).

Table 4.4. Significant wave heights and mean wave direction at reference points

Reference point	EXISTING SITUATION		ALTERNATIVE 2	
	H_{mo}	MWD	H_{mo}	MWD
1	1,82	326	1,69	318
2	1,96	328	1,59	334
3	1,84	336	1,58	338
4	2,26	336	2,13	326
5	1,89	329	1,92	329
6	1,69	332	1,57	339
7	1,33	341	1,22	341

Existing situation

The existing situation describes the waves that would occur in case of the storm with the return period of 25 years without any quay line. Reference points 1 to 3 are located at the depth of ca 6 meters and the corresponding wave height at all three reference points is approximately 1.8 meters. As the water depth reduces smoothly from deep water towards the shore the wave direction follows the pattern of turning parallel to the contour lines and turns from 326 degrees at reference point 1 to 336 degrees at reference point 3.

Reference points 4 to 6 that are located parallel to the quay line but further offshore show the same trend. The wave fronts approach the area almost in the strait line under angles 330 degrees. Water depth at these points is 9-10 meters. The wave heights in the reference point 4 are somewhat higher than at reference point 1. At reference points 2 and 3 the wave heights are higher than at the corresponding offshore reference points. This is due to the shoaling effect. The shoaling occurs when waves travelling from deep water into shallow begin to grow due to the continuity criteria (energy excess). Shoaling will in the end lead to wave breaking. Shoaling effect is not noticeable at reference point 1, probably due to the impact of the channel of the coal terminal.

Alternative 2 – planned quay line

The wave heights at reference points 1 and 3 are considerably smaller than for the existing situation. Reference points 1 and 3 are located in the access channels and the shoaling will not take place. Waves run freely along the channels, whereat wave energy decreases gradually in the course of the wave. Reference point 2 describes the wave value in the point, which remains partially to the impact of the revetment between the berths 23 and 24. At the same it can be seen that wave values in undredged area between berths 23 and 24 are noticeable higher than for existing situation. It is due to the wave accumulation. Since waves are willing to turn parallel to bottom contours, wave energy is entered also from the sides and therefore the only method of energy losing here is wave braking. But since part of the energy is carried from access channels to the abovementioned area, the waves reaching the berths are shallower than they would be without the shallow area between the berths 23 and 24. In case of very bad weather conditions this uneven wave pattern may cause sediment suspension in shallower areas, with the material moving into access channels. This issue will be addressed in more detail in the section 4.3.3.3 Sediment transport.

Alternatives

Wave calculations were also carried out to the alternatives of planned activity. Table 4.5 shows the comparison of existing situation and alternatives at 7 reference points.

Table 4.5. Significant wave heights and mean wave direction at reference points

Reference point	EXISTING		ALTERNATIVE 1		ALTERNATIVE 3		ALTERNATIVE 4	
	H_{mo}	MWD	H_{mo}	MWD	H_{mo}	MWD	H_{mo}	MWD
1	1,82	326	1,69	326	1,69	326	1,52	324
2	1,96	328	1,82	332	1,82	332	1,47	328
3	1,84	336	1,57	338	1,56	338	1,31	339
4	2,26	336	1,85	328	1,86	328	1,37	319
5	1,89	329	1,88	331	1,86	331	1,60	329
6	1,69	332	1,63	335	1,60	335	1,46	338
7	1,33	341	1,31	341	1,30	341	1,27	338

The major differences in comparison of alternatives 1 and 3 with alternative 4 and planned activity will rise in connection with the configuration of dredged area and changed water depth in the basins.

The comparison of the existing situation and *alternative 1* shows that there are distinctive differences between the two. Despite of the fact that the wave heights at the offshore reference points are of the same order of magnitude, the near quay line wave heights are less that for the reference case. This is due to the dredged area in front of the quays. The new configuration of the seabed does not allow the waves to shoal and break. Instead the waves follow the basic rules of travelling over water with medium depths and loose all their energy when they hit the quay line.

As for the decrease of wave heights, there can not be great differences in comparison between alternative 1 and *alternative 3*, where the quay line has been moved shoreward 100 m. Since in case of alternative 3 the waves are to travel a slightly longer distance the wave height decreases slightly in comparison to the alternative 1.

The comparison of wave approach directions shows that dredging does not have effect on the approaching wave directions.

In case of a*lternative 4* the waves decrease considerably with comparison to the reference case. At reference point 1 the decrease is 30 cm, but in reference point 3 it is 53 cm. The alternative 4 due to its narrower approach channels damps wave energy the most and thus gives the best protection. The mean wave directions do not change in comparison to the reference case with an exception to reference point 4, which is located at the inclined side of the approach channel.

The anomaly that can be pointed out in case of the alternative 4 is the increase of wave heights between the approach channels. The shallower areas initiate the shoaling process that will in case of the higher waves lead to wave breaking. The very shallow bank between the approach channels to the coal terminal and future berths no 25 and 26 might have significant wave heights up to 2.91m. This is a possible source of problems from one side to navigation and from the other side to the erosion of the banks (from shallower undredged areas the material will be carried to dredged areas).

4.3.3.2. Current Pattern

Existing situation

Current calculations have been performed using MIKE21 HD module at the same initial conditions as previous wave agitation calculations, i.e. NW 25 year storm. Figure 4.5 depicts current pattern in Muuga Bay in case of existing situation. The flow velocity in the most part of the bay is low (V_c=0.02-0.08 m/s). The current follows the main circulation in the Gulf of Finland and is directed to the east along the coast of Estonia. Secondary circulations arising near oil and coal terminals create zones with higher values of currents (until V_c=0.5 m/s). The main circulation in Muuga Bay does not reach the area of the proposed quay line. The coal and container terminals protect the area from the flow. In the area of the future quay line the flow velocity does not exceed 0.16 m/s. Only at zones characterized with very shallow waters some flow velocity may reach 0.3-0.4 m/s.

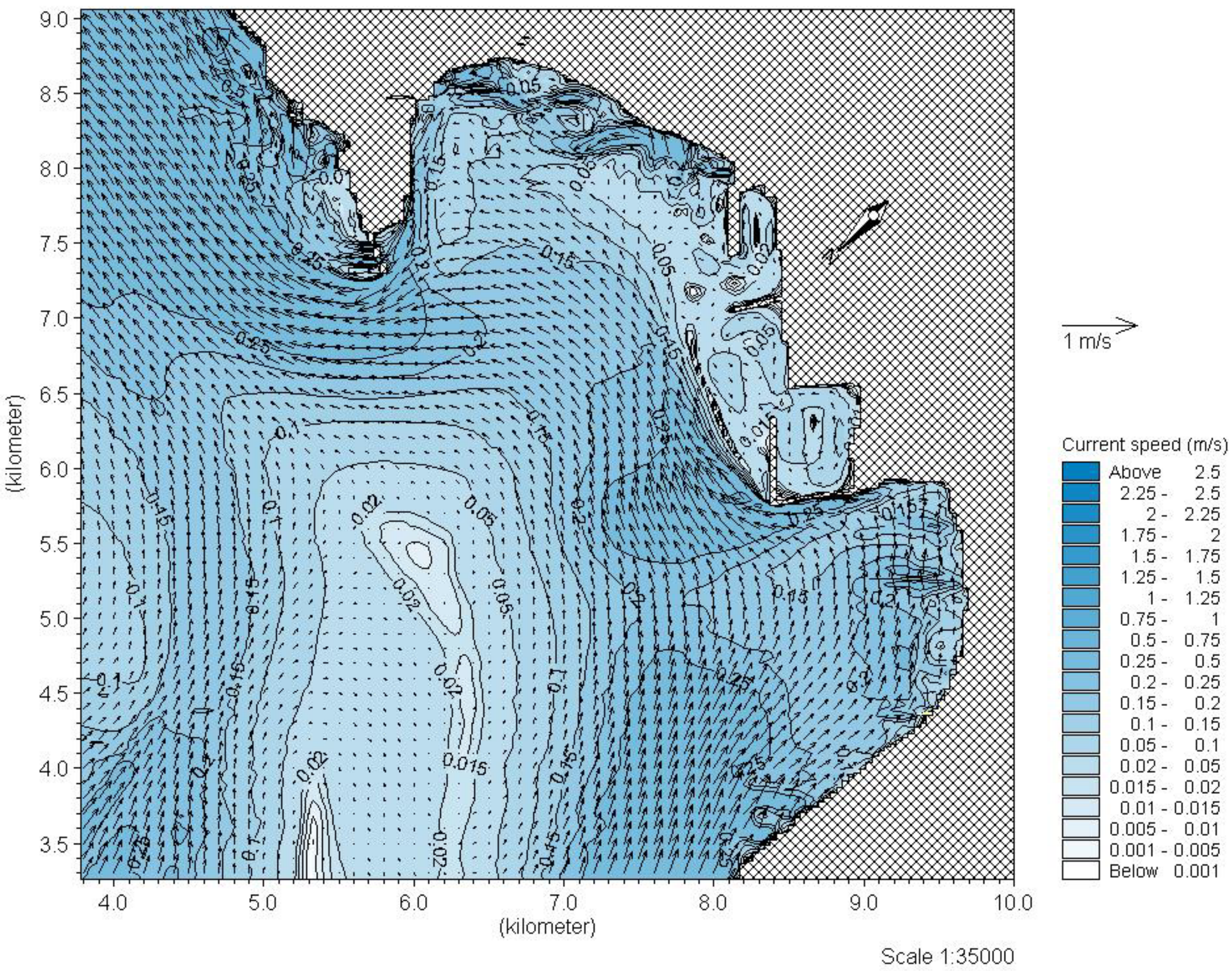


Figure 4.5. Current in Muuga Bay – existing situation

Alternative 2 – planned quay line

Figure 4.6 brings the current pattern in Muuga Bay after the completion of the eastern extension of the harbour at the same initial conditions as for the calculations with existing layout, i.e. 25 year storm. Calculations affirm that the new quay line do not change the current pattern significantly. The main flow direction is unchanged and the flow velocity stays in the limits of 0.02-0.08 m/s. The only change in the flow processes can be noticed in the vicinity of the proposed berths and fairways. As mentioned in previous section, due to the dredging there will be no shoaling and energy concentration in the area. As the flow depths are greater in comparison of existing situation, the flow speed is reduced slightly. The different tendency can be noticed between berths 23 and 24, where there will be no dredging and the increase in flow speeds can be observed. It can be explained by the growth of wave energy in the area observed and by the main principle of hydrodynamics (continuity equation), which states that in case of depth decrease velocity needs to grow in order to maintain the flow.

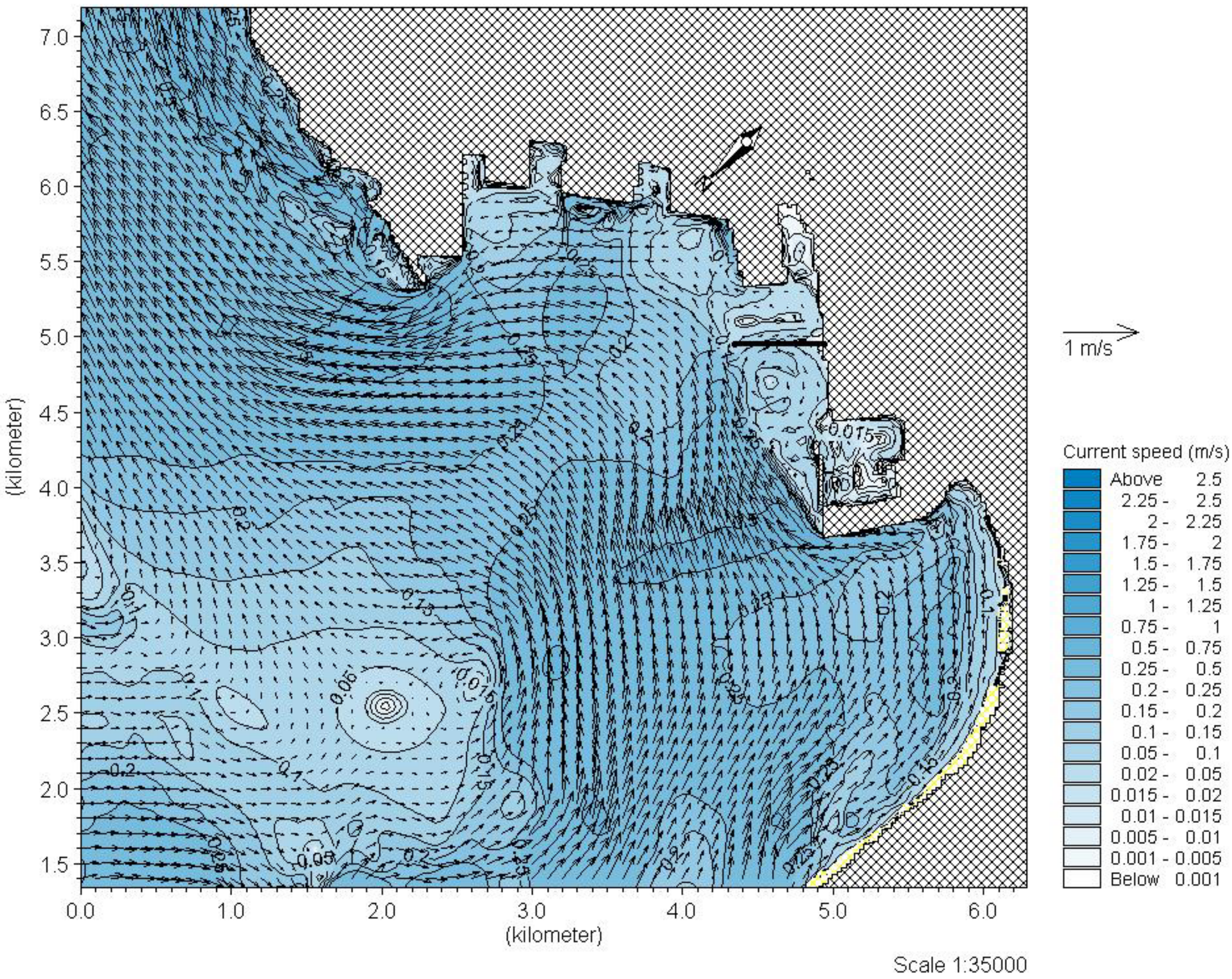


Figure 4.6. Current in Muuga Bay – alternative 2 (planned quay line)

For *alternatives* 1 and 3 the water depth along the quay line does not change and the current should be constant along the whole quay line. For the alternative 4 the bathymetry along the quay line has variable heights and therefore the banks between the channels may experience decreasing and increasing flow velocities.

4.3.3.3. Sediment Transport

Balance between erosion and deposition in front of the planned quay line

The balance of erosion and deposition in front of the planned quay line was modelled with MIKE 21 ST module (*Sand transport)*. The module uses previously calculated values of waves and currents as initial data. During the modelling the investigation of sedimentation balance of abovementioned undredged area between the berths no 23 and 24 was stressed.

The quantity of the material that will be eroded from the undredged area or that will settle in the dredged areas after the development of the eastern part of Muuga Harbour is depicted in the figure 4.7. The figure describes the areas with erosion (yellow areas) and deposition (red areas). The legend of the bottom change *dz/dt* is given on the left side of the figure.

The sediment transport calculations were performed with the following sand parameters: mean coarseness of particle $d_{50} = 0.09$ mm, gradation of soil particles $d_{84}/ d_{16} = 1.4$.

It can be seen that the main area of deposition is concentrated on the edge of the undredged bank next to the berth no 24. Despite of the fact that the maximum depth difference is almost 10 meters on the corner of the berth 24, the erosion and deposition do not have major impact on the bottom configuration. It can be seen that in the shallower area with water depths up to –6 to –9 m the rate of erosion on the edge on the bank is approximately 4-7 cm annually. In the deeper areas of the bank the value decreases to 2 cm annually. All over the undredged bank between berths 23 and 24, there is a constant erosion process, described with very low values of material carried away annually. The average growth in water depth in the area is approximately 1 cm/year. The eroded material will be carried into the approach channel NE of the bank, where it will settle. The deposition rate in the area should not exceed 1-3 cm/year. The flow passing by in front of the new quay line, finds its way out along the berths 31 and 32, resulting in self-induced dredging of the access channel. It can be seen on the figure 4.7 that the area in front of the coal terminal is characterized with slight erosion (erosion rate less that 1 cm/year).

Erosion and deposition problems do not exist in the access channel leading to the berths 21-23

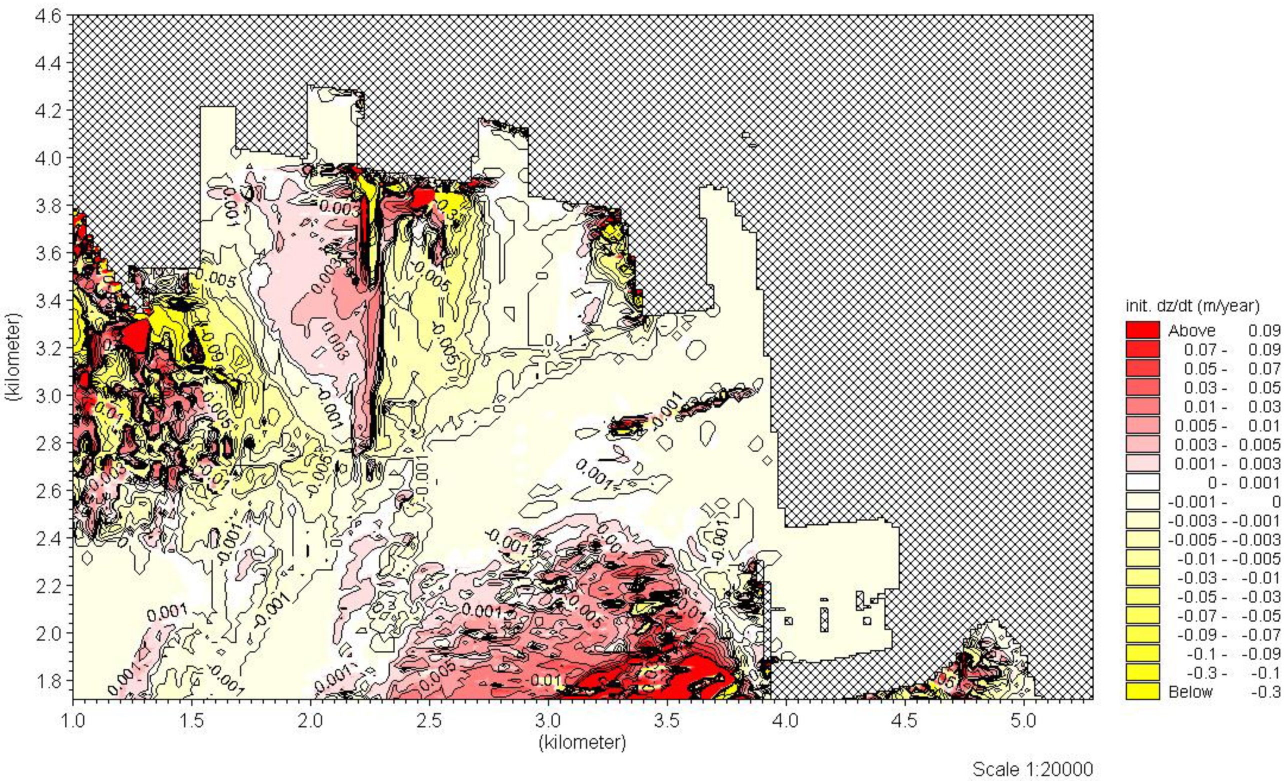


Figure 4.7. Balance between erosion and deposition (planned quay line)

The spreading of sediment spill during construction

The calculations for sediment spill during the construction phases were made with an assumption that the filling material would have the same physical properties as used in land reclamation for the coal terminal. As the next stage, the insertion point of the sediment was determined. On the figure 4.8 it is denoted with black dot. The dot represents a 50 meter long stretch of the berth, were land reclamation is taking place. The other assumption was the volume of filling sediment. It was decided that the volume and speed of dumping is 450 kg/s of particles with diameter of 0.063 mm.

The situation depicted on the figure will form after 6 hours of continuous dumping process. After 6 hours the impact area will not grow and the balance between transport and settling is established. Different colours on the figure represent the concentration of suspension cloud in water in kg/m^3. The area indicated with red colour on the figure shows higher concentration, where the most intensive settling of suspended matter occurs at given initial conditions.

Previous calculations and studies have shown that despite of the wind direction the sediment cloud moves towards the east. It can be seen from the figure, that most of the sediment matter settles within the harbour basin. Around the coal terminal only small amount of the suspended matter gets. The concentration of sediment particles in the flow around the breakwater of the coal terminal will not exceed 1 kg/m^3.

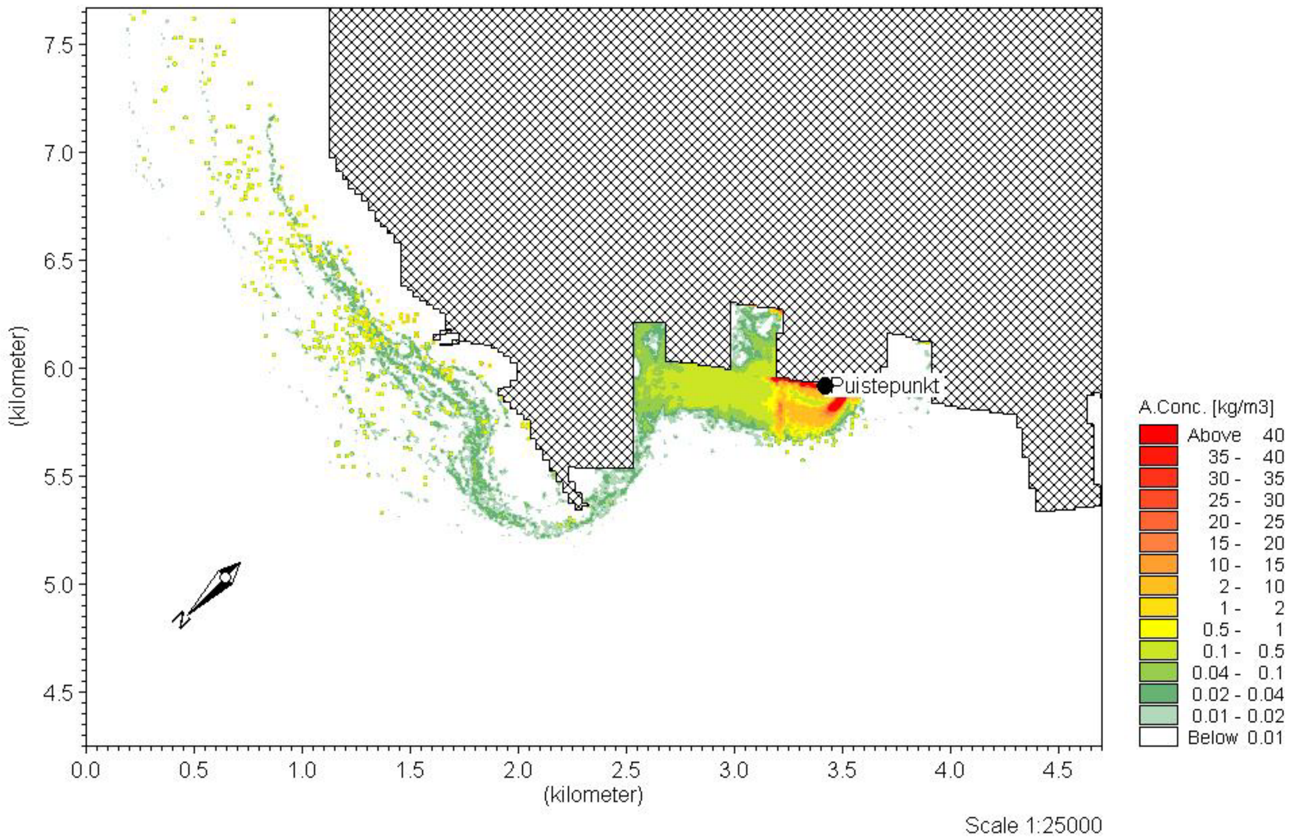


Figure 4.8. Spreading of the sediment cloud during construction

During dredging works of harbour basin suspended matter will form which settles mainly in the area of the works. Fine-grained fraction remains longer in the watercolumn and may spread towards the deeper middle part of Muuga Bay. In near-bottom layers constant sediment movement occurs. The spread of suspended matter towards the east around Tahkumäe Cape is unlikely and depends on the hydrodynamic conditions during the works.

4.3.4. Summary

1. Using the methods of mathematical modelling the wave and current analysis has been carried out for the existing situation and planned activity and its alternatives, and the calculation of sediment transport and spreading of suspended matter during construction.

2. As a result the fields of waves, currents and sediment transport have been found, taking into account the location of Muuga Harbour and hydrographic conditions.
3. During the storm occurring within 25 years the changes of wave heights are bigger in undredged areas of the extended Muuga Harbour than in dredged areas.
4. The current pattern will not change much in case of any alternatives of harbour extension as the area has even at present very low flow rates. More noticeable change occurs in undregded areas, where the increase of wave energy related to wave growth brings along also the growth of currents in the area.
5. Despite of the increase of current velocity the related sediment transport does not bring along particular problems, which could cause the need for large repeated dredging within next years in case of planned activity. Within 5 years the deposition into the access channels should not exceed 15-20 cm.
6. The spreading of the suspended matter during land reclamation works at dominating winds, when the wind strength remains within the limits of safety norms (the wind speed of up to15 m/s), the most of suspended matter will settle within the harbour waters.

4.4. Impact of Harbour Extension on the Benthic Biota

In autumn 2003 the construction of the coal terminal was started in Muuga Bay. Big amounts of suspended solids were emitted into water during the dredging and dumping operations, which continued in 2004 (over 1 million m^3 of soil was dredged and ca 2.4 million m^3 of fill was used). In 2004 the harbour basin was also dredged at the 14th and 15th quay (over 350,000 m^3 of soil). The suspended solids emitted into the water during dredging spread from the basin to the sea area bordering on the harbour and settled intensively on the bottom. The suspended solids settled on the bottom also in the harbour basin. The suspended solids emitted into the water by the dredging operations of the harbour in 2004 had an impact on the benthic fauna communities at the depth of up to 20 m.

With the improvement of nutrition conditions the numbers of benthic fauna and the biomass increased many times in two areas. One with a small area was in the roads near the harbour, the other large one was in the eastern part of Muuga Bay and the northern part of Cape Tahkumäe. The numbers of benthic fauna and the biomass increased on account of two species – *Macoma balthica* and *Mytilus edulis*.

During the dredging at the 14th and 15th quay in September and October 2004 there was no benthic fauna in the harbour basin at all. This was caused by an extremely big content of suspended solids, which settled intensively on the bottom. As compared to the previous years the species composition of the benthic fauna in the marine area near the harbour bordering on the 14th and 15th quay became poorer.

The extensive formation of suspended solids causes the decrease of the transparency of water and the decrease of the percentage of perennial species in phytobenthos. Also the spread of algae in deep waters will decrease. Since organic suspended matter is a food for benthic fauna, the improvement of the nutrition will be accompanied by the changes in the numbers of the benthic fauna and biomass. Usually 1-3 opportunistic species will dominate very powerfully in the composition of benthic fauna. The numbers and biomass of *Macoma balthica* and *Mytilus edulis* will increase especially much. The changes described above will bring about the disappearance of the biological balance in benthic communities, which will be expressed in sudden changes in the species composition, numbers and biomass in the next couple of years.

The monitoring data show that the construction of the harbour has had an inhibitory impact on the development of the flora and the fauna spreading between the plants. The impoverishment of the biota in Tahkumäe and partially also in Ihasalu is confirmed also by the investigations of flora in 2004. The character of the bottom sediments in the eastern part of Muuga Bay changed considerably upon the construction of the coal terminal: the concentration of organic matter in near-bottom water increased and the communities of phytobentos became poorer (the number of alga species, the percentage of perennial species and the spreading of flora in deep waters decreased). The impoverishment of phytobentos brought about big changes also in benthic fauna communities. The impact of suspended solids to the flora has been especially big in Tahkumäe, where the flora has disappeared entirely in some depth zones.

4.4.1. Impact on the Benthic Biota of Muuga Bay

Primary environmental impact is directly expressed in the removal of bottom communities (phytobenthos and zoobenthos) in the dredging area. Recovery of bottom communities can be expected during the period of up to 10 years. The disappearing of bottom communities as a result of dredging will cause the decreasing of biological diversity in the sea area and changes in the structure of communities.

Dredging and filling operations increase the numbers and the biomass of the benthic fauna. In the course of extensive dredging and filling works a large amount of suspended particles is thrown into the water, which will be intensely deposited on the bottom of the harbour eastern part aquatory and in some extent in its proximity.

In case of small-scale dredging and filling operations the numbers and biomass of practically all the species of benthic fauna are significantly bigger in Muuga Bay than in Ihasalu Bay.

The bigger biomass of species in Muuga Bay is due to the higher trophic level of the near-bottom water and sediments caused by dredging. This is a result of the impact of human activity (for example the former dredging operations, propellers of ships, etc.) in Muuga Harbour.

Drastic changes will take place in the benthic communities as a result of the large-scale dredging and filling works planned in Muuga Harbour, the population diversity will become poor in the range of the whole bay. Due to the instability of sediments phytobenthos will disappear from the depth between 0-1 m in the eastern part of Muuga Bay. The reproduction of the communities takes a lot of time (up to ten years), but the formation of new types of communities caused by constant changes of the character of sediments and currents cannot be excluded. Large-scale dredging and filling operations will increase also the biomass of the benthic fauna of neighbouring bays, which, however, will be restored on the initial level in two or three years. Spreading of suspended particles (above all of fine fraction, as the heavier part will deposit mainly in the region of port aquatory) from the area of construction works to the neighboring areas largely depends on wind conditions.

As a result of large-scale dredging and filling operations phytpophilous gammarids (*Gammarus* spp.) will become extinct in the whole bay. The disappearance of gammarids indicates that the dredging operations inhibit the development of the flora and through this also the fauna, which has spread between plants. The plant communities in Tahkumäe area (the eastern part of Muuga Bay) are especially sensitive to the increase of suspended matter.

Immediately after the dredging and filling operations the number of animals and the biomass will increase many times both, in Muuga Bay and the neighbouring bays adjacent to it. The extent of the increase of the numbers and biomass in Tahkumäe region will be probably smaller than in Ihasalu region. As a result of the change of the numbers and biomass in the same direction the regions of Tahkumäe and Ihasalu will be much similar to each other as for the quantitative composition of the communities of benthic fauna than in case of small-scale construction operations.

The general number and biomass of benthic fauna will increase as a result of the massive development of mainly two species *Macoma balthica* and *Mytilus edulis*.

As compared to the sedimentation areas the species composition of benthic fauna will become even poorer in the areas with intensive currents. In case of large-scale dredging and filling operations *Macoma balthica* will probably be the only species inhabiting the area. In some places also Oligochaeta and Polychaeta may appear beside *Macoma balthica.* Despite of the decrease of the population diversity, the numbers and biomass of benthic fauna will increase also in the areas with intensive currents.

As compared to the shallower areas, the large-scale dredging and filling operations have a smaller impact on the communities of benthic fauna at the depth of 30 m: the variations of numbers and biomass are very small in the depth zone of 30 m as compared to the variability in shallower areas.

4.4.2. Impact on the Benthic Biota of the Dumping Site

The fauna in the submarine trenches in the Gulf of Finland is already naturally very dynamic and the species of benthic communities found there are to a great extent of opportunistic character. For the most part oxygen regime in the deep basins is unfavorable for the development of zoobenthos, due to which the abundance and biomass of zoobenthos is very low or there is no zoobenthos. Therefore the dumping operations performed under controlled conditions (supervision) in the trenches of the Gulf of Finland, including in the area of Aksi Island will not have an impact on the benythic fauna.

As the spoiling material is discharged into the sea at the depth of at least 6 meters, in the course of this a relatively small amount of suspended matter rises into surface layers. There is constant movement of currents from the west to the east on Estonian northern coast and also the winds blow in the same direction, due to which the suspended particles generated at the distance of at least one kilometer are not likely to reach the coast of Aksi Island or the lower sea area and will not have an impact on the bottom communities there.

4.4.3 Impact of Harbour Operation on the Benthic Biota

Due to the influence of hydrodynamic fields generated by marine screw propellers in the aquatory and on the roads of Muuga Harbour the composition of deposits will change, also the amount of organic material in near bottom water will increase. More intensive vessel traffic increases the amount of suspended particles, which set into movement by marine screw propellers floats in the water of the port aquatory. During a peaceful period such suspended matter for the most part deposit in order to once again in turbulent gulfs return to the floating state after the passing of a new vessel. Such a process constantly occurs in Muuga Harbour, without being accompanied by unfavorable manifestations outside of the harbour area.

In areas with active vessel traffic (areas in the depth of 10-13 m) bottom communities are generally disturbed and are characterized by small size and a large number. Specific zoobenthos not comparable to the population of natural areas has developed in the aquatory. In the course of intensifying of vessel traffic population of the aquatory in the eastern part of Muuga Harbour will become the same. The flora has become poor or does not exist, also zoobenthos is represented with few species.

In areas, where the movement of near-bottom water is very intensive due to the impact of currents, waves or marine screw propellers, only zoobenthos with local mode of life spreads. On deposits with low organic content zoobenthos is represented only by three species: *Hediste diversicolor*, *Hydrobia ulvae* and *Macoma balthica*. In areas with larger or smaller accumulation of organic plankton the population diversity of zoobenthos is relatively larger. There worms *Oligochaeta* and *Hediste diversicolor*, crustacean *Corophium volutator*, insect larvae *Chironomidae*, snails *Hydrobia ulvae* and *H. ventrosa* and mussels *Cerastoderma glaucum*, *Macoma balthica*, *Mya arenaria* and *Mytilus edulis* spread.

4.5. Impact of the Fish Fauna of Muuga Bay and the Dumping Site

The dredging and filling operations performed in the course of the extension of Muuga Harbour and the accompanying dumping of soil in Aksi dumping site may have an impact mainly on such saltwater-fishes like Baltic herring, sprat, flounder, smelt and stickleback. The impact may concern to a smaller extent the fish species represented by smaller numbers in the Gulf of Finland, such as garfish, turbot, viviparous blenny, lumpfish, long-spined bullhead.

In Aksi marine area there are no fish spawns due to significant depth, however, in Muuga Harbour area to be dredged fish spawns have disappeared in the last years. At the same time, fish spawns still exist in the vicinity of both places. In the potential impact areas the total of two species of Cyclostomata and 34 fish species have been registered in fishery catches, from among which 24 species are of an industrial importance. The rest are so-called non-industrial fish species.

The monitoring of the environmental impact of Muuga Harbour, including the monitoring of fish communities, has been carried out systematically and consistently already since 1994. In the period between 1998-2004 the total of 20 species occurred in monitoring catches. In 1995 in the course of a relatively extensive dredging (over 50,000 m^3) and in the following years no uniquely defined impact of the dredging on fish communities was noticed in the course of monitoring. The changes in the communities of fish fauna of Muuga Bay are probably caused by significant positive changes in the ecosystem of the bay in 1990-ies after the closing of Maardu Chemical Plant (after the end of the pollution from there) on the one side and as a coeffect of the continuously intensifying shipping traffic and other negative impacts related to Muuga Harbour. Intensive coastal fishing has had also an additional impact.

Thus, the impact of the activity of the harbour on fish fauna has not been expressed much in Muuga Bay up to recent years. However, the impoverishment tendency of a suitable spawn substrate (marine flora) has occurred in the marine area bordering on the harbour.

However, clear impact on fish fauna became apparent in 2003, when the construction of the coal terminal was started on Cape Tahkumäe. It is very likely that that already in 2004 fish did not spawn west from Cape Tahkumäe up to the eastern pier of the harbour and it was unlikely also in the estuarine area of Ihasalu Bay.

Hydrotechnical works may have an undesirable effect on environmental conditions and the existing ecological relationships. In this case it is very likely that fish will be damaged due to the deterioration of the quality of water accompanying the re-location of soil, since the dredging and filling operations are very large-scaled. There is also a risk for causing direct mechanical damage to fish roe and larvae in water due to the increase of the concentration of suspended solids. This may happen directly in the work areas and also in the adjacent areas, if the concentration of suspended solids during the spawning time and the time of the occurrence of larvae exceeds the natural background level several times.

No additional damage will probably be caused to the fish fauna in the marine area west from Tahkumäe up to the present eastern pier of Muuga Harbour, since no fish spawns were found there already in 2004. As a result of larger hydrodynamic works the given sea area has obviously lost its natural environmental state and become a sea area, where local fish communities have been preserved to a minimum extent (or are about to disappear) and the fish on the given sea area mainly includes those coming there for food temporarily.

In Ihasalu Bay fish spawns have been partially preserved and are partially capable of reproduction. The additional sedimentation of big amounts of suspended solids makes the reproduction of the spawn areas in the estuarine area of Ihasalu Bay questionable even in a longer perspective than 2-4 years. Thus, upon dredging the time period (see below) important from the point of view of the protection of fish fauna shall be taken into consideration.

In the dumping site east from Aksi Island and in its vicinity there are no fish spawns, however, flounder larvae may be found there between April-June, probably in small numbers, who come from the flounder spawns near Prangli Island. At the same time, fish spawns (Baltic herring, perch) have been preserved in the coastal waters of Prangli Island and probably also in the shallow sea surrounding Aksi. These fishes spawn, depending on the temperature of the seawater, between April-June. If, in this period, the suspended solids generated upon dumping are carried west from the soil sinking area, the re-settling suspended solids may cover the developing roe. Special investigations in the initial stage of the construction of Muuga Harbour in 1980-ies showed that if the roe of Baltic herring is covered by a sedimentary layer of 2 mm and above it, the roe will, as a rule, be destroyed. Alabaster and Loyd (1984) have indicated that if the concentration of suspended solids in water column exceeds the normal background by 5 mg/l, the juvenile fish larvae may have problems with breathing.

Thus, it is rather likely that the reproduction capacity of the fishes (Baltic herring, flounder, perch) reproducing near Aksi and Prangli Islands will be damaged in case the suspended solids generated upon dumping are carried west – into the coastal waters of Aksi and Prangli to the depths below 10 m. There is an especially big likelihood to cause damage in the spring period between the end of April – the beginning of July (in the years with average weather). The most dangerous period for the reproduction of fish is concretely when the temperature of seawater is between +6ºC to +15ºC.

4.5.1. Impact on Fishing

Active fishing by the dwellers on the coast, especially by entangling nets, to a smaller extent also by traps, is characteristic of the marine area under discussion. Also, extensive game fishing takes place here. It appears from the results of the investigations that the catches of perch have increased considerably in the last three years. However, the catches of flounder and other fish species have decreased.

As expected, the works being the object of this environmental impact assessment do not have a significant direct impact on fishing, regardless of the technology of dredging and dumping. At the same time, the decrease of the reproduction areas of fishes will still bring about also a certain decrease of fish catches in Muuga Bay in the next couple of years.

4.6. Impact on Sea Water and Beaches

Port activity may have an impact on sea water upon getting of chemicals into the sea, whether through rainwater or directly at the depositing of the chemical (fertilizer dust) into the sea, for example at the loading of a vessel. Fertilizers handled are water-soluble nitrogen and phosphorous compounds causing eutrophication of water bodies.

Depending on the types of fertilizers handled, there are the following possibilities for the prevention of the getting of the potential pollution from the fertilizer terminal into marine environment and the purification of the **rainwater** of the terminal area:

1. To construct a waste water treatment plant for the purification of the rainwater of the territory of the fertilizer terminal, which in addition to mechanical pollution and oil products, would remove also nitrogen and phosphorus from rainwater.
2. To direct the rainwater of the fertilizer terminal into the common waste water treatment plant of Muuga Harbour and the town of Maardu through the public sewerage system, which effluent is discharged into the sea through deep-sea outlet.
3. Take a closed technology into use in the fertilizer terminal, which means that all the loading systems (loading terminal, conveyers, warehouses) are closed and protected against weather conditions and the getting of the pollution (total nitrogen and phosphorus) into the environment would be effectively excluded. In this case the mechanical sludge-sand-oil trap would be sufficient for the purification of the rainwater collected from the territory of the fertilizer terminal.

The implementation of the closed technology will prevent the potential pollution of the marine environment with nitrogen and phosphorus compounds.

§ 3 of Regulation No. 106 of the Minister of Transport and Communications of 6 December 2000 *Requirements for Storage Facilities for and Places of Loading, Unloading and Transhipment of Chemicals, and for Other Structures Necessary for Handling of Chemicals in Ports, Road Transport Terminals, Railway Stations and Airports and Particular Requirements for Handling Ammonium Nitrate* provides that the rainwater drainage system shall be disconnected in chemical handling premises. Thus, the collected rainwater cannot probably be discharged directly into the public sewerage system, in case the handling of ammonium nitrate will be taking place in the fertilizer terminal. The rainwater polluted with fertilizer needs to be purified in the local purification facility prior to its directing into the sea.

In any case a monitoring system shall be applied, in the course of which the content of total phosphorus and total nitrogen in the effluent discharged into the sea shall be monitored in addition to suspended solids and oil products (in the control wells of rainwater outlets; once in tree months). Prior to directing the polluted rainwater into the receiving water body it shall be purified in the way not to deteriorate the state of the receiving water body. Waste water treatment shall ensure the conformity of the content of pollution indicators in effluent to the following parameters of Government of the Republic Regulation No. 269 of 31 July 2001 *Procedure for Discharging Effluent into Water Bodies and Soil*:

- Suspended solids 40 mg/l
- Oil products 5 mg/l
- Total nitrogen 10 mg/l
- Total phosphorus 1,5 mg /l

On the berths of the fertilizer terminal also getting of rainwater directly into the water needs to be avoided. It shall be collected and directed into the receiving water body through purification equipment. Also, rainwater from the territories of other terminals (metal, container, general cargo) needs to be purified to ensure the limit norms of suspended solids content and oil products, 40 mg/l and 5 mg/l respectively.

In order to avoid generation of polluted rainwater or to decrease the amount of polluting substances in it the roads, places and other pollutant collecting areas from which rainwater is directed need to be regularly dry cleaned.

According to the comprehensive plan of Jõelähtme there are no public **beaches** in the rural municipality, but the whole seaside are, except Muuga Harbour, is used for recreational purposes. The area under discussion is prescribed as the development region of the harbour and it has the function of production land. Therefore it can't be used as recreational and beach area. However, in summer the sandy section of the coast in the eastern part of Muuga Harbour being the object of this EIA is still used as a bathing area by the local people, primarily by the inhabitants of the town of Maardu.

In perspective it is possible to develop the shores of Kaberneeme, Haapse and Neeme into public beaches. The abovementioned coasts do not remain on the impact area of Muuga Harbour. Other seaside places of Ihasalu and Kaberneeme Bays and Saviranna area are also used as recreational areas.

The closest beach to Muuga Harbour is Randvere beach, which is located ca 1 km north-west from the harbour and has a shore strip of ca 200 m. The beach has not been prescribed for public use by Viimsi rural municipality government, but it is used as a bathing area by the inhabitants. According to the results of the assessment of the status of sea water (water investigations have been performed in the bathing season in 1995-2002) the quality of sea water in Randvere bathing area has been in conformity with the health protection norms valid in the Republic and the oil terminals of Muuga Harbour have not had a specific impact on the status of sea water in Randvere bathing area (comprehensive plan of the mainland area of Viimsi rural municipality, 2003). In addition to Randvere, there are common beaches in the area between Rohuneeme and Kelving villages and beaches of local importance in Leppneeme and Tammneeme.

Hence, in the future the possible beaches for the people living in the area could include coastal areas remaining to the east of the harbour and belonging to Jõelähtme rural municipality and the recreational area of Lake Maardu and the beaches in Viimsi rural municipality remaining to the west of the harbour.

In order to prevent the deterioration of the status of seawater the best available technology and the relevant equipment shall be used in the terminals to be constructed, including the discharge of rainwater through purification facilities and the monitoring of its compliance with the norms.

The calculations of the spread of suspended solids during construction showed that most of the sedimentary particles, which have got into water upon the dredging and filling works of the harbour basin will settle in the harbour basin and while moving to the east, a small extent of the suspended solids spread in the surroundings of the coal terminal. Thus the impact at the time of construction will not reach the bathing areas.

4.7. Impact on Surface Water and Groundwater

Surface water from the area of the planned activity is drained through Kroodi Creek and Võerdla main ditch, which in the course of the development of the harbour will be directed together with the discharges of smaller ditches through the terminals into the sea. The potential pollution getting into Kroodi Creek and through this into the sea comes from the effluent discharged into the creek by the companies operating in the industrial region of Maardu. Therefore sufficient purification facilities shall be applied for the effluent directed into Kroodi Creek.

The eastern part of Muuga Harbour is located downstream of the water users of the Quaternary sediment horizon of the Ordovician water horizon, which is why the activity in the harbour area does not have an impact on the usage of groundwater resources. However, the measures necessary for the prevention of the pollution of the uppermost aquifer shall be kept in mind upon the construction of harbour facilities in order to avoid pollution of seawater through the water horizon connected with the sea. Handling premises of chemicals shall be separated from groundwater by a chemical and water resistant blocking layer and it shall be easy to collect chemicals from surfaces onto which they may be spilled. Covering of the fertilizer terminal territory with asphalt cover excludes the getting of the chemical into the soil and ground and surface water.

The groundwater of the Cambrian-Vendian water horizon used as the water resource for Jõelähtme rural municipality is naturally well protected in the area of the southern coast of Muuga Bay by Lower Cambrian blue clays.

Hence, construction work of Muuga Harbour extension and harbour activity do not have substantial impact on the surface and ground water of the area.

It appeared in the course of the public discussion of the EIA programme on the basis of the data heard from the inhabitants of Uusküla that the well water in the dwellings adjacent to Muuga railway station (Kiige and Liiva farms) has been polluted by oil products and the dwellers do not have clean drinking water there. It is likely that the pollution of groundwater originates from Muuga station. It is necessary to make the analysis of well water in order to find out the actual source and the magnitude of pollution. Upon reaching of corresponding agreements a solution lies in the supplying of drinking water to Uusküla households from the water network belonging to Port of Tallinn.

4.8. Impact on landscape

The extension of Muuga Harbour irreversibly affects the landscapes, which are located directly on the future construction sites. The land area on the beach to be filled forms approximately a quarter of the whole filled area; the remaining territory will be generated from seafloor. The biota in filled areas both on land and seafloor will perish. On the beach these areas are the flooded coastal meadows covered with reed. So far they have been untouched by human activity as far as to the border of the expansion of the railway station. In the area bordering with the coal terminal forests and natural meadows covered with brushwood occur.

More forests have preserved on Saviranna peninsula bordering Muuga Bay from the east, this area is not affected by the current extension of Muuga Harbour. The construction activity may in first order affect the woodland communities in the vicinities of the eastern part of the project site and the coal terminal, incl. valuable oak stands and the adjacent forest stands, where woodland key biotopes appear. In the course of harbour development the valuable forest stands and key biotopes in the region must be preserved in possibly large extent.

Broadleaved groves with majority of birch near the eastern bank of Kroodi Creek also remain on the extension area of the harbour and will be perished.

4.8.1. Impact on Protected Natural Objects

In the harbour expansion area and in its immediate surroundings there aren't any objects taken under nature protection. Therefore the extension of the Muuga Harbour does not have significant effects on protected natural objects, excluded protected bird species (see next chapter).

There are no Natura 2000 network areas or potential future Natura 2000 sites in the project area or in the immediate vicinity. The nearest Natura 2000 site – Ülgase Proposed Site of Community Importance, also Ülgase-Saviranna special conservation area is sufficiently far (ca 4 km in the east of Muuga Harbour) that the eastern extension of Muuga Harbour or operation of Muuga Harbour could have any significant effect on the protected areas.

The effect of dumping in the Aksi spoil ground area on Prangli proposed Site of Community Importance

According to the Regulation No 144 of the Government of the Republic of Estonia of 16.06.2005 "*Placing Special Conservation Areas in Harju County under Protection*" the area of 250 metres around Aksi island was formed as a part of Prangli Special Conservation Area. The Special conservation area includes mainly the seaboard up to 5 metres in depth. Prangli Special Conservation Area together with Prangli Landscape Reserve (which includes the whole Aksi island and a part of Prangli island) belongs to the **Prangli proposed Site of Community Importance** declared to the Natura 2000 Network (Figure 4.9).

According to the Provision No 615-k of the Government of the Republic of Estonia of 5.08.2004 „*The List of the Natura 2000 Areas Stated to the European Commission*" of Addition 1 point 308 the protection values of Prangli proposed Site of Community Importance are the following habitat types of Habitat Directive Annex 1: Coastal Lagoons (1150), Reefs (1170), Boreal Baltic islets and small islands (1620), Boreal Baltic coastal meadows (1630), Embryonic shifting dunes (2110), Shifting dunes along the shoreline with *Ammophilia arenaria* ("with dunes") (2120), Fixed coastal dunes with herbaceous vegetation ("grey dunes") (2130), Decalcified fixed dunes with *Empetrum nigrum* (2140), Wooded dunes of the Atlantic, Continental and Boreal region (2180), Dry sand heaths with *Calluna* and *Empetrum nigrum* (2320), Juniperus communis formations on heaths or calcareous grasslands (5130), Alkaline fens (7230).

At the eastern coastline of Aksi island there are not presented the most valuable habitat types as coastal lagoons, reefs, islets and small islands. The coastline of Aksi is little partitioned and the main shore type is gravel-shingle shore with plenty of cobbles, rocks and boulders (Photo, Annex 14).

Figure 4.9. Prangli proposed Site of Community Importance Scale 1 : 100 329

Protection regime: *protected area,* *Special conservation area;*

Natura 2000 site: *border of Prangli proposed Site of Community Importance*

About 1 km from the eastern coast of Aksi island, where the sea depth is 30-99 metres, there is a spoil ground area (Annex 14). The excavated soil related to the dredging works of Muuga Harbour has been dumped there during last 20 years. The sea deepens quickly in the dumping area from the west to the east. This means that the area is standing on a quite steep slope. In a natural state the spoil ground area is characterized by fine-grained marine sediments, which are represented by glaciolacustrine clays and the sediments of the earlier water bodies in evolution of the Baltic Sea. The last mentioned sediments are covered by the dumped soils.

The potential negative impact on Prangli proposed Site of Community Importance can be caused by suspended matter spreading to the protected coastal lagoons and reefs. As the spoiling material (during the extension of the eastern part of Muuga Harbour there will be dredged sediments with soft and fine-grained fractions (below 0.05 mm content 10-30%) – sand, silt, clay) is released into water about 6 metres in depth, a quite little portion of suspended matter can rise up to the surface. This was proved as well by the monitoring during the construction of the coal terminal, while the dumping in the spoil ground area was observed. The prevailing direction of the winds and the currents along the northern coast of Estonia is from the west to the east. Therefore the suspended matter, which is formed as a result of dumping at least a kilometre from the coast of Aksi island, will not reach the protected coast and a lower sea area. The distribution of suspension to the proposed Site of Community Importance during the dumping is more likely in case of strong eastern winds.

The low impact of dumping on the low seaboard of Aksi island can be proved also by the aspect that in spite of the large amount of material (over 20 million m³) dumped to the spoil ground area for decades, the communities of Aksi coastal sea have been stayed in such a good condition that they have been accepted to the list of Natura 2000 sites.

The dumping of dredging material shall be done under effective surveillance and there must be also a regular monitoring of suspended matter in the area.

Summary: The dumping works carried out during the construction works of eastern extension of Muuga Harbour do not have significant effects on Prangli proposed Site of Community Importance and do not endanger the objectives or entirety of the area.

4.9. Impact on Bird Fauna

The activity planned in connection with the extension of the harbour would be accompanied by the destruction of the habitats of wild birds in the area between Muuga railway station, the coal terminal and Kroodi Creek, together with which both, the migratory and the brooding birds would disappear. However, it is not very important from the point of view of the protection of wild birds, since there are plenty of habitats and stopping places for species nesting in the area.

The impact of felling and filling works on brooding birds is the smallest, if the these works would be planned for the period outside the nesting period (15 July – 1 April). In this case the individuals, who have already started nesting, their nests and broods would not be destroyed and the activity of the developer would not be contrary to the Government of the Republic Regulation No. 69 of 8 April 2005 *Procedure for Compensation and Rates of Compensation for Environmental Damage Caused by the Destruction or Damaging of a Protected Natural Object or an Individual of Bird or Mammalian Species* (RTI 2005, 21, 134).

When the extension of the harbour is completed, some bird species may start nesting in the harbour area, but this depends on the fact how many good nesting places the new buildings will provide. Those birds may be white wagtail, wheatear, common gull, herring gull and arctic tern.

The filling works connected with the extension of Muuga Harbour have a negative impact on non-nesting terrestrial and water birds, who use the given area for eating, resting and/or staying overnight. Among others, the species, who nest in the vicinity, eat in the area and their nesting performance may depend directly upon the conditions prevailing in the area.

Since the transparency of the water in Muuga Bay during filling works is probably significantly worse than the average and the settled suspended solids may destroy the benthic biota, it will complicate the eating possibilities of all the birds, who find food from the sea, which is why the birds will start avoiding this area. Therefore it may be presumed that the numbers of water birds will decrease in this period, but it will be restored, when the transparency of water improves. Turbid water may be carried also to farther areas of coastal waters under the impact of winds by causing analogous problems also there. Thus, all the measures shall be applied so that turbid water would not be carried significantly farther from Muuga Bay and that the eating area to be damaged would be as small as possible.

4.10. Impact on Ambient Air

During the EIA an air protection expert assessment was carried out. The purpose of the assessment was to calculate the emissions (tons per year, grams per second) from the fertilizer terminal planned to the eastern territory of Muuga Harbour and to evaluate their influence to the ambient air quality. The other planned eastern part terminals (container, metal and general cargo) were not considered, as they do not produce emissions of pollutants.

In the fertilizer terminal one-way transportation takes place and the fertilizers arrive by railway. Unloading, temporary storage and loading to the ships takes place in the terminal. The air pollutants emitted are solid particles and fluorides.

As the coal terminal of AS Transgroup is located in the vicinity of the planned fertilizer terminal, then the joint influence of the both terminals is calculated by air quality modelling.

The dispersion calculation of the assessment has been by software GARANT, which is based on the arithmetical model established by the Regulation No. 120 of the Minister of the Environment of 22.09.2004.

4.10.1. Meteorological Characteristics

The meteorological characteristics that determine the dispersion of pollutants in the air in Harjumaa County are the following:

- Atmosphere stratification coefficient that influences the dispersion 160
- The coefficient of the relief of the area 1
- Average yearly temperature 5°C
- The average temperature of the warmest month (July) at 13.00 o'clock 21.0°C
- The average temperature of a day of the warmest month 16.6°C
- The average temperature of the coldest month (January, February) -6.0°C

Wind speed:

- Yearly average 5,5 m/s
- The lowest monthly (August) average 4,4 m/s
- The highest monthly (December) average 6,4 m/s

Distribution of wind direction and calm %

N	NO	O	SO	S	SW	W	NW	Calm
10	8	8	11	20	21	11	11	4

The difference of geographical altitudes for 1 km does not exceed 50 meters, so it can be discounted during the dispersion calculation.

The border of industrial area lies in 300 meters from the fertilizer terminal and the closest dwelling house is situating 750 meters away from the terminal.

4.10.2. The Sources of Pollution of the Fertilizer Terminal and the Established Limit Values

Unloading, temporary storage and loading to the ships takes place in the terminal.

On the basis of preliminary data the following fertilizers are planned to handle in the terminal:

- Ammonia fertilizers:
    - ammonium nitrate;
    - diammonium phosphate;
    - ammofoss;
- urea;
- potassium chloride.

The total throughput of the terminal is up to 3 million tons per year by 2012.

Fertilizers arrive by rail transport to the terminal. The unloading of railcars takes place by downloading with the maximum capacity of 600 tons per hour.

The unloading of railcars and loading of ships can be envisaged as area pollution sources with conditional parameters:

Height: H =10 m

Diameter: d=0.5 m

Gas flow: V_t= 1 m^3/s

In storage of the fertilizers the emission height of the pollutants is planned to be minimum 20 meters.

The limit values of air pollutants are presented in Table 4.5 (according to the Regulation No 115 of the Minister of the Environment of 07.09.2004)

Table 4.5. The limit values in ambient air

Name	Code (Chemical Abstract Service Number)	The limit value of pollutant µg/m^3	
		One hour average SPV_1	24 hour average SPV_{24}
Solid particles, Total	-	500	150
Fluorides		30	

The limit values valid in working area are presented in Table 4.6 (according to the Regulation No 293 of the Government of the Republic of 18.09.2001). These limit values are valid in working environment and also on the territory of Muuga Harbour. Limit values shall be ensured in the working area – on the territory of the terminal.

Table 4.6. Limit values in working area of chemical factors

Name (Chemical Abstract Service'i number)	Formula	Limit value (during workday or work week)		Short-time limit value (during 15 minutes)	
		ppm	mg/m^3	ppm	mg/m^3
Solid particles: total inhaleble dust		-	 10 5	-	-
Fluorides	F	-	2,5	-	-

4.10.3. Air Emissions during the Loading of Ferilizers

The amounts of air emissions are calculated on the basis of methodology of US EPA AP-42.

On the basis of this methodology:

- **During the unloading and loading of ammonium phosphate the amount of particles emitted is 0.03 kg per ton of loaded material and the amount of fluorides emitted is 0.001 kg per ton of loaded material. During the loading of urea the amount of particles emitted is 0.095 kg per ton of loaded material. The usage of reduction measures decreases the amount of particles by 90 %. The maximum amount of particles emitted for any case of loading of fertilizers is 0.0095 kg per ton of loaded material.**

The maximum loading speed of railcars and ships is 600 tons per hour.

The emissions of pollutants during the loading per second:

Particles
600 t/h * 0.0095 kg/t * (1000 / 3 600) = 1.58 g/s

Fluorides
600 t/h * 0.001 kg/t * (1000 / 3 600) = 0.17 g/s

The yearly amount of emissions in case of the throughput of 3 million tons is the following:

Particles
(3 000 000 t/year * 0.0095 kg/t / 1000) x 3 = 85.5 t/year

Fluorides
(3 000 000 t/year * 0.001 kg/t / 1000) x 3 = 9 t/year

The real amount of dust depends on many conditions as its dispersion, humidity, weather conditions, wind speed and can vary quite a lot.

4.10.4. Other Sources of Pollution in the Vicinity of Fertilizer Terminal that Emit the Same Pollutants

AS Transgroup Muuga Port Coal Terminal

In the eastern part of Muuga Harbour the one way transit of coal takes place. The coal is transported there in railcars where it is unloaded, cleaned, sieved, crushed, fractionated. The yearly throughput of terminal is 6 million tons.

The terminal receives 4 echelons each including 66 railcars. One railcar contains 70 tons of coal.

The unloading of railcars takes place at the speed of 1600 tons per hour.

The size of the building where the unloading takes place:

Height	13 metres;
Length	25 metres;
Width	25 metres.

The unloading of coal is done by the way of turning the railcars upside down and the coal is falling to the bunkers in the depth of 10.5 meters. It is possible to unload one railcar at a time.

The unloading building is equipped with ventilation system that guarantees that the dust concentration in the room does not reach the limit of explosion. The air emitted is cleaned in the cyclon.

The parameters of the emission sources are the following:

V-1 The unloading of railcars

H = 15.0 m
D = 1.0 m
V_t= 10 m^3/s,
Particles´ concentration = 1.3 mg/m^3
T = 20ºC
Working time 6000 hours
Unloading speed 1600 tons per hour
Mass emitted M= 1.3 x 10 = 13 mg/s, i.e. 0.013 g/s

V-2 The reloading of coal T1

H = 10.0 m
D = 0.5 m
V_t= 1 m^3/s
Particles´ concentration = 2 mg/m^3
T = 20ºC
Working time 3000 hours
Unloading speed 1600 tons per hour

The concentration of dust in emission is 2 mg/m^3. This concentration can be achieved when the emission is 1 g per second.

V-3 and V-4 The storage to the heaps

H = 10.0 m
D = 0.5 m
V_t= 1 m^3/s
Particles´ concentration= 2 mg/m^3

T = 20ºC
Working time 6000 hours
Unloading speed 1600 tons per hour

The concentration of dust in emission is 2 mg/m^3.This concentration can be achieved when the emission is 1 g per second.

V- 5 Loading to the ship

H = 10.0 m
D = 0.5 m
V_t= 1 m^3/s
Particles´ concentration= 2 mg/m^3
T = 20ºC
Working time 3200 hours
Unloading speed 1600 tons per hour

The concentration of dust in emission is 2 mg/m^3.This concentration can be achieved when the emission is 1 g per second.

Table 4.7. The amounts emitted into ambient air from fertilizer terminal

Department Technological device	Pollution source					The emission parameters			The pollutant emitted		
	Name	Number on the scheme	Coordinates		Diameter D, m	Height of emission H, m	Volume V_t m^3/s	Temperature T, °C	Code	Name	The amount emitted per second g/s
			X	Y							
1	2	3	4	5	6	7	8	9	10	11	12
	Unloading of railcars	V-1	2700	1550	0.5	10	1,0	20		Solid particles	1.58
									7782-41-4	Fluorides	0.17
	The storage area	V-2	2700	1550	0,5	20	1,0	20		Solid particles	1.58
									7782-41-4	Fluorides	0.17
	Loading to the ships	V-3	2525	1745	0,5	10	1,0	20		Solid particles	1.58
									7782-41-4	Fluorides	0.17

4.10.5. Dispersion calculation

Table 4.8. The results of dispersion calculation

Pollution source		The emission parameters			The pollutant emitted into air					The results of dispersion calculation			
Number on the scheme	Diameter D, m	The height of emission H, m	Volume V_t m^3/s	Temperature T, °C	Code	Name	Maximum amount per second M, g/s	Sedimentation coefficient F	Limit value SPV_1, ug/m^3	Maximum concentration in ambient air C_m, ug/m^3	The distance from the source X_m, m	Ratio $\frac{C_m}{SPV_1}$	The distance from the source where the concentration is equal to SPV_1, x, m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
V-1	0.5	10	1,0	20		Solid particles	1,58	3	500	3168	29	6,3	196
					7782-41-4	Fluorides	0,17	1	30	114	57	3,8	286
V-2	0,5	20	1,0	20		Solid particles	1,58	3	500	529	57	1,06	103
					7782-41-4	Fluorides	0,17	1	30	23	114	77	-
V-3	0,5	10	1,0	20		Solid particles	1,58	3	500	3168	29	6,3	196
					7782-41-4	Fluorides	0,17	1	30	114	57	3,8	286

Figure 1 of Annex 13 shows the locations of dry bulk terminal to be planned to eastern Muuga Harbour and existing coal terminal.

Figure 2 gives the dispersion calculation for solid particles taking into account the existing and planned pollution sources in operation in the eastern part of Muuga Harbour. Maximum concentration of solid particles can reach up to 4750 µg/m^3 but this will be below the working environment limit value (5 000 µg/m^3). At the border of production territory the particles´ concentration of five pollution sources can reach half of the limit value (SPV_1). The maximum concentration of particles near the closest dwelling house at the distance of 750 m can reach up to 0,2 parts of SPV_1.

Figure 3 gives the dispersion calculation for fluorides taking into account the existing and planned pollution sources in operation in the eastern part of Muuga Harbour. Maximum concentration can reach up to 60 µg/m3. At the border of production territory the fluorides concentration can reach up to the limit value SPV1. The maximum concentration of fluorides near the closest dwelling house at the distance of 750 m can reach up to 0,4 parts of SPV1.

4.10.6. Conclusions

The dispersion calculations show that the planned loading of fertilizers in the eastern part of Muuga Harbour does not cause the exceeding of limit values of ambient air outside the working area (harbour area) even in interaction with the existing coal terminal. The following five existing and three planned sources can operate at the same time:

- the unloading of coal from railcars;
- the loading of coal at T1;
- the storage of coal into two heaps;
- the loading of coal into ship;
- unloading of fertilizers from railcars;
- the storage of fertilizers;
- the loading of fertilizers into ships.

The company shall ensure and observe that the concentration of fertilizer dust in production spaces and working zone is ensured, which excludes the danger of explosion.

It can be concluded from the dispersion calculations that:

- the pollution level of particles in the air layer near the surface on the border of the harbour area does not exceed half of the limit value SPV_1;
- near the closest dwelling house the pollution level in the air layer near the surface does not exceed 0,2 parts of SPV_1.

The amounts calculated are theoretical possible maximums. The real amounts emitted can be calculated when measuring the pollution sources during the operation at normal regime.

In the working area near the pollution sources the maximum particle concentration in operation of all pollution sources can reach up to 4750 µg/m^3, which is below the working area limit value – 5 000 µg/m^3.

In the course of preparing the terminal construction project the ambient air pollution permit including a project of the allowed pollution quantity of pollutants emitted into the ambient air from pollution sources, shall be applied.

4.10.7. Impact on Ambient Air during Construction Work

In the course of Muuga Harbour construction work minimal air pollution may be caused by loading and storage of dry bulk construction material on the harbour construction site. Upon storage of bulk in a heap dust emissions may occur in several stages: loading of material into heaps, with strong winds and removal of material from the heap. Movement of loading equipment and trucks may also cause dust emissions.

During port construction work trucks transporting dry bulk and other means of transport with diesel engine used at the construction generate exhaust gases.

Still, it may be concluded that loading and storage of dry bulk and use of transportation with diesel engine will not cause air protection related problems in Muuga Harbour eastern part production territory. Also, construction work in the area (including cars) does not pose danger of pollution to the neighboring areas. The area is open and there is continuous inflow of fresh air from the sea.

Dust emissions at construction work can be avoided with the help of decreasing the falling height of the material, covering of construction material during transport and storage, periodic cleaning of roads and equipment on the construction site and non-performing of the loading of construction material with strong wind.

4.11. Noise

One of the significant problems of environment protection and health protection caused by the development of the eastern part of Muuga Harbour is noise. Noise is a factor adversely affecting health and living in Jõelähtme rural municipality in the area of the railway and roads connecting the eastern part of Muuga Harbour with the harbour.

The noise sources connected with the eastern part of the harbour and its activity may be conditionally divided as follows:

- stationary noise sources outside the buildings (technological equipment of the terminals in the harbour, partially Muuga railway station);
- noise sources inside the buildings (technological equipment in the buildings of the harbour terminals and the wagon depot);
- construction noise;
- railway traffic, including locomotive depot, sorting of wagons, assembly and manoeuvring of rail vehicles in Muuga railway station;
- motor transport (= traffic noise).

The abovementioned noise sources have an impact / may have an impact on the environment of the inhabitants of two regions – Uusküla village and Kallavere gardening associations. These are two interest groups with respect to noise as an environmental factor hazardous to health. It is obvious that noise level will increase in the surroundings in connection with the development of the eastern part of the harbour.

4.11.1. Stationary Noise Sources

Stationary noise sources outside the buildings in the territory of the harbour are the loading devices of the terminals (cranes, belt conveyors, pneumatic transport devices, pumps, etc.). In the operating coal terminal the railway wagons are unloaded in a building, from where the coal is transported onto ships by a belt conveyor. These technological devices, whereto the operation of the electric filters of the dust emitted from the unloading building and the electrical emergency alarm system are added, are not considerable noise sources for the inhabitants of Uusküla taking into account the noise level generated by these noise sources and the distance of the terminal from the private dwelling houses (over 1 km).

It follows from the noise investigations carried out that the technological processes used in the terminals of the western and central part of the harbour have a relatively low level of noise (basis: *"Preparation of the Noise Protection Measures for Muuga Harbour. Part I. Noise Investigations in the Area of Muuga Harbour"*, OÜ E-Konsult, work No. E421. Tallinn, 1997). Liquid products are handled in the western part of the harbour and silently operating pumps are used in the technological process. Mechanical and pneumatic loading devices are used in the central part of the harbour.

In the eastern part of the harbour under discussion lifting devices are used mostly, which noise parameters differ from the abovementioned. Still, the noise of the technological (loading) devices of other terminals of eastern harbour will presumably not deteriorate the environment of the inhabitants of the area also. The loading processes of fertilizer terminal do not cause considerable increase of noise level, because conveyors operate relatively quietly. In the metal and container terminal higher instantaneous noise levels are possible, if the required work culture and work methods are disregarded. Proceeding from this the noise level caused by the mechanisms used upon loading may need to be measured.

4.11.2. Construction Noise

It is not excluded that short-time and periodical unpleasantness will be caused to the inhabitants of the area in the form of construction noise, which sources are the mechanisms and devices used upon the construction of the terminals (filling works of the quays, pile ramming, etc.). The noise condition of the area in the course of construction works may be deteriorated also by the movement of road transport, for the reducing of which speed limits shall be established on Nuudi road, if necessary. In order to decrease construction noise the construction activities shall definitely be stopped for the night. It is not practical to measure the noise level during the construction works of the terminals, because the works do not cause prolonged noise.

4.11.3. Motor Transport Noise

The percentage of motor transport in the goods turnover of the eastern part of Muuga Harbour is relatively small (5-10 %; mainly container cargo transport) and it is not expected considerable increase of the percentage upon developing the eastern part of the harbour). Motor transport as a noise source is considerable on the territory of the harbour and its connecting roads. Trucks with big load carrying capacity, which main noise sources are engines and exhaust systems, are used. Secondary noise is caused by the friction of the tyres of the moving trucks against the pavement. There is a speed limit for trucks in the area of the terminals and on the connecting roads of the eastern part of the harbour, which is why the noise caused by air resistance is not considerable. Additional speed limits shall be established, if necessary. The increase of noise in case of heavy-duty vehicles is noticeable at the speed over 60 km/h.

The perspective increase of motor transport may be expected for the satisfaction of cargo turnover on the 5 km long access road between the harbour and Tallinn-Narva highway (predicted increase of 40 % by the year 2025). The noise caused by motor transport is the biggest in the area of the intersection of Muuga-Kallavere road and Maardu-Muuga road. It has been noted at Maardu-Muuga road that the noise level at the garden house (residential building) closest to the road corresponds to the equivalent limit value day and night. The maximum sound power pressure level in the outdoor territory of the buildings reaches up to 68 dB(A) at night, which does not exceed the permissible limit 75 dB(A) (basis: *"Action Plan of the Environmental Health of Jõelähtme Rural Municipality"*, OÜ E-Konsult, work No. E758. Tallinn, 2001).

Ülgase road (located between the railway and Nuudi road) and Nuudi road used for truck traffic is at the distance of at least 300 m from the territory of the gardening associations located in Uusküla, which turns out to be sufficient from the point of view of noise protection. However, there are two farmhouses (residential buildings) located at the distance of 100 m from the road. On Ülgase road at the traffic intensity of 47 vehicles an hour in the daytime the equivalent noise level at the distance of 50 m from the road is 48 dB and the maximum instantaneous noise level is 65 dB(A), which conform to the requirements of the health protection norms in the residential area. It proceeds from the abovementioned that the garden houses and residential buildings by Ülgase and Nuudi road are in a safe zone as for the noise caused by the transport.

The movement of trucks from the western and eastern part of Muuga Harbour is concentrated on Põhjaranna road. According to the measurements on Põhjaranna road, at the traffic intensity of 101 vehicles an hour, the daily equivalent noise level caused by them in the territory of the garden houses of Uusküla gardening associations "Meedik" and "Paala-I" closer to the road (distance 50-130 m from the road) is 58 and 51 dB respectively. The maximum sound pressure levels reach up to 67 and 58 dB(A) respectively. According to the measurement results the noise level in the residential area under discussion conforms to the health protection norms. The traffic of motor transport will become more intense upon the extension of the harbour, which is why, according to the estimation, the noise level in the territory of the gardening associations near Põhjaranna road may exceed the maximum limit. Proceeding from that a noise level exceeding the permissible one may occur in the territories of the gardening associations "Meedik" and "Paala-I", on the total of ca 25 plots. It shall be taken into account that the garden houses are mainly with single-glazed windows and light walls, which is why their soundproofing according to experts is at least 12-15 dB.

On the basis of the measurement results it may be claimed that the daily maximum permissible noise level has been practically met in case of closed windows from the side of Põhjaranna road even in the garden house, which is in the most unfavourable location as for traffic noise. The nightly permissible noise level has also been ensured everywhere on the same conditions, except in about five garden houses of the gardening association "Meedik" by the road, if the garden houses have single-glazed windows. In the houses with double-glazed windows the nightly noise level should also not exceed the level permitted by the norms.

However, according to the environmental health plan of Jõelähtme rural municipality (OÜ E-Konsult, 2001) it is not recommended to reconstruct the garden houses of Uusküla into residential buildings in the area adjacent to the harbour and the railway.

The noise caused by motor transport depends on the traffic intensity and composition of the transport. At present there are no relevant data, which is why it is difficult to forecast the increase of noise level in the residential area at the roads leading to the harbour. After the development of the eastern part of the harbour, the construction of road network and the organisation of the road traffic it is necessary to perform measurements on the basis of the relevant programme in order to find out the levels and spreading range of noise. If necessary, measures shall be planned on the basis of the measurement results for reducing the noise affecting the inhabitants.

4.11.4. Railway Noise

The main source of environmental noise in Muuga Harbour, today as well as after the future expansion, is Muuga railway station and its railyard.

A survey and assessment study of the noise created in Muuga railway station in Muuga Harbour was carried out. The study consists of measurements of the noise emissions and noise levels, mapping of the existing situation and modelling the future, based on available data. The study covers the residential area of Uusküla village between Muuga railway station and Nuudi road, in Jõelähtme rural municipality. As a result, an overview is given of the main noise sources, their noise emission, and the noise levels in the neighbouring residential area. Possible measures for reducing the noise are presented and the obtainable reduction is estimated by model calculation. The whole study is annexed to the report (Annex 15).

The Muuga railway station is not a usual "railway station" but a freight train station and an associated railyard. The main activity taking place in Muuga station is the shunting and sorting of freight trains; the main events producing noise are, apart from the to-and-from movement of the locomotives, especially the braking of wagons and their collisions. The activities do not resemble ordinary rail traffic, the passing-by of trains travelling with a steady speed along a railway line track. Therefore, the activities cannot be handled using the usual methods and tools meant for railway traffic noise.

It was interpreted here that such a complex noise source should be termed as industrial noise, in accordance with Regulation No. 42 of the Ministry of Social Affairs, 4 March 2002 *Standard Noise Levels in Living and Recreation Areas, Residential Buildings and Buildings in Joint and Methods of Measurement of the Noise Levels*.

In this project the propagation of noise to the surroundings of the station and railyard was estimated with two means:

- The noise levels were predicted using a calculation model;
- The noise levels were measured near the sites of possible nuisance (residential houses).

In large environmental noise surveys and assessment studies, a calculation model is usually the primary tool to use. Mere measurements of the noise seldom provide a representative and reliable view of the situation. The results of the measurements tend to represent the noise only at the measurement positions and only during the measurement periods themselves rather than the overall long-term noise situation of the whole area in question.

However, calculation surveys dealing with noise of this type and origin have been relatively rare when compared with, for instance, ordinary traffic noise. In this case the additional information which direct noise level measurements can give complement and support considerably the predictions of model calculations.

The prediction method used was the general Nordic calculation model[1], listed also in Act no. 42 of the Ministry of Social Affairs. The model needs as input data the noise emissions of the noise sources. No previous information is available of the sources of the railyard. Thus in this project it was necessary to obtain the noise emission data by carrying out own new measurements of noise emission.

[1] KRAGH J, ANDERSEN B & JACOBSEN J, Environmental noise from industrial plants. General prediction method. *Danish Acoustical Laboratory, Report* 32. Lyngby 1982. 54 p + app. 35 p.

The assessment of noise will be done by comparing the rating levels L_R to normative values. The rating levels are calculated or measured equivalent sound levels L_{Aeq} which are corrected, if applicable, with level adjustments relating to the character of the noise. The normative values are set in Regulation No. 42 of Ministry of Social Affairs.

4.11.4.1. Muuga Harbour and Muuga railway station

General description of the area and noise sources

Muuga railway station is located on the eastern part of Muuga Harbour in Jõelähtme municipality. Maardu town is 1.2 km away, Kallavere 2.4 km away and Muuga cottage area 2.2 km away. Uusküla village is located in south and east side of the railway station. Closest residential house (Liiva farm) is 50 m away from the border of the station.

The terrain of the residential area next to the railway station is mainly flat, rising in south and east towards Nuudi road – the height difference to the road is 5 m. There is no actual forest or other objects which could considerably affect noise propagation. The ground level of the railyard is 3 m higher than the ground level in the yards of the closest residential property.

In the railyard of Muuga railway station, composing of freight trains takes place. Locomotives are repaired and maintained in Muuga depot. Thus, the residential area next to the railyard and depot is influenced by the following activities producing environmental noise:

- sorting, shunting and composing of trains,
- pass-by of trains,
- locomotive maintenance.

More specifically, the actual sources of noise are the following machinery, activities, devices or events:

- diesel engines of locomotives, when idling, moving alone or pulling wagons;
- testing of diesel engines at high rotation speed;
- mechanical braking systems (operated remotely or locally by manpower);
- collisions between wagons and between wagons and locomotives;
- clanking of wheels of a moving train at rail joints and switches.
- whistles.

Traffic

Traffic data of Muuga railway station was obtained from Estonian Railway Ltd [letter 06.03.2006].

- The average number of trains composed is 16 per day (117 trains per week, 507 per month and 6092 per year). No data is available of the distribution of composing the trains over different weekdays. The composing of trains takes nominally place in the day and night during four time intervals: 09-12, 16-19, 21-24, and 04-07.
- The average speed of locomotives and trains in Muuga railway station is 15 – 25 km/h.
- The locomotives drive from the depot to the station and back an average of 60 times per day.

- Currently 3 trains arrive at and 3 trains depart from the coal terminal daily.
- The arrival of trains takes mainly place on the four tracks closest to the depot (tracks no. 1-4) and the departures take place from tracks 11-17.
- There are altogether 20 tracks in Muuga railway station; the nearest track is 70 m away from closest residential house.

Locomotives and wagons

Only locomotives with diesel engines operate in Muuga railway station. In shunting the trains, single or double locomotives are used.

Estonian Railway Ltd uses as main shunters/freight locomotives the General Electric types C30-7Ai (Conrail) and C36–7i (Missouri Pacific). These are so-called "*American*" locomotives. The heavy shunter locomotives ČME3 (so-called "*Russian*" locomotive, in fact produced in Czech) are also used for shunting. The operators use mainly locomotives manufactured in Russia. There are an average of 9 such locomotives in Muuga railway station every day. Some of the locomotive types are shown in Annex 15, Figures 1.

The average train consists of 57 conventional wagons (with a typical length of 14 m). Thus the nominal total length of a train is 800 m, plus the length of locomotive, 35 m. The actual number of wagons in a train may vary and is usually between 55 to 66 wagons. The traffic consists of trains with several different wagon types. Some of the most common are shown in Annex 15 Figures 2.

4.11.4.2. Assessment of environmental noise

Level quantities describing noise

The two most important characteristics describing environmental noise are the **noise emission** of a noise source and the **noise level** at a receiving point. The noise emission is the same as the sound power level of a noise source; usually it is expressed as the sound power level. The noise level is the sound pressure level at a receiving point; commonly expressed as the A-weighted sound level.

The ***sound level*** is A-weighted sound pressure level. It is defined as

$$L_{pA} = 20 \lg (p_A/p_0)$$

where p_A is A-weighted sound pressure and p_0 the reference sound pressure (20 μPa).

The ***A-weighting*** is a noise signal filter which conforms approximately to the response of the human ear.

The ***sound power level*** is defined as

$$L_W = 10 \lg (P/P_0)$$

where P is the sound power and P_0 the reference power (1 pW). The overall noise emission is usually expressed as the A-weighted sound power level (L_{WA}). For propagation calculations, the sound power level is given in octave bands (and then the A-weighting is not applied).

Both the mentioned level quantities have the same unit, the decibel (dB). This may create confusion, as the numerical values of the two levels usually differ considerably from each other. The value of the sound power level is generally much higher than the value of the common sound level.

For input to propagation calculations, the sound power levels of each noise source shall be determined as a function of frequency and direction. In the calculation model the noise source or sources are represented by an equivalent point source, which is located at the acoustical centre of the real source. The sound power level is presented in octave bands from 31,5 Hz to 8 kHz (including third-octave bands 25 Hz – 10 kHz).

<u>Assessment of annoyance</u>

For assessing the annoyance and other negative effects due to environmental noise, the A-weighted sound level is primarily used. As such, the A sound level is directly applicable to continuous and steady noise only. When needed to assess the long-term effects of a noise varying in time – whether fluctuating, intermittent or impulsive – using a single-number quantity, the measure to use is the *equivalent A-weighted sound level* L_{Aeq}:

$$L_{Aeq} = 10\lg\left[\frac{1}{T}\int_T \frac{p_A^2(t)}{p_0^2}\,dt\right]$$

where $p_A(t)$ is the A-weighted instantaneous sound pressure at running time t and T is the reference time interval.

Almost all of the noise of the railyard varies considerably or strongly in time. The equivalent sound level is needed for this type of noise, because random short-term sound level measurements cannot represent well the whole reference time interval. Despite a common prejudice, the equivalent sound level is not an ordinary average of the sound level. Instead, the mean-square of the pressure in the formula means that higher sound pressures have an emphasized contribution on the final value.

One very basic characteristic of the equivalent sound level is the following: If a noise source operates only part of the specified time interval, then the calculated equivalent sound level for the longer period (e.g. day or night) is smaller compared to any *short-term* A-weighted sound level, observed while the source operates. A very high momentary A-weighted sound level (for instance, at the moment of a collision of wagons) may be remarkably higher than the equivalent level. This is called the *maximum sound level* L_{Amax}.

Noise which is *impulsive* or *tonal* in character is regarded as more annoying than steady noise. If the assessed noise is impulsive or tonal, a respective adjustment may be added to the measured or calculated level before comparing it to the normative values.

<u>Normative values and noise limits for category II residential areas</u>

The normative values are specified in Act no. 42 of the Ministry of Social Affairs. The Act defines three types of levels:

- **Target level** is a sound level which generally does not cause annoyance and represents good acoustical conditions.
- **Limit value** is a sound level the exceeding of which may cause annoyance and which generally represents sufficient (acceptable) acoustical conditions.
- **Critical level** is a sound level which causes strong annoyance and represents unsatisfactory noise situation.

The noise level descriptor to be compared to all normative levels is the (rating) equivalent sound level L_{Req} during a specified reference time interval T. The rating means that the measured or calculated equivalent levels L_{Aeq} are adjusted, if applicable, based on the annoying quality of noise. Adjustments of +5 dB are specified for noises which are tonal or impulsive in character. Only one adjustment should be applied at a time.

Critical levels have been set for traffic and industrial noise. These values are used for assessing existing situations nearby external noise sources. The construction of new noise sensitive buildings to areas where critical values prevail is generally forbidden.

The normative values are compared with rating levels during day and night periods and rating levels should not exceed normative values. The reference time intervals are:

- daytime 07–23 (including evening 19–23)
- night-time 23–07

Based on the classification in general planning, the area to be assessed belongs to category II: residential area. In this case the situation is an existing one, and the noise levels should be assessed considering the normative values for existing areas. The different normative values for environmental noise are given in table 4.9.

Table 4.9. Normative levels for environmental noise. The noise descriptor is the (rating) equivalent sound level L_{Req} *(dB)*.

		daytime	night-time
Target levels			
	Industrial noise	55	40
	Traffic noise	60	50
Limit values			
	Industrial noise	60	45
	Traffic noise	60	55
	—“— noisy facade[1]	65	60
Critical levels			
	Industrial noise	65	55
	Traffic noise	70	65

[1] allowed on the noisy side of a noise-sensitive building (facing road or railway)

The normative value requirements for industrial noise are stricter than the requirements for traffic noise.

The maximum noise levels L_{Amax} are assessed in relation to single noise events of traffic. The maximum noise levels should not exceed 85 dB during daytime and 75 dB during night-time. This requirement has been followed in this report.

<u>Survey method: measurement or calculation?</u>

Basically the noise levels created by noise sources of industrial type could be assessed simply by measuring the noise levels close to noise sensitive locations (e.g. residential buildings), and comparing the results with normative values. When dealing with complex source combinations and large areas, this approach alone is generally not reliable enough and impractical in the needed extent. A possible exception may be measurements at fixed control positions for monitoring changes.

A more powerful means of assessing environmental noise is to measure, instead, the noise emissions of noise sources at a short distance, and to calculate the propagated noise levels using a calculation model. The calculation of noise of the industrial type differs from the other environmental noises (e.g. road traffic or railway noise) in the sense that the noise sources are usually unique. Their noise emissions are generally not known and each noise source shall be measured separately for calculations.

By using model calculation the propagation of noise can be predicted also everywhere else than at the measurement points alone. A larger area can be covered in a reasonable time. Accurate and reliable results can be obtained efficiently and cost-effectively as compared to using only measurements. Other advantages are that average weather conditions are used and that noise emission measurements will give information about different sources, to be used when planning eventual noise abatement measures.

Control measurements of noise levels in receiving points

Although the model calculation is the primary survey method in this project, several noise level measurements were taken in the neighbouring residential areas, where the noise is heard and annoyance may be experienced.

The different noise phenomena created in the railyard vary considerably as to the character and strength, duration and spectral content. It was considered valuable that measurements at receiver sites could provide additional information for subjectively describing the noise levels in the area in question. Measurement results can also be directly compared to normative values, and on the other hand the results can be used for checking the calculated results.

4.11.4.3. Measurements

Purposes and locations

Measurements were taken for two different purposes, for determining the emission of the noise sources of the railyard, and for checking the noise levels at a number of receiver positions in the surrounding residential area.

In priciple, the noise emission of basic train types is known in the pass-by situation. However, when it is a question of the activity taking place in the station and railyard, the situation is different from ordinary traffic running at constant speed along standard track. No emission data is available in beforehand. For obtaining the input data for the model calculation, it was necessary to take new emission measurements of the various noise sources and noisy events of the railyard.

The emission measurements were carried out at “near points” in the railyard area, at distances of at most a few tens of metres from the positions or incidents where the noise was born. There were two main observation sites: in front of the control tower of the station building near the downhill brake, and the shunting and braking area approximately 200 m southwest of the previous location.

The measurements of ordinary noise levels were taken outside the railyard area. There were altogether 20 so-called “far points”, long-distance measurement positions. The points were selected so that they cover in a representative way the residential area at Uusküla village between Muuga railway station and Nuudi road.

Table 4.10. Measurement periods

Monday	20.2.2006	14.50 – 17.00
Tuesday	21.2.2006	09.20 – 15.30
Monday	6.3.2006	12.00 – 17.00
Saturday	11.3.2006	10.30 – 12.30
Saturday	11.3.2006	21.30 – 23.00
Sunday	12.3.2006	10.30 – 13.00
Sunday	12.3.2006	17.00 – 18.30

The locations of the far points are shown in the map of Annex 15 A. The measurement results obtained in these points could be directly compared to the normative values, and on the other hand the results could be used for checking the calculated noise levels.

Conditions

The measurements were carried out during randomly chosen days and periods in February and March 2006. The measurement intervals were selected over a day period, so that they would contain a sufficient amount of typical and representative noise events in the railyard area. The measurement periods are listed in table 4.10.

The weather conditions during the measurements are listed in table 4.11. In principle, the weather may have a notable effect on the propagation of noise over distances of at least a couple of hundreds of metres or more. For the more distant far points the wind direction was in almost all the cases neutral or slightly favourable. The wind had a negligible influence on the emission measurements taken at short distances, up to 60 m.

At the distance of the houses closest to the railyard, the weather has only a minor influence on the propagation due to the favourable terrain topography. The variation in the measurement results were clearly first of all produced by changes in the activity in the railyard itself.

Table 4.11. Weather conditions during the measurements.

date	wind direction	speed, m/s	cloudiness	temperature, °C
20.2.	E	2…3	8/8	–1
21.2.	NE	2…3	8/8…2/8	–2
6.3.	NE	2…3	8/8	–1
11.3.	E	1…2	1/8	–7
11.3.	E	2…3	1/8	–17
12.3.	E	3…4	2/8	–5

Methods and equipment

Most of the emission measurements of the noise sources were taken in accordance with, as far as applicable, the standard Nordtest NT ACOU 080[2]. This method is a complement and extension of the general international methods of measuring noise emission, the ISO 3744[3] and 3746[4]. The measurements of the ordinary sound levels in the far points were taken according to the respective basic standard ISO 1996[5].

[2] NT ACOU 080. Industrial plants. Noise emission. *Nordtest,* Espoo 1991.
[3] ISO 3744. Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane. *International Organization for Standardization,* Geneve.
[4] ISO 3746. Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane. *International Organization for Standardization,* Geneve.
[5] ISO 1996-1, -2, -3. Acoustics — Description, measurement and assessment of environmental noise. *International Organization for Standardization,* Geneve.

Table 4.12. Measurement equipment and analysis software

sound level meters	Brüel & Kjær	2235
	Brüel & Kjær	2260 Investigator
	Norsonic	118
sound level calibrator	Brüel & Kjær	4231
DAT-recorder	Sony	TCD-D100
	Tascam	DA-P1
PC sound device	Korg	1212 I/O
sound processing program	Adobe	Audition 1.5
analysing program	Pioneer Hill	Spectra Plus 3.0

Moving locomotives and trains were measured with applied methods, specially adapted to determining the sound power level of a moving point source and a moving finite-length line source, respectively.

In every measurement point the sound pressure signal from the microphone was recorded digitally with a DAT-recorder. During the recordings a sound level meter worked as a preamplifier of the recorder.

The microphones were at a height of 1.5 – 1.7 m above the ground. They were protected with a windscreen. All equipment was calibrated with a sound level calibrator before and after the measurements. The equipment used for the measurements and analyses are listed in table 4.12.

The recorded data was transferred digitally to a PC for post-processing and analysis. For every recording the either the A-weighted equivalent sound level L_{Aeq} or the sound exposure level L_{AE} were determined, together with the respective spectra in 1/3 octave bands. The noise emission, as the sound power level L_W or the sound energy level L_E, were then obtained using the procedures of the appropriate standards.

Overview about calculation of noise levels and maps is given in Annex 15 section 5.

4.11.4.4. Results

The measured noise emissions of the main noise sources are presented in Annex 15 B. The single-number noise emissions, the A-weighted sound power levels L_{WA} or sound energy levels L_{EA} are also listed in table 4.13. The A-weighted levels are not used as such in the calculations, but they can be used for comparing the mutual strengths of different noise sources.

The results of the sound levels measured at the far points are presented in Annex 15 C. The single-number sound levels are also listed in table 4.14.

The calculated results of the 5 situations are presented in Annexes 15 D1 – D5, in the form of noise level maps.

<u>Noise emissions</u>

The dominant noise sources are the braking and the collisions of wagons, and the locomotive engines. The braking with either means, the hydraulic downhill brake and the man-operated mechanical shoe brake, creates the most prominent noise events. The high-level part of the braking noise may last for several seconds at a time.

The collisions create the highest momentary sound levels, but the duration of the crash noise event is short.

The locomotive engines are important noise sources because of the long durations of operation. A locomotive may have its engine idling during most of the day. There may be several locomotives having their engines running at the same time. The base or "floor" noise level coming from the railyard is produced by the engines.

Moving trains do not cause as much noise as the shunting and sorting activities. The main part of the noise of a moving train is created by the locomotive. The influence of the number of wagons is minor. The clanking of wheels of a moving train at the rail joints and switches is not very distinctive due to the low speed.

The whistles of the locomotives are distinctive events in the sense that they are noteworthy when observing the maximum momentary sound levels. The energy of the whistle sounds are, however, so small that their effect on the long-term equivalent levels is almost negligible.

Table 4.13. Noise emissions of the main noise sources (A-weighted sound power levels L_{WA} or sound energy levels L_{EA}) during the active, effective time of operation.

source		emission L_{WA}, dB	L_{EA}, dB
L1	locomotive, moving alone	**109**	
L2	locomotive, stand-by, idling	**103**	
L3	downhill brake	**124**	
L4	shoe braking	**114**	
L5	collisions	**99**	
L6	whistle		**122**
L7	train (locomotive + 60 wagons)	**113**	

Table 4.14. A-weighted equivalent sound levels L_{Aeq} and maximum sound levels L_{Amax} measured at the far points, without impulse or tone adjustments. The equivalent levels are listed as long-term overall levels and the variation range, if available, of the short-term measurement results

point	location	L_{Aeq}, dB overall	short-term
KP1		**58**	43 – 65
KP2		**57**	45 – 65
KP3		**51**	51 – 52
KP4		**55**	47 – 64
KP5		**60**	48 – 64
KP6		**55**	–
KP7		**56**	55 – 57
KP8		**48**	48 – 49
KP9		**51**	–
KP10		**51**	46 – 53
KP11		**50**	48 – 51
KP12		**45**	45 – 46
KP13		**47**	–
KP14		**56**	–
KP15		**49**	43 – 51
KP16		**45**	–
KP17		**47**	47 – 48
KP18	On the border of railyard	**66**	–
KP19	On the border of railyard	**64**	–
KP20	Purification plant	**39**	–

The trains moving along the more seaward-side tracks do not cause considerable noise to the residential areas, because they are usually screened by other wagons and the distance to the railyard border is large. This is also the main reason why the station extension has only a small effect on the overall noise situation.

The other noise sources were quiet enough, compared to the main noise sources, so that these could be left out of calculation and assessment without diminishing the accuracy. These are for example ventilation equipment, cars, etc.

Character of noise

The noise of the braking is high-frequency, harsh and shrill, and highly tonal; a tone adjustment of +5 dB is applicable to the predicted and measured levels due to braking in the neighbouring residential area.

The collisions of the wagons form other distinctive noise events; the crashes are highly impulsive, and an impulse adjustment of +5 dB is applicable in the nearby area.

The noise emissions of the locomotives are typical for large and slowly-rotating diesel engines. The noise is very low-frequency and also tonal.

In all, almost all of the noise created in the railyard is either impulsive or tonal by character. This means that practically all the noise deserves either the impulse adjustment or the tonal adjustment, when heard in the area of the closest resiential properties. Thus an adjustment of +5 dB is to be added to the overall levels, measured or predicted, before comparing the results with the normative values. This conclusion is valid at least at short distances from the railyard, that is, at the nearest residential houses.

Noise levels at receiving points

Detailed measurement results obtained at representative far points are given in Annex 15 C. The annexes show the third-octave spectra and selected samples of the running AF-weighted sound level $L_{AF}(t)$. The A-weighted sound levels are listed in table 4.14.

The measured sound levels at the receiving points were in most cases within a range of ±2…3 dB from the sound levels calculated at the same points. It should be noted that most the measured levels correspond to active phases in the operation of the station and railyard. Also, the measured levels represent the more or less random noise situation and events in the measurement days and during the measurement periods only. In principle, the calculated results represent more generally the noise situation.

Anyway, the result of the comparison between measured and calculated levels confirms that noise emission measurements were sufficiently exact and reliable. The created noise model and the measurements carried out comply with each other.

Due to the steady schedule of composing the trains mentioned in Sec. 4.11.4.1, the noise emissions and the long-term equivalent noise levels stay constant 24 hours, all day and all night. Thus the calculated equivalent sound levels in the noise maps are directly the daytime sound levels and simultaneously also the night-time sound levels.

This means also that if one wants to calculate the rating level for the daytime (7–23) or the rating day-evening-night level, the mathematical expressions become very simple:

The rating levels for the daytime L_D (7-23), including a time-of-day penalty of 5 dB for the evening hours (19-23), are

1,5 dB higher than the direct results.

The day-evening-night rating levels, including also a +10 dB penalty for the night hours (23-07), are

6,3 dB higher than the direct results.

Assessment of disturbance

Within the whole residential area between the station and Nuudi road, the equvalent sound levels exceed the night-time limit value 45 dB even without adjustments. At the distance of the closest houses, the inadjusted levels exceed 50 dB and are close to the night-time critical value of 55 dB. With impulse/tonal adjustments, the latter limit is exceeded.

The maximum normative levels are exceeded at least during the night at the closest residential houses.

4.11.4.5. Expansion of Muuga Harbour and extension of Muuga railway station

The traffic in Muuga harbour is intensive and constantly growing. An extension of Muuga railway station is needed in order to keep the flow of goods and traffic fluent. An extension of the station and railyard enables the accommodation of trains with a total length of 1 km.

Altogether 28 new tracks are planned next to the existing tracks of the railyard. The main purpose of the new tracks is the transport of goods to and from operator warehouses and ships. The traffic is estimated to increase up to 100% in the future after the entire infrastructure has been developed.

As the new tracks are planned further away from the residential area, on the seaward side of the existing tracks, their effect on the noise will be minor. There will be only a slight increase of the noise levels in the residential areas. The main noise sources for the residential areas will remain the same.

4.11.4.6. Conclusions

The present noise survey and assessment concentrated on the residential area next to the Muuga railway station and railyard, approximately between the depot and the station building. The survey was conducted using both measurements and calculation. A similar wider noise assessment study will be prepared for whole Muuga Harbour (including expansion).

Based on the information obtained from Estonian Railway, the active work periods (and the noise events) are distributed evenly over day and night, and over longer periods of time. Thus the equivalent noise levels created by Muuga station are the same for the day and night.

The results of both the measurements and the noise mapping showed that the noise level at and near the closest houses exceed 50 dB even without any adjustments. The night-time limit value 45 dB is clearly exceeded. The rating equivalent sound levels L_{Req} (which include an adjustment of +5 dB for impulsive/tonal noise) exceed the night-time critical value 55 dB.

4.12. Odour pollution as an environmental disturbance

Olfactory pollution is a significant environmental disturbance next to intense industrial, agricultural, transport areas and landfills. In Denmark, the fertilizer industry is also considered to be a potential source of olfactory pollution (Maasikmets, 2004). Thus, a fertilizer terminal may turn out to be a source of odour, though the potential for significant pollution is less than with fertilizer production.

Various pollutants are subject to maximum values, but often this is not enough. While the concentration of the pollutants in the air may fall within allowed limits, the odour is still recognizable. An odour has been compared to noise – its disturbance is psychological, rather than physical, since it disturbs people and causes stress and repugnance towards the location where the disturbance takes place.

Odour is generated mainly through the anaerobic microbiological decomposition process where organic compounds decompose. The conditions for the anaerobic microbiological decomposition process and thus also the creation of odours are: high temperatures, high levels of humidity, low C/N ratio.

Distances (ie. distance from the residential area) to the industrial enterprises are generally determined in advance. The distances can be reduced if the amount of pollutants can be reduced (through purifying equipment) and modelling will prove that the spread of pollutants is smaller than the enforced distance. Olfactory pollution can be reduced with both biological and physicochemical means. Biofilters and biowashers are generally used to minimize olfactory pollution.

Olfactory pollution is regulated by the *Ambient Air Protection Act* § 34, according to which a substance of annoying or irritant odour (*odorous substance*) is a substance or mixture created as a result of human activity and released into the ambient air, which may cause the population to experience undesirable sensations of odour. The presence of odorous substances in the ambient air is determined by an expert group formed for this task. Determining the presence of odorous substances occurs according to the order and means set in the Minister of the Environment regulation no. 124 from 6.10.2004. The expert group assesses the presence of the odorous substances in the ambient air and, if odour is present, demands the pollutant source administrator to compile an action plan for reducing the emitted amounts of odorous substances. The polluting source administrator will implement the additional means to reduce the emitted amounts of odorous substances.

Thus, if it turns out that the activity of the fertilizer terminal can cause or does cause the odour emission, spread or creation of irritant odour perception for the population and there are respective complaints, the situation calls for the means set in the act (the assessment of pollutant presence).

The *Ambient Air Protection Act* § 89 section 3 assign the pollutant source administrator the obligation of assessing the possible presence of odorous substances in the ambient air when applying for a pollution permit or environmental complex permit.

4.13. Socio-economic Impacts

4.13.1. Impact on Human Health, Welfare and Property and Connection with Plannings and Development Plans

Areas of garden houses and summer-houses border on Muuga Harbour in Muuga and Uusküla and residential buildings border immediately on Muuga railway station. The environment of the inhabitants in the area of eastern part of the harbour is deteriorated mainly by the noise originating from rail transport. According to the comprehensive plans of both, Viimsi and Jõelähtme rural municipalities, it is not recommended to reconstruct garden houses and summer-houses into residential buildings in the areas adjacent to the harbour and the railway. It is also not recommended to construct new residential buildings in the harbour area due to air pollution and high noise level.

According to the comprehensive plan of Jõelähtme rural municipality the expanding part of the harbour is locating in Jõelähtme rural municipality. According to the comprehensive plan of Jõelähtme rural municipality the activity planned on the territory of the rural municipality –

the extension of Muuga Harbour – affects the environment through the operation of the harbour, Muuga railway station, the railway and road of the harbour, which is accompanied by: industrial and transport noise, noise from technological equipment; pollution of ambient air by fertiliser and coal dust and gaseous pollutants and potential pollution by oil products. The comprehensive plan requires the establishment, ensuring, planting with vegetation of a sanitary protection zone. So far an estimated sanitary protection zone of 100 m has been left for the harbour. Background noise level shall be checked and noise and dust barriers shall be constructed. It is necessary to establish a single transit corridor for the rail and road transport of Muuga Harbour together with the sanitary protection zone against noise, as a result of which the transit traffic in the area of gardening associations should decrease.

One of the strategic activities mentioned among other things in the comprehensive plan of Jõelähtme rural municipality is as follows: it is necessary to ensure decent living conditions to the inhabitants near Muuga Harbour proceeding from noise and vibration limits. Measures implemented for noise control during harbour extension should make living conditions more acceptable. The existence of Muuga Harbour in the given area is still inevitable and noise disturbances from the activity of the railway station stay and these cannot be liquidated totally. Still, the railway branches of railway extension are added seawards from the existing station and remain further from residential buildings than the existing railways. Therefore increase in the noise level will not be considerable, as the main noise sources for the residential areas remain the same.

The western part of Muuga Harbour is located in the territory of Viimsi rural municipality. Viimsi rural municipality sees Muuga Harbour and its industrial development as the weak point of its prerequisites for development (comprehensive plan of Viimsi rural municipality), which means that the intensive development of the harbour, including the transit transport has a certain negative impact on the environment and the welfare of the inhabitants. At the same time the extension of Muuga Harbour and the increase of transit is viewed as a possibility, also the restructuring of the harbour, to reduce the hazardous impacts on the environment. Muuga Harbour offers possibilities also to Jõelähtme rural municipality. However, the harbour with its activity represents also a threat to residential areas, including due to the increase of air pollution.

The central part of Muuga Harbour is located on the territory of the town of Maardu, where the harbour administrative building and the extended container terminal remain. In the development plan of the town of Maardu supporting of harbour development and in relation to this development of transit and construction of the transit corridor connecting Muuga Harbour and Tallinn-Narva Road are considered important, plans also foresee the construction of a multi-layer traffic knot of Peterburi Road and Muuga Harbour.

A very actively used railway branch directed to Muuga Harbour passes through Muuga. Residents of Muuga are disturbed by noise and vibration accompanying cargoes directed to Muuga Harbour. Heavy cargoes also move at night, due to which noise occurs also at night. Therefore it is necessary to develop alleviating measures to the railway branches passing through Muuga. In the course of preparing of the general plan of Maardu a dialogue with railway transporters shall be started and possibilities for the alleviation of the accompanying negative impacts shall be found. As concrete measures construction of a noise abatement barrier, review of train schedules, technical possibilities for the decreasing of vibration (a more decent railway bed, technical state of the rails, etc) should be considered. Plans foresee the designing/construction of functioning green buffer areas and noise barrier between production and residential areas.

Based on the aforementioned Muuga Harbour extension may have negative impacts on the health and welfare of people in the form of air pollution (fertilizer dust and fluorides) and disturbances due to noise generated by transport (above all railway). The property of the harbour and operators may be damaged by fertilizer dust emerging from the fertilizer terminal. Upon implementing the measures of environmental protection the reaching of fertilizer dust to the dwelling houses of the area is quite unlikely.

Several measures shall be applied (chapter 5) for ensuring the welfare of the inhabitants of the region, especially of Uusküla; for both reducing the noise level and prevention of possible air pollution. It is possible by terminal operators to avoid air pollution emissions emerging from the harbour.

According to Harju county plan the cargo and passenger harbours located in Harju county have a good development potential and constitute the main share of the Estonian foreign and transit cargo volume. The planned development trend includes extension of cargo and passenger harbours and increasing of the throughput capacity of the infrastructure related to this (roads, railways), thereby following the requirements set to the quality of human environment.

4.13.2. Impact on Climate and Cultural Heritage

In the course of Muuga Harbour extension and operation pollutants are not emitted into the ambient air in the quantities having substantial impact on ambient air quality and based on this substantially influencing the climate. Transport vehicles may have an indirect impact on the climate. At the organization of transport it has to be kept in mind that vehicles use fossil fuels and emit exhaust gases into the air, including greenhouse gases. Hence, as the transport of cargo is to the extent of 90-95 % performed by railway and the rest by motor transport the impact of air pollutants proceeding from this is minimal. Also, the impact of cargo vessels and railway transport on ambient air and climate is not substantial, as the amount of air emissions is small, compared to auto transport or some other production activity.

Muuga Harbour eastern part extension is not expected to have a negative impact on the cultural heritage of the area. The valuable landscape nearest to the area includes Kallavere traditional landscape, which is traditional village landscape next to the panel houses of the residential area of Maardu town. Harbour construction activity remains sufficiently far from the aforementioned area and harbour extension in the given limits will not influence this. Also, harbour extension will not influence Rebala heritage conservation area, where many archeological and architectural monuments remain in Rebala village south-east of Maardu town.

4.13.3. Economic Impacts and Volumes of Roads and Railway

Muuga Harbour plays an important role in Estonian transit trade thanks to its favourable location and good rail and road connection with the inland. Muuga Harbour holds a lead position in the handling of cargo flows between Russia and Western Europe. The goods turnover of Muuga Harbour forms three fourths of the total turnover of Port of Tallinn and approximately 90% of the total volume of the goods in transit passing through Estonia. The extension of Muuga Harbour increases the percentage of transit trade even more. The objective of the extension of the eastern part of Muuga Harbour is to increase the efficiency of the operation of the harbour by stressing at the same time the network of connecting roads passing through Europe.

The extension of Muuga Harbour has to be seen in the larger context of an overall Trans-European Network (TEN-T) of which Muuga Harbour forms an integral part. Therefore the extension of Muuga Harbour is important also more broadly than only in the regional or national frames. Estonia is part of the multimodal Pan-European Corridor I, which is one of nine EU priority projects linking countries in Central and Eastern Europe with regions in Western Europe. The corridor stretches from Helsinki to Warsaw through the cities of Tallinn, Riga, Vilnius and Kaunas. The main points of destination and origin of the corridor are defined by the harbours in Estonian Northern coast, from which Muuga Harbour offers easy navigational access and deep waters.

Muuga Harbour is also an integral part of the connecting routes of Via Baltica and Railway Baltica, which link transport flows between Finland and Continental Europe. This situation guarantees Muuga Harbour a strong competitive situation against its neighbouring countries in the future.

Port development will likely raise real estate prices on the areas bordering on the harbour, which purpose is not residential land, but production land or business land for development of business. Real estate prices of residential land bordering directly on the harbour may decrease, if the purpose of land remains the same.

Muuga Harbour is connected to Tallinn-Narva Road by Põhjaranna tee, where in relation to harbour development increase in truck traffic volume is expected. Intensifying of motor transport proceeds above all from increasing of container traffic. By 2025, the volume of harbour related truck traffic is forecasted to increase by 40 %. In relation to harbour development it is necessary to reconstruct the transit corridor connecting Muuga Harbour and Tallinn-Narva Road by 2010.

The present share of truck traffic on Tallinn-Narva Road generated by Muuga Harbour is around 8% of the overall traffic volume. Additional truck traffic will contribute with a share of around 11-12% in the year 2025 (based on an assumed constant volume of average daily road traffic).

Expected rail cargo volumes increase more than twice by the year 2025. The capacity improvement of the railway will be necessary by the year 2010.

4.13.4. Maritime Safety

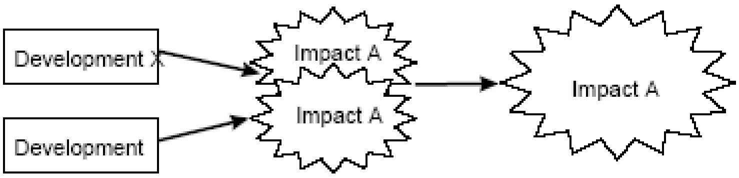
The basin of Muuga Harbour is open to north-western, northern and north-eastern winds, which shall be taken into account from the point of view of maritime safety. If the speed of a wind blowing from these directions is above 17 m/s, laying in the harbour, in particular at the piers No. 4, 7, 8 and 11, becomes dangerous for the ships due to high waves. If the wave height is above 1.5 m, the use of harbour tugs is limited. In this case the resolution on the departure of the ship shall be adopted by the captain of the ship in co-ordination with the department of the harbour master.

The wave conditions, which prevent the loading operations, vary as for wave length, vessel size, berthing orientation, goods handling, the used equipment and other factors. The wave height 0.60 m may be considered mean threshold for cargo ships, in case of which the ship can be operated without difficulties. Bigger ships and bulk vessels are able to adapt to higher waves. Smaller ships, mainly upon container carriages, may have different problems upon loading and unloading of goods.

The northern quays in the extension area of the harbour are better protected against waves than the southern ones. As compared to the variant of the planned activity (quay line with two basins), the main disadvantage of the alternatives 1 and 3 (with a straight quay line) is the negative impact of waves on ships and loading operations, which may occur in 6% a year. At the same the variants 1 and 3 offer better flexibility in the location of berths and easier and safer berthing of ships. However, the ships shall use one and the same entrance canal, which may be a bottleneck in case of more intense traffic.

4.14. Cumulative and Indirect Impacts and Impact Interactions

Cumulative and indirect impacts and impact interactions result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project.



Cumulative Impact

In case of this project the following may be viewed as cumulative and indirect impacts and interactions and impact sources:

1. Impact on air: the constructed coal terminal + the planned fertilizer terminal
2. Noise: Muuga railway station + the extension of Muuga Harbour
3. Impact on marine biota and seawater status: approximately one fifth will be added to the goods turnover of Muuga Harbour upon the completion of the new terminals.

A serious issue in assessing environmental impact is the determination of **indirect** and **cumulative** impacts and impact interactions (*Guidelines For The Assessment of Indirect And Cumulative Impacts And Impact Interactions*, 1999). The definitions of the three types of these impacts overlap to a greater or lesser extents. However, there is a lack of universally accepted definitions (*Guidelines...*). The implemented environmental impact assessments therefore consider all three types of impacts under one combined title – cumulative impacts. On a principal level, this approach is justified, since the accumulation aspect is common to all three environmental impact types. However, the assessment of all three impact types must move from „analysis to synthesis“, using the widest possible differentiation between the impact areas (Table 4.15).

Table 4.15. Opinion of an expert

IMPACTS			Identification	Evaluation
Indirect	Interactions	Cumulative		
√	√	√	√	√

This document has used the step scheme of environmental impact (Table 4.16) in discussing the aforementioned three-type impacts, determining the development components (A); complex planned activities (B); influencing milieu receptors (C); and cumulative, incl. indirect and interactive impact (D).

On the one hand, the cumulative impact assessment matrix (Table 4.17) treats the whole life cycle (from foundation to demolition) of the planned activity. On the other hand, the matrix discusses what has happened in the past, what is happening now and what could happen in the future.

Table 4.16. Stepped scheme of environmental impacts

A Development components
- Harbour quays
- Storages, equipment
- Access
- Navigation channels

B **Activities**
- Dredging
- Dumping
- Land reclamation
- Formation of infrastructure
- Road construction
- Parking and organizing technological process
- Designing works and landscape

C **Receptor**
- Coast
- Coastline
- Landscape of littoral zone
- Landscape of contact area
- Protected areas
- Dwelling area

D **Cumulative and indirect impacts and impact interactions**
- Soil removal, sediment formation and coastline change
- Changes of marine biota
- Changes of bird fauna
- Waves and currents conditions and changes of coast abrasion
- Landscape changes
- Changes of living conditions, environmental damage and disturbances

Muuga Harbour is the largest sea transport junction of Estonia, handling 31 million tons of shipments a year. In the next 20 years, the shipment turnover will be increased to 73 million tons a year, incl. 50 million tons of liquid bulk.

13 fuel terminals are located in the harbour and its surrounding areas. 24 million tons of liquid fuel passes through the harbour in one year. Two air monitoring stations are active in the harbour. Since the summer of 2005, the coal terminal is working in the eastern part of the harbour, on the north side of the planned expansion area, handling over 250 wagons of coal a day.

The western part of the harbour is home to the fertilizer terminal (2.2 million tons a year). A second fertilizer terminal (3.0 million tons a year, presumably also ammonium nitrate) is planned in the eastern part of the harbour by 2015.

Table 4.17. Impacts matrix

Potential impact area, resource and factor affected	Activities						Cumulative impact, incl. indirect impact and impact interactions
	Construc-tion	Opera-tion	Mitigation	Past activities	Planned activities	Future activities	
1	2	3	4	5	6	7	8
– Landscape of contact area	x x	x	+	x x	x...x x x	x x	x x
– Landscape of littoral zone	x x x	x		x x	x	x...x x x	x x
– Adjoining area of harbour basin	x x x	x...x x	+	x x	x x	x x x	x x
– Other harbour basin	x x	x		x x x	x x	x...x x x	x x
– Dumping area	x x x	x	+	x x x	x x	x x x	x x x
– Other area of open sea	x x	x		x x x	x x	x x...x x x	x x
– Quality of sea water in harbour basin and in dumping site	x x x	x	+	x x	x x	x x...x x x	x x
– Quality of ground water	o	o	+	x x x	x x	x x	x x x
– Quality of surface water	x	o	+	x x	x x	x x	x x
– Benthic biota	x x x	x		x x x	x x	x...x x x	x x
– Fish fauna	x x x	x	+	x x x	x x	x...x x x	x x
– Bird fauna	x x x	x	+	x x x	x	x	o
– Coastline change	x x x	o		x x x...+	x	x x...+	x x x...+
– Coast abrasion	x	o		x x	x	x x	x x
– Quality of ambient air	x x x	x	+	x x x	x x x	x...x x x	K M
– Noise	x x x	x x	+	x x x	x x x	x x...x x x	x x x K M
– Light impact	x x	x x		x x	x x	x x	K M
– Rural living conditions	x x x	x x	+	x x x	x x...x x x	x x...x x x	x x
– Urban living conditions	x x	x		x x	x x	x x	x

– Recreational conditions	x x x	x x		x x x	x x	x x	x
– Cultural heritage	x x	o		x x x	x	x x	x
– Protected areas	x	x	+	x x	x	x	x
– Remote impact, incl. transboundary impact	o	o		x	o...x	o...x	o
– Microclimate	x x	x		x x x	x	x x	x x
– Land use	+	+		x x x...+	x x	x x...+	x x...+
– Risk occurrence	x	x x x	+	x x x	x x x	x x x	x x x K M
– Sustainable use of natural resources	x x x	+	+	x x x...+	x x...+	x x x...+	+

Explanation:

o – non-existent or inconsiderable impact
x – relatively inconsiderable impact
xx – moderate impact
xxx – relevant impact
K M – impact interactions
+ – jointly beneficial impact

Muuga Harbour and its land transport (railway, highway) technical infrastructure is a polyfunctional community that handles diverse liquid and dry bulk. Several habitats and residential areas, home to over 20 thousand people, are close to the harbour.

As such, the harbour's activity has significant environmental impact (incl. cumulative impact) and risk level.

The cumulative load of air pollution is formed from:

- organic hydrocarbons (benzene, toluene, xylene) that are emitted during the handling of liquid fuel in the chain railroad train unit – terminal – tanker;
- solid particles (dust) from the (existing and planned) fertilizer terminals;
- solid particles (dust) from the coal terminal;
- solid particles (dust) from other dry bulk;
- solid particles from metal cargo terminal;
- emissions from the other harbour operations and service area maintenance.

Dispersion calculations about the cumulative impact of fertilizer handling operations and coal terminal emissions showed that the level of air pollution in the air layer near the surface on the production territory does not exceed the maximum allowed value even with the simultaneous operation of all planned pollution sources. While this may generally be the case, there could always be exceptions.

The cumulative aspect must also take into account the cumulative impact of organic hydrocarbons emission that are based on liquid fuel handling and solid particle (primarily dust) emission created during the handling of solid cargo (coal, fertilizers, other dry bulk, metal etc). Here we do not just consider the emissions exceeding the maximum allowed levels, but also the impact that causes environmental disturbance. Environmental disturbance does not have to mean just the olfactory effect, but also dust; noise; the gathering of birds, rodents or insects; the presence of aerosols in the air; or the dispersal of the waste due to the winds (*Waste Act* § 18). The human as an organoleptic receptor is the best meter. Organoleptic assessment should also be written into the legislation concerning the assessment of solid particles, noise, light pollution and other visual effects in the air.

When considering accumulation, it must be emphasized that the aromatic, organic volatile compounds include carcinogenic compounds the effect of which is amplified by the solid particles in the air. Noise pollution, a very individually perceived phenomenon, may add its own impulse to the matter. However, noise is a technogenic environmental factor that affects the persons even when they think they are used to it. Sound accumulation is expressed in unnoticed deafening.

The increasing goods turnover in terms of time and thus, the increasing cargoes cause the increase of the noise level. Both, the noise caused by direct activity of the harbour and the noise of rail transport and road transport, cause disturbances to the inhabitants of the area.

The author hereby presents the following rule as a hypothesis:

$$M_1 + M_2 + M_3 + \ldots + M_n < 1,$$

where $M_{1 \ldots} M_n$ is the portion of various pollution factors (odour, noise, solid particles etc) from their maximum allowed values, whereas M must be less than 1 ($M < 1$).

According to the dispersion calculation of this report, the maximum dust concentration at the nearest residential building can be 0.2 of the maximum allowed value (M_1) and the concentration of fluorides can be 0.4 of the maximum allowed value (M_2). The proportion of the noise cause by the railway is 0.8 ... 1.1 (M_3) of the maximum allowed nightly noise level (incl. equivalent level). The emission of organic compounds that originate from the harbour fuel terminals at the beginning of 2006 has exceeded the disturbance level ($M_4 > 1$). In a simplified way, the cumulative impact can be expressed as follows:

$$0{,}2 + 0{,}4 + (0{,}8 \ldots 1{,}1) + (> 1) > 3{,}5$$

Therefore $M > 1$.

The cumulative impact of the planned activity area to the contact area and littoral zone landscape, harbour aquatic area, open sea, marine biota, sea water and groundwater quality, and coast abrasion can be considered moderate (Table 4.17).

Considering the activities planned for the future (incl. repeated dredging and demolition activities), the cumulative impact on the dumping area must be considered significant. Since the railway has turned out to be the cause of local groundwater pollution, it is considered significant in terms of cumulative impact. Noise as a technogenic environmental factor is considered significant due to its cumulative creation sources.

The planned activity will have considerable impact on the region’s coastline. About 90 ha of land (filled area) is taken from the sea. This output must be considered in two ways – first as a significantly negative impact factor, but in the future also as a positive phenomenon.

Since only a very small portion of the dredged soil is reused due to economic concerns, the assessment for the construction period cannot consider this a sustainable use of natural resource. However, the sustainable use of the natural resource in the form of sea resource will become evident later when the harbour is exploited.

The modelling of the spread of marine pollution indicated the spreading direction and speed. The probability of pollution hazard will increase proportionally with the increase of the goods turnover (in 2025 ca 75 million t/y, from which the part of the harbour to be extended will provide ca 13%), according to which the preparedness of control shall be planned.

4.15. Hazards and Risks Arising from the Extension of Muuga Harbour

Due to the character of the goods handled in the terminals to be constructed, the extended eastern part of Muuga Harbour will not pose bigger hazards and risks to the environment than the existing western part of the harbour, where liquid goods are handled in oil terminals. The likelihood of the occurrence of potential emergency situations will increase due to the intensification of shipping traffic.

There are also certain risks in the terminal of fertilizers upon the handling of ammonium nitrate.

4.15.1. Spreading of Oil Pollution

Oil pollution occurs at sea in an emergency situation, where an operative prognosis shall be received about the potential behaviour of the pollution in order to control the limitation and the elimination of the pollution. The system of prognosis shall be easily controlled, reliable and sufficiently accurate.

In order to determine the circulation of coastal waters a system of related models has been developed in the Estonian Marine Institute – the model of the operative prognosis of currents and the spreading of oil pollution (Elken, 2001).

The modelling of horizontal components of currents is of primary importance upon the development of the model. The spread of the pollution, which may accompany the operation of the harbour, in particular the probable routes and distances of the spread, depend directly on them.

In the context of the harbour the currents are of determinative importance as the influencer of the pollution spread and they have a moderate role in the formation of navigation conditions. In the experiment made for the determination of the spread of potential oil pollution (both, emergency leakages and incorrect handling of bilge waters) the 68-days long time row of modelled currents starting from 04.07.1997 was used. In every 20 minutes 100 markers indicating oil pollution were left drifting with the currents in the square with the side length of 115 m. The following was found out upon the calculation of the probability of the occurrence of oil pollution: number of days a year, during which oil pollution may occur in a square with the area of 1 ha.

The spatial division of the probability of oil pollution spread (figure 4.10, source: *Elken, Kõuts, 2003. Estonian Marine Institute. Monitoring of the Marine Environment of Muuga Harbour 2002*) indicates that in case of an oil leakage occurring at Muuga Harbour, the probable spread of oil pollution in case of the weather used in the experiment is mainly 2 km to the east within 24 hours. Rapid oil spread is prevented here by the whirlpools forming often east from the harbour. Small transmission speeds facilitate localisation and collection of oil pollution. The area remaining east from the harbour up to Cape Tahkumäe is endangered most of all.

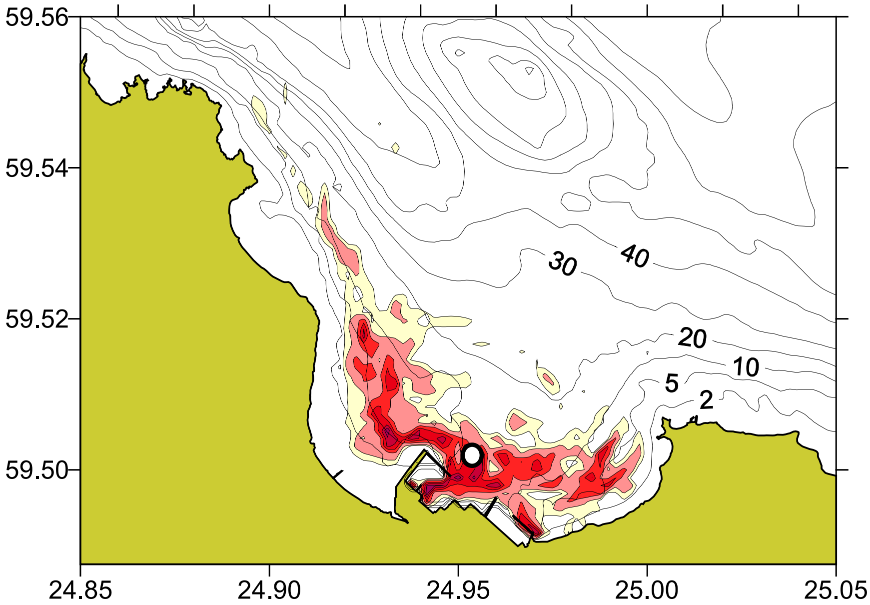


Figure 4.10. Probability of the oil pollution spread 24 hours after the accident. The pollution source has been marked by a circle. The values of isorithms 0.05, 0.1, 0.2, 0.3 etc. days a year, during which oil pollution may occur in a square of 1 ha. Depth lines have been marked on the figure.

Oil pollution may spread 4 km, more probably 2 km north-west, along the coast of Viimsi peninsula. Thereat the currents, which speed is the highest a little away from the coast at the depth of 5-10 m, do not facilitate (on an average) the reaching of the pollution to the coast.

The mazut pollution of the tanker "Alambra", which occurred in September 2000 (the leakage was discovered 16.09.2000) proves that a smaller probability of the pollution spread towards Viimsi Peninsula does not still exclude such an event.

The model of the currents and pollution spread in Muuga Bay shall be implemented into the operational work of the harbour in real time in order to be prepared for emergency situations in the waters of Muuga Harbour. It is also necessary to connect the automatic meteorological station and the calculation model into a single information-technological system.

The physical and calculation part of the model are on such a level that its results could be used in the operational work of the harbour. At the same time additional investigations and audit measurements shall be performed.

Muuga Harbour is prepared to limit and remove a possible oil spill. The pollution response equipment includes 3 cleanup ships, 2950 meters of oil barriers or booms, a boom installer, 6 skimmers for collecting the oil from the water surface (incl. 4 brush skimmers), various pumps, power blocks, a steam generator, bilge water collector, transport means. There are also people trained to prevent pollution and ready around the clock.

4.15.2. Ammonium Nitrate

This report has considered that the possible fertilizer type to be handled in the dry bulk terminal to be built in the eastern part of Muuga Harbour will include ammonium nitrate fertilizers.

Ammonium nitrate with high nitrogen content is a dangerous chemical, which threshold quantity of enterprises liable to be affected by major accident and dangerous enterprises is 1250 tons pursuant to the EU Directive 2003/105 and Regulation No 67 of the Minister of

Economic Affairs and Communication of 14 June 2005 *The Minimum Hazard Level of Chemicals, the Threshold Quantities of Dangerous Chemicals, the Hazard Category of Enterprises Liable to be Affected by a Major Accident and the Procedure for the Identification of Dangerous Enterprises* (RTL, 30.06.2005, 72, 994).

At ambient temperature the decomposition of ammonium nitrate is slow, which is of no practical importance. When the temperature rises the speed of the decomposition process will increase. At the temperature of 65°C and above that spontaneous decomposition of ammonium nitrate will begin together with the release of heat and the emission of water vapour and nitrogen oxides. At the temperatures 200-210°C, regardless of the existence of air, intensive decomposition takes place with the release of heat and emission of toxic nitrogen oxides, which leave the impression of smoke. Once begun, the decomposition process will become self-sustained and it can be stopped only by intense cooling (by the use of good ventilation and plenty of water). However, if the temperature reaches 300-350°C, ammonium nitrate will explode with the whole mass. The explosion power is increased by an enclosed area and several impurities. A big amount of toxic nitrogen oxides will be emitted as a result of the explosion. The concentration of one of them, nitrogen dioxide, above 2 mg/m^3 is already dangerous.

The chemical stability of ammonium nitrate is decreased (the instability and explosiveness is increased) by several factors, such as sintering or disintegration of granules due to recrystallization at certain temperatures, which are -16, 32, 84 and 125°C. The mixture of any combustible material with ammonium nitrate is extremely dangerous. Also, the increase of acidity makes ammonium nitrate more explosive hazardous.

The instructions worked out in Russia for safe transport of ammonium nitrate on ships requires a possibility to measure the content of oxygen and nitrogen oxides in holds.

A dry storage space at the temperature between -15 and +30°C is the safest for ammonium nitrate. In this sense a domed storage facility would be the most suitable way in our climatic zone for keeping the necessary temperature and dryness of air. A significant disadvantage of a domed storage facility upon the storage of ammonium nitrate is the fact that there is no ventilation and the potentially hazardous chemical processes in the heaps can be detected only when it is hopelessly late to do something.

The risk is increased also by the fact that ammonium nitrate is produced in Russia and it is transported by train. We do not have adequate control over relatively important links of the logistic chain. Thus there is a non-zero probability that ammonium nitrate will be polluted or spoiled in some other way before reaching the storage facility in Muuga and a source of the decomposition of ammonium nitrate may form in the storage facility. So the probability of an explosion cannot be considered as non-existing. Taking the disastrousness of the consequences into account it is, in the end, a very serious risk, which must not be ignored.

If to presume modestly that there are 100 victims in case of the explosion of 18,000 tons of ammonium nitrate, one should not acquiesce to the probability of explosion above 10^{-12} a year according the general standpoints in the world. This probability is millions of times smaller than the probability that there is a wagon with hazardously substandard ammonium nitrate or there will be a deviation in some other point of the handling chain, which may lead to hazardous decomposition of ammonium nitrate in the domed storage facility. Figuratively expressed, if 60,000 of 50-ton wagons with ammonium nitrate are transported through the storage complex a year, the probability 10^{-6} indicates that, as statistical average, there may be one wagon with substandard (spoiled) ammonium nitrate once in 17 years. But this does not exclude the possibility that it will happen in the near future and several times in succession. If now only one event per 100,000 such wagons would realise as an explosion, the risk would be 10 times bigger than the risk acceptable in this case (10^{-12}).

Dangerous chemicals and the requirements to their storage facilities, means of transport and equipment shall be established by a regulation of the Minister of Economic Affairs and Communications. There are the following regulations concerning it:

- Regulation No. 106 of the Minister of Transport and Communications of 6 December 2000 *Requirements for Storage Facilities for and Places of Loading, Unloading and Transhipment of Chemicals, and for Other Structures Necessary for Handling of Chemicals in Ports, Road Transport Terminals, Railway Stations and Airports and Particular Requirements for Handling Ammonium Nitrate* (RTL 2001, 7, 110; 2003, 47, 687; 2005, 106, 1629);

Chapter 3^1 will set special requirements on the handling of ammonium nitrate, incl. ammonium nitrate fertilizers. The fertilizer terminal operator must follow the safe handling requirements set for the chemicals and be aware of the hazardous properties of ammonium nitrate.

Ammonium nitrate must be kept separate from other chemicals, in order to avoid contact with materials that increase the fire and explosion hazard of ammonium nitrate. The substance must be stored in a precipitation-proof, locked and fire-resistant building where the floor is of concrete or other non-flammable material. If required, the storage building must have plenty of ventilation and also sufficient fire-extinguisher and first aid resources and water. The storage personnel must be aware of the correct behaviour during a fire.

If the fertilizer terminal storage holds over 3000 tons of ammonium nitrate, the load's internal temperature and nitrogen oxide content in the air must be measured at least twice per 24 hours using calibrated temperature or gas sensors.

Upon designing of a construction planned for handling of ammonium nitrate in the amount of over 100 tons, environmental impact assessment shall be carried out according to *Environmental Impact Assessment and Environmental Management System Act* for determining environmental impacts.

- Regulation No. 55 of the Minister of Economic Affairs and Communication of 3 April 2003 *Requirements for Means of Transport* (RTL, 14.04.2003, 47, 688);
- Regulation No 67 of the Minister of Economic Affairs and Communication of 14 June 2005 *The Minimum Hazard Level of Chemicals, the Threshold Quantities of Dangerous Chemicals, the Hazard Category of Enterprises Liable to be Affected by a Major Accident and the Procedure for the Identification of Dangerous Enterprises* (RTL, 30.06.2005, 72, 994).

5. MEASURES SUGGESTED FOR AVOIDANCE AND MITIGATION OF NEGATIVE ENVIRONMENTAL IMPACT

5.1. Best Available Technique

Best available technique (BAT) is a way of acting where the company employs a production system that has the least possible effect on the environment during its whole life cycle. The BAT implementation obligation is compulsory for companies that apply for an environmental complex permit according to the *Integrated Pollution Prevention and Control Act*. According to the *Ambient Air Protection Act*, the possessor of a stationary pollution source shall use the best available technique, energy-saving technology, environmentally friendly energy sources and abatement equipment in order to reduce pollutant amounts as much as it is technically possible and economically reasonable, especially in the face of potential damage.

- **Best** means most effective in achieving a high general level of protection of the environment as a whole.
- **Techniques** includes both the technology used and the way in which the installation is designed, built, maintained, operated, terminated and closed.
- **Available techniques** means up-to-date techniques reasonably accessible to the operator and the implementation of which is economically and technically viable, taking into consideration the costs and advantages, and which ensures the best compliance with the environmental requirements.

According to *Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control* (IPPC Directive) BAT shall mean the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole.

Pollution should rather be avoided during handling than removed in the final cleanup. Avoidance means minimizing pollution, using environmentally friendly raw materials, producing environmentally friendly products and using resources (water, energy, raw materials) efficiently.

The BAT must correspond to the most efficient and developed level of the activity field and its implemented work methods. In order to determine the best possible equipment in a field of activity, the European Integrated Pollution Prevention and Control Bureau has designed the recommended documents (BREF – BAT Reference Notes) that offer instructions about technologies to the fields or sub-fields of activity. The BREFs are all-encompassing and give detailed overviews of the techniques that are currently considered to be the best and include the levels of special pollution and production costs that can be achieved by using the BAT.

- Recommendations about the best available techniques concerning emissions in dry bulk cargo storage are found in the document: *Reference Document on Best Available Techniques on Emissions from Storage. January 2005.*
- Recommendations on the BAT is also available for large chemicals and fertilizers industries: *Draft Reference Document on Best Available Techniques in the Large Volume Inorganic Chemicals, Ammonia, Acids and Fertilizers Industries, Draft March 2004*, but this does not directly affect fertilizer transport and storage outside the production companies.

The operator cannot be forced to choose a specific technology, however it must guarantee that the BAT principles are followed by limit values, resource usage and waste creation norms. If it is technically and economically acceptable, technologies lacking in waste or technologies that recycle waste should be preferred.

Considerations to be taken into account when determining best available techniques, bearing in mind the likely costs and benefits of a measure and the principles of precaution and prevention:

1. the use of low-waste technology;
2. the use of less hazardous substances;
3. the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate;
4. comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;
5. technological advances and changes in scientific knowledge and understanding;
6. the nature, effects and volume of the emissions concerned;
7. the commissioning dates for new or existing installations;
8. the length of time needed to introduce the best available technique;
9. the consumption and nature of raw materials (including water) used in the process and their energy efficiency;
10. the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
11. the need to prevent accidents and to minimize the consequences for the environment;
12. the information published by the Commission or by international organizations on best available techniques, associated monitoring, and developments in them.

By the Directive *emission limit values* shall mean the mass, expressed in terms of certain specific parameters, concentration and/or level of an emission, which may not be exceeded during one or more periods of time. Emission limit values may also be laid down for certain groups, families or categories of substances, in particular for those listed in Annex III. In Annex III there is an indicative list of the main polluting substances to be taken into account if they are relevant for fixing emission limit values. Taking into account the emissions into water and air from the activity of fertilizer terminal, the list contains:

- Air – dust; fluorine and its compounds;
- Water – materials in suspension; substances which contribute to eutrophication (in particular, nitrates and phosphates)

Implementing the best available technique will demand additional expenses from the company, but will later help to save on exploitation costs that may be incurred through pollution charge, especially for pollution that exceeds the norms. Using the best available technique will also give a certain feeling of confidence to both the company and the other companies and inhabitants in the area that the possible negative environmental impact has been minimized.

5.2. Protection of Ambient Air

When choosing the technology for loading of dry bulk the best available technique and most modern technologies should be applied, with loading sites covered and protected from weather. In designing the terminal and selecting the technology, attention must be paid to the measures that reduce the spread of fertilizer dust.

The simplest methods for reducing dust emission are moisturising, chemical stabilization and reducing the wind effect. The cheapest of them is moisturising, but its effect is only temporary. Chemical stabilization is expensive and may have adverse side effects.

When considering the application of best available techniques upon loading of dry bulk in harbour the reference document of European IPPC Bureau (Sevilla Bureau) on the best available techniques (BAT) (*Reference Document on Best Available Techniques on Emissions from Storage.* January 2005) must be followed. The following recommendations for dust reduction in storage of dry bulk cargo can be pointed out in the document:

- reduction of the drop height when the material is discharged;
- total closure of grab/jaws after material pick-up;
- avoiding of open loading process with high wind speed (more than 15 m/s);
- choosing the right speed of a conveyor;
- avoiding overloading of a conveyor;
- reduction of transport distances on loading from one location to another;
- regular cleaning of equipment and territory;
- usage of cascade systems;
- usage of moistening equipment;
- usage of closed conveyors;
- usage of closed storage.

In choosing the loading technology, transporters and cleaning equipment, the aforementioned organizational and technical means must be taken into account. The equipment selection and means for controlling dust emission will also depend on the type of fertilizer with several significant factors, like the product's caking ability, chemical stability, moisture sensitivity etc.

In compiling the fertilizer terminal project and organizing its work, the following principles must be taken into account:

- The fertilizers cannot be accepted, loaded or transferred in a pneumatic way.
- Conveyers, elevators and mixers must be enclosed and their covers must reduce air pollution and always be in a good shape and checked.
- In ship loading, the conveyers must also be covered and a special cascade pipe must be used in the direction of the flow into the hold.
- The fertilizer unloading area must be completely enclosed and the doors must be shut during loading. The unloading equipment must be such that can reduce dust emissions during loading (be equipped with a loading sleeve and loading jag). Fertilizer dust

must be sucked away during unloading in order to reduce volatile emissions. The unloading area must not emit visually observable air emissions.

- It is necessary to constantly catch the dust during the technological process with dust filter equipment in both the loading unit and conveyers. Air pollution reduction means must be checked for work status and reliability.
- Concrete instructions for preventing the spread of dust shall be provided in the rules of operation of the devices of the fertilizer terminal, in particular of the loading systems.
- The chief dispatcher and work supervisor (shift supervisor) will ensure that fertilizer handling goes according to the technological scheme and requirements. Weather conditions must also be monitored and the fertilizer loading process must be adjusted according to the wind strength and direction.

Duties of possessor of stationary source of pollution

The possessor of a stationary source of pollution shall:

- guarantee that the quantities of pollutants released into the ambient air by the source of pollution in the possession thereof are not higher than the established environmental targets or cause the limit values of ambient air pollution in the area to be exceeded.
- use the best available techniques, technology which promotes energy conservation, environmental friendly sources of energy and abatement equipment to reduce emission levels of pollutants in so far as it is technically possible and economically viable, taking into consideration the expenses to be incurred and possible damage.
- plan measures for limitation of the quantities of pollutants released into the ambient air with the aim to reduce levels of pollution in the event of unfavourable weather conditions.
- use equipment installed for the abatement of pollutants, regularly check their efficacy and keep documented records of the checks;
- If the limit value or target value of the pollution levels in the air layer near the surface of the area around a source of pollution is exceeded, the possessor of the source of pollution shall apply the measures for reduction of the emission levels of pollutants in order to bring the level of pollution in conformity with the limit or target values of pollution levels.

At loading, storing and using of dry bulk materials used for construction work, best available work methods must be used on the construction site located on the harbour's territory in order to reduce the amount of emitted dust. Dust emissions at the construction works can be reduced by the following methods: reducing the falling height of materials; covering construction materials during transport and storage; reducing transport distances; using dust catching and vacuuming equipment; periodically cleaning the roads and equipment of the construction lot; avoiding the loading of dry bulk construction materials during strong winds. During the transportation of dry bulk building materials the load must be covered in order to avoid dust emission.

- Government of the Republic Regulation No. 377 of 8 December 1999 *Occupational Health and Safety Requirements at Construction Sites* (RT I, 17.12.1999, 94, 838), section 4, subsection 3 establishes that: the building contractor shall ensure that, before construction work commences, a safety and health plan is prepared setting out, which must envisage also the measures to avoid noise and air contamination in the immediate vicinity of the construction site.

Other mitigation measures for protection of ambient air:

- The preservation of the green zone around the harbour shall be ensured. Only communications and light traffic servicing the harbour may pass the green zone.
- Along road sections of intensive traffic, firstly in residential areas, as many trees and bushes as possible must be planted or preserved. One roadside row of them reduces 7–10 % the contamination with exhaust gases of ambient air, two rows of trees and bushes – for 30–40 %, and four rows of trees and two rows of bushes – 50–60 %. In winter the protective effect of trees is 3–4 times less than in summer (Rannamäe, 1993). In addition to the existing wooded area, greenery must be added to the external borders of the terminals on the eastern part of the harbour territory and along the Hoidla road and parallel cycling/walkway (in strips of at least 3-4 meters) in the total length of the road (ca 1350 m).
- The concentration of contaminants in exhaust gases of vehicles and their noise level must meet the requirements established by the Regulation of the Minister of the Environment No. 122 of 22 September 2004 *Maximum permissible concentrations of contaminants in exhaust gases and noise level of motor transport* (RTL, 27.09.2004, 128, 1986).
- For protection of people, works with heightened noise level generated by building equipment and machinery (sinking of piles, transport, construction of quays, etc.) must be carried out during the daytime.

5.3. Ensuring safety in fertilizer terminal

The *Chemical Act* sets conditions for the handling and safety of chemicals that a chemical handler must adhere to in its activity.

Regulation No. 106 of the Minister of Transport and Communications of 6 December 2000, amended by Regulation No. 121 of Minister of Economic Affairs and Communications of 13 October 2005, *Requirements for Storage Facilities for and Places of Loading, Unloading and Transhipment of Chemicals, and for Other Structures Necessary for Handling of Chemicals in Ports, Road Transport Terminals, Railway Stations and Airports and Particular Requirements for Handling Ammonium Nitrate* shall be observed upon the storage and loading of ammonium nitrate as a dangerous chemical (see section 4.15.2).

All ammonium nitrate based fertilizers are, under normal conditions stable materials which in themselves present no risk. Most fertilizer grades of ammonium nitrate are manufactured in such a way that the resistance of the product to detonation is high. However, they can decompose under fire conditions and may enhance the severity of the fire and give off toxic fumes and gases. Under extreme fire conditions, particularly if the fertilizer is contaminated with combustible material and confined in an enclosed space, there is the possibility of an explosion. Mixtures of ammonium nitrate dust and air do not present an explosion hazard.

Fertilizers are normally manufactured as high quality materials in the form of prills or granules. It is in the interest of all concerned with the handling and storage of fertilizers to ensure that the quality is maintained right up to the point of usage: namely no moisture pick up or caking, free from contamination and of minimal dust content.

This requires closed systems (loading, conveyers, blenders) and keeping storage buildings and loading areas closed as much as possible to prevent ingress of moist air and dust emissions.

In order to prevent contamination of fertilizers storage areas should be cleaned before fertilizer is introduced. Access areas should be kept clean during storage. Spillage should be cleared up as soon as practicable. Fertilizers should not be stored in direct sunlight or in conditions where temperature cycling can occur, otherwise particles may breakdown.

For every storage location there should be a written procedure to be followed in the event of an emergency. Personnel involved in the handling and storage of fertilizers should be adequately instructed in these procedures and as to the potential hazards of the fertilizers stored. Regular practice of the emergency procedures should be carried out.

Buildings should have good access for fire fighting purposes and should be provided with adequate natural or mechanical ventilation to cope with fumes from a fire situation. In normal circumstances, however, ventilation should be restricted to avoid moisture uptake.

The essential principles which govern the preservation of quality and safe storage of ammonium nitrate based fertilizers are:

- Avoidance of moisture uptake;
- Prevention of contamination with foreign matter, whatever its composition, but particularly combustible matter, farm chemicals such as weedkillers, organic materials, oils and greases, acids and alkalis;
- Observance of good housekeeping principles;
- Avoidance of involvement of fertilizers in a fire;
- Storage away from sources of heat and explosives;
- Observance of fire precautions;
- Avoidance of serious confinement.

5.4. Reducing noise level

In order to reduce the noise levels caused by the Muuga railway station, action plans for reducing the noise levels shall be prepared and carried out, taking into consideration the results (p 4.11.4) and possible noise control measures presented in the report and in the noise study carried out for the Muuga railway station. A separate noise assessment study shall be prepared for the whole Muuga Harbour (including the expansion).

A plan of action for reducing ambient noise levels deals with the measures for reducing noise levels and the impact of noise, which shall set out a list of planned measures, including the cost of such measures, the persons who are responsible for applying the measures and the term for application thereof.

In the year 2003 the design company OÜ EstKONSULT designed a noise barrier on the location of existing border fence (work no. A319). Location of noise barrier was shown in the detail plan drawing. The planned height of the barrier was 6 m.

In this study the effectiveness of the planned barrier was checked using the calculation model. The result is seen in Annex 15 D2. The best effect appears directly behind the barrier up to a distance of some 70 – 80 m from the barrier. At longer distances the effect is smaller. The calculation predicts that the barrier will decrease the initial noise level at the nearest residential houses by ca. 7 dB. The fact that the ground level is somewhat lower in the residential premises than along the railyard border is slightly favourable for the screening action of the barrier.

Thus the barrier will be fairly effective and will improve the noise situation of the nearby houses. This will be the main measure for improving the noise situation.

The suggestion is that the lower part of the barrier shall be built as an earth berm, and an actual thin noise barrier shall be erected on top of it.

The originally designed barrier was acoustically incomplete at the north-east end, near the station building. The end of the barrier did not screen the line-of-sight from the downhill brake to the nearest houses. The barrier to be supplemented with a sufficient, roughly 25 m long extension. This extension was already included in the calculations of this study.

As regards the strongest partial noise, due to the braking, the screening action of the barrier could further be improved with two other screen structures as follows:

- The downhill brake has a fixed location; its noise could be effectively reduced with another, fairly shallow screen, situated *very close to the brake*. The height of the screen could be of the order of 1.5 m and its length just longer than the brake. The front side of the screen should be sound absorbing.
- Alternative solution would be erecting walls and ceiling covered inside with sound absorbing materials above the downhill brake, in which wagons would be in the moment of braking and thus would prevent noise propagation to the environment. Length of the structure should be at least equal to the length of downhill brake (25 m) and height according to height of locomotive/wagon. Operating could be done using surveillance cameras.
- The station building and the two smaller buildings nearby could be connected with a screening wall; this would improve the overall situation at longer distances (the original barrier acts well only on short distances, but to other receivers further away, the noise will propagate more easily over the barrier).

At both sides of the noise barrier trees and bushes should be planted, because they give good damping effect and are attractive as well. The greenery is of great importance, all existing trees and bushes should be preserved in their valuable extent. However, greenery alone cannot be considered as a direct noise control measure. It shall be taken into account that a green zone may be used as a noise barrier, if it is adequately thick and wide (at least 30 m). Conifers (for example a spruce hedge planted in the form of chequers) shall be used in the green zone. The necessary vegetation can be planted, if the existing overhead transmission lines between the railway and the residential buildings are installed into underground cables and the area of the future green zone would be filled. At present there is a natural green zone between the railway and the residential buildings consisting of deciduous trees, which has only a psychological effect (when the bushes are in leaf, it hides the moving noise sources).

Based on results obtained during this project it shall be pointed out that building of new residential houses closer than 400 m is inadvisable and should be forbidden by local municipality.

Reducing of noise level in the residential area under discussion is a complicated problem, which can be solved in a complex manner by the technical and organisational measures of planning.

Other noise control measures which may be applicable in Muuga railway station are as follows:

- Increasing the sound insulation of the facade elements (windows) of the residential houses. For selecting suitable windows, sound level measurements should be taken inside the houses. If possible changing the room plan (allocation of bedrooms and children's rooms to the opposite side as for the railway station).

- Improving the technology of shunting and sorting the wagons, in order to reduce the number and strength of collisions. It is important to slow the speed of wagons at the moment of collision.
- Changing the work of depot so that testing the diesel engines of locomotives on high rotation speed will happen inside or further away from residential areas.
- The use of more quiet whistles upon the manoeuvring and assembly of the trains. The use of whistles could perhaps be replaced with radio communication.
- Foresee the location for locomotives where they can stay with engines idling, taking into account the location of residential buildings.

After the described measures have implemented the noise level at day (60 dB) and night (45 dB) can be assured on the dwelling areas in the vicinity of Muuga railway station.

Due to the harbour development and increase in transit, it is necessary to build/reconstruct a transit corridor that links Muuga Harbour and Tallinn-Narva highway, currently going through the Muuga residential area in the town of Maardu (Põhjaranna road). It is also necessary to develop alleviating measures to the conditions of the railways going through Muuga. A dialogue must be initiated with the railway administrators during the compilation of Maardu's general planning in order to find means to alleviate the negative impacts. Specific methods to be considered include creating a noise barrier screen, reviewing train time tables, using technical means to reduce vibration (better railway bed, technical condition of the rails, etc). Green buffer zones and a noise barrier must be designed/developed between the production areas and residential areas.

5.5. Protection of Fauna and Flora

- Construction works of the harbour, incl. dredging, filling and dumping works must be carried out considering the biota of Muuga Bay (fishes, birds, benthos etc), especially important is the timing, which is related to weather conditions (see also sections 4.5 Impact on fishes, 4.9 Impacts on birds);
- Dredging, filling and dumping works must be avoided in spring time (medium weather years) during end of April – beginning of July. In case of extraordinary weather conditions, this period can extend to August. This period is related to sea water temperature and the most dangerous time for fishes to spawn, when water temperature is between +6º - +15º C.
- The construction works in the area of the grove and the ponds east of the Kroodi Creek must be forbidden during the nesting period (from 1 April to 15 July). Construction works at that time may cause death to nesting birds, their eggs and nestlings. Effect on the birds is less significant, when felling and filling works are started and carried out outside breeding season.
- The operation territory of the machines used upon construction works shall be limited and the area affected negatively shall be minimised, so that as big amount of the flora and fauna would be preserved also in the part of Muuga Harbour not affected directly, i.e. in the vicinity of the project area. It means that construction activities shall be delimited with the project area.

- The spread of turbid water into the surroundings shall be prevented, for example by temporary dams, so that the nutrition possibilities of the waterfowl staying there would not be destroyed.
- Woodland key biotopes and valuable forests in the area and their growing conditions must be preserved during the development of the eastern Muuga Harbour. Greenery should be planted on the territory (plant bushes and trees on the borders of terminals and on the side of Hoidla Road).

5.6. Protection of Water

- The rainwater collected on the terminal territories must be directed into the sea through the purification equipment to guarantee the compliance to the limit values of suspended solids and oil products in the effluent.
- The rainwater collection roads, fields and other areas from where the rainwater is redirected must be regularly cleaned when dry in order to avoid the generation of polluted rainwater or to reduce the amount of pollutants in the water.
- Areas of the fertilizer terminal territory, where the rainwater is likely to have become polluted by fertilizers (eg. loading area vicinity, mechanism routes) must be determined. The rainwater from these areas is collected separately and directed into the sea through a respective purification facility that guarantees the permitted nitrogen and phosphorus content. If the terminal does not handle ammonium nitrate, it is possible to direct the potentially fertilizer-rich waters through the Muuga Harbour sewerage system into the biological waste water treatment plant.
- If ammonium nitrate fertilizers are handled, the sewage collection system must be isolated or it must be possible to isolate it from the general sewage system or publicly used water body as soon as possible. In this case, it may become necessary to clean the rainwater from nitrogen and phosphorus compounds through a respective purification facility.
- The fertilizer handling area must be isolated from the groundwater by a barrier layer that is resistant to chemicals and water. The ground where the chemical may end up must make it easy to collect any spillage.
- When protecting the water environment during fertilizer loading, the only chance to minimize fertilizer dust emission into ambient air is to use the best available technique.
- Considering the significant impact of the fertilizer terminal activity on the water environment, it is necessary to fixate the requirement of regularly analyzing the rainwater coming from the territory for total nitrogen and phosphorus (in addition to suspended solids and oil products), when the special water usage permit is issued.

Table 5.1. Secondary and residual impact of measures suggested for avoidance and mitigation of negative environmental impact

No	**Measure**	**Secondary impact**		**Residual impact**	
		Impact	Extent	Impact	Extent
1	2	3	4	5	6
	<u>Dry bulk cargo</u>				
1	Moisturising	• Additional	x	• Sediment in	x

		pollution load to water		sewage system	
2	Chemical treatment	• Additional pollution load to ambient air	xx	• Impact interactions to human • Property damage	x x
3	Using closed non-pneumatic systems		O		O
4	Cleaning filters, using loading sleeve and loading jag	• Additional pollution load to ambient air	x		O
5	Determining endangered areas and separate rainwater treatment in biological purification facility	• Odour	x	• Sediment in system	x
6	Other treatment facility of rainwater for removing oil and suspended solids		O	• Sediment in system	
7	Control wells on the border of terminals		O		O
8	Monitoring of rainwater, incl. analysis of total N and P		O		O
9	Monitoring of dust and gases (fluorides)		O		O
	<u>Construction</u>				
1	Considering nesting period of birds and spawning time of fishes		+		+
2	Using measures to prevent the spreading of suspended solids during dredging and filling works			• Increase of sedimentation at the location	x
3	Carry out ramming and other works with high noise level during daytime	• Additional noise load in the daytime	x	• Impact of deafening	x
4	Using wet treatment	• Additional pollution load to water	x	• Sediment in sewage system	x

	Noise prevention				
1	Joint activity of Port of Tallinn and Estonian Railways	• All-embracing	+	• All-embracing	+
2	Modernization of rail vehicles and other infrastructure at the best level		+		+
3	Cargo handling by good environmental practice		+		+
4	Building of artificial noise barriers	• Visual	x	• Exploiting additional land	x
5	Improvement of sound insulation of houses	• Deterioration of ventilation	x	• Health disorders from worsening of air quality	x
6	Planting of greenery	• Living and resting place for birds and small animals	+	• Visual • Forest litter	+ O
	Other				
1	Regular meetings with people living in the impact area	• Time loss	O	• Future planning	+
2	Possible compensation	• Health improvement	+	• Habit developing	O
3	Buyout of property	• Finding new possibilities	+	Loss of a home place	xxx

O – non-existent or inconsiderable impact
x – relatively inconsiderable impact
xx – moderate impact
xxx – relevant impact
+ – jointly beneficial impact

5.7. Waste Management

Construction wastes must be managed according to waste legislation and regulation of local government.

Waste generation must be reduced by reasonable work arrangement at construction site – to increase using reusable materials and decrease wasting of materials (for example unnecessary damaging) at construction works. This also means more efficient usage of natural resources. Construction wastes shall be sorted at site to enable reuse and recycling. Separately should be collected into separate containers:

- mineral wastes (stones, bricks, plaster, concrete, glass, etc.);
- metal;
- wood;
- plastic;

- paper and cardboard;
- reinforced concrete and concrete details, asphalt without tar.

Sorted wastes shall be recycled or given to appropriate waste management company who owns waste permit. Construction wastes shall be directed to suitable inert waste landfill. For proper management of waste generated during construction works, waste management plan is required in construction design and further waste reporting obligation to supervisor.

Hazardous wastes (asbestos containing wastes, paint, varnish, glue and resin wastes, incl. their empty packages and impregnated materials, wastes containing oil products, contaminated soil) shall be also collected separately and given according to the regulation to waste handler holding a hazardous waste handling licence.

Construction technology must exclude (in case of need immediately eliminate) construction waste and materials to fall into the sea.

The procedure for reception of bilge water, sewage, garbage, oil products and waste containing oil, and cargo-associated waste and other ship-generated waste has been established by Regulation No. 19 of the Minister of Economic Affairs and Communication of 2 December 2002 (RTL2002, 137, 2012; 2003, 44, 650; 2004, 160, 2406). It is also regulated by the Helsinki Convention and EU Directive 2000/59/EC.

A harbour authority shall organise reception of the following ship-generated waste:

1) bilge water;
2) waste from the engine room or cargo tanks containing oil products or oil;
3) cargo residues containing pollutants specified in the list set out in Annex 2 to the Regulation;
4) garbage;
5) sewage.

Persons receiving waste shall hold a waste permit and persons receiving hazardous waste shall, in addition, hold a hazardous waste handling licence.

For the ships to know on what conditions (which types of waste, which are the rates of the charge, etc.) can the waste be given away, this information shall be available to them. A harbour authority is obliged to inform ship owners of the procedure for the reception of ship-generated waste. For this purpose the harbour shall inform ship captains/ship agents about the harbour rules and establish the procedure and the rates of the charge for the reception of bilge water, sewage, consumer waste and other pollutants in the rules.

The existence of a ship-generated waste reception and handling plan shall be ensured, which shall be developed and implemented by the harbour authority so that the reception of waste from ships would be arranged in an easy and available manner for the ships. The harbour authority shall also maintain records on the ship-generated waste received from ships by ships and by the types of ship-generated waste. The role of the harbour authority shall be specified in detail together with the obligations and liability upon the receipt of ship-generated waste in the harbours, also the person responsible in case of the occurrence of pollution shall be specified.

In the harbours of Port of Tallinn ships (ship agents) shall order a waste handler for giving away municipal waste. The reception of bilge water in Muuga Harbour is organised on account of harbour fees by the relevant company.

Pursuant to the EU Directive 2000/59/EC the countries are obliged to apply a single system of charges to all the waste so that the ships would pay for waste handling regardless of the fact whether they give away waste or not.

6. COMPARISON OF ALTERNATIVES

The following alternatives (see chapter 3.2) of the extension of the eastern part of Muuga Harbour are compared:

- Alternative 1 – a straight quay line will be built
- Alternative 2 (planned activity) – a quay line with two basins will be built
- Alternative 3 – a straight quay line, which is shifted 100 m towards landside compared to alternative 1, will be built
- Alternative 4 – a quay line with three basins will be built
- 0-alternative – there will be no extension of eastern part of the harbour

In order to compare the alternatives and determine the ranking list, they have been compared on the basis of the criteria, which reflect such significant impacts caused by the construction and operation of the extension of the harbour, which are expressed to a different extent in case of different alternatives:

- impact on the movement of sediments and necessity of repeated dredging operations;
- impact on hydrodynamic processes – waves, currents;
- the impact of dredging and dumping operations on marine biota, in particular in connection with the spread of suspended solids – on phytobenthos and benthic fauna, fish fauna;
- the impact of the use of natural resources;
- economic impacts,
- feasibility of the project and the rate of the achievement of the desired objective.

It appears on the basis of the results of the assessment that 0-alternative, where there is no extension of the harbour turned out to be the best one. In this case there will be no negative impact on marine biota, hydrodynamic and geological processes. Also the danger of air pollution and noise level will not increase in the area of residential buildings; but still, the present impacts of harbour operation remain. At the same time it is likely that more attention will be paid to the improvement of the living conditions and welfare of the inhabitants and the relevant measures will be applied for securing it in the course of the development of the harbour.

Alternatives 1 and 3 are equal as for their total environmental impact. There are differences in the volume of filling and dredging works. If it is taken into account that the material necessary for filling shall be excavated from the sea and thus, the impact to the marine environment will increase, certain preference may be given to variant 3, since the volume of filling works is smaller there. Anyway the volumes of dredging and filling works are very big, which has a significant impact on the biota.

As for environmental impact it is realistic to carry out alternative 2, i.e. the planned quay line solution, if relevant measures are applied for reducing the negative impact, including planning of dredging, filling and dumping operations in the relevant period, when the impact on the biota is as minimal as possible. Alternative 2 is the best in

The disadvantage of alternative 4 is the biggest need for repeated dredging in the course of harbour operation, due to the seafloor being dredged to the different depths. The access channels of the basins will be filled with sediments in short period of time. Besides, the use of terminal areas is limited.

The impact on the welfare of the inhabitants affected primarily by the railway noise was not taken into account as a criterion, because it does not differ in case of the different alternatives of the project (there is a noise disturbance anyway).

It is almost always better for the natural environment, if the activity affecting it is not performed, but if to look more broadly by including also socio-economic and local and regional (also global) impact, the most suitable option for the performance of the project is alternative 2, if mitigation measures of negative impacts are implemented.

7. ENVIRONMENTAL MONITORING AND AUDITING

7.1. Recommendations for Monitoring

In connection with the eastern extension of Muuga Harbour it is required to continue and complement the monitoring programme of marine environment of Muuga Harbour and Aksi dumping area. The purpose of the Muuga Harbour marine environment monitoring is to assess the spread of suspended matter created during the dredging and filling works; the impact on benthic biota and fish fauna and the possible changes of the coastal processes. Also, monitoring of suspended matter spread and benthic biota and fish fauna must be carried out near the dumping area (immediate vicinity of the island of Aksi) and the island of Prangli.

- Spread of suspended matter – monitoring of the suspended matter created by the construction works related to the planned ground removal in the Muuga Harbour aquatory, in the permanent monitoring stations of Muuga Bay and the Aksi island;
    - Collecting regular water samples during dredging and filling works (twice a month) in order to determine the concentration of suspended matter in the 15 stations of the Muuga polygon; measuring the spread of suspended matter with an optic sensor; based on the results the modelling of possible movement of suspended matter has been done; determining the qualitative and quantitative properties of the suspended matter spread on the basis of satellite images;
    - Constant operative monitoring of the spread of suspended matter must be implemented near the dumping area – measuring the turbidity of the upper and lower water layer in one location on the edge of the dumping area and 2-3 miles from that point. The measurement must indicate the local dynamics of the suspended matter cloud near the dumping area in both the sea surface and bottom layer. If possible and necessary, the measurement data should be presented on the web in real time, enabling interested parties to operatively observe the changes of the suspended matter concentration in time. Suspended matter monitoring should take place during two months in the course of dumping works; if necessary, the monitoring should be continued during the works and even after the works have completed.
- Phytobenthos observations must be twice a year (in spring and autumn) carried out in four inspection sites in Muuga Bay and Ihasalu Bay, one inspection site on the south coast of Aksi, and in three inspection sites in the coastal waters of the Prangli island. The observations must be carried out in order to describe the situation of phytobenthos through diving to the depths of 0-13 m. The observations must describe the phytobenthos coverage and the depth distribution of various species, also the presence of loose sediment and the amount of sediment on the sea floor and on the plants. The observation are to be documented by photos and, if possible/necessary, by videos.
- Benthic fauna observations must be twice a year (in spring and autumn) carried out in the standard stations (total 11 stations) of Muuga Bay, in one inspection site on the south coast of Aksi, and in three inspection sites in the coastal waters of the Prangli island. Zoobenthos samples must also be collected directly next to the coal terminal and planned terminals. For comparison, zoobenthos samples must be collected from eight stations in Ihasalu Bay from the depth and sediment structure that corresponds to the sample locations in Muuga Bay.

- Control fishing must be done in Muuga Bay, on the south coast of Aksi and coastal waters of the Prangli island with entangling nets of various size of mesh (32-120 mm), and fykes according to the methodology of other monitoring works done in Estonian coastal waters. The caught fish must be assessed to determine their species and length; also age, if possible. The areas suitable for the Baltic herring spawning grounds and the spawning efficiency must also be assessed.
    - Figure 7.1 shows the fish monitoring stations in Muuga Bay. Monitoring must be continued in stations 1, 2, 4, 5; station 3 remains in the coal terminal basin and cannot be used anymore. Station 1 conducts monitoring all year round, making 10-15 catches a month depending on the weather, except during the ice cover. Fish monitoring in stations 2, 4 and 5 must be conducted during spring, summer and autumn (3-4 times a year). During spring, the Baltic herring spawning grounds must also be dragged for roe in order to determine changes to the Baltic herring spawning conditions.

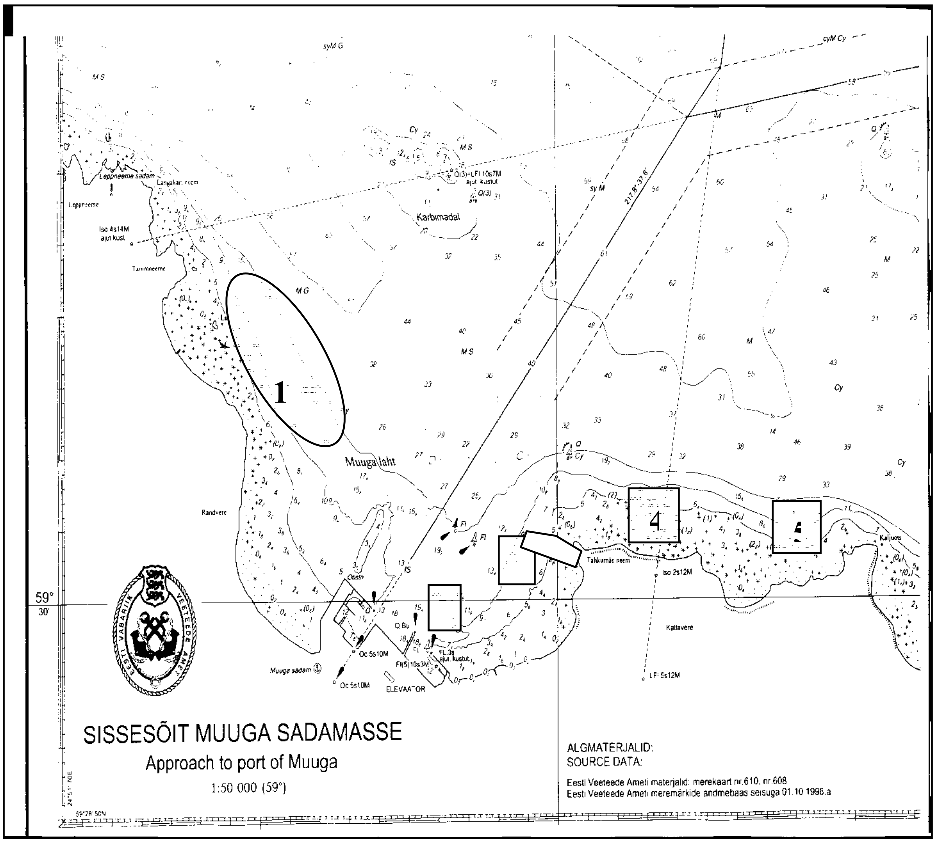


Figure 7.1. Scheme of fish monitoring during the marine environment monitoring of Muuga Harbour

- Coastal process and sediment dynamics – observing the possible coastline changes in 7 permanent inspection-measurement areas (Saviranna region – the coast from Cape Tahkumäe towards the east till and including the Saviranna residential area), using the repeated measurement network of shore cross-sections established during previous inspections. These so-called repeated inspection sites characterize the coast section in terms of natural processes on the basis of the works implemented so far, and are also the most intensely developing coastal regions, exhibiting active shore destruction, landslides, shore slope regress and primarily negative coastline changes – the regress towards mainland. Samples must be taken from the coastal sediments and analyzed.

Integrating the sample changes will give information about the peculiarities of coastal sediment piling or erosion.

It is important to carry out more tightened observations of biota and analyze the results before the beginning of construction works, during construction works and at least during 3 years, in case of coastal processes 6 years after the completion of the construction works.

Dumping works must be followed carefully during construction supervision.

In the eastern part of Muuga Harbour, both the coal terminal and the planned fertilizer terminal are the sources of dust emissions. In order to operatively measure the ambient air pollution level (especially for dust concentration), it is necessary to establish a permanent, real-time monitoring station by the coal terminal. The planned fertilizer terminal must also have dust sensors to measure the fertilizer dust content in the air. If the pollutant concentration levels are exceeded, the operator must have an action plan to reduce the level of pollution.

Monitoring must also be done for the effluent directed into the sea through the terminal rainwater outlets, analyzing the content of oil products and suspended solids in the effluent (effluent outlet, once a quarter). Due to the potential fertilizer impact on the marine environment, the rainwater of fertilizer terminal must also undergo testing for nitrogen and phosphorus content.

7.2. Environmental auditing

Environmental management system is part of the management system of the organization and entails the inspection, decreasing and prevention of environmental impact due to organizational activity and through improvement of competitiveness. The objective of environmental auditing is periodic evaluation of the compliance of the former or present activity with the requirements of the legal acts, plans of environmental policy, environmental management system and environmental plan or provisions of the standards and contracts based on the criteria of the audit client.

According to *the Environmental Impact Assessment and Environmental Auditing Act* (2001) effective until April of 2005 the operations of the terminals constructed in the eastern part of Muuga Harbour are not included among activities with high environmental risk, due to which auditing of the environmental management system is not required. Still, implementation of the environmental management system in the organization is useful, as among the rest it will contribute to the competitiveness and saving of expenses, improve occupational health and safety, compliance of company activity with the legal acts and motivate the employees and increase the environmental awareness of the employees in their activity.

The management system of Port of Tallinn has been declared to be in compliance with the requirements of the international quality management standard ISO 9001:2000 and the environmental management system standard ISO 14001:1996. As a confirmation of this after the certification audit Lloyd´s Register Quality Assurance (LRQA) issued quality and environmental management certificates to Port of Tallinn. The certificates issued for the integrated quality and environmental management system of Port of Tallinn will be effective until March 31, 2006, the compliance will be audited twice a year in the course of regular audits.

Environmental management system internal audits are performed in accordance with the procedure of performing internal audits. Regular audits show whether the environmental management system has been implemented efficiently, functions and complies with the requirements of the environmental management standards ISO 14001:2004. Port of Tallinn has determined important aspects proceeding from its activity, which may have an impact on the environment and in relation to this has established procedures to be followed for the organization of processes and establishing of future objectives, continuous improvement of the management system.

Environmental aspects have also been determined for the activity of operators and based on vessel traffic. Port of Tallinn maps and follows these environmental aspects, but the terminal operators have to implement measures.

Internal audits are planned based on the state and importance of timed audited activity and performed by Port of Tallinn employees, who have acquired corresponding training and not directly liable for the activity audited.

The results of the auditors are documented and submitted to the employee liable for the audited domain, who will arrange correction activity for the elimination of the non-conformities discovered in the course of the audit or the realization of improvement possibilities. In the course of follow-up audits realization and efficiency of correction activity will be evaluated

The head of the quality and environmental management department will submit a summary of the results of the internal audit at the management inspection meeting.

8. ASSESSMENT OF THE PURPOSEFULNESS OF THE USE OF NATURAL RESOURCES

Sea with Estonian geopolitical position and nature is one of the main riches that together with Estonian people form Estonian essential natural resource. Exit to sea enables better to use the sea as natural resource. Position of the area, environment and possibilities deriving from their conditions constitute also as natural resource.

It is almost always more favourable for the natural environment, if artificial objects are not built or human activity does not influence nature in other adverse way, because threats and risks accompany with every activity. But if we look more broadly by including socio-economic and global impacts, the most appropriate alternative for the performance of the project shall be found out.

Location is ecological and socio-economic factor. It determines largely the ecological and marketing value of the object considered (assessed). Great value of Muuga Bay and therefore also Muuga Harbour is their location. This natural resource must be used (also protected) as efficiently and sustainably as possible.

Muuga Bay together with its biota and Muuga Harbour is not only the resource of exploitation but also aesthetic resource and the object of scientific research. It can be considered that Muuga Harbour, which is built and operated in accordance to the best knowledge, competence, customs and technologies, is environment conservative and has been functioned so far without causing any substantial environmental problems.

Consequently from the extension of the harbour the using extent of all natural resources – landscape and waters, including fauna and flora – will increase. Relative importance and use of artificial landscape also increases. Using capacity of the resources is controllable by adequate environmental management.

Land use is efficient in case harbour facilities are contemporary, corresponding to the norms, best available technology is applied and their capacity is used in the most optimal way. Furthermore, the land will be reclaimed from the sea. Unfortunately, biota will be disappeared from the areas exploited.

In construction works of the harbour extension natural resources can be used sustainably in case dredged material will be used possibly efficiently for the land filling material – on the basis of preliminary estimation, in the amount of 200 000 m^3, in case of alternative 2 300 000 m^3 dredged material can be used for that purpose. The use of natural resources is the most efficient in case of alternative 3, where the least material is needed for filling works, and considering the ratio of the volume of the needed fill and the size of the filled area. As the material needed for filling works must be extracted from sea, the environment is affected considerably at that.

Utilization of the eastern area of Muuga Harbour is the best possible using option for the given natural resource, incl. the land and sea. Muuga Harbour is necessary for the use of marine natural resource.

The main goal of **environmental strategy** is to ensure a satisfactory healthy environment and resources necessary for the development of economy without substantially damaging nature, preserving the diversity of landscapes and biota and considering the development level of economy.

Based on the principles of sustainable development a healthy physical and social environment of the residents of the area has to be ensured and harbour operations and terminal operations cannot have substantial negative impact on people or the natural environment, including avoiding of air pollution crossing the borders of the production territory. Railway noise control measures implemented in the course of the harbour eastern part development make the living conditions on the area directly bordering on the railway station more acceptable to some extent. Pollution prevention measures (best available technique) need to be implemented in the operations of the operators of the constructed terminals rather than later on liquidate the consequences.

In the general activity of the harbour and work of operators besides economic development possibilities and consideration attention needs to be paid also to environmental aspects.

Keeping in mind the principles of nature protection and preservation it is important to ensure preservation of areas remained naturally in the face of forest areas and key biotypes in the harbour area, also to make the technogenetic environment of the area more vivid.

Muuga Harbour has to minimize the amount of pollutants getting into the sea due to its operations, including dangerous chemicals, which may cause deterioration of the ecological state of the coastal sea. This assumes purification of the rainwater of harbour territory in accordance with the requirements. In order to preserve the good state of the marine environment collection of ship generated waste (bilge water, sewage, garbage and other pollutants) has to be ensured.

Due to vessel traffic and dredging work performed in the harbour natural reproduction of marine biota cannot be achieved in the acquatory. At the performing of dredging and filling work certain temporary restrictions need to be established not to deteriorate the natural state of neighboring marine areas in respect of marine biota.

Muuga Harbour has to be ready to liquidate major accidents and environmental emergencies.

Muuga Harbour extension will not be accompanied by a negative cross-border impact.

SUMMARY AND CONCLUSIONS

Port of Tallinn (AS Tallinna Sadam) is planning the development of the area in the eastern part of Muuga Harbour, between the coal terminal, Muuga railway station and the container terminal. The new terminals – metal terminal, general cargo terminal, dry bulk terminal and extension of the container terminal are planned to be constructed on land taken from the sea and partially on the existing narrow coast section. The harbour basin will be dredged in the course of the project up to the depth of 12-17 m in order to secure a safe depth for the ships for entry and at the berths.

Considered harbour extension area forms an integrated whole with the coal terminal in the north-east and the container terminal in the south-west. Functionally, Muuga railway network also belongs to the association. Larger part of the area between the sea and railway is altered for now by human – filled with sand and gravel.

Somewhat more of natural landscape has been remained in the southern part of the extension area. There broadleaved grove grows, bushes and reed-bed appear. Besides, the area is the richest place of birds where numerous breeding birds may nest. Valuable forest stands and woodland key biotopes adjoin with the extension area in the north-east and east, which should be preserved during further development of the harbour.

- Extension of Muuga Harbour has a negative effect on nesting birds in the area between the bay and the railway. Nesting birds lose their nesting sites and they may get killed during the enlargement works. The filling works connected with the extension of Muuga Harbour have a negative impact on non-nesting terrestrial and water birds, who use the given area for eating, resting and/or staying overnight.
- The impact of felling and filling works on brooding birds is the smallest, if these works would be planned for the period outside the nesting period (15 July – 1 April).
- Drastic changes will take place in the benthic communities of **marine environment** as a result of the large-scale dredging work planned in Muuga Harbour. The first direct environmental impact of the harbour construction works on marine biota will be the total removal of the sea bottom communities (phyto- and zoobenthos) across immediate extraction area. The recovery time of the bottom communities concerned is expected to be about 10 years. The removal of the bottom communities during the extraction works will be accompanied by the decrease of biological diversity and changes in the structure of bottom communities.
- Extraction works will also be accompanied by the production of a considerable amount of suspended matter within the water column, which will settle in the harbour basin and partially will be transported by the currents to the areas east of Muuga Harbour. Sedimentation of suspended matter will enrich the bottom layer with organic matter and increase the productivity of some zoobenthos species.
- Large-scale dredging operations will increase significantly also the biomass of the benthic fauna of neighbouring bays, which, however, will be restored on the initial level in two or three years.
- Sedimentation of suspended matter during the fish spawning period (April-July) will endanger the fish spawning grounds in the east of Muuga Harbour. It would take several years for the fish spawning grounds to recover after expected damage.
- Fish spawns (Baltic herring, perch) have been preserved in the coastal waters of Prangli island and also in the shallow sea surrounding Aksi island. Thus, it is rather

likely that the reproduction capacity will be damaged in case the suspended solids generated upon dumping are carried west – into the coastal waters of Aksi and Prangli to the depths below 10 m. There is an especially big likelihood to cause damage in the spring period between the end of April – the beginning of July (in the years with average weather). The most dangerous period for the reproduction of fish is concretely when the temperature of seawater is between +6ºC to +15ºC.

- Therefore, dredging, filling and dumping works must be avoided in spring time (medium weather years) during end of April – beginning of July.

In Muuga Bay the Quaternary deposits are represented by glacial (loam / sandy loam till), glaciolacustrine (varved clay) and marine (silt, sand) deposits. Between the coal terminal and Muuga Harbour mainly sandy beach occurs, with few sections where cobbles and boulders are also found. The distribution of bottom deposits in this region has been influenced by human activity (filling). The erosion has been more intense in the shore section near the coal terminal. The eroded material has been carried to the shallow sea and to the sandy beach near Kroodi Creek. The sand dumps near the coal terminal have been partly carried to the sea, in result of which the sea has become shallower in this area.

- When new quays will be established, the described beach will be filled. As a result, a man-made shore will form, with the quay as its seaward boundary.
- The analysis of pollution indicators of bottom sediments in eastern harbour basin indicated that the content of heavy metals and oil products does not exceed the reference value of industrial zone and therefore suitable soil may be used for the filling of the terminals' area in order to minimize the dumping volumes, enable sustainable use of natural resources and waste recycling.
- From the four alternative design versions submitted, versions 1 and 3 would least influence the future **geological processes**.
    - In case of alternatives 1 and 3 most of the area to be dredged presents a quadrangle basin in front of the quay line. The need for repeated dredging is the least.
    - Alternative 2 (planned activity) comprises two basins, each 200 m wide. It is possible that the seafloor deposits from the undredged area in front of the quay line will be carried to the dredged area.
    - In case of alternative 4, the seafloor between the access channels of harbour basins will not be dredged. Considering the geological setting of the area, the channels will be filled with sediments in short period of time; therefore repeated dredging will be needed more often.

Muuga Harbour is situated in the south-eastern part of Muuga Bay and due to its location it is sheltered by the mainland from the winds blowing from the southern directions. The eastern part of the harbour basin is also protected from the winds blowing from the eastern directions by Tahkumäe peninsula.

As a result of the current work the fields of waves, currents and sediment transport have been found, taking into account the location of Muuga Harbour and hydrographic conditions. For the modelling of **hydrodynamic processes** the following data was used as boundary input data: wind from NW with the return period of 25 years and 5 % probability would blow with average speed of 26 m/s. The waves entering the harbour with the NW wind, with significant wave height of 3.04 m and mean wave period of 8.2 seconds were observed.

- When comparing the existing and proposed alternatives, it can be seen that the new quay line and access channels influence the wave values considerably.
  - During the storm occurring within 25 years the changes of wave heights are bigger in undredged areas of the extended Muuga Harbour than in dredged areas.
  - In case of alternative 2 (planned quay line) the wave heights in access channels are considerably smaller than for the existing situation, because the shoaling effect will not take place. Waves run freely along the channels, whereat wave energy decreases gradually in the course of the wave. It can be seen that wave values in undredged area between the berths 23 and 24 are noticeable higher than for existing situation. It is due to the wave accumulation, which in the end leads to wave breaking.
  - In case of alternative 1 and 3 waves reach the quay line almost undamped by the bottom profile. All the energy carried along the wave has to be absorbed by vertical wall.
  - In case of alternative 4 the waves decrease considerably on the quay line, with comparison to the reference case. The alternative 4 due to its narrower approach channels damps wave energy the most and thus gives the best protection to the quay line. The anomaly that can be pointed out in case of the alternative 4 is the increase of wave heights between the approach channels.
- The current pattern will not change much in case of any alternatives of harbour extension as the area has even at present very low flow rates (V_c=0.02-0.08 m/s). The current follows the main circulation in the Gulf of Finland and is directed to the east along the coast of Estonia. More noticeable change occurs in undregded areas, where the increase of wave energy related to wave growth brings along also the growth of currents in the area.
- Despite of the increase of current velocity the related sediment transport does not bring along particular problems, which could cause the need for large repeated dredging within next years in case of planned activity. Within 5 years the deposition into the access channels should not exceed 15-20 cm.
- The spreading of the suspended matter during land reclamation works at dominating winds, when the wind strength remains within the limits of safety norms, the most of suspended matter will settle within the harbour waters.

- The dumping works carried out during the construction works of eastern extension of Muuga Harbour do not have significant effects on Prangli proposed Site of Community Importance and do not endanger the objectives or entirety of the area.
- Port activity may have an impact on sea water upon getting of chemicals into the sea, whether through rainwater or directly at the depositing of the chemical (fertilizer dust) into the sea, for example at the loading of a vessel. Fertilizers handled are water-soluble nitrogen and phosphorous compounds causing eutrophication of water bodies.
- In order to avoid contaminating the sea water, the rainwater coming from the terminal territories must be purified to guarantee the content of pollutant indicators within the limits and the effluent directed into the sea must be analysed for quality (in addition to

the oil products and suspended solids, the fertilizer terminal rainwater must also be controlled for nitrogen and phosphorus content).

- The deterioration of the environment of the inhabitants in the area of the eastern part of the harbour is caused mainly by the noise from rail transport. Extension of Muuga Harbour may cause negative impact on the human health and welfare also through air pollution (fertilizer dust and fluorides). However, if the environmental protection measures are implemented, it is not very likely that the fertilizer dust will reach the residential areas.
- Muuga Harbour and its expansion can have a significant impact on **ambient air quality**. The cumulative impact aspect indicates an interaction of the emissions of organic hydrocarbons caused by liquid fuel handling and the solid particles (dust) caused by dry bulk (coal, fertilizers, other dry bulk cargo) handling. The important aspect here is not just the emission that could exceed permitted limit values, but also the impact that can cause environmental disturbance.
- In assessing the environmental impact of the Muuga Harbour extension the situations where environmental hazard is greater has been considered. Ammonium nitrate as a dangerous chemical and its dangers have been treated as a potentially handled fertilizer type in the terminal. In predicting emissions from dry bulk terminal, the assessment has considered the theoretically maximum pollutant amounts that can occur in fertilizer handling. The actual pollutant amounts emitted can be calculated when measuring the pollution sources during the operation at normal regime.
- The dispersion calculations show that the planned handling of fertilizers in the eastern part of Muuga Harbour does not cause the exceeding of limit values of ambient air outside the working area (harbour area) even in interaction with the five existing and three planned sources operating at the same time. While this may generally be the case, there could always be exceptions. It can be concluded from the dispersion calculations that:
    - the pollution level of particles in the air layer near the surface on the border of the harbour area does not exceed half of the limit value SPV_1;
    - near the closest dwelling house the pollution level in the air layer near the surface does not exceed 0,2 parts of SPV_1.
- The main source of **environmental noise** in Muuga Harbour, today as well as after the future expansion, is Muuga railway station and its railyard. A survey and assessment study of the noise created in Muuga railway station was carried out. The noise of the station and the railyard has been assessed by means of both model predictions and measurements. The noise levels in the neighbourhood of the railyard were determined using a calculation model. Noise levels were also measured at 20 positions. In addition, to obtain initial data for the calculation, the noise emission of the various noise sources were measured at a close distance within the railyard area.
- The main results of the survey and assessment are as follows:
    - The dominant noise sources are the braking and the collisions of wagons, and the locomotive engines;
    - The braking and collisions create the most prominent noise events; the crashes are impulsive and the braking sounds are highly tonal; the respective impulse and tone adjustments of +5 dB are applicable to the predicted and measured levels in the neighbouring residential area;

- The equivalent sound levels (L_{Aeq}) at the closest residential houses exceed 50 dB (without level adjustments) day and night; the noise is still clearly recognizable up to a distance of some 400 m;
- The proposed noise barrier is able to lower the noise, at most by approximately 7 dB at the distance of the closest residential houses;
- From an acoustical point of view, another effective noise abatement measure would be a low absorbing noise screen very close to the brake.

- As the new tracks are planned further away from the residential area, on the seaward side of the existing tracks, their effect on the noise will be minor. There will be only a slight increase of the noise levels in the residential areas. The main noise sources for the residential areas will remain the same.
- Muuga Harbour eastern part extension is not expected to have a negative impact on the climate nor the cultural heritage of the area.
- The cumulative impact of the planned activity area on the landscape of contact area and littoral zone, on the harbour aquatic area, open sea, marine biota, seawater and groundwater quality and on coast abrasion can be considered moderate. Considering the activities planned for the future (incl. repeated dredging and demolition activities), the cumulative impact on the dumping area must be considered significant. Noise as a technogenic environmental factor is considered significant due to its cumulative creation sources.
- In connection with the eastern extension of Muuga Harbour it is required to continue and complement the monitoring programme of marine environment of Muuga Harbour and Aksi dumping site.
- Development of the eastern part of Muuga Harbour corresponds to the detailed plan of the eastern part of Muuga Harbour and is also in compliance with the comprehensive plan of Jõelähtme rural municipality.
- Since only a very small portion of the dredged soil is reused, the assessment for the construction period cannot consider this a sustainable use of natural resource. However, the sustainable use of the natural resource in the form of sea resource will become evident later when the harbour is exploited.

Suggestions for the extension of the eastern part of Muuga Harbour

- The extension of Muuga Harbour – i.e. creating the infrastructure and construction of the terminals – is in principle possible, if the necessary measures are implemented in order to avoid and mitigate the negative environmental impact.
- The terminal design and construction must consider the valid environmental and other legal acts and also work safety and health requirements.
- When finding possible operators for the terminals, Port of Tallinn can appoint a prerequisite for using the kind of technology in the terminals that avoids environmental damage or minimizes the negative environmental impact. This also means that the technological equipment must be as effective and developed as possible; the emissions must be treated by technically and economically feasible purification equipment; the monitoring system is sufficient.

- The best available technique principles must be implemented primarily in the dry bulk cargo terminal (the fertilizer terminal). The prerequisite for constructing and operation of the fertilizer terminal is the use of covered loading systems – the loading unit, conveyers and storages must be covered and protected from weather conditions. In mineral fertilizer loading, the best available modern technique must be used and attention must be paid to measures that reduce the spread of fertilizer dust.
- The world's best available technique (WBAT) must be used to build and operate new terminals.
- The operators must be subject to the requirement that their activity cannot result in environmental pollutant levels (both in ambient air and water) exceeding the limit values permitted by legal acts and activity permits. In order to ensure this, both air pollutants and rainwater directed to the sea must be subjected to control (purification + monitoring).
- All dry bulk cargo loading-unloading works must be suspended in case of weather inversion.
- In order to reduce the noise levels caused by the Muuga railway station, an action plan must be compiled, taking into consideration the results and possible noise control measures (including building the noise barrier) presented in the report and in the noise study carried out for the Muuga railway station. A separate noise assessment study shall be prepared for the whole Muuga Harbour (including the expansion).
- As a result of Muuga Harbour extension, the amount of cargo passing through and being handled in the terminals will increase. The handling of metal goods and container will become more intense, possibly increasing noise incidents (thumps). Noise in the terminals is not constant, but could rather experience occasionally higher noise levels when the work culture is ignored during loading. If necessary, the empty containers can be used to alleviate noise in the container terminal by stacking the containers on top of each other on the border of the terminal.
- Transport arrangement, technological and construction means must all be used to restrain noise.
- Expanding Muuga Harbour to the east is acceptable in terms of environmental load, if the eastern part will not have liquid fuel and liquid chemicals handling that would entail heightened risks to the environment. Since the oil flows passing through Muuga Harbour have been focused in the oil terminals in the western part of the harbour, fuel handling should not expand to the east of the harbour.
- The metal terminal planned in the eastern part of the harbour must not handle scrap metal.
- Handling the metal, general, container and dry bulk cargo (fertilizers) according to the predicted cargo flows (approx. 10 million tons by 2025; incl. about 3 million tons both of fertilizers and metal) is acceptable in the eastern part of Muuga Harbour, considering the tolerance limits of the environment in the area.
- It is recommended not to handle ammonium nitrate in the dry bulk terminal constructed in the eastern part of Muuga Harbour due to its high environmental risk. Though the emergence of the risk has a low probability factor, the consequences of an accident can be extremely serious. The possible handling of ammonium nitrate should

be continued in the existing terminals in the western part of the harbour. The storage location there will have to adopt the fertilizer temperature monitoring system.

- Due to the additional cargo flows that will pass through the eastern part of Muuga Harbour and the Muuga railway station, it is necessary to improve the living conditions of the people living next to the harbour and the railway, mainly by implementing measures to reduce the noise levels. Also, the operator of dry bulk cargo terminal must guarantee its activity within the permitted limit values of pollution levels.
- Since the first horizon of the Uusküla village groundwater is polluted in the area between the Muuga railway station and Nuudi road, it is necessary to find measures to provide drinking water to the households from the water system of Port of Tallinn.

USED MATERIALS

Altakon Grupp OÜ. 2005. Muuga sadama laiendamise projekti keskkonnamõju eelhindamine. Mõjutatava keskkonna geoloogiline ehitus ja rannaprotsesside iseloomustus. Töö nr 2/2005. Tallinn.

Altakon Grupp OÜ. 2005. Muuga sadama laiendamise projekti keskkonnamõju hindamine. Mõjutatava piirkonna geoloogiline ehitus ja põhjasetted. Töö nr 5/2005. Tallinn.

Arumägi, E., Ründva, M. 2004. Liiklusmüra. Lk 22-27. Keskkonnatehnika 3/2004.

Corson OÜ. Muuga sadama idaosa laiendamise kolme versiooni hüdrodünaamiline modelleerimine keskkonnamõjude aspektist. Töö nr 0504. Tallinn.

E-Konsult AS. 1993. Muuga sadama laiendamise võimaluste keskkonnaekspertiis. Töö nr E075. Tallinn.

E-Konsult OÜ. 2001. Jõelähtme valla keskkonnatervise tegevusplaan. Lõpparuanne. Töö nr E758. Tallinn.

E-Konsult OÜ. 2003. Muuga sadama idaosa detailplaneeringu strateegilise keskkonnamõju hindamise aruanne. Töö nr E846. Tallinn.

ETP Grupp AS. 2003. Muuga sadama idaosa detailplaneering. Seletuskiri ja joonised. Tallinn.

Harju Maavalitsus. 2003. Harju maakonnaplaneeringu teemaplaneering. Asustust ja maakasutust suunavad keskkonnatingimused. Tallinn.

Helm, A., Luht, H. 2003. Muuga sadama metalliterminaal. Täiendavate pinnaseuuringute aruanne. Töö nr. 03-07-0273. OÜ IPT Projektijuhtimine.

Helm, A., Talviste, P., Luht, H. 2003. Metal terminal in Muuga harbour. Summary soil data. Geotechnical report. Report nr. 03-10-0299. OÜ IPT Projektijuhtimine.

HPC Hamburg Port Consulting GmbH. Inros Lackner AG. Aprill 2005. Economic Analysis. Technical Assistance for Extension of Muuga Port on the Trans-European Network.

Johnston, J., Walker, L.J. 1999. Guidelines on the Assessment of Indirect and Cumulative Impacts as well as Impact interactions. EC DG XI. Environment, Nuclear Safety and Civil Protection.

Jõelähtme valla arengukava aastateks 2004-2015. Vastu võetud 22.12.2003 nr Jõelähtme Vallavolikogu määrusega nr 25

Jõelähtme valla üldplaneering. Kehtestatud Jõelähtme Vallavolikogu 29.04.2003 otsusega nr 40.

Järvik, A. (koost.). 1997. Muuga sadama ehitusaegne seire 1996. a. Eesti Mereinstituut. Tallinn.

Järvik, A. (koost.). 1997. Muuga sadama ehitusaegne seire 1997. a. Eesti Mereinstituut. Tallinn.

Järvik, A., Ojaveer, E. (koost.). 1998. Muuga sadama ehitusaegne merekeskkonnaseire 1998. a. Eesti Mereinstituut. Tallinn.

Järvik, A., Saat, T. (koost.). 1999. Muuga sadama ehitusaegne merekeskkonnaseire 1999. a. aruanne. Eesti Mereinstituut, Tallinn.

Kotta, I. 1998. Zoobentose koosluste muutused Eesti rannikumeres Liivi ja Soome lahe näitel 70., 80. ja 90. aastatel. Magistritöö bioloogias. Tallinna Pedagoogikaülikool, bioloogia õppetool, Tallinn.

Kupi OÜ. 2004. Muugal asuva AS Eesti Raudtee veduridepoo ja vagunite sorteerimisjaama müratasemete mõõtmised. Aruanne. Tallinn.

Luht, H. 2003. Summary soil data at Muuga Coal Terminal area. Geotechnical report. IPT Projektijuhtimine. Töö nr. 02-12-0209. OÜ IPT Projektijuhtimine.

Orviku, K. (vastutav täitja R. Aps) 2004. Rannaprotsessid. Muuga sadama merekeskkonna seire. TÜ Eesti Mereinstituut.

Palo, A. 2005. Minu isiklik (metsa)väärielupaik. Harmoonia võimalikkus süsteemis inimene-keskkond-ühiskond (Vissak, P., koostaja). Tallinn.

Rannamäe, R. 1993. Autojuhi töötervishoid. Tallinn.

Sedman, P. 2000. Geotechnical model of the area of Muuga Port. Töö nr. 00-08-0012. OÜ IPT Projektijuhtimine.

Sedman, P. 2004. Detsember. Eastern territory of Muuga harbour. Geotechnical investigations. Report nr. 04-09-0412. OÜ IPT Projektijuhtimine.

Suuroja, K., All, T., Mardim, T., Morgen, E., Ploom, K., Vahtra, T. Eesti geoloogiline baaskaart (mõõtkavas 1 : 50 000). 7321 Prangli. Seletuskiri. OÜ Eesti Geoloogiakeskus. Tallinn, 2002, 72

Tallmac AS. 2003. Muuga söeterminali territooriumi haljastuse dendroloogiline hinnang. Aruanne. Tallinn.

TÜ Eesti Mereinstituut. 2003a. Muuga sadama keskkonnamõjude seire 2002.a. Käsikiri TÜ Eesti Mereinstituudi raamatukogus.

TÜ Eesti Mereinstituut. 2003b. Mereelustiku seire Prangli liivamaardla võimalikus mõjupiirkonnas liiva ammutamise eel 2003.a septembris. Käsikiri TÜ Eesti Mereinstituudi raamatukogus.

TÜ Eesti Mereinstituut. 2004a. Muuga sadama merekeskkonna seire 2003.a., osa III Mereelustik ja kalastik. Vastutav täitja A. Järvik. Tallinn. Käsikiri TÜ Eesti Mereinstituudi raamatukogus.

TÜ Eesti Mereinstituut. 2004b. Muuga sadama merekeskkonna seire 2004.a., Alapeatükk „Kalastik ja kalapüük". Vastutav täitja A. Järvik. Tallinn. Käsikiri TÜ Eesti Mereinstituudi raamatukogus.

TÜ Eesti Mereinstituut. 2004. Muuga sadama merekeskkonna seire 2004. Lõpparuanne. Tallinn.

TÜ Eesti Mereinstituut. 2005. Muuga sadama isaosa laiendamise ja ekspluatatsiooni mõju rannikumere elustikule (põhjataimestik, põhjaloomastik, kalastik ja koelmud). Tallinn.

Viimsi valla mandriosa üldplaneering. Kehtestatud Viimsi Vallavolikogu 11. jaanuari 2000 otsusega nr 1.

Legal acts and regulations

- Euroopa Nõukogu direktiiv 85/337/EMÜ, 27. juuni 1985, teatavate riiklike ja eraprojektide keskkonnamõju hindamise kohta

- Euroopa Nõukogu direktiiv 97/11/EÜ, 3. märts 1997, millega muudetakse direktiivi 85/337/EMÜ teatavate riiklike ja eratööde keskkonnamõju hindamise kohta
- Euroopa Nõukogu direktiiv 79/409/EMÜ, 2. aprill 1979, loodusliku linnustiku kaitsest
- Euroopa Nõukogu direktiiv 92/43/EMÜ, 21. mai 1992, looduslike elupaikade ja loodusliku loomastiku ja taimestiku kaitsest
- Euroopa Nõukogu Direktiiv 96/61/EÜ, 26. september 1996, reostuse kompleksse vältimise ja kontrolli kohta
- Läänemere piirkonna merekeskkonna kaitse konventsiooni ratifitseerimise seadus (RT II 1995, 11/12, 57; 2001, 28, 139)
- Looduskaitseseadus (RT I 2004, 38, 258; 53, 373; 2005, 15, 87; 22, 152)
- Planeerimisseadus (RT I 2002, 99, 579; 2004, 22, 148; 38, 258; 84, 572; 2005, 15, 87; 22, 150)
- Ehitusseadus (RT I 2002, 47, 297; 99, 579; 2003, 25, 153; 2004, 18, 131)
- Säästva arengu seadus (RT I 1995, 31, 384; 1997, 48, 772; 1999, 29, 398; 2000, 54, 348; 2005, 15, 87)
- Veeseadus (RT I 1994, 40, 655; 1996, 13, 240; 13, 241; 1998, 2, 47; 61, 987; 1999, 10, 155; 54, 583; 95, 843; 2001, 7, 19; 42, 234; 50, 283; 94, 577; 2002, 1,1; 61, 375; 63, 387; 2003, 13, 64; 26, 156; 51, 352; 2004, 28, 190; 38, 258; 2005, 15, 87; 37, 280)
- Välisõhu kaitse seadus (RT I, 19.05.2004, 43, 298; 2005, 15, 87)
- Keskkonnajärelevalve seadus (RT I 2001, 56, 337; 2002, 61, 375; 99, 579; 110, 653; 2003, 88, 591; 2004, 30, 209; 38, 258; 2005, 24, 182; 57, 451)
- Keskkonnaseire seadus (RT I 1999, 10, 154; 54, 583; 2000, 92, 597; 2002, 63, 387; 2004, 43, 298; 2005, 15, 87; 29, 214)
- Keskkonnamõju hindamise ja keskkonnajuhtimissüsteemi seadus (RT I, 24.03.2005, 15, 87)
- Saastuse kompleksse vältimise ja kontrollimise seadus (RT I 2000, 85, 512; 2002, 61, 375; 2003, 73, 486; 2005, 15, 87)
- Kemikaaliseadus (RT I 1998, 47, 697; 1999, 45, 512; 2002, 53, 336; 61, 375; 63, 387; 2003, 23, 144; 51, 352; 75, 499; 88, 591; 2004, 45, 315; 75, 521; 89, 612)
- Metsaseadus (RT I 1998, 113/114, 1872; 1999, 54, 583; 82, 750; 95, 843; 2000, 51, 319; 102, 670; 2001, 50, 282; 2002, 61, 375; 63, 387; 88, 594; 2004, 9, 53; 38, 258)
- Keskkonnainfo kättesaadavuse ja keskkonnaasjade otsustamises üldsuse osalemise ning neis asjus kohtu poole pöördumise konventsiooni ratifitseerimise seadus (RT II 2001, 18, 89)
- Müra normtasemed elu- ja puhkealal, elamutes ning ühiskasutusega hoonetes ja mürataseme mõõtmise meetodid (RTL 2002, 38, 511), Sotsiaalministri 04.03.2002 määrus nr 42
- Heitvee veekogusse või pinnasesse juhtimise kord (RTL 2001, 69, 424), Vabariigi Valitsuse 31.07.2001 määrus nr 269
- Välisõhu saastatuse taseme piir-, sihtväärtused ja saastetaluvuse piirmäärad, saasteainete sisalduse häiretasemed ja kaugemad eesmärgid ning saasteainete sisaldusest teavitamise tase (RTL, 16.09.2004, 122, 1894), Keskkonnaministri 07.09.2004 määrus nr 115
- Välisõhu saasteloa ja erisaasteloa taotluse ja loa vormid, loa taotluse sisule esitatavad nõuded, (RTL, 27.09.2004, 128, 1983), Keskkonnaministri 22.09.2004 määrus nr 119
- Saasteainete heitkogused ja kasutatavate seadmete võimsused, millest alates on nõutav välisõhu saasteluba ja erisaasteluba (RTL, 12.08, 2004, 108, 1726), Keskkonnaministri 02.08.2004 määrus nr 101
- Tiheasustusega piirkonnad, kus on põhjendatud välisõhu kvaliteedi hindamise ja

kontrolli vajadus (RTL, 27.09.2004, 128, 1982), Keskkonnaministri 22.09.2004 määrus nr 118

- Tiheasustusega piirkondade välisõhus kohustuslikult määratavate saasteainete nimekiri (RTL, 27.09.2004, 128, 1981), Keskkonnaministri 22.09.2004 määrus nr 117
- Töökeskkonna keemiliste ohutegurite piirnormid (RTI, 26.09.2001, 77, 460), Vabariigi Valitsuse 18.09.2001.a määruse nr 293