Klaipėdos universitetas

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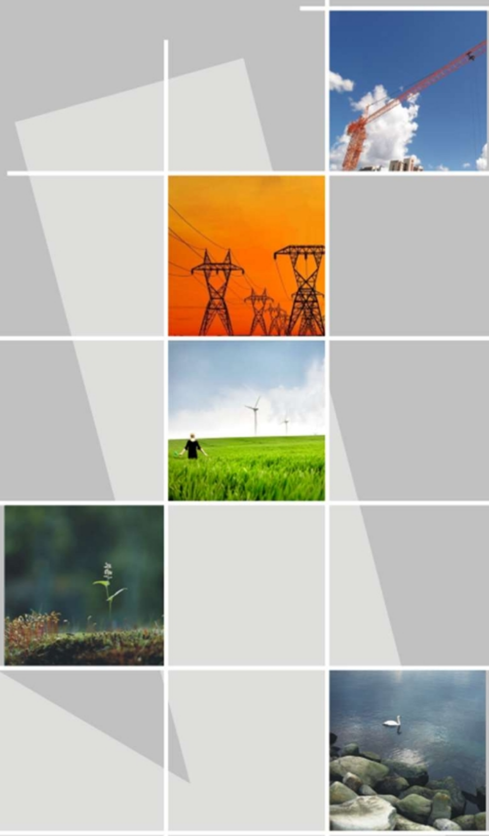
Planuojamos ūkinės veiklos organizatorius **Klaipėda State Seaport Authority**



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ENVIRONMENTAL IMPACT ASSESSMENT OF THE DEVELOPMENT OF THE SOUTHERN PART OF THE KLAIPĖDA STATE SEAPORT

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Planned economic activity, its location	ENVIRONMENTAL IMPACT ASSESSMENT OF THE DEVELOPMENT OF THE SOUTHERN PART OF THE KLAIPĖDA STATE SEAPORT
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In order to comply with the provisions of the General Data Protection Regulation [1], which came into force on 25 May 2018, copies of the qualification documents of the preparers of environmental impact assessment documents are no longer included in the environmental impact assessment documents. Textual Annex 1 provides a summary of the qualifications and experience of the Environmental Impact Assessment preparers. Should you wish to examine the documents proving the preparers' qualifications in more detail, please contact the Environmental Impact Assessment document preparer – UAB "Sweco Lietuva".

ABBREVIATIONS AND TERMS USED IN THE TEXT

Abbreviation/term	Explanation of the abbreviation/term
AAA	Environmental Protection Agency
AB	Public limited company
AM	Ministry of the Environment of the Republic of Lithuania
Breakwater	A hydraulic structure for the closure of seaports or coastal protection, constructed at sea and not connected to the shore. It may be a gravity structure (vertical, sloping or mixed type), floating, pneumatic and hydraulic (STR 2.02.06:2004)
Breakwater	A hydraulic structure designed to protect an area from flooding or inundation, to divert water flow, or to create an artificial water body adjacent to a watercourse. The construction is analogous to a dam; see also protective and barrier dams (STR 2.02.06:2004)
EEPOL	Overhead power transmission line
EU	European Union
KVJUD or the Authority	AB “Klaipėda State Seaport Authority”
KVJU or Port	Klaipėda State Seaport KU
Klaipėda University	
LEI	State Enterprise Lithuanian Energy Institute
LOD	Lithuanian Ornithological Society
Marina	Marina – a port specialising in yachts and boats for mooring and servicing, with a quay or jetties. A marina port in that it does not serve large vessels, whether passenger, cargo or other
MD	Main gas pipeline
Pier	A marine hydraulic structure used to enclose ports, connected at one end (the root) to the shore, extending straight or otherwise into the sea and ending in a tip (head). A port requires one or two jetties. These may be vertical, sloping, mixed or bridge-type (STR 2.02.06:2004)
EIA	Environmental Impact Assessment
EIA programme	Klaipėda State Seaport Southern Section Development Environmental Impact Assessment Programme
PK	Picket

PŪV	Planned economic activity
LNG	Liquefied natural gas
TP	Transformer substation
TPD	Spatial planning document
TU	Technical specifications
UNESCO	United Nations Educational, Scientific and Cultural Organisation A
Southern port gates	hydraulic structure in the northern part of the Curonian Lagoon, the primary function of which is preventive environmental protection. Once the optimal type and design of this hydraulic structure have been selected, it would possible to minimise changes in water permeability and, at the same time, the dispersion of saline water into the Curonian Lagoon by improving (deepening, widening, changing the direction of) the port’s navigation channel and water areas
Port infrastructure Port	A complex of hydraulic and engineering structures and facilities, navigational aids, as well as roads and access railway lines A complex of ship-handling facilities and other structures and installations not classified as port infrastructure

superstructure

CONTENTS

1 INTRODUCTION

Through the consistent planning and implementation of the Klaipėda State Seaport's long-term plans, KVJUD envisages the development of the southern part of the port, the aim of which is – to create additional land areas to facilitate the expansion of cargo terminals, enabling them to provide additional value-added services and accommodate BALTMAX-class vessels with maximum dimensions, i.e. up to 430 m in length (eventually up to 490 m), up to 60 m in width (eventually up to 70 m) and with a draught of up to 15.5 m [14].

To assess the environmental impact of the planned solutions, KVJUD launched a public tender, which was won by a consortium of companies operating on a joint venture basis, comprising UAB 'Sweco Lietuva' (lead partner), the Lithuanian Energy Institute and Klaipėda University. On 3 August 2022, this consortium signed public procurement contract No. 34-2022-269 with the State Enterprise "Klaipėda State Seaport Authority" to provide the following services: "to carry out an environmental impact assessment and related procedures for the planned economic activity (the development of the southern part of the Klaipėda State Seaport)".

1.1 The aim, purpose and fundamental provisions of the environmental impact assessment programme and report for the planned economic activity

In accordance with the regulatory requirements in force in Lithuania and the European Union, all planned economic activities that may have an impact on the environment must be assessed in terms of their potential environmental impact. Under the Law on Environmental Impact Assessment of Planned Economic Activities of the Republic of Lithuania [2], all planned economic activities are divided into two categories: activities for which an environmental impact assessment is mandatory, and activities for which a screening must be carried out to determine the necessity of an environmental impact assessment.

The planned economic activity of the State Enterprise 'Klaipėda State Seaport Authority' – the development of the southern part of the Klaipėda State Seaport, involving the reclamation of part of the port's water area and the formation of new land territory, the construction of new quays, and the deepening of the water area, Annex 1, sub-paragraph 8.1 and paragraph 11 of the Law of the Republic of Lithuania on the Environmental Impact Assessment of Planned Economic Activities [2] Annex 1, sub-paragraph 8.1 and paragraph 11, is defined as "the construction of seaports (including loading and unloading terminals) or marinas, including the installation of loading and/or unloading terminals, for vessels with a deadweight tonnage of 1,350 tonnes or more, excluding ferry berths' and 'a modification or extension of planned economic activities listed in this Annex or in Annex 2 to the Law on Environmental Impact Assessment of Planned Economic Activities of the Republic of Lithuania, where such a modification or extension is equal to or greater than the threshold values set out in this Annex, if any", for which an environmental impact assessment of the planned economic activity must be carried out. Some of the planned activities fall within the list in Annex 2 to the Act and are described in sub-paragraphs 10.7, 10.9 and paragraph 15 as the 'construction of sea ports or inland waterway ports (including fishing ports, loading or unloading terminals) (for vessels with a deadweight of less than 1,350 tonnes, or where an area of 0.5 ha or more is developed in the water area and on land)", 'dredging of sea port water areas', 'modification or extension of planned economic activities listed in this Annex, including the reconstruction of existing structures, the modernisation or replacement of production processes and technological equipment, changes to production methods, production volume (scale) or type, and the introduction of new technologies, where the modification or extension of the planned economic activity may have a significant adverse effect on the environment, except for the cases specified in point 11 of Annex 1 to the Law on Environmental Impact Assessment of Planned Economic Activities, for which a screening must be carried out to determine the necessity of an EIA.

Given that the planned economic activities in question are linked both in terms of the implementation of solutions and from a technological perspective, a comprehensive environmental impact assessment of the planned economic activities is being carried out.

In accordance with the requirements of the Law on Environmental Impact Assessment of Planned Economic Activities of the Republic of Lithuania [2], the organiser of the planned activity or the preparer of the environmental impact assessment documents appointed by them shall prepare and coordinate the environmental impact assessment programme for the planned economic activity with the environmental impact assessment authorities, inform the public and submit it to the Environmental Protection Agency for review and approval.

KVJUD, under a signed contract, commissioned the EIA document preparer – the joint venture UAB 'Sweco Lietuva' and its partners – to carry out an environmental impact assessment of the planned economic activity and to prepare the EIA programme and report for the development of the southern part of KVJU, to discuss the prepared documentation with the public, coordinate it with the EIA stakeholders, and submit it for consideration and approval to the competent authority – the Environmental Protection Agency.

In November 2022, UAB Sweco Lietuva, together with its partners, prepared **the 'Environmental Impact Assessment Programme for the Development of the Southern Part of the Klaipėda State Seaport'**, which was published in accordance with the established procedure, coordinated with the EIA stakeholders and approved by the EAA (Textual Annex 2).

Following the necessary studies and expert assessment, **the 'Environmental Impact Assessment Report for the Development of the Southern Part of the Klaipėda State Seaport'** was prepared. The EIA report for the planned economic activity was prepared in accordance with the requirements of the Law on Environmental Impact Assessment of Planned Economic Activities of the Republic of Lithuania [2] and in accordance with the "Procedures for the Environmental Impact Assessment of Planned Economic Activities" [3] and the approved EIA programme for the planned economic activity. During the assessment, a preliminary analysis was carried out of the existing natural and social environment of the PŪV site and its surroundings, taking into account currently available information at district and local levels. This analysis was based on previously prepared spatial planning documents [6, 10, 11, 12], EIA documents for the PŪV [7, 8, 9, 17, 19], data and documents submitted by the PŪV organiser (client)
, as well as other publicly available information [13, 14, 15, 20, 21, 22,
23].

Objectives of the environmental impact assessment of the PŪV:

- to identify, describe and assess the potential significant direct and indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative impacts of the PŪV on the environment (on ambient air, water, soil, subsoil, shorelines, landscape, material assets and the interaction between these environmental elements) and the impact of biological, chemical and physical factors caused by the PŪV on public health, as well as the interaction between environmental elements and public health;
- to identify the potential impact of the PŪV on the specified environmental elements and public health due to the risk of vulnerability of the PŪV to extreme events and/or potential emergencies;
- to identify the measures to be taken to prevent, reduce or, where possible, offset the anticipated significant adverse effects on the environment and public health;
- determine whether the PŪV, taking into account its nature, location and/or impact on the environment, complies with the requirements of legislation on environmental protection, public health, the protection of immovable cultural heritage, fire safety and civil protection.

The EIA for the PŪV was carried out in the established sequence and in accordance with the following procedures:

- Preparation of the EIA programme for the PŪV, consultation with EIA stakeholders and the public, receipt and assessment of their conclusions, proposals and comments on the EIA programme, consultation with the competent authority and approval of the programme;
- Assessment of the environmental impact of the PŪV and preparation of the EIA report;
- Publication and presentation of the EIA report to the public; receipt and assessment of proposals and comments on the EIA and the EIA report; coordination of the EIA report with EIA stakeholders; coordination of the EIA report with the competent authority; and adoption of a decision on the feasibility of the project.

The EIA was carried out in accordance with the following provisions:

- The EIA for the PŪV is carried out in accordance with the Law of the Republic of Lithuania on the Environmental Impact Assessment of Planned Economic Activities [2], the Description of the Procedure for the Environmental Impact Assessment of Planned Economic Activities [3] and other applicable laws and regulations of the Republic of Lithuania and the European Union, recommendations and methodologies, and taking into account the final solutions planned in other KVJUD projects that may affect the PŪV, as well as the information provided by KVJUD.
- The PŪV solutions are described and justified on the basis of the report on the development of the southern part of the KVJU [20], prepared by the company ‘Moffatt and Nichol’ and submitted by KVJUD;
- The PŪV area covers approximately 270 ha of the southern part of the KVJU territory, the approximate boundaries of which extend from PK80 (in the north) to PK111 (in the south), and from the western part of the Smeltė peninsula (in the east) to the western boundary of the port territory (in the west) (Graphical Appendix 1, Fig. 3.1.1).
- The EIA for the PŪV is assessed for the following stages of implementation of the PŪV solutions: construction of the facilities and operation of the facilities. The assessment of the facility operation (use) stage covers only the environmental impact assessment directly related to the operation and maintenance of the facilities (the shipping channel, the areas being developed, etc.) and does not directly address the shipping and cargo handling activities currently carried out and planned in the port. The EIA does not specify a decommissioning period; therefore, no assessment is carried out for this phase.
- The current state of the environment is described primarily on the basis of the situation in 2021. The situation in 2021 is classified as the ‘baseline’ condition, i.e. it is assumed that if the PŪV were not implemented, the environmental indicators would correspond to the situation in 2021. Data for 2022 is used only partially for the assessment, as it was not yet possible to obtain all the necessary summary information for that year at the time of preparing the EIA report.
- The assessment was carried out for the following alternatives:

  - **Alternative 0** – the PŪV solutions would not be implemented, and the environmental conditions would correspond to the situation in 2021–2022 and would not be affected by the PŪV;
  - **Alternative 2A** – the PŪV solutions are implemented (expansion of the southern part of the port: extension of the inner navigation channel by approximately 1.7 km and construction of a turning basin, dredged to a depth of 17.0 m, construction of quays (approx. 1,803 m) and formation of new land area within the water area (approx. 81.7 ha), dredging of the water area near the new quays to a depth of 16.5 m, reconstruction of quays Nos. 151–152 to a design depth of 16.5 m and dredging of the water area near quays Nos. 149–152 to a depth of 16.5 m, and the reconstruction of the section of the electricity transmission line to the Curonian Spit.
  - **Alternative 3A** – implementation of the PŪV solutions (expansion of the southern part of the port: extension of the inner navigation channel (approx. 2.4 km) and construction of a turning basin, dredged to a depth of 17.0 m,

construction of quays (approx. 1,665 m) and formation of new land area within the water area (approx. 60.5 ha), dredging of the water area near the new quays to a depth of 11.0–16.5 m, reconstruction of quays Nos. 151–152 to a design depth of 16.5 m and dredging of the water area near quays Nos. 149–152 to a depth of 16.5 m, and the re-routing of the electricity transmission line to the Curonian Spit.

- **Alternative 4A** – implementation of the PŪV solutions (expansion of the southern part of the port: extension of the inner navigation channel (approx. 1.7 km) and construction of a turning basin, dredging to a depth of 17.0 m, construction of quays (approx. 1,284 m) and formation of new land area within the water area (approx. 83.5 ha), dredging of the water area near the quays to a depth of 16.5 m, reconstruction of quays Nos. 151–152 to a design depth of 16.5 m and dredging of the water area near quays Nos. 149–152 to a depth of 16.5 m, and the re-routing of the electricity transmission line to the Curonian Spit.

  The PŪV alternatives also examine and evaluate alternative technological and environmental solutions for specific measures.

- The EIA solutions are provisionally divided into ‘primary’ and ‘secondary’ solutions. Primary solutions are directly related to the activities of KVJU, i.e. all solutions described in the EIA alternatives, with the exception of the reconstruction of the 110 kV EEPOL Marios–Juodkrantė section (dismantling of the existing line section and laying of a new underground power cable). The latter solutions are classified as ‘secondary’.

  - The assessment of the PŪV alternatives will also integrate solutions already planned and implemented or currently being implemented under previous projects, specifically the improvement of the outer and inner navigation channels of the Klaipėda State Seaport (dredging and widening), the reconstruction (construction) of the southern and northern breakwaters, and the stabilisation of part of the Curonian Spit slope and the construction of the southern port gates, approved by the AAA in 2019 [19]. Some of the aforementioned solutions (e.g. the southern port gates, shoreline management measures) may be refined during the EIA for this project.
  - The reconstruction of KVJU quays Nos. 149, 150 and 151, which fall within the project area, and the dredging of the water area to a depth of 10 m are currently planned, and the screening for the EIA procedure for this project has already been completed [22]. These planned solutions will also be taken into account during this EIA and are expected to be implemented before the start of the PŪV.
  - The project area includes the existing KVJU contaminated soil storage site, adjacent to which a new contaminated soil storage site of approximately 6.6 ha is planned to be established. EIA screening procedures were carried out for this planned economic activity, and on 5 September 2022, the Environmental Protection Agency (EPA) adopted screening conclusion No. (30-5)-A4E-9865, stating that an environmental impact assessment of the project is mandatory [23]. In accordance with the aforementioned EIA screening conclusion, UAB ‘Ardynas’, having won the public tender announced by KVJUD, carried out an environmental impact assessment of the construction of the KVJU contaminated soil storage site at 19 Kairių Street, Klaipėda, and on 29 March 2024, the AAA adopted Decision No. (30-5)-A4E-4197, stating that the aforementioned economic activity (in accordance with the alternative specified in paragraph 13 of this decision), subject to the implementation of the measures and conditions set out in points 6 and 11 of this decision, will comply with the requirements of environmental protection, public health, immovable cultural heritage, fire safety and civil protection legislation and will not have a significant adverse impact on the environment [68]. In carrying out the EIA for the development of the southern part of the KVJU, the impact of existing and planned contaminated soil storage sites will not be assessed separately, but it is assumed that, prior to the implementation of the project solutions, the operation of the contaminated soil storage sites will be discontinued, i.e. the sites will be backfilled, the contaminated soil treated and stabilised, and the area prepared for backfilling, capping and subsequent adaptation for alternative use (landfill).

- During the EIA for the PŪV, the necessary environmental field surveys were carried out:
  - Seabed habitat surveys (carried out by KU specialists);
  - Bird surveys on Kiaulės Nugaros Island and in the northern part of the Curonian Lagoon (carried out by LOD specialists);
  - Surveys of the shoreline and foreshore (carried out by Dr G. Žilinskas);
  - Seabed scanning using side-scan sonar (carried out by KU specialists);
  - Underwater archaeological surveys (carried out by KU specialists).
- During the assessment of the EIA programme for the PŪV, the Environmental Protection Agency and the Coordinating Authority (the Ministry of the Environment of the Republic of Lithuania) did not conclude that it was necessary to carry out transboundary environmental impact assessment procedures for the PŪV.

1.2 Procedure for public participation in the EIA procedures

Public participation in the EIA process for the PŪV is carried out in accordance with the requirements of the Law on the Environmental Impact Assessment of Planned Economic Activities of the Republic of Lithuania [2] and the Description of the Procedure for the Environmental Impact Assessment of Planned Economic Activities [3].

The procedures for public information and participation are:

- notification of the prepared EIA programme;
- public presentation of the EIA report for the planned economic activity;
- notification of the decision taken regarding the planned economic activity.

The EIA report for the planned economic activity will be made public in accordance with the procedure laid down in legislation:

- information regarding the opportunity to review the prepared EIA report for the project will be published in the press, on municipal and parish notice boards, and online;
- a public meeting to present the EIA report for the PŪV to the public will be organised at premises selected by KVJUD, in consultation with the city council and with the public being informed in accordance with the established procedure, as well as via remote broadcast.

1.3 Participants in the PŪV environmental impact assessment process

The participants in the EIA process are:

- Project organiser: State Enterprise ‘Klaipėda State Seaport Authority’ (Section 2.1);
- Competent authority: Environmental Protection Agency;
- EIA document preparer: UAB “Sweco Lietuva” and partners (Section 2.2);
- EIA stakeholders (see below);
- The public.

The assessment of the EIA documents for the project is carried out by the following EIA stakeholders:

- Klaipėda Department of the National Public Health Centre under the Ministry of Health;

- Klaipėda Branch of the Department of Cultural Heritage under the Ministry of Culture;
- Klaipėda County Fire and Rescue Board;
- Klaipėda City Municipality Administration;
- Neringa Municipal Council;
- State Service for Protected Areas under the Ministry of the Environment*;
- Lithuanian Geological Survey under the Ministry of the Environment*.

* - In accordance with Article 5(2) of the EIA Law [2], the Environmental Protection Agency invited the State Service for Protected Areas under the Ministry of the Environment and the Lithuanian Geological Survey under the Ministry of the Environment to participate in the EIA process for the PŪV as EIA entities (Textual Annex 2).

It should also be noted that the PŪV site is adjacent to the Curonian Spit – a UNESCO World Natural and Cultural Heritage site, the protection of which is the responsibility not only of the country's state institutions but also of UNESCO, represented by the Permanent Delegation of Lithuania to UNESCO and the Lithuanian National Commission for UNESCO.

2 GENERAL INFORMATION ON THE PROPOSED ECONOMIC ACTIVITY ( )

2.1 Details of the organiser of the planned economic activity

Company name	AB “Klaipėda State Seaport Authority”
Address, telephone, fax	J. Janonio g. 24 92251 Klaipėda Tel. (8 46) 499 600 Fax (8 46) 499 777 Email info@port.lt Website: www.portofklaipeda.lt
Contact person’s name, surname, position	Deputy Head of the Development and Environmental Protection Department Gedeminas Sakutis Tel. (8 46) 499 719 Mobile: 8 686 02502 Email g.sakutis@port.lt

2.2 Details of the preparer of the environmental impact assessment documents for the planned economic activity

Company name	UAB “Sweco Lietuva”
Address, telephone, fax	Ozo g. 12A-1, 08200 Vilnius Tel. (8 5) 262 26 21 Fax (8 5) 261 75 07 Email info@sweco.lt Website: www.sweco.lt
Contact person’s name, surname, position	Vytautas Belickas Head of the Environmental Protection and Planning Department Tel. (8 5) 279 6088 Mobile: 8 699 83628 Email vytautas.belickas@sweco.lt

2.3 Name, purpose and implementation deadlines of the PŪV

Name of the project	Development of the southern part of the Klaipėda State Seaport
Project stage	Environmental impact assessment of the planned economic activity
Location of the planned activity:	Klaipėda County, the southern part of the territory of the State Enterprise Klaipėda State Seaport within the territories of Klaipėda City and Neringa Municipality (Graphical Appendix 1, see Section 3.1 for details)
Project facilities and their capacity/parameters	• a section of the inner navigation channel (1.7 to 2.4 km in length depending on the project alternative), with a width of at least 200 m in the channel and 600 m at the turning area for vessels, and a depth of 17.0 m), excavation of part of Kiaulės Nugaros Island (from 13.2 to 13.6 ha depending on the PŪV alternative);

	• newly formed land area in the water area with quays and protective breakwaters (from 60.5 ha to 83.5 ha of land area and from 1,803 m to 1,665 m of quay length, depending on the PŪV alternative); • a water area dredged to a depth of 11.0–16.5 m near the newly constructed quays (depending on the PŪV alternative); • reconstructed quays Nos. 151–152 (to a design depth of 16.5 m); • a new water area dredged to a depth of up to 16.5 m adjacent to the reconstructed quays No. 149–152; • the existing 110 kV power transmission line section has been dismantled, and a power transmission to the Curonian Spit.
Purpose of the PŪV facilities:	Development of the southern part of the Klaipėda State Seaport
Project implementation **:**	By 2034
Project alternatives	Alternative 0* – The PŪV solutions would not be implemented, and the state of the environment would correspond to the situation in 2021–2022 and would not be affected by the PŪV; Alternative 2A* – the PŪV solutions are implemented (expansion of the southern part of the port: extension of the inner navigation channel by approximately 1.7 km and construction of a turning basin, dredged to a depth of 17.0 m, construction of quays (approx. 1,803 m) and creation of new land area within the water area (approx. 81.7 ha), dredging of the water area adjacent to the quays to a depth of 16.5 m, reconstruction of quays Nos. 151–152 to a design depth of 16.5 m and dredging the water area near quays No. 149–152 to a depth of 16.5 m, and the reconstruction of the power transmission line branch to the Curonian Spit; Alternative 3A* – implementation of the PŪV solutions (expansion of the southern part of the port: extension of the inner navigation channel (approx. 2.4 km) and construction of a turning basin, dredging to a depth of 17.0 m, construction of quays (approx. 1,665 m) and formation of new land area within the water area (approx. 60.5 ha), dredging of the water area adjacent to the quays to a depth of 11.0–16.5 m, reconstruction of quays Nos. 151–152 to a design depth of 16.5 m and dredging of the water area near quays Nos. 149–152 to a depth of 16.5 m, and the reconstruction of the electricity transmission line to the Curonian Spit; Alternative 4A* – implementation of the PŪV solutions (expansion of the southern part of the port: extension of the inner navigation channel (approx. 1.7 km) and construction of a turning basin, dredging to a depth of 17.0 m, construction of quays (approx. 1,284 m) and formation of new land area within the water area (approx. 83.5 ha), dredging of the water area adjacent to the quays to a depth of 16.5 m, reconstruction of quays No. 151–152 to a design depth of 16.5 m, and

	dredging of the water area near quays No. 149–152 to a depth of 16.5 m, and the reconstruction of the electricity transmission line to the Curonian Spit. * - the assessment of all project alternatives is carried out on the assumption that the solutions approved by the AAA in 2019 for the 'Improvement (dredging and widening) of the outer and inner navigation channels of the Klaipėda State Seaport, reconstruction (construction) of the southern and northern breakwaters, and the stabilisation of part of the Curonian Spit slope and construction of the southern port gates' [19] will be implemented and, where necessary, adapted to this PŪV solutions.
The expected operational life of the PŪV facilities **operational life**	Unlimited

3 DESCRIPTION OF EXISTING ACTIVITIES AND THE PROPOSED DEVELOPMENT PROJECT ( )

3.1 Brief description of the current state of the PŪV territory

KVJU is a multimodal, universal port where stevedoring, ship repair, construction and other companies operate, providing all services related to the maritime business and cargo handling.

The PŪV solutions are planned for an area of approximately 270 ha in the southern part of KVJU, which includes the western part of the Smeltė Peninsula, the Kiaulės Nugaros Island, covering an area of approximately 18.0 ha, and the port basin in the northern part of the Curonian Lagoon between the Smeltė Peninsula and the Curonian Spit from PK80 to PK111 (Graphical Appendix 1, Figs. 3.1.1–3.1.2). The PŪV also covers the conversion (dismantling and laying of a new underground cable) of the existing 110 kV Marios–Juodkrantė overhead power line section.

The project area in relation to sensitive areas is shown in Graphic Appendix 1 and described below.

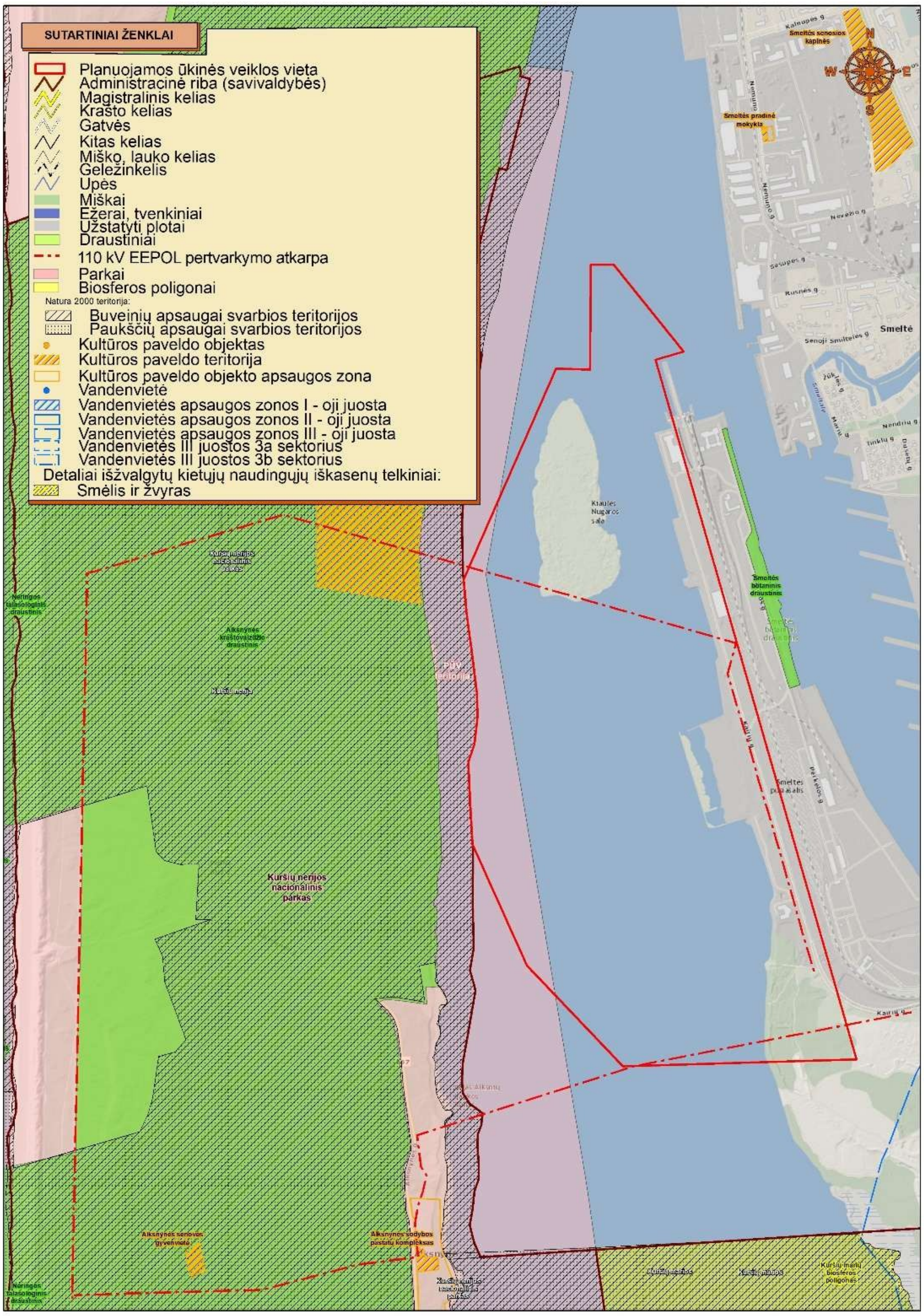
3.1.1 Fig. View of the PŪV area

The project area is owned by the Republic of Lithuania and is managed under a trust agreement by AB Klaipėda State Seaport Authority. The quays are leased to stevedoring companies.

The PŪV territory comprises 5 land plots or parts thereof (part of the land plot with cadastral No. 2101/10:1, intended use: other; part of the land plot with cadastral No. 2101/10:61, intended use: water management, method and nature of use: water bodies used for economic activities; part of the land plot with cadastral No. 2101/10:62, intended use: water management, method and nature of use: water bodies used for economic activities; part of the land plot with cadastral No. 2101/10:44, intended use: other, method and nature of use: areas for industrial and storage facilities; part of the land plot with cadastral No. 2101/10:43, intended use: other, method and nature of use: recreational areas.

According to the General Plan for the Territory of the Klaipėda State Seaport, approved by Resolution No. 1278 of the Government of the Republic of Lithuania on 11 December 2019 [12], the PŪV area falls within the zones of engineering infrastructure and engineering infrastructure in waters, for which the following usage regulations apply: transport and engineering network corridor areas.

Information on the compliance of the PŪV solutions with the applicable spatial planning documents is provided in Section 3.2 of the PŪV EIA report.



3.1.2 Fig. Location of the PŪV

Location of the PŪV in relation to protected areas and the European ecological network 'Natura 2000'

The protected natural areas closest to the PŪV site are:

- The Curonian Spit National Park, including its nature reserves and the European ecological network (Curonian Spit BAST/1000000000215 and Curonian Spit National Park PAST/1100000000057) (bordering the main PŪV area to the west, whilst the 110 kV EEPOL line conversion solutions are also planned within the Curonian Spit National Park);
- Smeltė Botanical Reserve (approximately 140 m to the east of the project site);
- The Curonian Lagoon Biosphere Reserve (approximately 670 m south of the project site). The boundaries of the Curonian Lagoon Biosphere Reserve coincide with the areas of the European ecological network 'Natura 2000': Curonian Lagoon PAST/1100000000082 and Curonian Lagoon BAST/1000000000101.

The PŪV area in relation to the nearest deposits of solid mineral resources and groundwater sources

The nearest thoroughly surveyed mineral deposit to the PŪV area is the Kairiai sand and gravel deposit, located 1.5 km to the south-east. The PŪV area falls within the Gintaras I (No. 1651) prospective area. The Smeltė amber deposit, which was previously located nearby, was exhausted in 1997 and removed from the Subsurface Resources Register.

The nearest water supply area to the PŪV site (Klaipėda III) is approximately 0.6 km away, and the boundary of its AZ 3 zone is 0.23 km to the south-east. The distance from the PŪV site to the Klaipėda I water supply area and the currently unused Klaipėda II municipal water supply area is approximately 5.7 km and 4.1 km to the north-east, respectively.

Location of the PŪV in relation to immovable cultural heritage assets

The location of the main solutions of the PŪV does not fall within the territories of immovable cultural heritage objects and sites or their protection zones. The nearest immovable cultural heritage sites are the Alksnynė defensive complex (unique object code 30540), located 160 m west of the PŪV site, the King William Canal structures complex (unique object code 25965) – approximately 560 m to the south-south-west; and Smeltė Primary School (unique object code 33607) – approximately 730 m to the north. The planned 110 kV EEPOL section to be dismantled runs over the Alksnynė defence complex.

Location of the project area in relation to residential and public areas

The project area does not include residential or public areas or buildings. The nearest residential buildings to the project site are located approximately 610 m to the east, at Marių g. 1, 3, 5, 7, 9, 11, 13, 15, 17.

The nearest public buildings to the PŪV site are to the east: 1,370 m away is the Klaipėda Regional Customs Office; 2,000 m away is the Molas shopping centre (Taikos per. 139); and 2,140 m away is Smeltė Lower Secondary School (Reikjaviko g. 17).

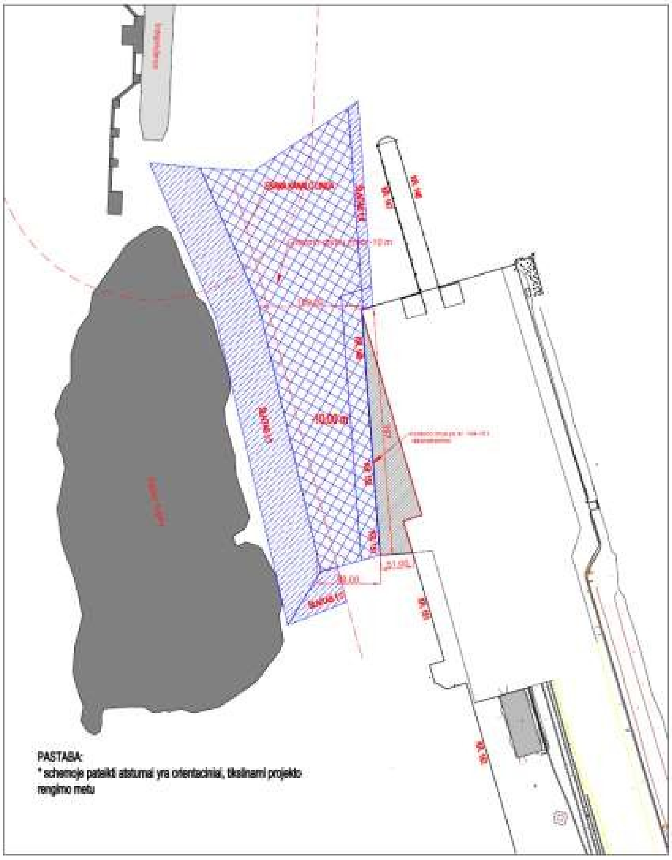
A description of the PŪV territory is provided below.

This southern part of the port is not used intensively for port purposes due to shallow waters and insufficiently developed infrastructure and superstructure. The PŪV area can be divided into the following conditional areas (land areas – the western part of the Smeltė Peninsula and Kiaulės Nugaros Island; water area – the port water area in the northern part of the Curonian Lagoon from PK80 to PK111).

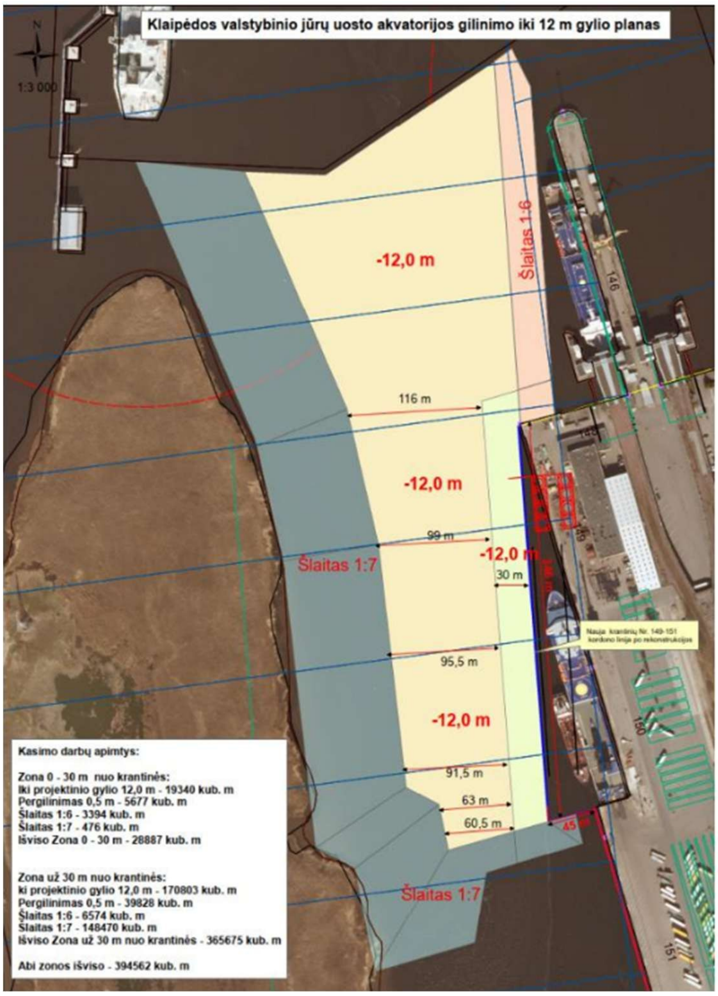
Smeltė Peninsula

Kairių Street and railway tracks run along the Smeltė Peninsula to its end, and port companies operate in the majority of the area. UAB 'Klaipėdos konteinerių terminalas' is located and operates in the south-eastern part of the area. This company uses quays No. 143 and No. 143a for cargo handling. Quay No. 144, located in the central part of the eastern side of the peninsula, and quays No. 145–152, located in the north-western part, are operated by AB Klaipėdos jūrų krovinių kompanija (KLASCO). Plans are currently underway to reconstruct quays No. 149–151 and deepen the water area adjacent to them to 10 m (on 30 November 2022, the AAA adopted screening conclusion No. (30-2)-A4E-13290, stating that an EIA is not required) [22] (Fig. 3.1.3).

Subsequently, following a change in circumstances, the KVJUD initiated an additional EIA screening procedure regarding the deepening of the water area adjacent to the aforementioned quays Nos. 149–151, which are planned for reconstruction, to 12 m. On 13 November 2023, the AAA adopted screening conclusion No. (30-2)-A4E-11412 regarding this development project, stating that an EIA is not required [67] (Fig. 3.1.4).



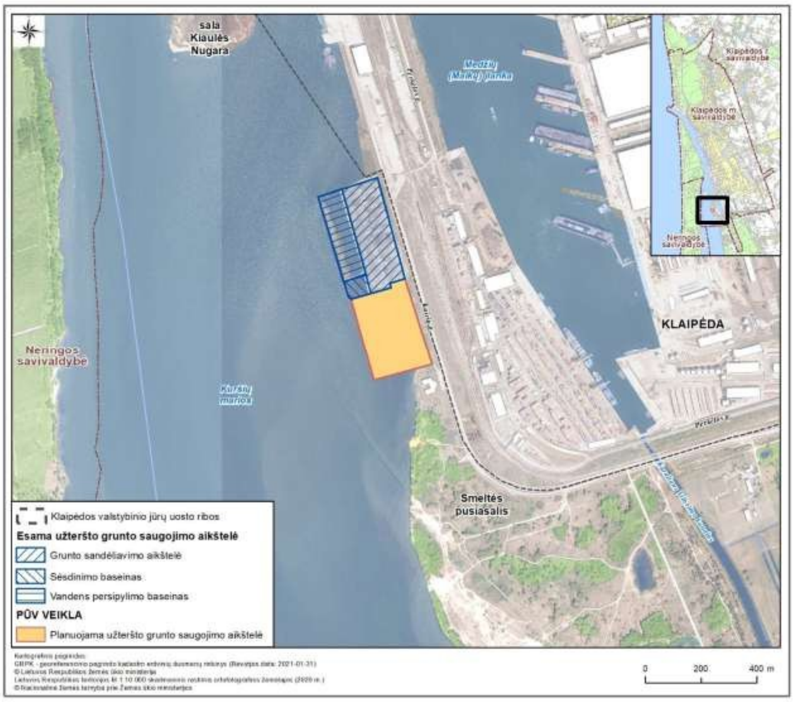
3.1.3 Fig. Proposed solutions for the reconstruction of quays Nos. 149–151 and the dredging of the water area adjacent to them to a depth of 10 m [22]



3.1.4 Fig. Solutions for the planned dredging of the water area to a depth of 12 m (in the water area from the newly reconstructed section of quays No. 149–151 along the cordon line towards Kiaulės Nugaros Island,

forming slopes) [67]

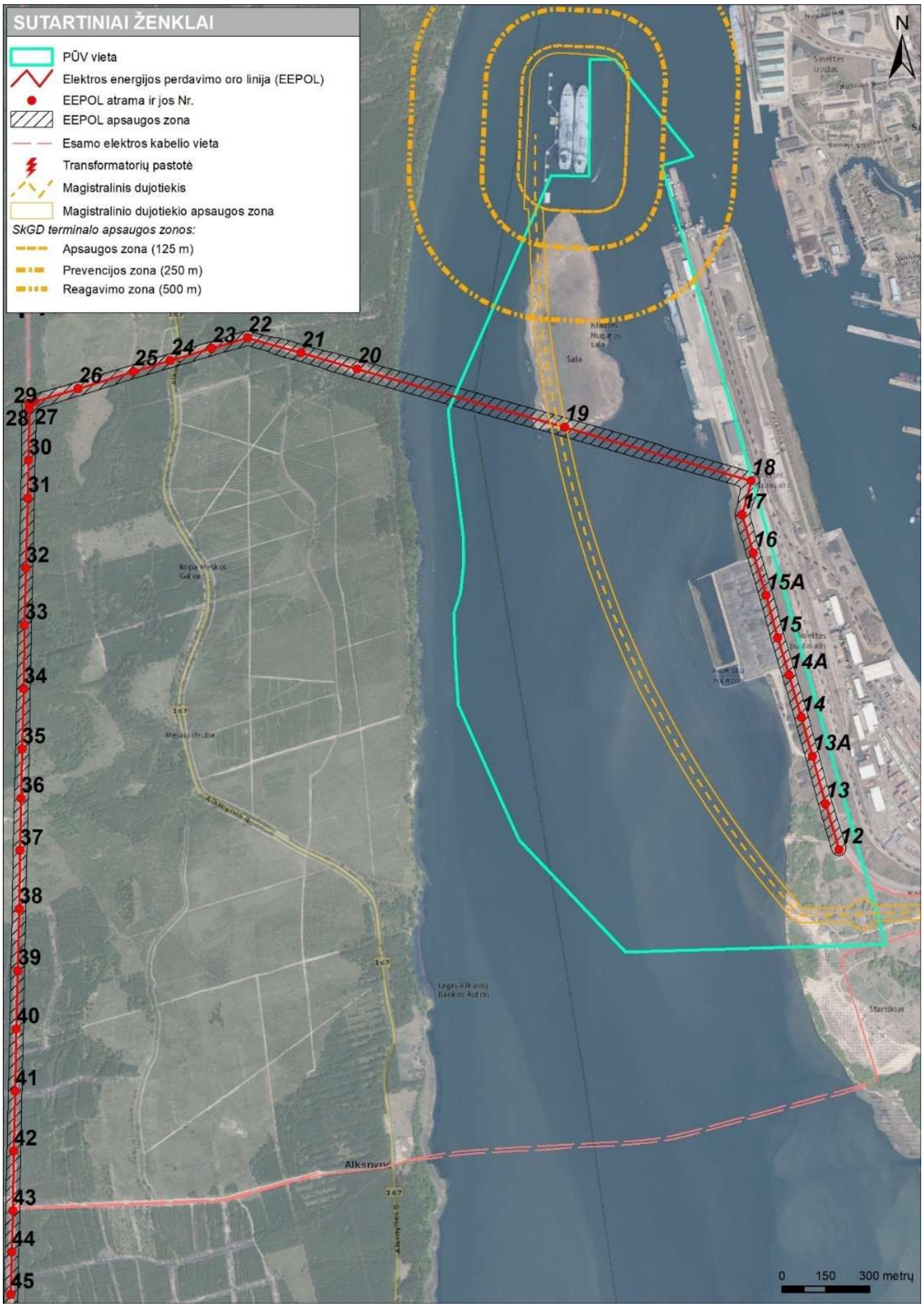
In the eastern part of the peninsula, along a stretch of approximately 1,020 m along the Malkų Bay water area, lies the Smeltė Botanical Reserve. On the western side of the peninsula, near the central part, there is a KVJU contaminated soil storage site covering an area of approximately 8.6 ha. Adjacent to it on the southern side, there are plans to establish an additional new contaminated soil storage site of approximately 6.6 ha [23] (Fig. 3.1.5).



3.1.5 Fig. Existing and planned new contaminated soil storage site [23]

Kiaulės Nugaros Island

Across the approximately 18-hectare Kiaulės Nugaros Island, a 110 kV Marios–Juodkrantė overhead power transmission line runs from the mainland, from the Marios substation to the Curonian Spit and on to the Juodkrantė substation (from the Marios substation to support No. 12, it runs as an underground cable). This line is maintained and operated by AB Litgrid. Pylon No. 19 of this power line is located on the southern edge of the island (Figs. 3.1.6–3.1.7). An underground main gas pipeline to the LNG terminal, located in the port basin north of this island, also runs across the island (Fig. 3.1.6). In the north-western part of the island, there is also a disused power line pylon (Fig. 3.1.7).



3.1.6 Fig. A section of the 110 kV Marios–Juodkrantė overhead power line and the main gas pipeline across Kiaulės Nugaros Island

3.1.7 Fig. Pylon No. 19 of the 110 kV Marios–Juodkrantė overhead power line (top two photos) and a disused pylon (bottom two photos) on Kiaulės Nugaros Island

The waters of the northern part of the Curonian Lagoon

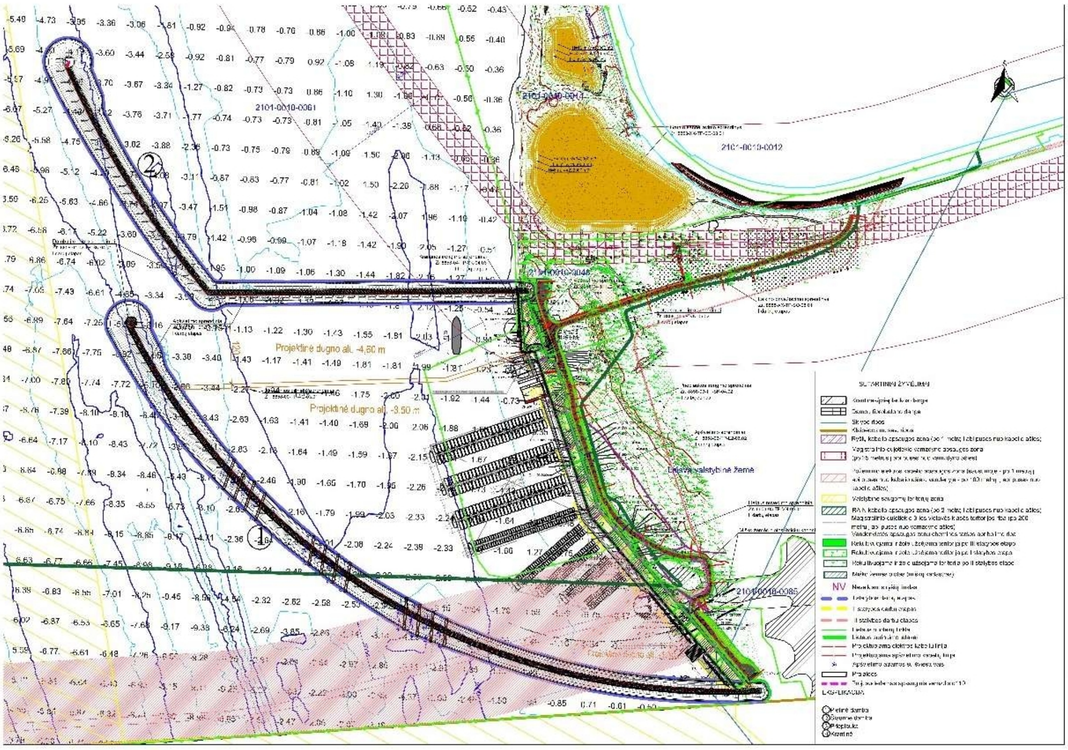
The waters of the northern part of the Curonian Lagoon beyond Kiaulės Nugaros Island up to the boundary of the Curonian Lagoon Biosphere Reserve (up to the southern boundary of the port area) (from PK87 to PK118) is hardly used for port shipping, with the exception of the eastern channel between the Smeltė Peninsula and Kiaulės Nugaros Island, where quays Nos. 149–151 are located and the water depth there is approximately 8–9 m.

The depth of the existing shipping channel at the western channel of Kiaulės Nugaros Island and onwards to the southern boundary of the port (PK118) is 5–9 m, whilst the maximum depth of the water area beyond Kiaulės Nugaros Island reaches up to 4 m (Fig. 3.2.1).

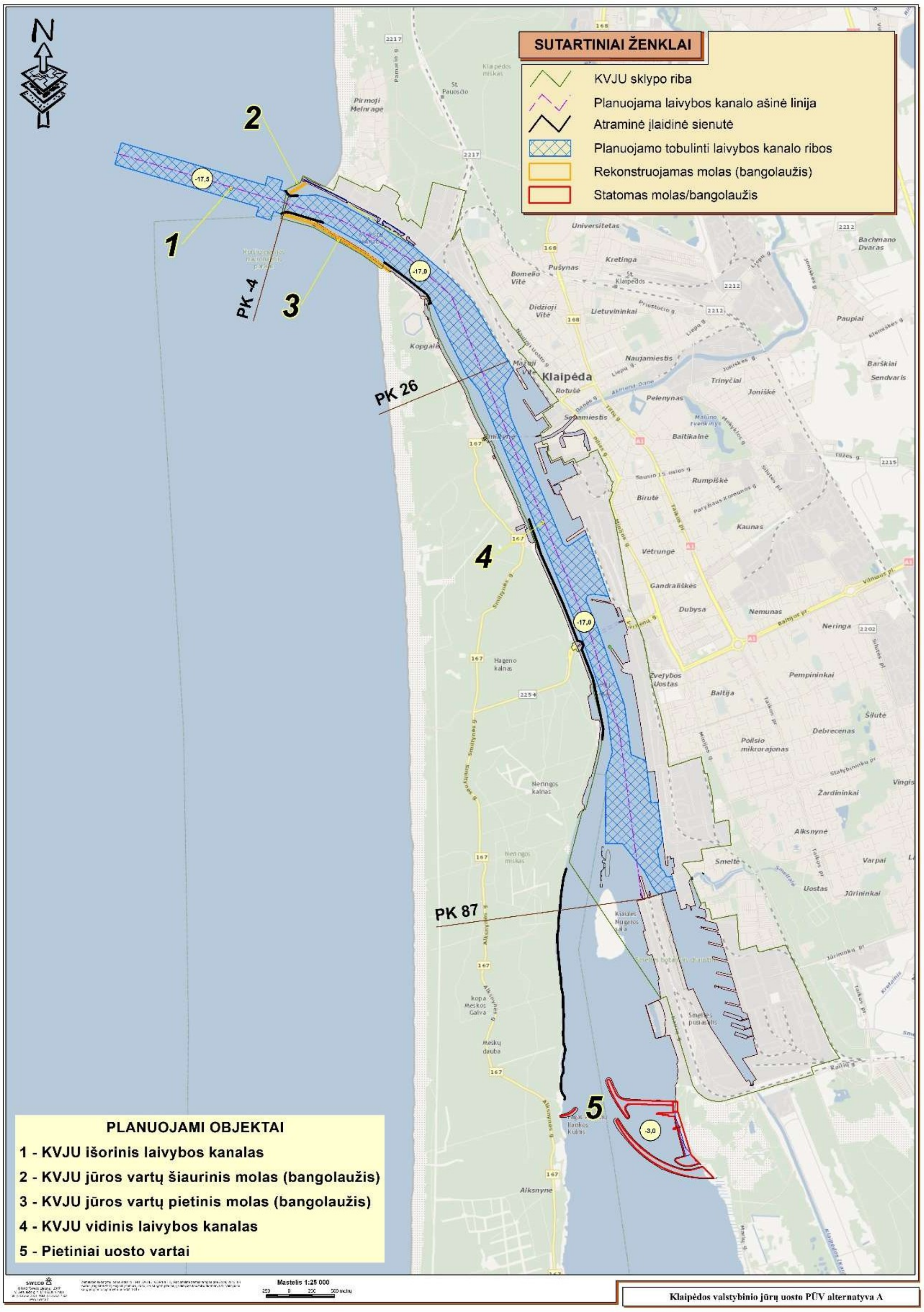
In this water area, the aforementioned main gas pipeline has been laid along the seabed of the lagoon at a depth of approximately 50 m (Fig. 3.1.6).

In accordance with the EIA conclusions for the 2019 project to improve (dredge and widen) the outer and inner navigation channels of the KVJU, reconstruct (construct) the southern and northern breakwaters, reinforce part of the Curonian Spit slope, and construct the southern port gates, in accordance with Alternative A [19], which were approved by the AAA in letter No. (30.1)-A4-1585 dated 4 March 2019, in this part of the water area, south of the project site, it is planned to construct the southern port gates, consisting of protective breakwaters approximately 0.88 km long to the north and approximately 1.24 km long to the south, as well as a marina for small and recreational vessels, the water area of which will be dredged to a depth of 3
m. A 190 m long shore protection breakwater would also be constructed at Alksnyne. In part of the water area, measures to reinforce the underwater slope of the Curonian Spit would be implemented (Fig. 3.1.9).

A technical design for the southern entrance to the port (protective breakwaters and the marina for small and recreational vessels) is currently being prepared, with a preliminary solution shown in Fig. 3.1.8. These solutions slightly refine and elaborate on the solutions envisaged in the 2019 EIA report [19].



3.1.8 Fig. Technical solution for the southern entrance to the port (protective breakwaters and the small and recreational craft harbour) (UAB 'Kelprojektas')



3.1.9 Fig. Environmental impact assessment report for the improvement (deepening and widening) of the outer and inner navigation channels of the Klaipėda State Seaport, the reconstruction (construction) of the southern and northern breakwaters, the stabilisation of part of the Curonian Spit slope, and the construction of the southern port gates [19]

Planned and implemented solutions

In planning the implementation of the solutions (the southern port gates (protective breakwaters and the small and recreational craft harbour) in accordance with the 2019 EIA [19] and in preparing the technical design for these solutions, certain solutions are being refined: The water area of the southern port gates is planned to be dredged from 1.5 to 4.6 m (instead of the previously planned 3 m), and the excavated surplus soil is to be temporarily stored on the KVJU site at Kairių

, Klaipėda (Fig. 3.1.8). A screening was carried out regarding the need for an EIA for the aforementioned solutions, and on 20 June 2023, conclusion No. SR23-00771 was received from the AAA stating that an EIA is not mandatory for the PŪV [49].

3.2 Location of the PŪV in approved spatial planning documents

A list of the comprehensive and special spatial planning documents and other relevant documents in force within the project area and its immediate surroundings is provided in Table 3.2.1.

3.2.1 Table 3.2.1. List of comprehensive and special spatial planning documents and other relevant documents in force within the PŪV area

No.	Title	Document approving the TPD
Comprehensive TPD – general plans		
1	General Plan for the Territory of the Republic of Lithuania	Resolution No. 789 of the Government of the Republic of Lithuania of 29 September 2021 ‘On the Approval of the General Plan for the Territory of the Republic of Lithuania’.
2	General Plan for the Klaipėda State Seaport (land, inner harbour, outer harbour and related infrastructure)	Resolution No. 1278 of the Government of the Republic of Lithuania of 11 December 2019 “On the Approval of the General Plan for the Klaipėda State Seaport (land, inner harbour, outer harbour and related infrastructure)”.
3	Klaipėda City Master Plan	Klaipėda City Municipal Council Decision No. T2-191 of 30 September 2021 “On the Approval of Amendments to the Klaipėda City Master Plan”.
4	Master Plan for the Territory of Neringa Municipality and its Parts	Neringa Municipal Council Decision No. T1-164 of 21 September 2012 “On the approval of the master plan for the territory of Neringa Municipality and its parts ”.
Comprehensive TPD – detailed plans		
5	Detailed plan for the territory of the Klaipėda State Seaport south of Senoji Smiltelė Street	Klaipėda City Municipality Decision No. 1-247 of 23 June 2004 “On the approval of the detailed plan for the territory of the Klaipėda State Seaport south of Senoji Smiltelė Street”;
6	Amendment to the detailed plan for the territory of the Klaipėda State Seaport south of Senoji Smiltelė Street, approved by Klaipėda City Municipality Decision No. 1-247 of 23 June 2004, in respect of part of the territory	Order of the Director of the Klaipėda City Municipality Administration of 17 August 2018 No. AD1-2014 “On the detailed plan for the territory of the Klaipėda State Seaport south of Senoji Smiltelė Street, approved by Klaipėda City Municipality Resolution No. 1-247 of 23 June 2004 “On the detailed plan for the territory of Klaipėda State Seaport south of Senoji Smiltelė Street

		detailed plan, approval of the part of the territory subject to amendment”.
Special TPD		
7	Special Plan for the Construction of the NordBalt Interconnector in Klaipėda County	Order No. 1-79 of the Minister of Energy of the Republic of Lithuania of 27 April 2012 “On the approval of the special plan for the construction of the NordBalt interconnector in Klaipėda County”.
8	Special Plan for the Construction of a Liquefied Natural Gas Terminal, Related Infrastructure and Gas Pipeline	Order No. 1-130 of the Minister of Energy of the Republic of Lithuania of 13 June 2013 “On the Approval of the Special Plan for the Construction of a Liquefied Natural Gas Terminal, Related Infrastructure and a Gas Pipeline”.
9	Plan of the Curonian Spit National Park and its zones	Resolution No. XI-1248 of the Seimas of the Republic of Lithuania of 22 December 2010 Resolution No. XI-1248 “On the Approval of the Plan of the Boundaries of the Curonian Spit National Park and its Zones”
10	Management Plan for the Curonian Spit National Park	Resolution No. 702 of the Government of the Republic of Lithuania of 6 June 2012 “On the Approval of the Management Plan for the Curonian Spit National Park”, (as amended by Resolution No. 1080 of the Government of the Republic of Lithuania of 30 October 2019)
Other plans		
11	Plan for the development of possibilities for the maximum deepening and widening of the shipping channel of the Klaipėda State Seaport	

General Plan for the Territory of the Republic of Lithuania

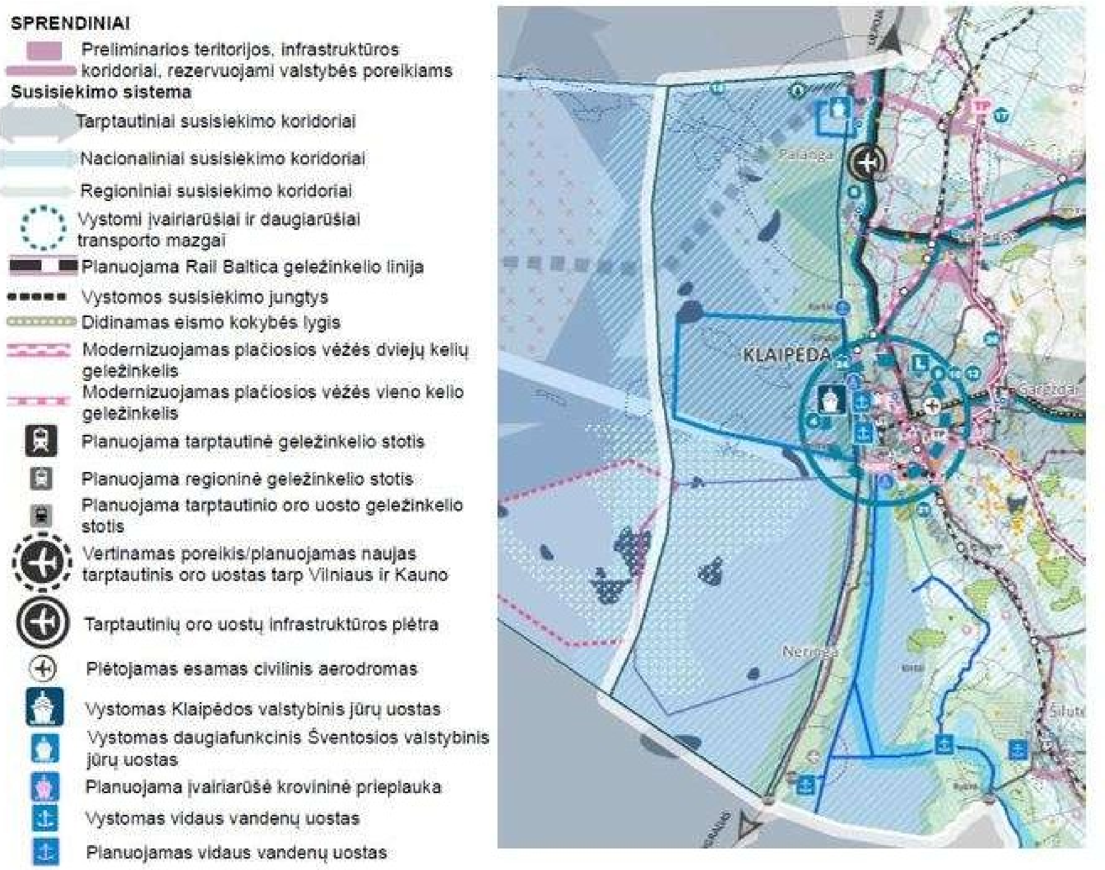
In the LRBP solutions, the city of Klaipėda, which includes the PŪV territory, remains an international-level metropolitan urban centre located on the internationally significant East-West IXB transport corridor and possessing waterways. The LRBP envisages the development of Klaipėda as a metropolitan urban centre featuring a seaport of regional importance in the Baltic Sea region, transport services (air, road, rail and water), and international-level tourism centres and infrastructure.

The foundation of the Republic of Lithuania’s international and national transport system is formed by multimodal and single-mode transport corridors and transport terminals that form part of the European Union’s trans-European, comprehensive and core transport network, one of the key elements of which is the Port (Fig. 3.2.1).

In the LRBP solutions, when assessing cargo volumes, the Port of Klaipėda remains the leader among the Baltic States, and in order for it to remain so and grow stronger, it is noted that the Port’s capacity must be expanded and its land transport infrastructure improved.

3.2.2 Table. Infrastructure development projects for the seaport (or related to it) envisaged in the LRBP

Project name / content	Project duration
Internal (southern) expansion of the KVJU	2030
Development of land transport infrastructure, dispersing and diverting freight from the city area.	2030
Reservation of land areas on the mainland for the back-up infrastructure necessary for the development of an external deep-water port (Melnragė and Būtingė alternatives) Implementation	2050

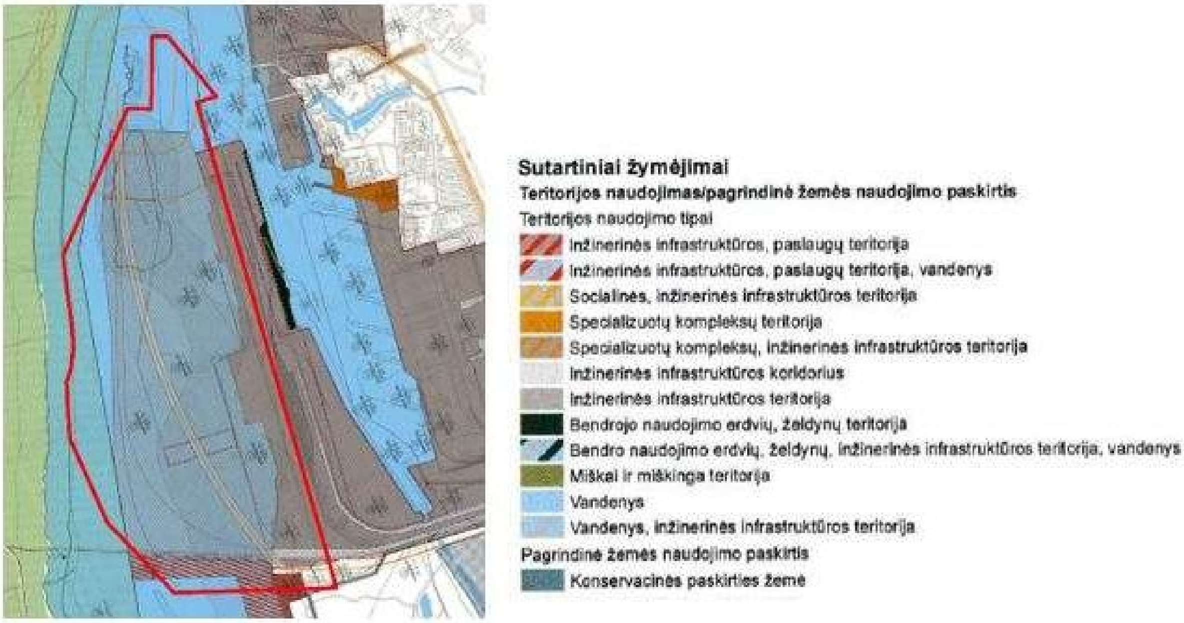


3.2.1 Fig. Extract from the LRBP drawing: Comprehensive infrastructure and land reservation for state needs (Source: www.tpdr.lt)

Klaipėda State Seaport Master Plan

The KVJU Master Plan solutions for the area containing the PŪV territory envisage the following land use types (Fig. 3.2.2): Built-up and to-be-built-up areas: 1) engineering infrastructure area. An area designated for transport and engineering communications service facilities; 2) engineering infrastructure and services area. An area designated for transport and engineering communications service facilities, utility companies and/or an area designated for retail and service facilities, administrative and other non-residential buildings in which economic activities unrelated to polluting production are carried out; 3) engineering infrastructure, service area, water. An area designated for transport and engineering infrastructure facilities, public utilities and/or an area designated for retail and service facilities necessary for serving the residents of the entire city or its district, administrative buildings, other non-residential buildings in which economic activities unrelated to polluting production are carried out, and/or water bodies and the area required for their operation.

Unbuilt and non-buildable areas: 1) Engineering infrastructure corridor. A linear unbuilt area designated for transport links and engineering networks.



3.2.2 Fig. Excerpt from the Master Plan of the Klaipėda State Seaport (Source: www.tpdr.lt)

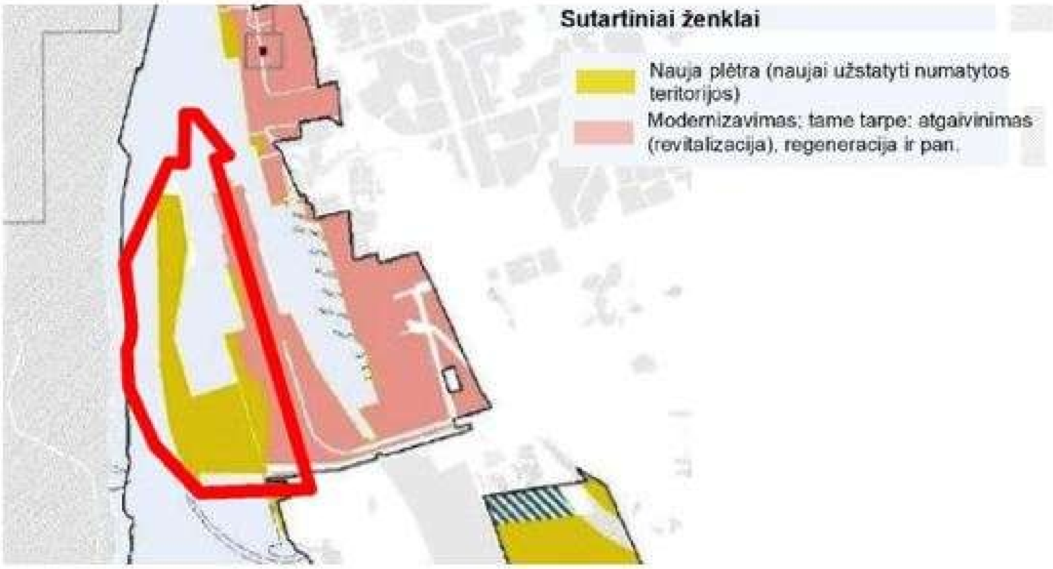
The KVJU BP solutions envisage new development and modernisation of the area containing the PŪV territory (Fig. 3.2.3). The new development is being carried out by utilising reserve areas allocated to the Port by Resolution No. 822 of the Government of the Republic of Lithuania of 3 November 1993 'On the Approval of the Boundaries of the Land, Port Water Area and Port Reserve Areas of the Klaipėda State Seaport' (as amended by Resolution No. 54 of the Government of the Republic of Lithuania of 20 January 2016), as well as by creating new land areas. The largest expansion of territories (land formation) is planned in the southern part of the Port – in the current Curonian Lagoon waters beyond Kiaulės Nugaros Island – and in the northern part, in the Baltic Sea waters.

Modernisation is being carried out through a comprehensive renewal of the built environment, development and infrastructure, combining revitalisation and regeneration.

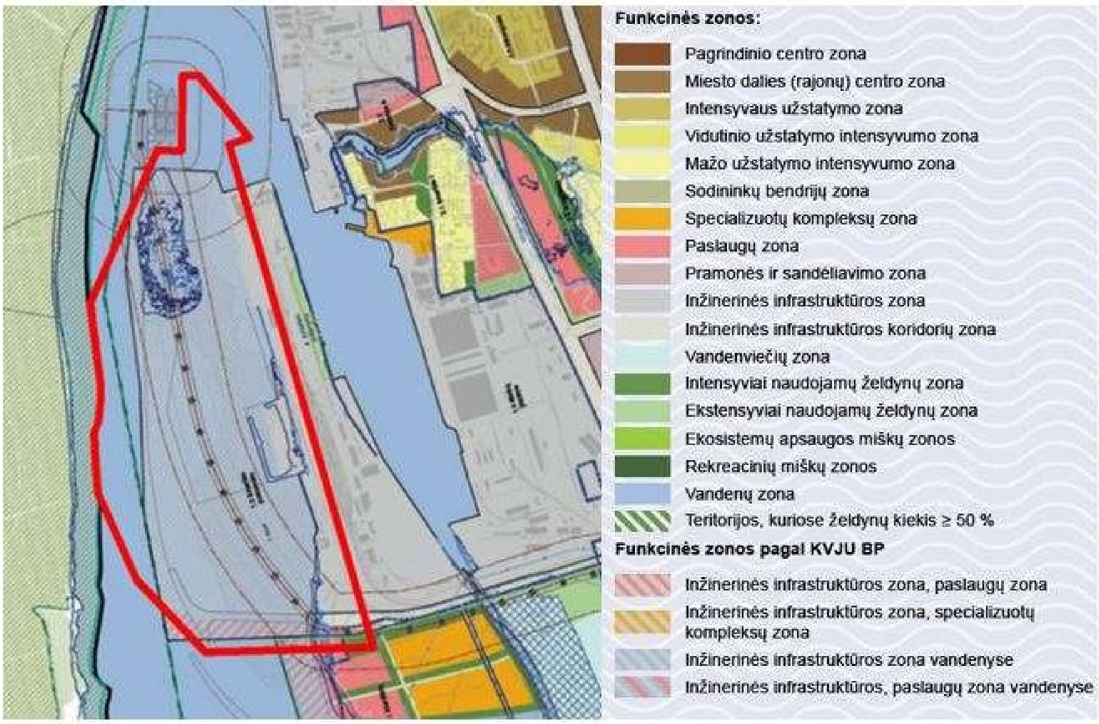
Klaipėda City Master Plan

In the Klaipėda City Master Plan, the KVJU is identified as a site of national importance, whilst the interaction between the Port and the city and their territorial functional expression is a key issue for the city; however, the Port is also the foundation for Klaipėda's economic development. The success of this sector depends on convenient access to the Port's infrastructure.

The Klaipėda City Master Plan stipulates that, when implementing solutions for the deepening and widening of the KVJU's internal and external navigation channels, the impact on surface water bodies (the Curonian Lagoon, the Klaipėda Strait, the Baltic Sea) and, where necessary, measures to prevent and mitigate the impact on the shores must be selected and implemented. The Klaipėda City Master Plan designates the following zones within the PŪV area: engineering infrastructure, water bodies, engineering infrastructure corridors, services and intensively used green spaces (Fig. 3.2.4).



3.2.3 Fig. Extract from the explanatory note of the Klaipėda State Seaport Master Plan: Schemes for the development of the port area (Source: www.tpdr.lt)



3.2.4 Fig. Extract from the Main Drawing of the Klaipėda City Master Plan (Source: www.tpdr.lt)

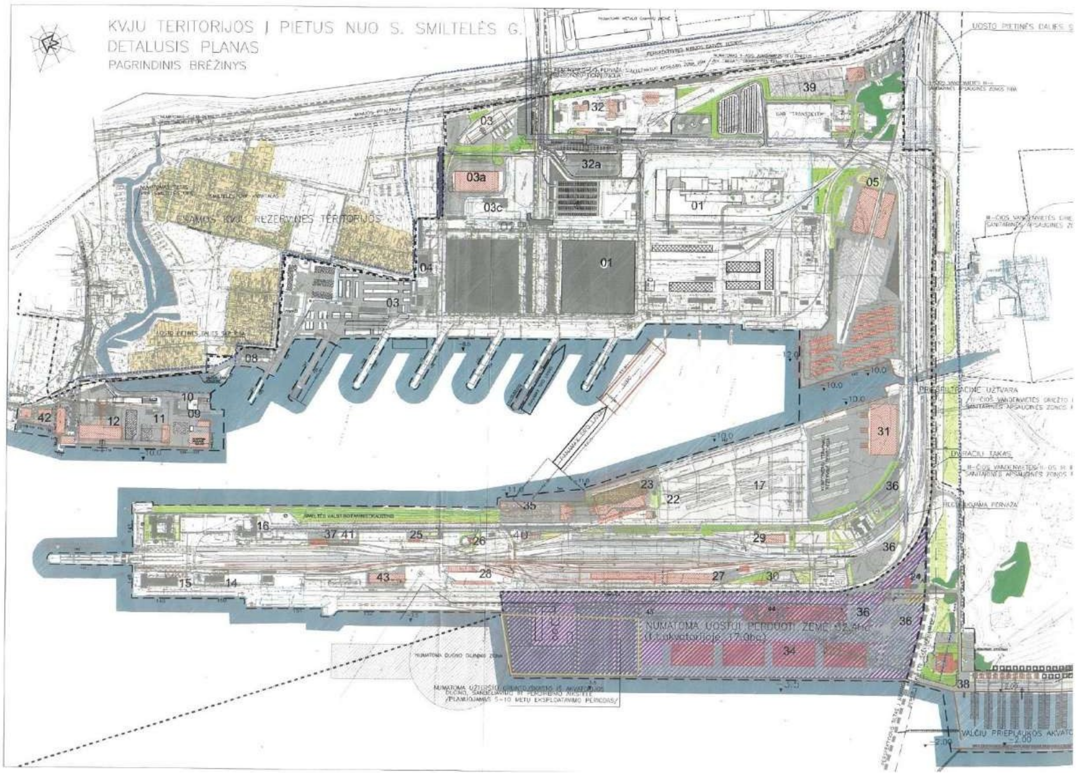
Master plan for the territory of Neringa Municipality and its parts

The PŪV territory borders the territory of the General Plan for the Territory of Neringa Municipality and its Parts. Part of the PŪV territory and the planned solutions (reconstruction of the power line and laying of the cable) fall within the territory of the Curonian Spit National Park.

In the immediate vicinity of the PŪV area lies the Alksnynė problem section identified in the Neringa BP, which includes: the Alksnynė hamlet and its immediate surroundings, the area around the control post, the construction of a jetty, the development of a coastal recreational area, the exhibition of former military fortifications, an overhead high-voltage line, the management of the main fire-prone area, and the territorial connection between the main coastal and seaside recreational areas.

The Alksnynė Landscape Reserve is one of the key nature conservation priority zones within the natural framework of the territory.

Detailed plan for the area of the Klaipėda State Seaport south of Senoji Smiltelė Street



3.2.5 Fig. Detailed plan solutions for the KVJU territory south of Senoji Smiltelė Street (Source: www.tpdr.lt)

The prepared detailed plan provided for: creating favourable financial, legal and economic-commercial conditions for the planned facilities in the area; to develop the area for storage, business, and the transport of international freight and passengers, and to divide it into functional zones, thereby enabling investment in these areas; to construct and equip terminals and enterprises in accordance with the applicable spatial planning documents; to ensure high operational efficiency and cargo handling safety, and to address relevant environmental issues.

The detailed plan covers an area of 284.0 ha. This includes the existing port area south of Senoji Smiltelė Street and the urban area in the western part of the Smiltelė peninsula, which, following expansion at the expense of the filled-in water area, are proposed to be allocated to the KVJU reserve areas for port development. The detailed plan addresses the development of the western peninsula’s shoreline by constructing quays at the expense of the water area.

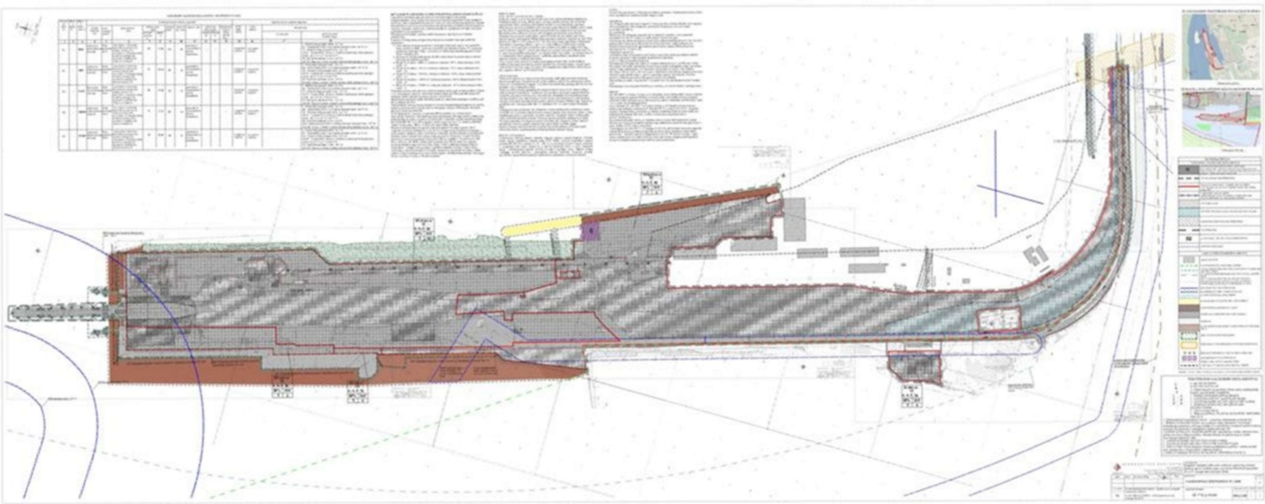
Amendment to the detailed plan for the territory of the Klaipėda State Seaport south of Senoji Smiltelė Street, approved by Klaipėda City Municipality Resolution No. 1-247 of 23 June 2004, in part

By amending the detailed plan without changing the main purpose or method of land use and without contravening the requirements of laws and other legal acts or the provisions of higher-level comprehensive or special territorial planning documents, to revise (amend) the regulations governing the use of the territory; establish additional regulations for the use of the planned area.

The activities carried out in the planned area remain unchanged – cargo handling and temporary storage.

The detailed plan amendment shall adjust and establish the following land use regulations: the purpose and method of use of the land plots (area) remain unchanged – land for other purposes, method of use – areas for industrial and storage facilities (P), an additional method of use has been established – areas for transport and engineering infrastructure facilities (I1); planned building height up to 30 m; building density for plots (Nos. 1–5) – 80%, plot floor area ratio – 10.

For engineering structures (radar tower), maximum height limits do not apply; the height may exceed 30 m.



3.2.6 Fig. Amendment to the detailed plan for the KVJU area south of the old Smiltelės Street, approved by Klaipėda City Municipality Decision No. 1-247 of 23 June 2004 in part of the area Main drawing (Source: www.tpdr.lt)

Special plan for the construction of the NordBalt interconnector in Klaipėda County

In February 2016, the strategic electricity project was completed – the ‘NordBalt’ electricity interconnector with Sweden was laid. In accordance with the decisions of the special plan for the construction of the NordBalt interconnector in Klaipėda County, a high-voltage underground/submarine cable interconnector has been laid in the Curonian Lagoon.

3.2.7 Fig. Extract from the diagram 'Location of the interconnector route' in the Explanatory Note of the Special Plan for the construction of the NordBalt interconnector in Klaipėda County (Source: www.tpdr.lt)

The PŪV solutions are planned in the vicinity of this interconnector.

Special plan for the construction of a liquefied natural gas (LNG) terminal, associated infrastructure and gas pipeline

The PŪV area borders the liquefied natural gas (LNG) terminal area. Following the implementation of the solutions set out in the special plan for the construction of the LNG terminal, associated infrastructure and gas pipeline (hereinafter referred to as the LNG terminal SP), the LNG terminal commenced operations in December 2014.

The LNG terminal is a hazardous facility subject to the provisions of the Regulations on the Prevention, Response and Investigation of Industrial Accidents, approved by Resolution No. 966 of the Government of the Republic of Lithuania of 17 August 2004 'On the Approval of the Regulations on the Prevention, Elimination and Investigation of Industrial Accidents and the List of Hazardous Substances and Mixtures, the Determination of Their Qualification Quantities and the Description of Criteria for Classifying Chemical Substances and Mixtures as Hazardous Substances' (as amended by Resolution No. 517 of the Government of the Republic of Lithuania of 27 May 2015).

Part of the PŪV territory falls within the LNG terminal protection zones established in the LNG terminal SP solutions: 125 m protection zone, 250 m prevention zone, 500 m response (incident mitigation) zone. In the event of an accident, navigation is prohibited within the 500 m response (incident management) zone, whilst operations at port facilities are suspended and evacuation procedures are initiated.

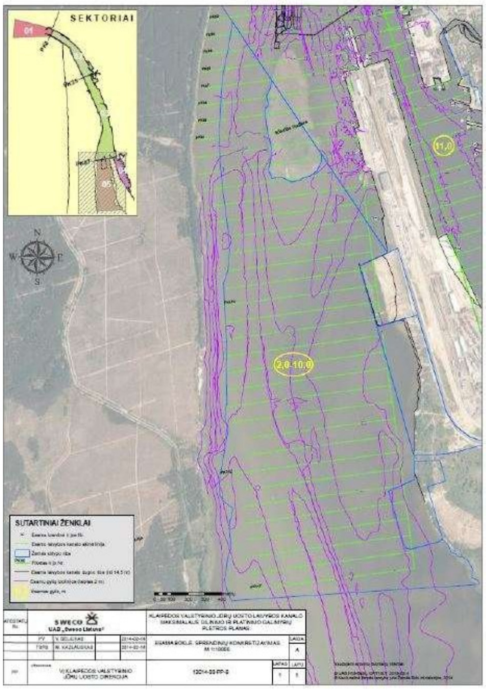
The PŪV territory is crossed by the LNG terminal connection – a gas pipeline through which natural gas is supplied from the LNG terminal to the natural gas transmission system. In accordance with the LNG terminal SP solutions, a Class 3 trunk gas pipeline has been implemented. The PŪV solutions are planned above this section of the gas pipeline.

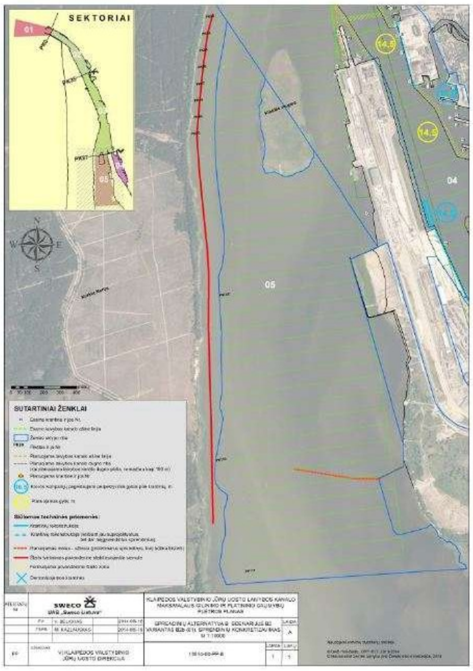
3.2.8 Fig. Extract from the Master Plan for the Construction of the Liquefied Natural Gas Terminal, Related Infrastructure and Gas Pipeline (Source: www.tpdr.lt)

Plan for the development of options for the maximum deepening and widening of the Klaipėda State Seaport navigation channel

The plan for the development of the maximum dredging and widening potential of the KVJU shipping channel identifies three alternatives: 0 – do nothing, A – maximum development, B – partial development, and the port's water area, taking into account hydrological conditions, water levels, wave action, seabed processes and navigation characteristics, is divided into several sections: 01 – outer roadstead; 02 – northern part of the inner harbour (from the harbour entrance to the mouth of the Danė River); 03 – southern part of the inner harbour (from the mouth of the Danė River to Malkų Bay); 04 – Malkų Bay water area; 05 – the water area near Kiaulės Nugaros Island and the boat marina. The PŪV territory covers part of the southern section of the inner water area (03) and part of the water area near Kiaulės Nugaros Island and the boat marina (05).

Alternative 0 is assessed and analysed as a baseline for the Development Plan alternatives (A and B) and is linked to the description of existing and ongoing solutions and the assessment of their impact. Alternative A (divided into two scenarios – A1 and A2) assesses the maximum possibilities for deepening and widening the navigation channel throughout the port's outer and inner water areas. Alternative B (divided into two scenarios – B1 and B2) assesses the maximum possibilities for deepening and widening the navigation channel in part of the port's outer and inner water areas.





3.2.9 Fig. Current state of the KVJU water area from PK84 to PK117 (left) and proposed specific solutions (right)

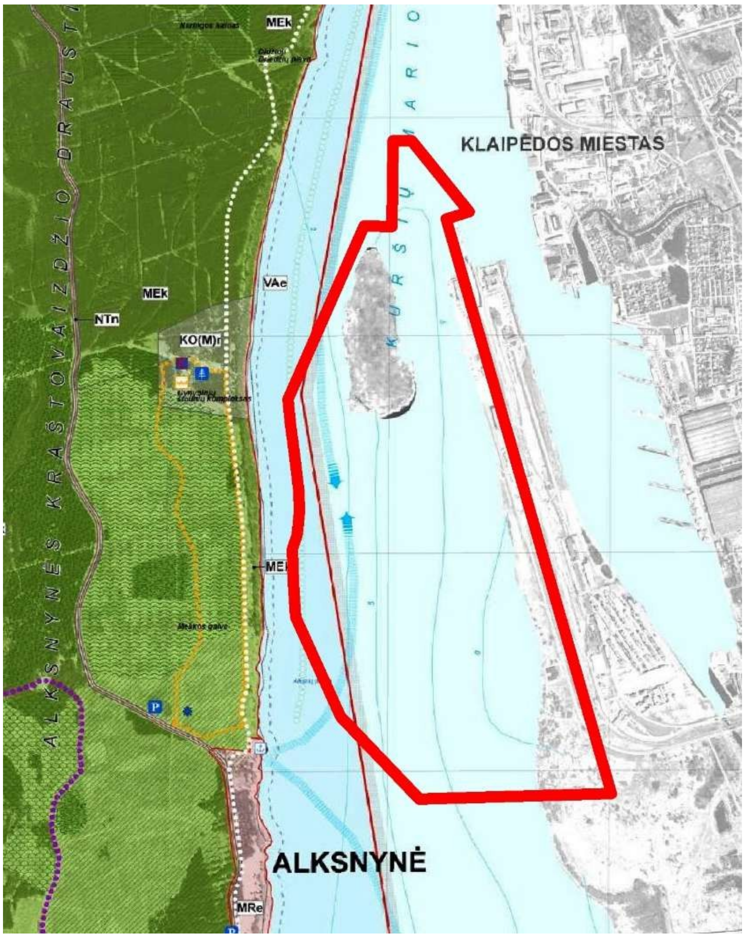
Management Plan for the Curonian Spit National Park

The following landscape management zones are envisaged in the part of the Curonian Spit National Park located in the immediate vicinity of the PŪV territory: Mek – Forestry land landscape zones, Ecosystem protection forests, Conservation farming landscape management zone; Mre – Forestry land landscape zones, Recreational forests, Extensive use (forest parks) landscape management zone; Vae – Landscape management zones for land designated for water management: Ecosystem-protecting waters, Extensive protective farming landscape management zone; KO(M)r – Conservation land landscape management zones, Areas of natural and cultural heritage sites, Regulated protection zone for natural heritage sites.

In the immediate vicinity is the Alksnynė Landscape Reserve, which includes the Bear's Head Dune (viewpoint). There is also a cultural heritage site – the Alksnynė Defensive Complex (reg. No. 30540).

Tourist routes are also planned in this section.

Some of the PŪV solutions (reconstruction of the existing power line and laying of an underground power cable) would fall within the territory defined in the management plan of the Curonian Spit National Park.



3.2.10 Fig. Extract from the Kuršių Nerija National Park plan

Conclusion

The location of the PŪV has been selected in accordance with the local and higher-level comprehensive and special spatial planning solutions in force within the PŪV area, as well as the Development Plan. In the selected area, the PŪV is permissible in accordance with the economic activities envisaged in the local and higher-level TPDs. The activities envisaged for the PŪV do not conflict with the TPDs in force in the territory.

3.3 Description of the PŪV and the assessed PŪV alternatives

Commissioned by KVJUD, in February 2022, the company 'Moffatt and Nichol' prepared a report on the development of the southern part of the Klaipėda State Seaport [20]. In preparing this report, design proposals for the development of the southern part of the Klaipėda State Seaport were analysed and presented for four alternatives (1A, 2A, 3A and 4A), of which Alternatives 1A–3A each have two implementation stages. The aforementioned report also proposed preliminary solutions for access roads to the project site, crane tracks and railways, structural solutions for the installation of quays and protective shore reinforcement measures, solutions for the dismantling of the Marios–Juodkrantė section of the 110 kV overhead power line and the installation of a new underground power cable, and others.

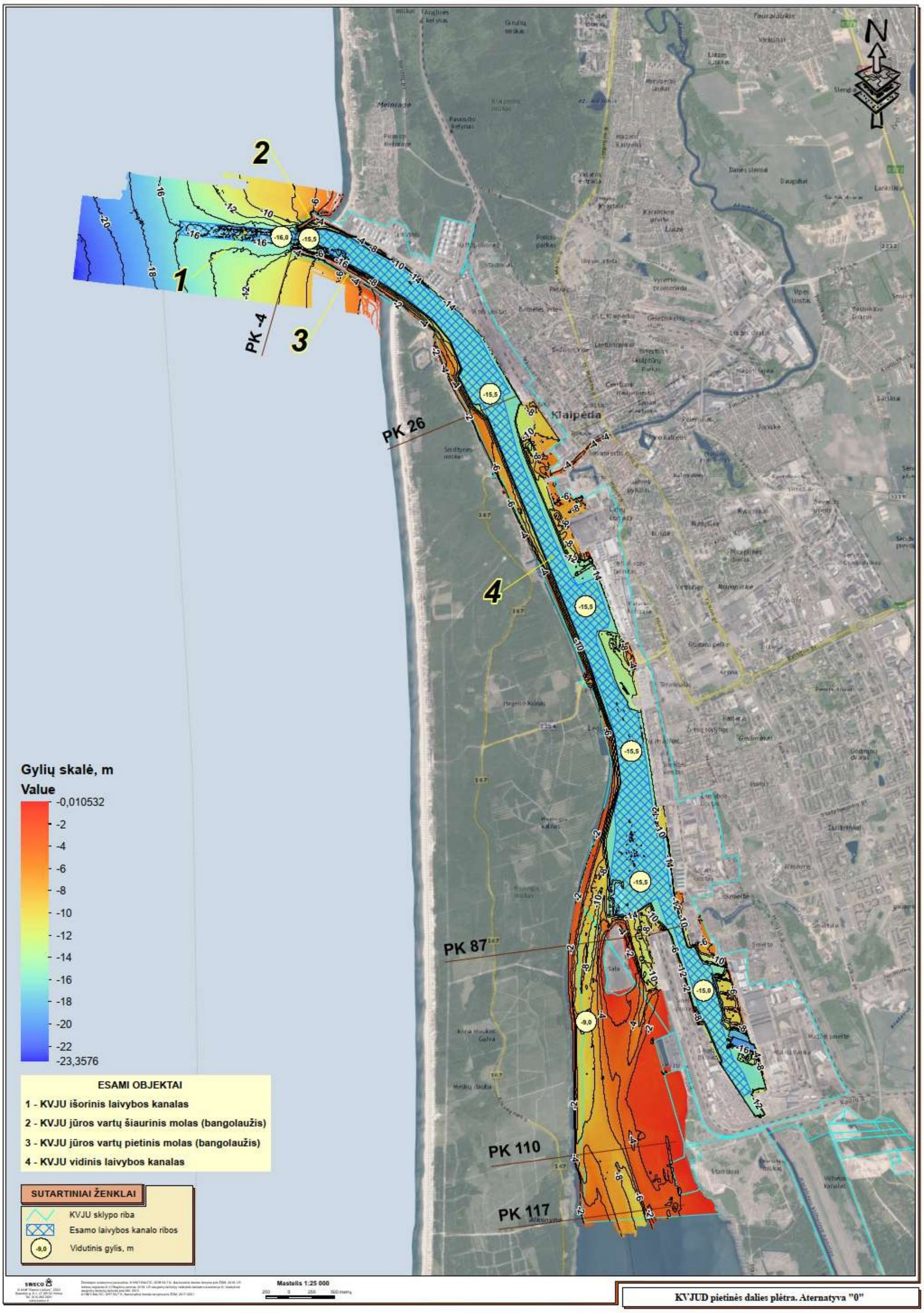
For further assessment and the EIA of the project solutions, the EIA Working Group selected three alternatives for the development of the southern part of the port (2A, 3A and 4A). A description of the assessed project alternatives is provided in Table 3.3.1 and

3.3.1 - Fig. 3.3.4

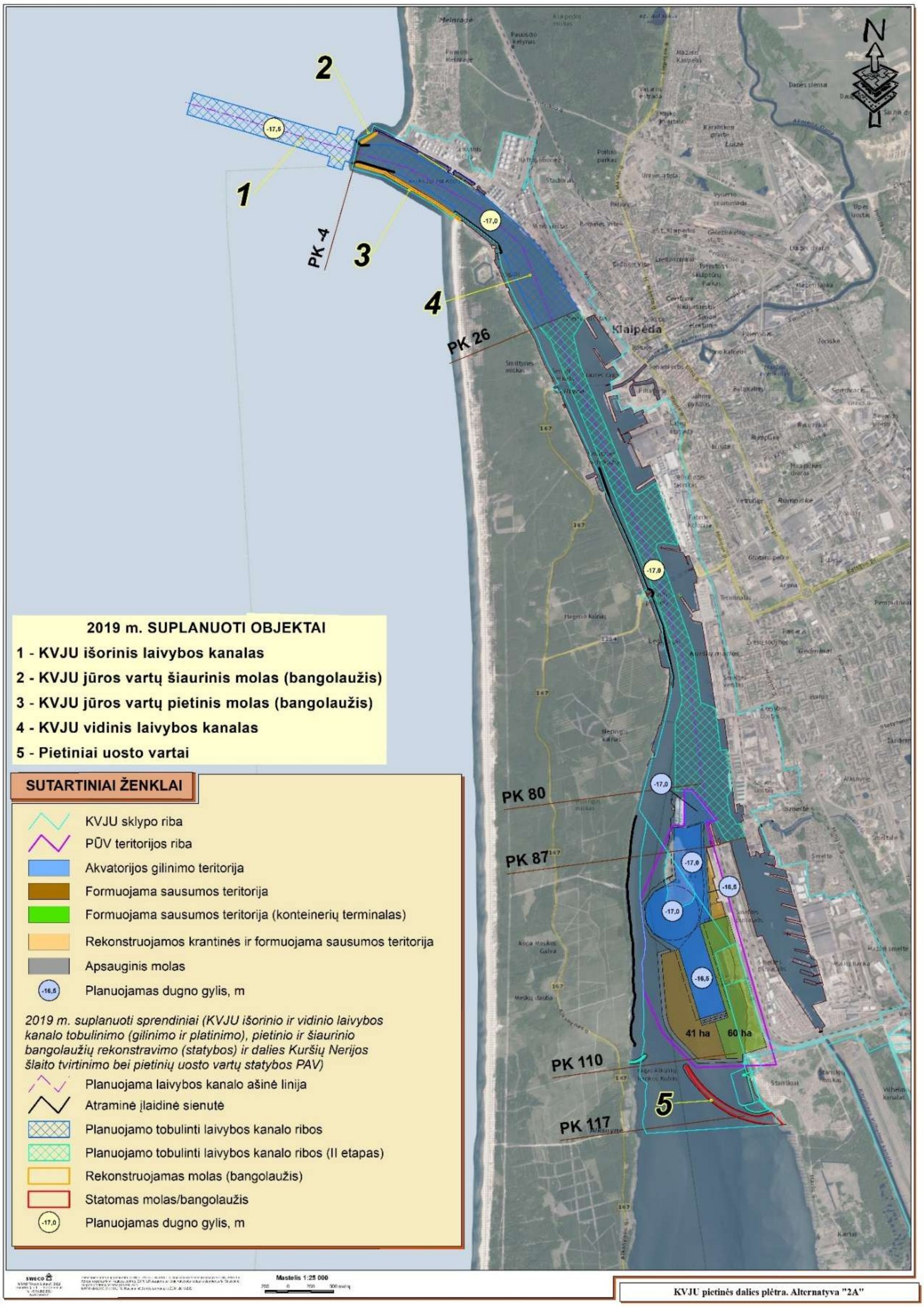
Table 3.3.1. Brief description of the assessed PŪV alternatives

Alternatives	Description of the alternatives	Comments
Alternative 0 – current situation	The current situation in 2021–2022, which will not be affected by the project.	Fig. 3.3.1 and Appendix 2 Appendix
Alternative 2A* – implementation of the PŪV solutions	Development of the southern part of the port: extension of the inner navigation channel (approx. 1.7 km) and construction of a turning basin, dredged to a depth of 17.0 m, construction of quays (approx. 1,803 m) and formation of new land area within the water area (approx. 81.7 ha), dredging of the water area adjacent to the quays to a depth of 16.5 m, reconstruction of quays Nos. 151–152 to a design depth of 16.5 m and dredging of the water area near quays Nos. 149–152 to a depth of 16.5 m, reconfiguration of the power transmission line branch to the Curonian Spit (laying of an underground cable and dismantling of the EEPOL branch).	Fig. 3.3.2 and Graphical Appendix 2
Alternative 3A* - PŪV solutions to be implemented	Development of the southern part of the port: extension of the inner navigation channel (approx. 2.4 km) and construction of a turning basin, dredged to a depth of 17.0 m, construction of quays (approx. 1,665 m) and formation of new land area within the water area (approx. 60.5 ha), dredging of the water area adjacent to the quays to a depth of 11.0–16.5 m, reconstruction of quays Nos. 151–152 to a design depth of 16.5 m and dredging of the water area near quays Nos. 149–152 to a depth of 16.5 m, reconstruction of the electricity transmission line to the Curonian Spit (laying of an underground cable and dismantling of the EEPOL branch).	Fig. 3.3.3 and Graphic Appendix 2
Alternative 4A*: PŪV solutions to be implemented (expansion of the southern part of the port) Fig. 3.3 and Graphical Appendix 2	Development of the southern part of the port: extension of the inner navigation channel (approx. 1.7 km) and construction of a turning basin, dredged to a depth of 17.0 m, construction of quays (approx. 1,284 m) and formation of new land area within the water area (approx. 83.5 ha), dredging of the water area adjacent to the quays to a depth of 16.5 m, reconstruction of quays Nos. 151–152 to a design depth of 16.5 m and dredging of the water area near quays Nos. 149–152 to a depth of 16.5 m, reconfiguration of the electricity transmission line to the Curonian Spit (laying of an underground cable and dismantling of the EEPOL branch).	Fig. 3.3.4 and Graphic Appendix 2

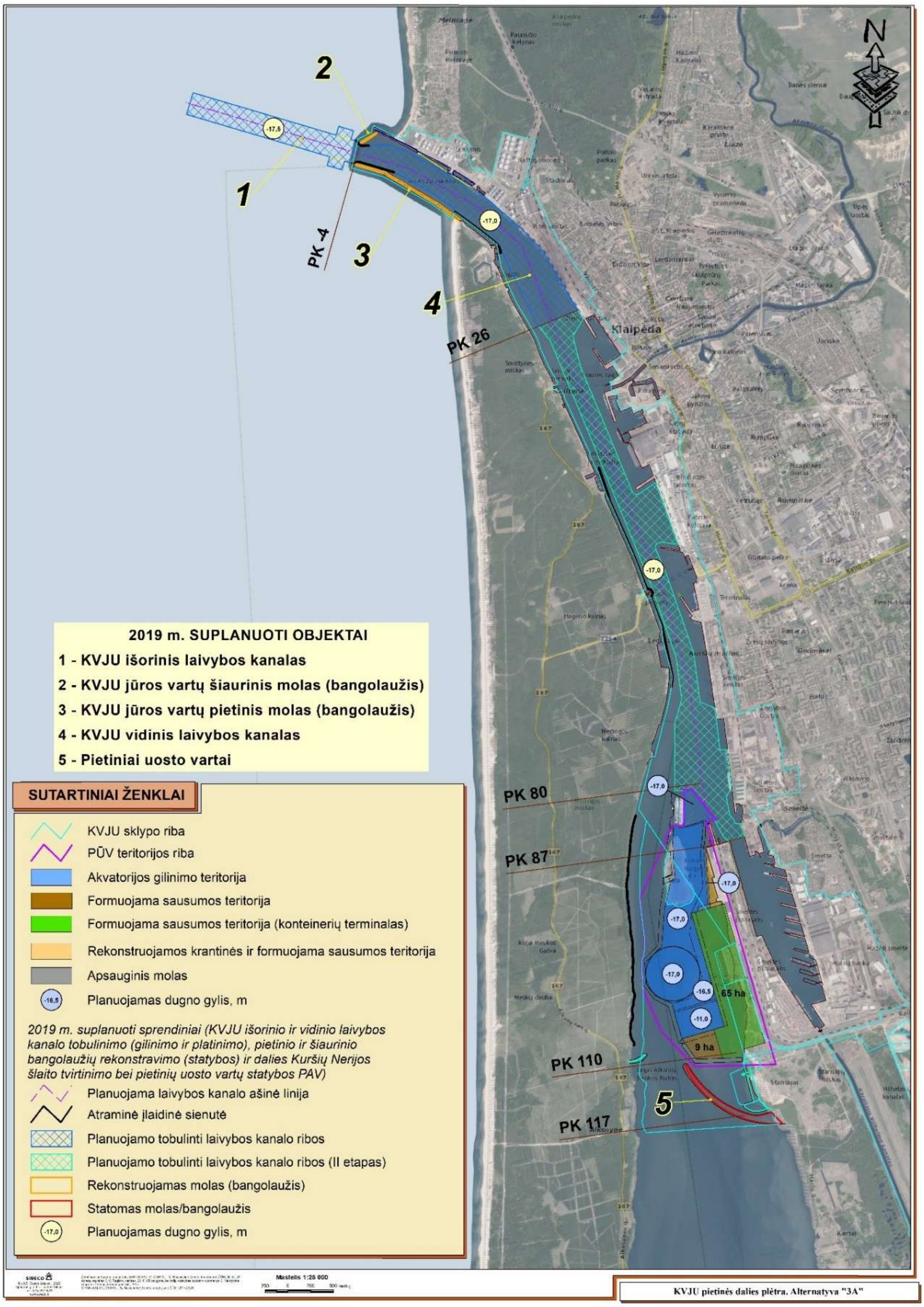
* - the assessment of all project alternatives is carried out on the assumption that the measures approved by the AAA in 2019 for the 'Improvement (dredging and widening) of the outer and inner navigation channels of the Klaipėda State Seaport, reconstruction (construction) of the southern and northern breakwaters, and the stabilisation of part of the Curonian Spit slope and construction of the southern port gates' [19] will be implemented, and, where necessary, solutions adapted to this PŪV.



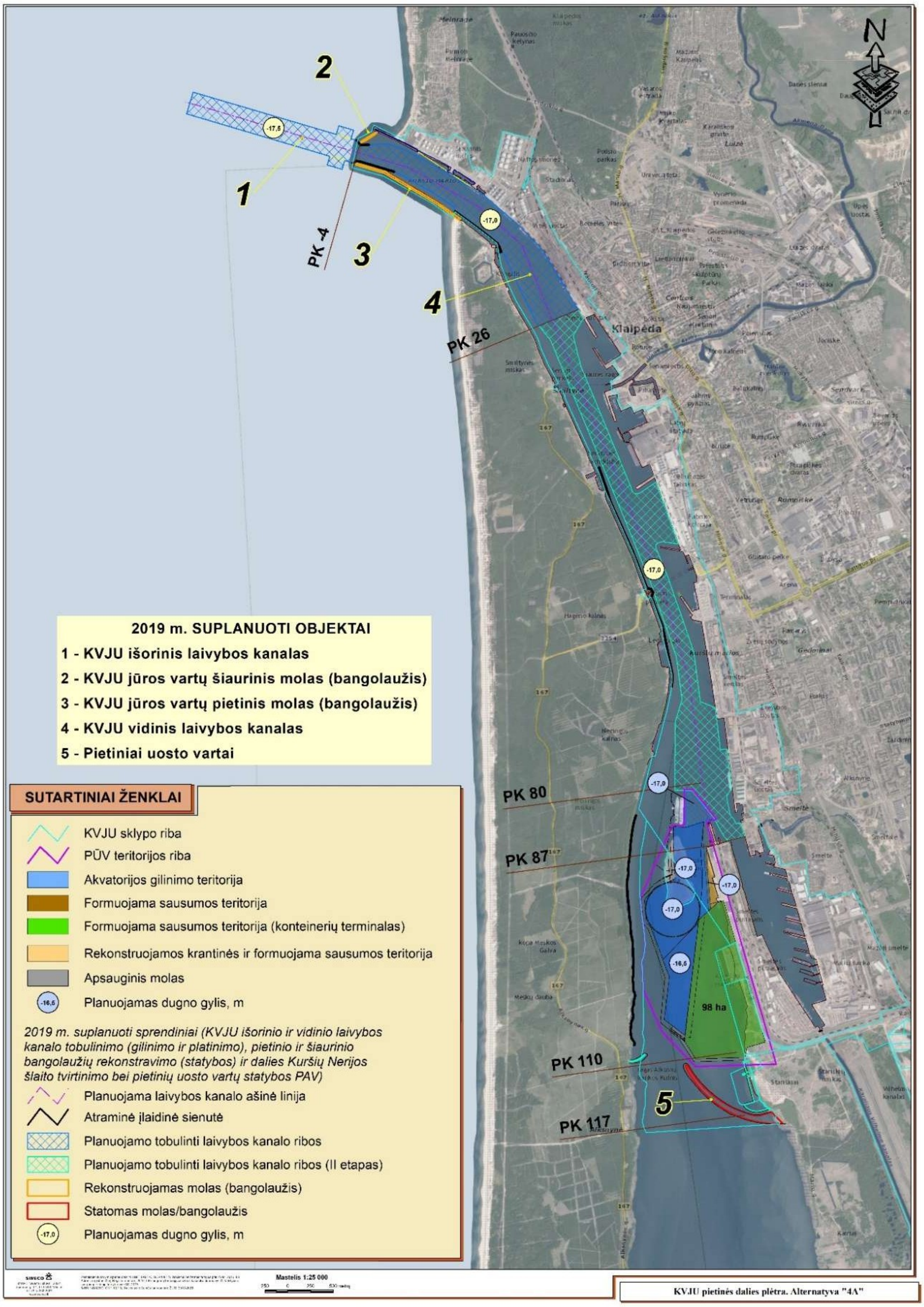
3.3.1 Fig. Alternative 0 (current state)



3.3.2 Fig. PŪV Alternative 2A



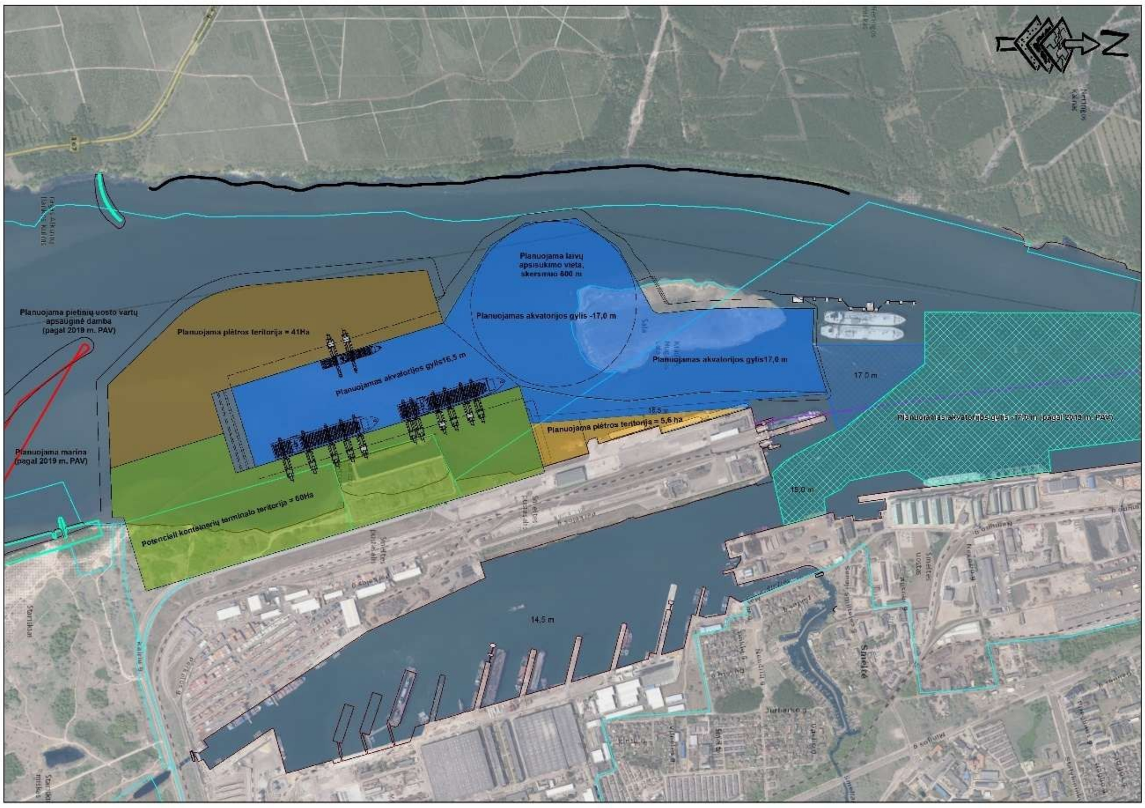
3.3.3 Fig. PŪV Alternative 3A



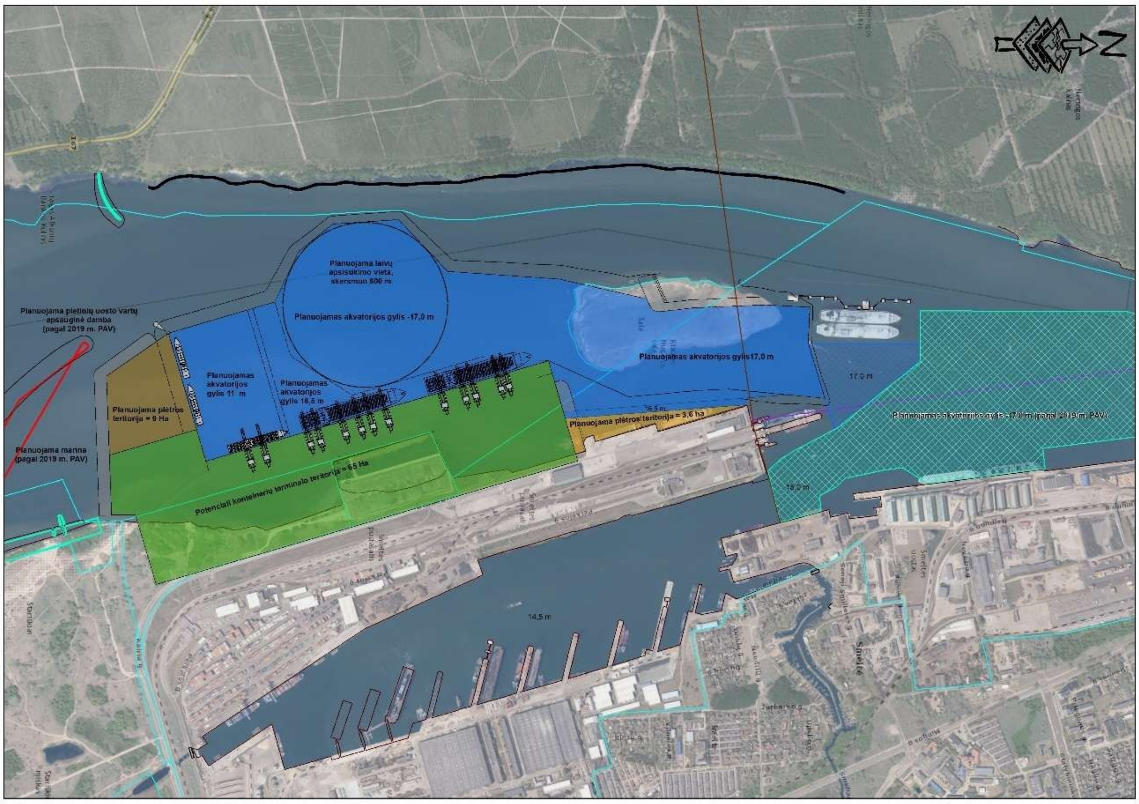
3.3.4 Fig. PŪV Alternative 4A

3.3.1 Description of the PŪV solutions

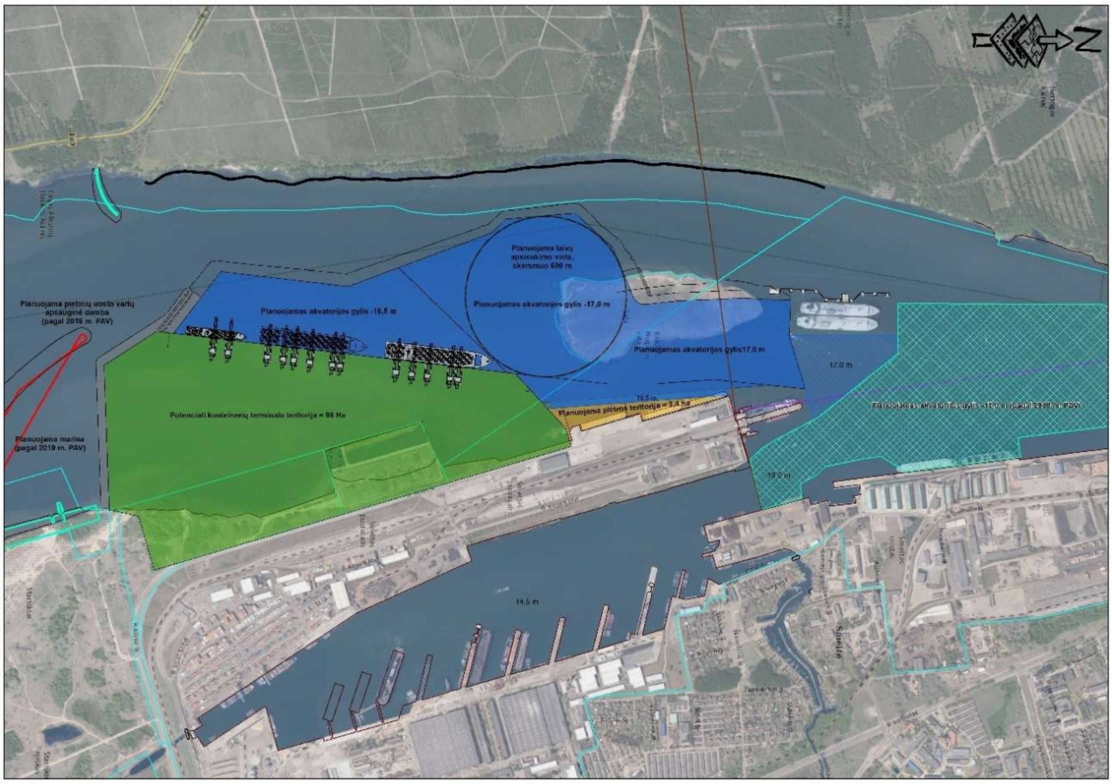
The PŪV solutions are shown in Figures 3.3.5–3.3.7 and in Graphical Appendix 2.



3.3.5 Fig. Solutions for PŪV alternative 2A



3.3.6 Fig. PŪV Alternative 3A Solutions



3.3.7 Fig. PŪV Alternative 4A Solutions

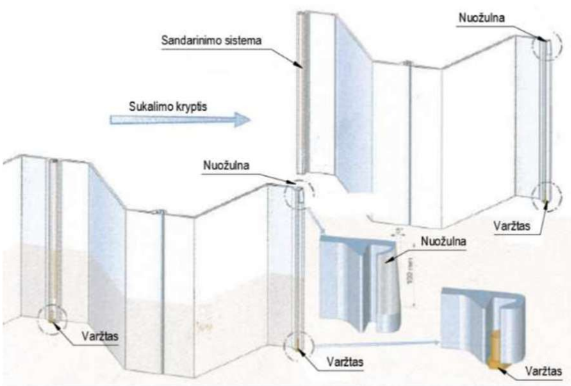
The planned solutions assessed in this EIA would be implemented in the following preliminary sequence (the exact steps for organising the construction works would be determined during the technical design stages of the structures):

- Construction of the southern port gates (planned under other projects and may be carried out in conjunction with the works specified in the following point);
- Construction of the southern retaining structure for the newly formed land area in the southern part of the port, including the necessary dredging works for its installation;
- Dredging works in the water area and the formation of new land areas (starting the land formation from its southern part, having already installed the retaining structure, and along the eastern shore north of the contaminated soil site);
- Once the southern part of the newly formed land area has been developed, an underground power cable will be laid from its western edge to the Curonian Spit, tunnelling beneath the lagoon bed and running from support No. 12 on the mainland to support No. 43 on the Curonian Spit. Once the underground power cable has been installed, the section of the 110 kV overhead power transmission line between Marios and Juodkrantė, including the existing support on Kiaulės Nugaros Island, will be dismantled.
- A section of Kiaulės Nugaros Island will be dredged, and its banks reinforced with retaining walls.
- The remaining part of the water area is dredged and the excavated soil is used to form land.
- Once the land area has been partially formed, new quays are constructed.
- Work on the formation, levelling, covering and installation of infrastructure for the area is completed.
- Formation of the remaining land area following the decommissioning of the KVJU contaminated soil site (by backfilling the contaminated soil site and installing the necessary surfacing).
- Final works.

Below is a brief description of the implementation of the PŪV solutions.

Excavation of part of Kiaulės Nugaros Island and stabilisation of the island's slopes

In order for vessels of the required size to enter and serve the newly planned port areas in the southern part, the existing inner navigation channel will need to be extended, with a turning area for vessels installed at its end. The PŪV solutions envisage widening the eastern channel between Kiaulės Nugaros Island and the quays under reconstruction (Nos. 149–152) to 340 m (for all PŪV alternatives) and deepening it to 17.0 m, and the water area 25 m from the quays to 16.5 m. To this end, in the case of Alternative 2A, it is planned to dredge approximately 13.4 ha of the island's territory (about 78% of the total area), in the case of Alternative 3A – approximately 13.2 ha of the island's territory (approximately 76.7% of the total area) and in the case of Alternative 4A – approximately 13.6 ha of the island's territory (approximately 79% of the total area) (Figs. 3.2.5 – 3.2.6). To protect the island's shores from erosion, protective walls would be installed along a stretch of approximately 470 m in all PŪV alternatives. The walls would be installed prior to excavating the island's soil, using steel piles or driven piles, which would be driven into the ground and secured with ground anchors and a distribution beam. An indicative example of the wall elements and their installation is shown in Figures 3.3.8–3.3.9. The design of the retaining wall solutions must be selected and detailed during the technical design phase.
Excavated soil meeting the lithological and contamination requirements would be used for land reclamation or shoreline management works. Soil unsuitable for land reclamation will be transported by barges and dumped at special soil disposal sites in the Baltic Sea or managed at special onshore disposal sites.



3.3.8 Fig. View of a retaining wall element

3.3.9 Fig. Example of the installation of a driven retaining wall near the Smeltė Botanical Reserve (progress of works – the wall is almost fully driven at the very front, closer to the camera – still

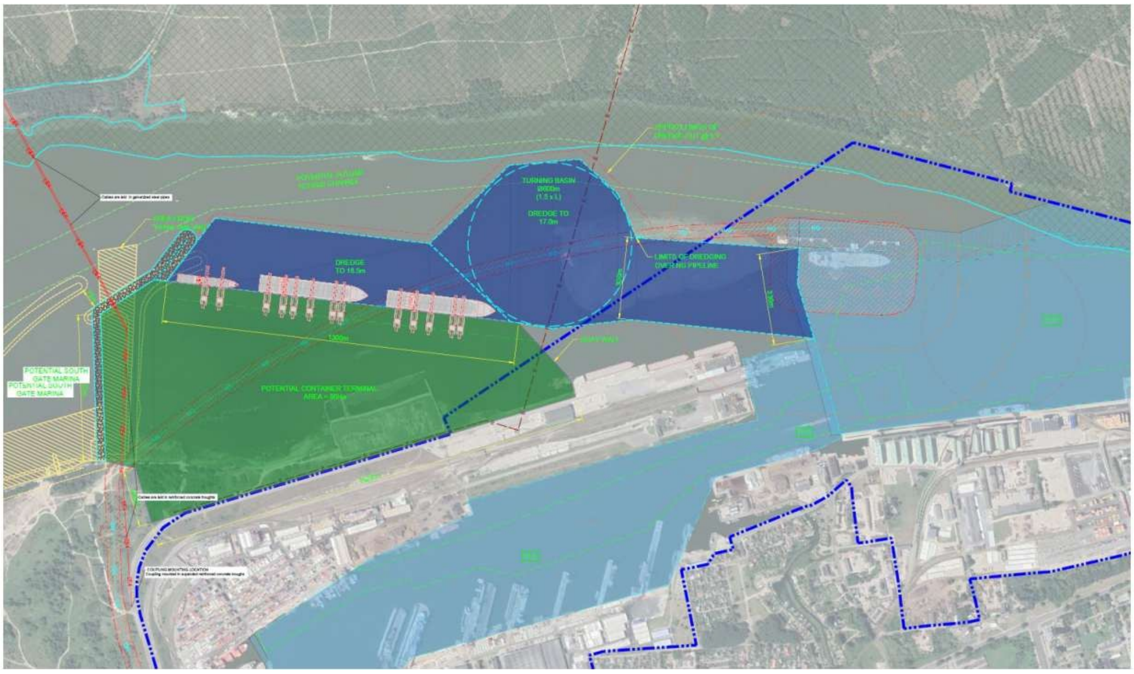
being driven)

Rearrangement of the Marios–Juodkrantė section of the 110 kV overhead power transmission line (secondary solutions are necessary to implement the main solutions of the PŪV and are unrelated to KVJU activities)

Extending the inner navigation channel to the southern part of the port and, for this purpose, dredging part of Kiaulės Nugaros Island will require the reconstruction of the Marios–Juodkrantė section of the 110 kV overhead power line, as support No. 19 located on the island will have to be dismantled. In 2015, commissioned by KVJUD, AB
'Energetikos tinklų institutas' prepared design proposals entitled 'Replacement of the 110 kV Marios–Juodkrantė overhead line with a cable line' [23], in which it examined four alternative options for the power line modification. According to the consultants from the company "Moffatt and Nichol", who prepared the EIA solutions, the most suitable solution from the four alternative power line conversion options is to dismantle the 110 kV overhead power line section Marios – Juodkrantė is dismantled from pylon No. 12 to pylon No. 43 and a new underground power cable is connected to the existing underground cable, which runs to pylon No. 12, a new underground power cable is connected via a connecting joint and laid to the newly installed pylon No. 43a, where it is connected to the same 110 kV Marios–Juodkrantė overhead power line. From the connection point to the Curonian Lagoon, the power cable would be laid in deepened reinforced concrete trenches, which are backfilled with sand, covered with reinforced concrete slabs, and covered with soil. Across the Curonian Lagoon, the cable is laid in galvanised steel conduits along the lagoon bed using horizontal directional drilling to a depth of approximately 30 m. In the Curonian Spit area, up to pylon No. 43 of the Marios–Juodkrantė overhead power transmission line, the cable would be laid in reinforced concrete ducts buried at a depth of 1.5–2 m, which are installed by excavating a 2 m wide trench. Taking into account the cable load and the magnitude of short-circuit currents, a single-phase shielded 110 kV cable with 500 $^{mm^2}$ copper conductors is planned for the proposed power cable line [23]. The works would involve the use of cranes, excavators, lorries and other construction machinery, to be selected by the Contractor during the construction works.

In total, approximately 6.61 km of the existing 110 kV Marios–Juodkrantė overhead power transmission line would be dismantled and 34 pylons removed. Approximately 3.76 km of underground cable line would be laid, of which approximately 1.27 km would run along the seabed of the Curonian Lagoon.

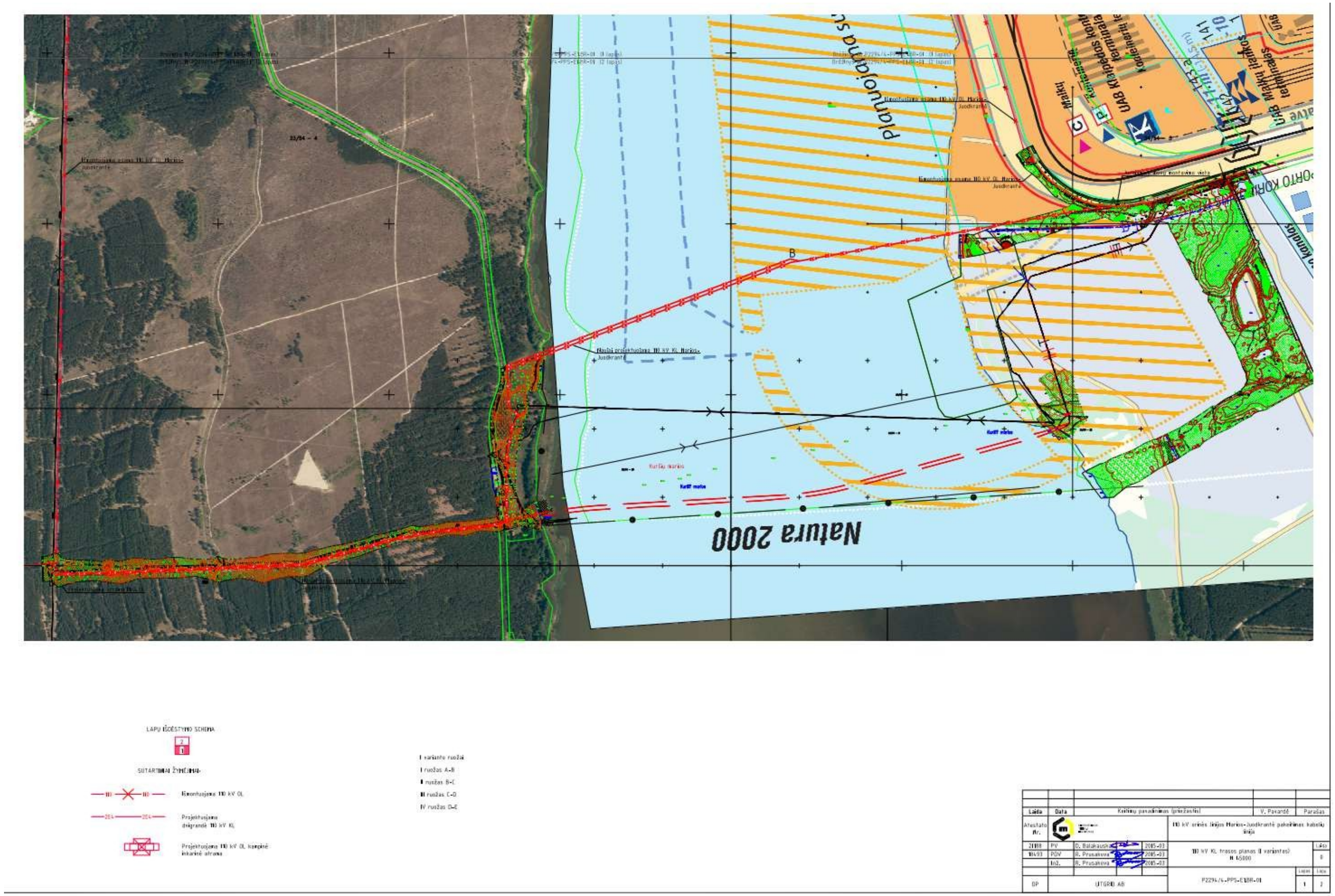
An indicative solution for the laying of the underground power cable (based on solutions by Moffatt and Nichol) is shown in Figure 3.3.10. (A similar solution is proposed for all project alternatives), whilst the solution for the reconstruction of the Marios–Juodkrantė section of the 110 kV overhead power transmission line, prepared in 2015 by AB 'Energetikos tinklų institutas' [23], is shown in Figures 3.3.11 and 3.3.12.



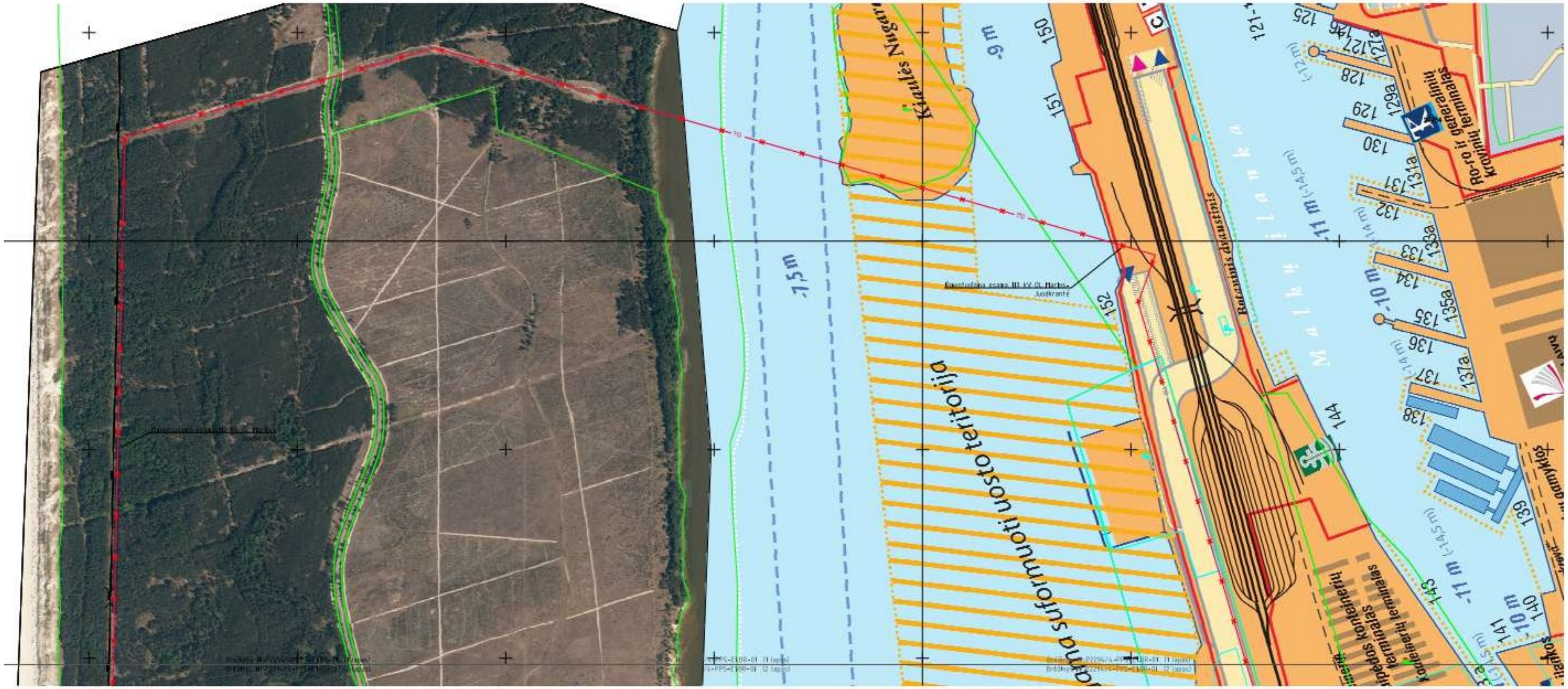
3.3.10 Fig. Solution for the reconstruction of the Marios–Juodkrantė section of the 110 kV overhead power transmission line in the case of Alternative 4A

Extension of the inner navigation channel and deepening of the water area

The environmental impact assessment report [19], the planned and implemented solutions provide for the widening of the KVJU inner navigation channel to at least 200 m and its dredging to a depth of 17.0 m up to PK87. However, the end of the channel improvement zone envisaged by these solutions is oriented more towards the entrance to Malkų Bay and does not provide for the deepening of the water area adjacent to the LNG terminal on its eastern side (Fig. 3.1.5).



3.3.11 Fig. Solution for the reconstruction of the Marios–Juodkrantė section of the 110 kV overhead power transmission line, prepared by AB 'Energetikos tinklų institutas' (1 page) [23]

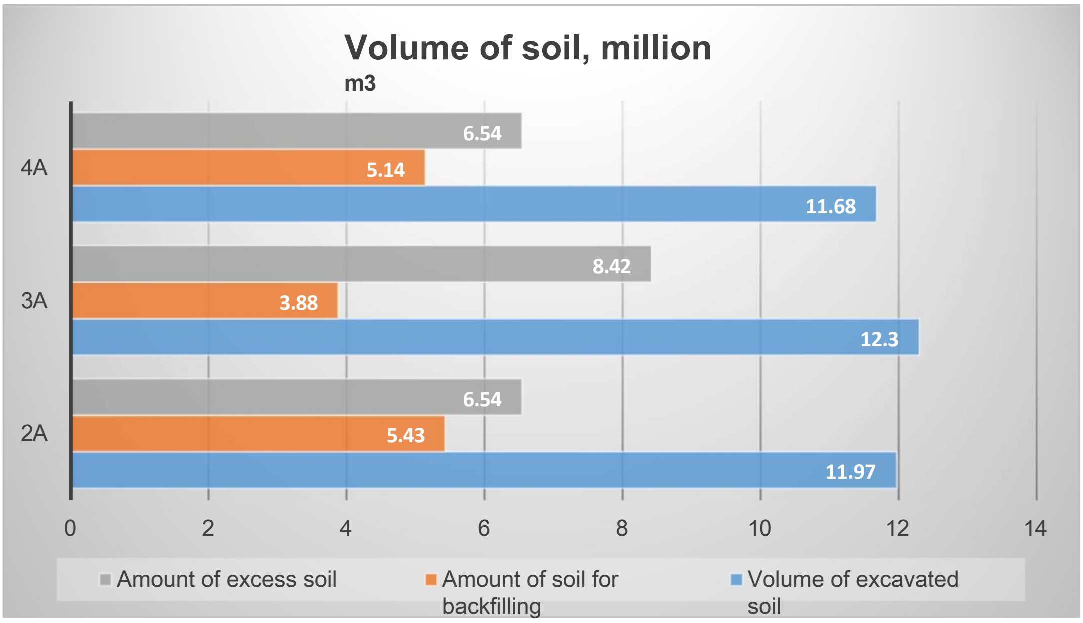


3.3.12 Fig. Solution for the reconstruction of the Marios–Juodkrantė section of the 110 kV overhead power transmission line, prepared by AB ‘Energetikos tinklų institutas’ (page 2) [23]

The project solutions described in this EIA report for the project envisage extending the inner navigation channel into the newly constructed southern part of the port and directing it towards the eastern channel between Kiaulės Nugaros Island and the Smeltė Peninsula, deepening it to 17.0 m and widening it to 340 m (for all project alternatives). For all project alternatives, the inner navigation channel will terminate at a turning basin with a diameter of 600 m. It is planned to extend the inner navigation channel (measured from the end of the dredging area envisaged in the previously planned solutions [19] to the southern boundary of the planned turning basin) by approximately 1.7 km for Alternative 2A, in the case of Alternative 3A – by approximately 2.4 km, and in the case of Alternative 4A – by approximately 1.7 km. Accordingly, the area of the water area to be dredged to a depth of 17.0 m, comprising the extended inner navigation channel and the vessel turning area, will be approximately 66.2 ha for Alternative 2A, approximately 85.5 ha for Alternative 3A and approximately 67.9 ha for Alternative 4A. From the southern boundary of the turning area, a water area will be constructed and dredged for the approach and servicing of vessels at the newly planned quays. In the case of Alternative 2A, approximately 27.0 ha of the water area will be dredged to a depth of 16.5 m, In the case of Alternative 3A, approximately 12.1 ha of the water area will be dredged to a depth of 16.5 m and approximately 15.5 ha to 11.0 m, whilst in the case of Alternative 4A, approximately 26.8 ha of the water area will be dredged to a depth of 16.5 m. The water area near the quays under reconstruction (Nos. 149–152) will also be dredged to a depth of 16.5 m (the area of these water areas will be approximately 2.0 ha in the case of Alternative 2A, in Alternative 3A – approximately 1.66 ha, and in Alternative 4A – approximately 1.7 ha). The total area of the water areas to be dredged would be approximately 95.2 ha for Alternative 2A, approximately 114.8 ha for Alternative 3A and approximately 96.4 ha for Alternative 4A (Figures 3.2.5–3.2.7).

Dredged material meeting the lithological and contamination requirements would be used for the formation of new land areas and for shoreline management purposes. Soil unsuitable for land reclamation and shoreline management works would be dumped at existing soil disposal sites in the Baltic Sea or managed at special disposal sites on land.

The estimated volume of soil to be excavated during the dredging of the water areas, its requirement for the formation of new land areas, and the surplus volume for all PŪV alternatives are shown in Figure 3.3.13. When calculating the indicative volumes of dredged soil, the possible excess of the design parameters for dredging/suction (in depth and width) was not taken into account.



3.3.13 Fig. Estimated volume of soil to be excavated during the dredging of the PŪV water areas, the volume required for the formation of new land areas, and the surplus volume for all PŪV alternatives

Filling of the water area and development of land areas

The main objective of the development is to create additional land areas and water areas in the southern part of the KVJU territory, complete with the necessary port infrastructure and superstructure, which would enable the expansion of cargo terminals with the potential to provide additional value-added services and accommodate BALTMAX vessels with maximum parameters, i.e. up to 430 m in length (eventually up to 490 m), up to 60 m in width (eventually up to 70 m) and with a draught of up to 15.5 m [14]. The PŪV solutions envisage the creation of three additional land areas at different implementation stages, the size of which would vary depending on the specific development alternatives.

These conditional areas can be described as follows (Table 3.3.2):

- Area I – a potential container terminal area, covering part of the western section of the Smeltė Peninsula and part of the adjacent Curonian Lagoon water area (marked in green in Figures 3.3.5–3.3.7);
- Area II – a planned development area, to be formed by reconstructing quays Nos. 149–152 and reclaiming part of the water area (marked in light brown in Figs. 3.3.5–3.3.7);
- Area III – a planned development area formed by filling in part of the Curonian Lagoon water area (marked in brown in Figs. 3.3.5–3.3.7).

3.3.2 Table. Land areas formed by the PŪV solutions according to individual PŪV alternatives

Development alternative	**Area of Area I, ha (water area to be filled in water area/land area formed on land)**	**Area of Area II, ha (reclaimed water area)**	**Area of Zone III, ha (to be filled water area)**	**Total area of all Zones I, II and III, ha**
Alternative 2A	approx. 35.1/24.9 (60.0)	approx. 5.6	approx. 41.0	106.6
Alternative 3A	around 47.9/17.1 (65.0)	around 3.6	around 9.0	77.6
Alternative 4A	around 80.1/17.9 (98.0)	around 3.4	-	101.4

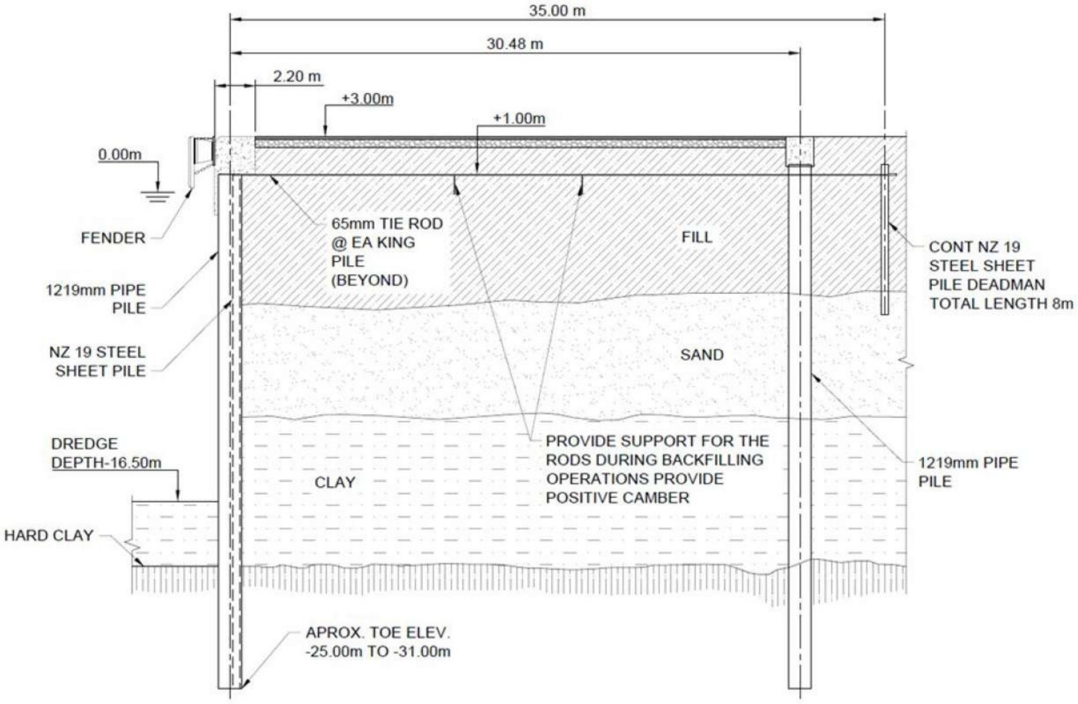
The estimated soil requirement for the formation of new land areas for all PŪV alternatives is shown in Figure 3.3.13. It is tentatively planned that the soil excavated during the dredging of the water areas and loaded onto barges will be transported to the disposal sites and either dumped or sprayed (where it is not possible to navigate due to shallow depths) or otherwise unloaded (the technology will be selected by the contractors). The deposited soil will be levelled by bulldozers to the required surface elevations and compacted.

The formed areas in the contact zone with the Curonian Lagoon will be bounded by quays and protective hydraulic structures for reinforcing the banks and slopes. Consultants from Moffatt and Nichol [20] proposed and compared several quay design options and recommended a combined quay with steel piles as the most suitable solution (such solutions are currently being implemented at KVJU) (Figs. 3.3.14–3.3.15). When planning water areas with a depth of 16.5–17.0 m adjacent to the quays, the quay piles would be driven to a depth of up to 30 m (the required depth is determined following detailed design engineering and geological surveys during the technical design phase).

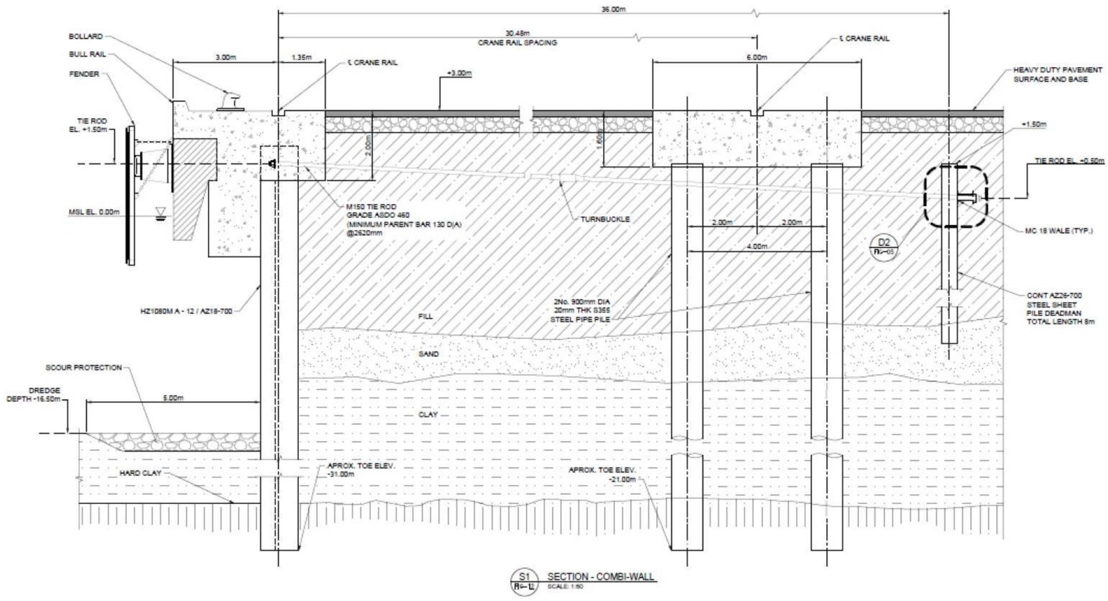
The PŪV solutions envisage that, in the case of Alternative 2A, approximately 1,803.0 m of quays would be constructed; in the case of Alternative 3A, approximately 1,665.0 m of quays; and in the case of Alternative 4A, approximately 1,284.0 m

(Figs. 3.3.5–3.3.7). Quays Nos. 149–151 will also be reconstructed, with a total length of approximately 800 m for Alternative 2A, approximately 662 m for Alternative 3A, and approximately 678 m for Alternative 4A.

The developed area would be covered with impermeable surfaces (e.g. concrete, concrete slabs, asphalt, etc.). The exact area and type of surfacing will be determined during the detailed design stage.



3.3.14 Fig. Typical design of a combined quay with steel piles [20]



3.3.15 Fig. Typical design of a combined quay with steel piles and a quay area [20]

3.4 Project output and maximum capacity

The parameters of the PŪV solutions are described in Section 3.3.1.

3.5 Data on energy, fuel and fuel consumption, and energy production

During the construction of the PŪV facilities, vehicles and machinery with internal combustion engines will be used (ships, barges – dredgers, pile-driving rigs, drilling rigs, lorries, cranes, hoists, excavators, bulldozers, generators, etc.), which will consume fuel (petrol, diesel, gas). Electricity will also be used during construction to power machinery and to provide lighting for the site and temporary facilities.

The exact quantities of energy, fuel and petrol used during the project will be determined during the preparation of the technical design for the construction of the facilities.

No energy generation will take place during the project.

3.6 Data on raw materials, chemicals and mixtures used, and their storage

Various raw materials will be used for filling the water area and forming land areas, as well as for the construction of quays, protective walls and other hydraulic structures: soils (sand, gravel, loam, silt) and rock (granite and dolomite rubble, stones), asphalt, concrete, various reinforced concrete and metal structures and products.

Clean natural soil excavated during the dredging of the water areas will be used for the formation of new land areas and bank reinforcement works, by mechanically compacting it and without the use of any hazardous chemicals or mixtures. The quantities of excavated soil fully meet the requirements for backfilling (Fig. 3.3.13).

3.7 Data on chemical substances and mixtures containing solvents, and their storage

No chemical substances or mixtures containing solvents will be used or stored during the project.

3.8 Data on radioactive materials intended for use during the PŪV No radioactive

materials will be used or stored during the PŪV.

3.9 Information on waste

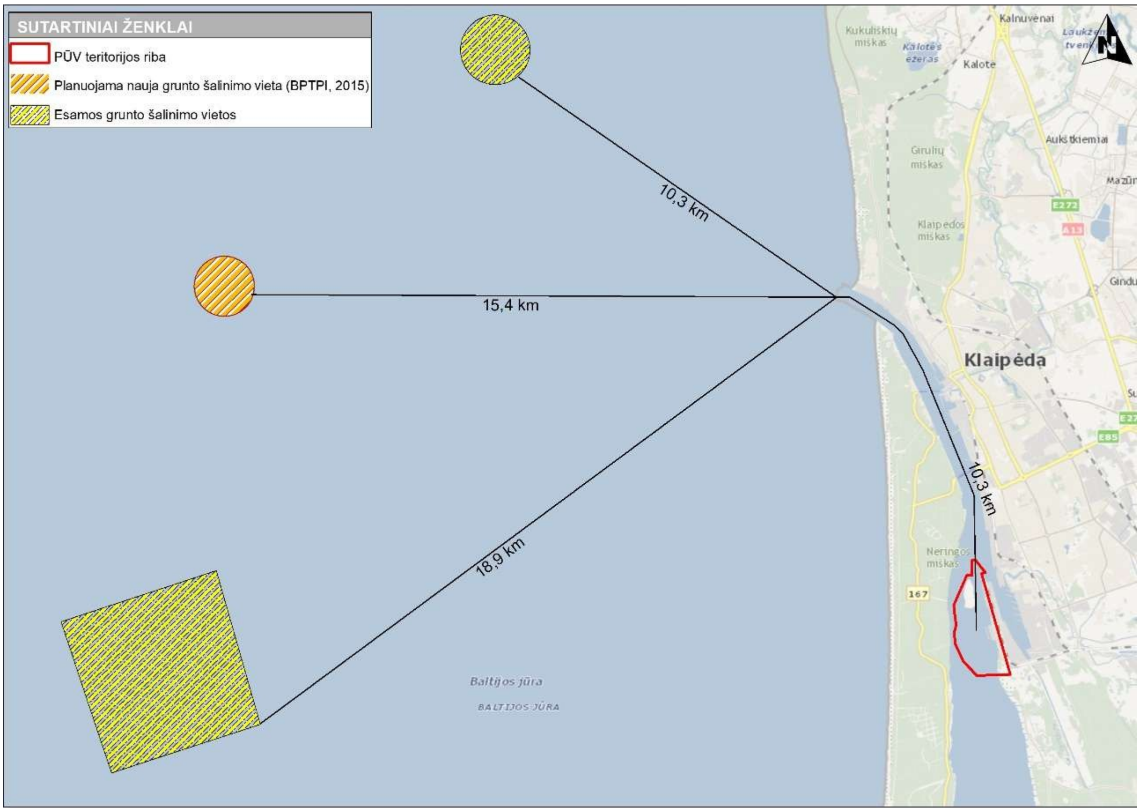
Construction period of the PŪV facilities

During the construction, installation and modification of the PŪV facilities (construction of piers, quays and retaining walls, land reclamation, dredging of water areas, reconstruction of the 110 kV power line section, etc.), a certain amount of surplus materials (excavated soil, sludge, boulders, etc.) and various types of construction waste (metal structures, concrete waste, etc.).

Dredging works for new water areas would be carried out in accordance with the dredging project designs, in compliance with the requirements of the environmental protection standard LAND 46A-2002 'Rules for soil excavation in sea and seaport water areas and the management of excavated soil' [16], i.e. depending on the lithological composition and contamination level of the excavated soil, the soil would be put to appropriate use (for the formation of new land areas, shoreline management works, beach replenishment, etc.) or disposed of in existing marine disposal sites

It is estimated that, upon implementation of the PŪV solutions, approximately 11.97 million m^3 of soil could be excavated in the case of Alternative 2A, approximately 12.3 million m^3 in the case of Alternative 3A, and approximately 11.68 million m^3 in the case of Alternative 4A (Fig. 3.3.13). The majority of this will be sandy rock (approximately 55%), with the remainder consisting of clayey rock (moraine loam and sandy loam), silt, etc. All excavated soil will be assessed in accordance with the requirements of LAND 46A-2002, determining its volume, lithological composition and contamination class, and on this basis determining its potential uses and management options. Part of the excavated clean soil with a suitable lithological composition will be used for the formation of new areas, whilst the surplus soil will be: Class I contaminated sand – for beach replenishment and shoreline management works, whilst various types of soil and silt unsuitable for the needs of the port development project (Class II-III contamination) will be deposited in landfills. The planned quantities of surplus soil are shown in Figure 3.3.13.

Currently, soil excavated/dredged from the port, classified as pollution classes II–III, is deposited in the existing third and fourth soil disposal sites, depending on its lithological composition (Fig. 3.9.1). Soil of various compositions (moraine rocks, silt, silty sand) is dumped at the remote landfill site No. III, whilst only sandy soil (sand, aleuritic sand) is dumped at the nearby landfill site No. IV.



3.9.1 Fig. Existing and planned soil disposal sites in the Baltic Sea [22]

In the Environmental Impact Assessment Report on New Marine Soil Disposal Sites prepared by BPATPI and LEI in 2014 [22], a new soil disposal site was proposed for final planning from among several options, located approximately 15.6 km from the port entrance at a depth of 42 m on the western side of the Klaipėda port roadstead (Fig. 3.9.1).

All construction waste generated during the construction and installation of the PŪV facilities must be managed in accordance with the 'Construction Waste Management Rules' [24] and the 'Waste Management Rules' [25]. It is planned that the waste generated will be transferred to licensed waste management companies for disposal.

Operational period of the PŪV facilities

It is predicted that, during the operation of most of the PŪV facilities, no waste will be generated directly as a result of their activities (this EIA assesses only the planned infrastructure solutions for the development of the southern part of the Port, and not future activities in the newly formed territory and water area). Annually, periodic cleaning of the new water area will be required to remove accumulated sediments, which are carried in with the inflowing water from the Curonian Lagoon or the Baltic Sea and settle in the aforementioned water area (in the inner navigation channel and the vessel turning area). The preliminary annual quantities of sediment deposited in the PŪV water area during years of average and high water levels, calculated based on the sediment balance assessment carried out during this EIA [18, Textual Appendix 3], are presented in Table 3.9.1 for each PŪV alternative.

Table 3.9.1. Annual quantities of sediment (m³/year) in the PŪV water area [18]

Water availability	**Alternatives**			
	0	**2A**	**3A**	**4A**
Year with average water availability Q = 1,080 m³/s	127,357	126,268	194,754	164,342
Wet year Q= 1343 m³/s	218,091	200,714	391,676	328,751

Sediment dredging and management works would be carried out in accordance with the requirements of the environmental protection regulatory document LAND 46A-2002 'Rules for dredging in marine and seaport waters and the management of dredged material' [16].

4 MEASURES TO PREVENT, MITIGATE AND OFFSET THE PROJECT'S ANTICIPATED SIGNIFICANT NEGATIVE IMPACT ON THE ENVIRONMENT ( )

4.1 Water

The PŪV solutions are largely planned within the waters of the Klaipėda Strait and the northern part of the Curonian Lagoon in the KVJU territory (Graphical Appendix 1).

4.1.1 Description of the current situation

The Klaipėda Strait is a water area approximately 9.6 km long, stretching from Kiaulės Nugaros Island in the south to the KVJU sea gate in the north. It is a complex hydrosystem connecting water bodies of different densities: the fresh Curonian Lagoon and the salty Baltic Sea, with differing hydrospheric processes. At the same time, it is a unified system regulating energy flows and the circulation of sediments and biomass between the different bodies of water. The flow rate of water through the strait depends on the difference in water levels between the Curonian Lagoon and the Baltic Sea. When the water levels of the Curonian Lagoon and the Baltic Sea are approximately equal, the denser seawater flows through the bottom of the strait. The less dense water of the Curonian Lagoon flows in the opposite direction along the surface of the seawater.

Changes in water levels in the Curonian Lagoon, the inner channel of the Curonian Lagoon and the entrance channel depend on river inflow, the water level of the Baltic Sea, and the processes of tidal ebb and flow in the Klaipėda Strait. The water surface of the Curonian Lagoon slopes downwards towards the Klaipėda Strait. The average long-term water level trend in the northern part of the Curonian Lagoon and the Baltic Sea is presented in Table 4.1.1.1.

4.1.1.1 Table. Average long-term water levels in the Curonian Lagoon and the Baltic Sea (cm) [19]

Water level measuring station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Juodkrantė	15	11	1	10	-5	-5	6	6	9	8	12	16	7
Klaipėda	9	3	-6	-5	-10	-4	6	6	9	6	9	12	3
Pionerskas	5	-6	-16	-15	-17	-10	2	-3	2	0	3	6	-4

Two rises in water level are observed in the northern part of the Curonian Lagoon: during the spring flood and in the autumn–winter months, when the likelihood of stormy winds increases. The influence of stormy winds on water level changes is greatest in the ice-free part of the Klaipėda Strait.

A characteristic feature of water level fluctuations is that there are very marked daily changes in water level in the Klaipėda Strait. Sudden fluctuations caused by dams are most commonly observed in autumn and winter.

In the Klaipėda Strait, the instantaneous water level most often (in 95% of cases) fluctuates within the range of 50 to -50 cm. Over the last 50 years, the highest water levels in the KVJU water area were recorded on 18 October 1967 at +186 cm above the Baltic System (BS) 'zero', on 4 December 1999 at +165 cm, and on 8 January 2005 at +154 cm. The lowest levels during the period in question were recorded on 23 November 1984 – 90 cm and on 8 January 1972 – 80 cm BS (data from the Lithuanian Hydrometeorological Service). The long-term averages of extreme water levels in Klaipėda are presented in Table 4.1.1.2, whilst the instantaneous levels are shown in Table 4.1.1.3.

4.1.1.2 Table. Long-term average values of maximum and minimum water levels in the Klaipėda Strait [19]

Level, cm	Months												Year
	01	02	03	04	05	06	07	08	09	10	11	12	
Maximum	59	43	51	28	15	18	29	27	33	43	46	41	18
Minimum	-35	-44	-43	-34	-31	-23	-9	-17	21	-49	-37	-44	-14

Maximum water level rises are short-lived (1–3 hours), whilst minimum levels are observed for longer periods (~10 hours). The rise is caused by strong winds from the W, WNW and NW, whilst the fall is caused by winds from the opposite directions.

In the Klaipėda Strait, short-lived, non-periodic water level fluctuations—tides—are observed, caused by wind, water circulation and atmospheric pressure. The amplitude of tides in the Klaipėda Strait reaches 0.3 m, whilst the period of fluctuations is 20–30 min.

4.1.1.3 Table. Maximum and minimum instantaneous water levels (in the Baltic Sea level system) [19]

Probability, %	99	50	20	10	5	2	1
Repetition	1	2	5	10	20	50	100
Maximum level, cm	45	85	110	124	143	162	180
Minimum level, cm	-50	-68	-77	-83	-89	-97	-103

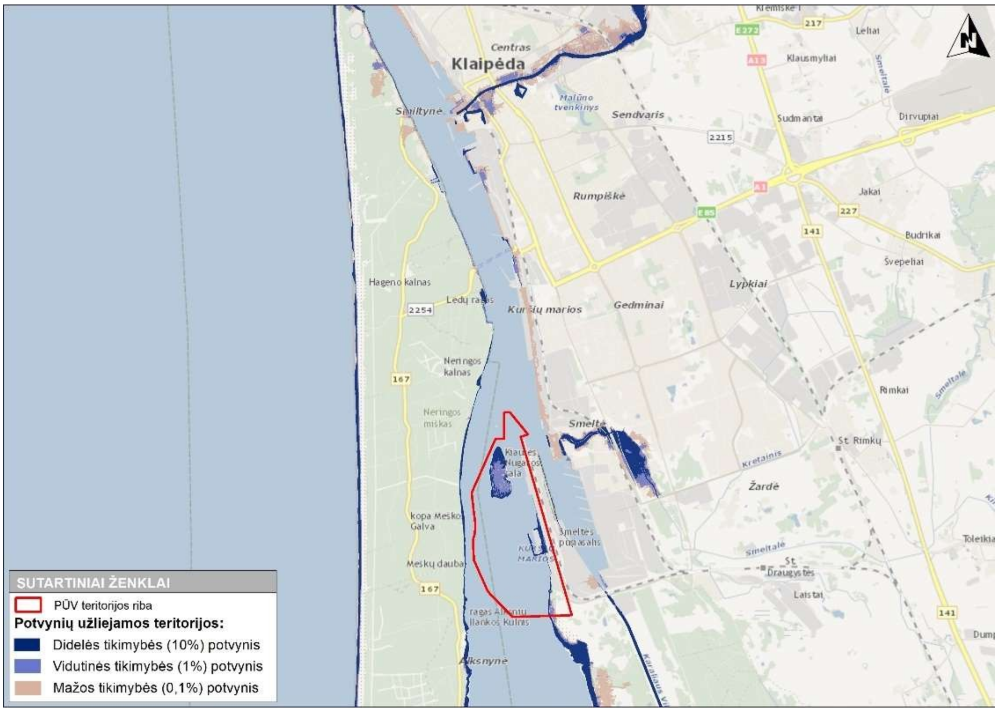
Short-period water level fluctuations caused by swells are also observed in the Klaipėda Strait. Swells typically form during storms, when waves from the Baltic Sea enter the Klaipėda Strait, causing a local rise in water level. Occasionally, such waves reach the strait even before the storm, or even when the storm has passed over another part of the Baltic Sea. The period of water level fluctuation during a surge is 0.5–3.0 minutes, and the maximum amplitude reaches 50 cm. Spring tides are dangerous due to their unexpected, sudden formation and often create emergency situations for ships in the port. Spring tides are observed in the port on average ~19 times a year. The average duration of tidal bores is 34–35 hours, with the longest lasting 3 days. Tidal bores have been observed throughout the Port of Klaipėda – at the port entrance, in the northern part of the strait, near the mouth of the Danė River, in Smiltynė, and even in Malkų Bay. The strongest tides occur 2–3 km from the harbour entrance, near AB 'Klaipėdos jūrų krovinių kompanija (KLASCO)' and at the Smiltynė quays on the Curonian Spit. The strongest and most dangerous tides in the Port of Klaipėda occur when north-north-easterly winds blow, when the amplitude of water level fluctuations in the strait's waters exceeds 20 cm.

A characteristic feature of water level changes in the Klaipėda Strait is the very pronounced daily fluctuations in water level. Sudden level fluctuations caused by dams are most commonly observed in autumn and winter. In the Klaipėda Strait, the instantaneous water level most often (in 95% of cases) fluctuates within a range of 50 to -50 cm, with the observed extreme levels being +186 cm and -100 cm.

In the Klaipėda Strait, the water level depends directly on wind conditions and, to a lesser extent, on Baltic Sea swells. This is influenced by the Curonian Spit, which provides protection from the direct impact of sea swells. Sea swells passing through the harbour gates affect only the northern part of the harbour basin, gradually weakening as they move away from the harbour gates.

In the long-term fluctuations of the Baltic Sea level during the 20th century and the early 21st century, an upward trend has been observed. In the 20th century, the water level along the south-eastern Baltic coast rose by approximately 14 cm, and in the 21st century, this process has continued and intensified. Since the 1960s, the average sea level along the Lithuanian coast, as well as across the entire Baltic Sea and the Curonian Lagoon, has been rising by an average of about 3 mm per year.

According to the Flood Hazard and Risk Map [5], the Kiaulės Nugaros Island, the KVJU contaminated soil storage site and the south-western coast of the Smeltė Peninsula fall within the high and medium probability flood hazard and risk zones in the PŪV area (Fig. 4.1.1.1).



4.1.1.1 Fig. Location of the PŪV in relation to flood hazard and risk areas

Currents

The nature of the currents in the Klaipėda Strait is determined by several natural factors – river inflows, differences in water levels between the Curonian Lagoon and the sea, water exchange with the sea through the strait, and wind. River inflow into the Curonian Lagoon is a particularly important factor, and the dynamics of water mass in the strait depend largely on its volume and seasonal variations. An average of 22.1 km³ of fresh water flows into the sea via the Curonian Lagoon each year. In particularly dry years, the inflow amounts to 14.3 million m³, whilst in very wet years it reaches 35.6 km³. The river inflow forms a constant outflow into the sea, with an average long-term velocity of 30–40 cm/s. The speed of the outflowing currents increases significantly during the spring flood and reaches 1.0–3.0 m/s.

The dynamics of the prevailing outflows to the sea are significantly altered by sudden changes in water levels caused by strong winds. During such surges, inflows into the Curonian Lagoon are formed. These currents form when winds of storm force blow from the W, NW and S directions.

Two-layer currents are also observed in the strait. They form when the water level in the Curonian Lagoon differs only slightly from that of the Baltic Sea and the direction of the currents in the Klaipėda Strait changes. In such cases, the lighter, fresher lagoon water flows out to sea through the surface layer, whilst the saltier and heavier seawater penetrates into the Curonian Lagoon through the lower layer; or, on one side of the strait, seawater flows from the surface to the bottom into the strait, whilst on the other, fresh water flows from the surface to the bottom out to sea.

The recurrence of currents in various directions in the Klaipėda Strait, depending on the wind direction, is presented in Table 4.1.1.4.

4.1.1.4 Table. Frequency of current directions in the Klaipėda Strait [19]

Wind direction and speed, m/s	**Frequency of currents, %**		
	Out to sea	Two-layer	Into the strait
By direction			
Š	56.7	23.3	20.0
NW	50.9	36.8	12.3
R	70.3	29.7	-
R	77.2	18.5	4.3
P	73.1	26.9	-
PV	73.3	24.7	2.0
V	68.1	14.9	17.0
SW	54.4	24.5	21.1
R-PV	73.5	24.9	1.6
V-SR	57.5	24.9	17.6
By speed			
0–5	65.9	28.5	5.6
6–10	62.7	18.5	19.1
11–15	64.7	5.9	29.4
Total:	65.1	24.4	10.5

Wave action

In the Klaipėda Strait, wave action is directly dependent on wind conditions and differs from that of the Baltic Sea. This is influenced by the Curonian Spit, which provides protection from the direct impact of sea waves. Sea waves passing through the harbour entrance affect only the northern part of the harbour basin, gradually weakening as they move away from the entrance. The largest waves at the entrance channel to Klaipėda Port form during major storms when strong winds blow from the W, WNW and NW. Waves from the W and WNW directions travel furthest into the port's water area. In addition to the usual wind-induced swell, the Klaipėda Strait is characterised by distinctive low-frequency, long-period waves caused by tidal currents, as well as wave scattering – a chaotic swell where, at the junction of different waves, smaller waves ride atop larger ones, and even smaller ones atop those.

Bathymetric conditions

The depth of the KVJU water area ranges from 0.5 m (in the southern part, beyond Kiaulės Nugaros Island) to 15.5 m (at the port's sea gate). The depth of the port's inner navigation channel reaches 14.5–15 m, and 15.5 m in the approach channel (Fig. 3.3.1). The width of the Klaipėda Strait within the port limits varies from 0.4 to 1.1 km.

The seabed topography of the Klaipėda Strait has been significantly affected by human activity. Changes began in the 19th century, starting with the southern part. In 1873, the King William Canal was dug, which shaped the current contours of Malkų Bay. At that time, the Klaipėda Strait was characterised by relatively shallow depths compared to the current situation. The natural depth ranged from 4.5 to 7.0 metres, with a maximum depth of up to 7.0 metres at the northernmost part of the strait – the mouth. The beginning of the Klaipėda Strait was also shallower, with a sandbank forming there; part of this, due to the soil deposited during projects carried out in the port and hydrodynamic processes (for more on this, see Section 4.6). The eastern channel of the island is considerably shallower (0.5–6.0 m deep) than the western one, where the depth in the fairway reaches 9.0–10.0 metres.

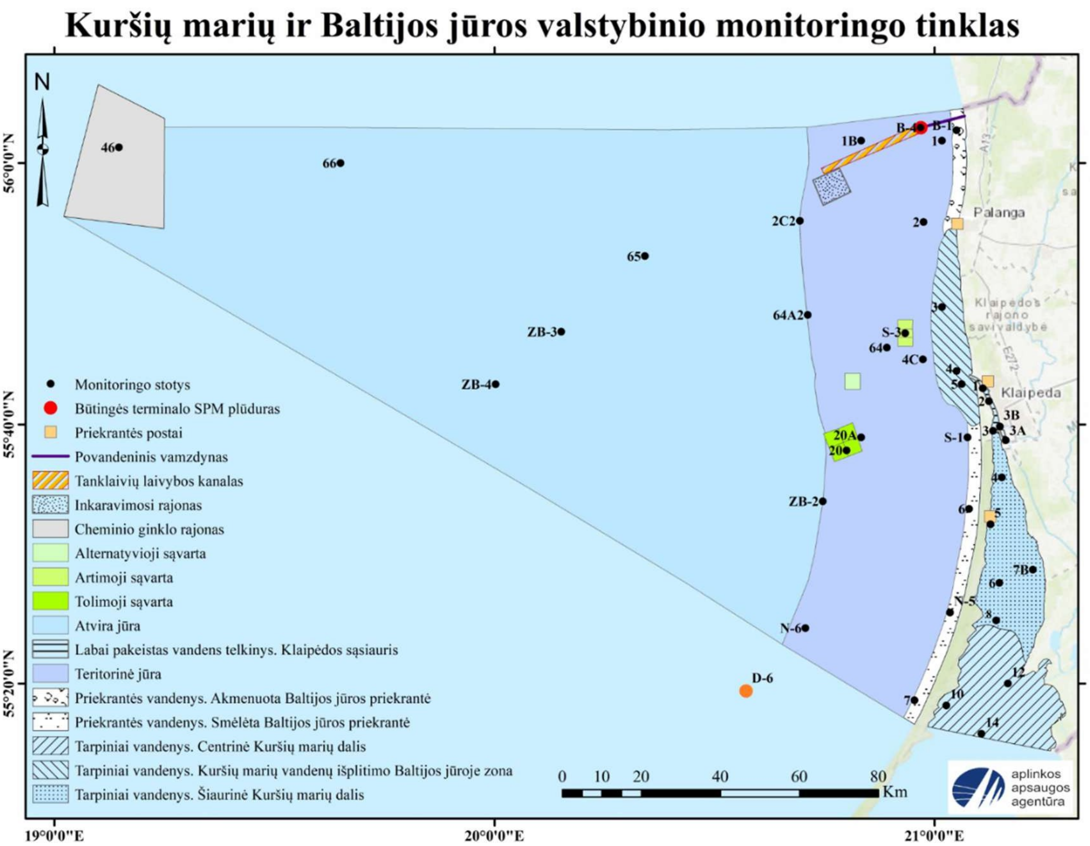
Currently, the nature of the seabed relief in the Klaipėda Strait is very closely linked to hydrodynamic conditions, and consequently to the sedimentation processes of current deposits. Therefore, the changing seabed topography during the implementation of the PŪV solutions (dredging of the southern part of the KVJU water area) will inevitably influence the aforementioned processes.

Ecological and chemical status of surface water

In the Klaipėda Strait, where the Port of Klaipėda is located, there is a water exchange between the Curonian Lagoon and the Baltic Sea. The ecological and chemical status of the waters in the Klaipėda Strait is influenced by wastewater discharged from treatment plants in towns and other facilities within the Nemunas River basin, which enters the Curonian Lagoon via the Nemunas, as well as by the economic activities of the city of Klaipėda and the port.

To monitor and assess the aforementioned surface water conditions in the Baltic Sea and the Curonian Lagoon, the following is carried out:

- State environmental monitoring of the Baltic Sea and the Curonian Lagoon (Fig. 4.1.1.2) in accordance with the 2018–2023 State Environmental Monitoring Programme [31];
- Environmental monitoring of the Klaipėda State Seaport [26–30]



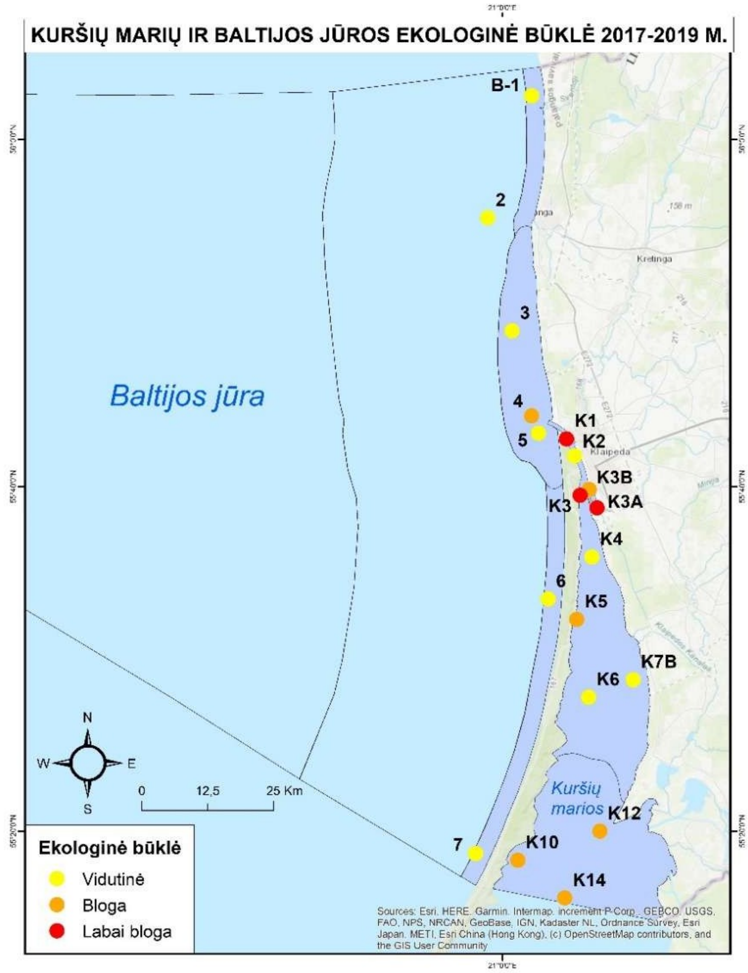
4.1.1.2 Fig. State environmental monitoring sites in the Baltic Sea and the Curonian Lagoon [34]

More detailed information on the ecological status of the Curonian Lagoon and the Baltic Sea in 2018–2021 can be found on the Environmental Protection Agency's website at https://aaa.lrv.lt/lt/areas-of-activity/water/curonian-lagoon-and-baltic-sea/ecological-status-of-the-curonian-lagoon-and-the-baltic-sea .

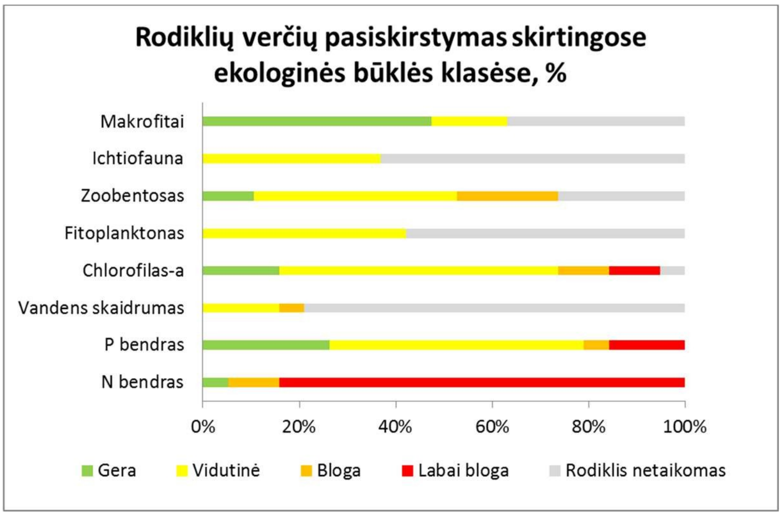
Ecological status of the Curonian Lagoon and the Baltic Sea in 2017–2019 [32]

In 2017–2019, the ecological status of the Curonian Lagoon and the Baltic Sea at the survey sites was: moderate (10 sites), poor (6 sites), and very poor (3 sites) (Fig. 4.1.1.3) [32].

Not all indicators met the criteria for good ecological status, but total nitrogen concentrations were the furthest from good ecological status – at 16 sampling sites, the ecological status was very poor based on total nitrogen concentrations (Fig. 4.1.1.4).



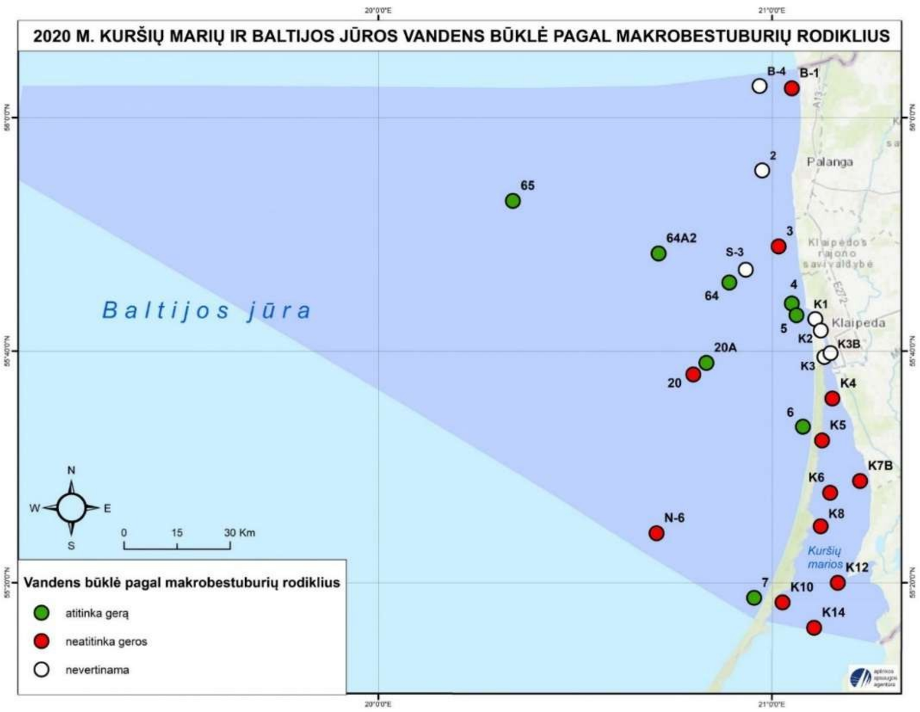
4.1.1.3 Fig. Ecological status of the Curonian Lagoon and the Baltic Sea, 2017–2019 [32]



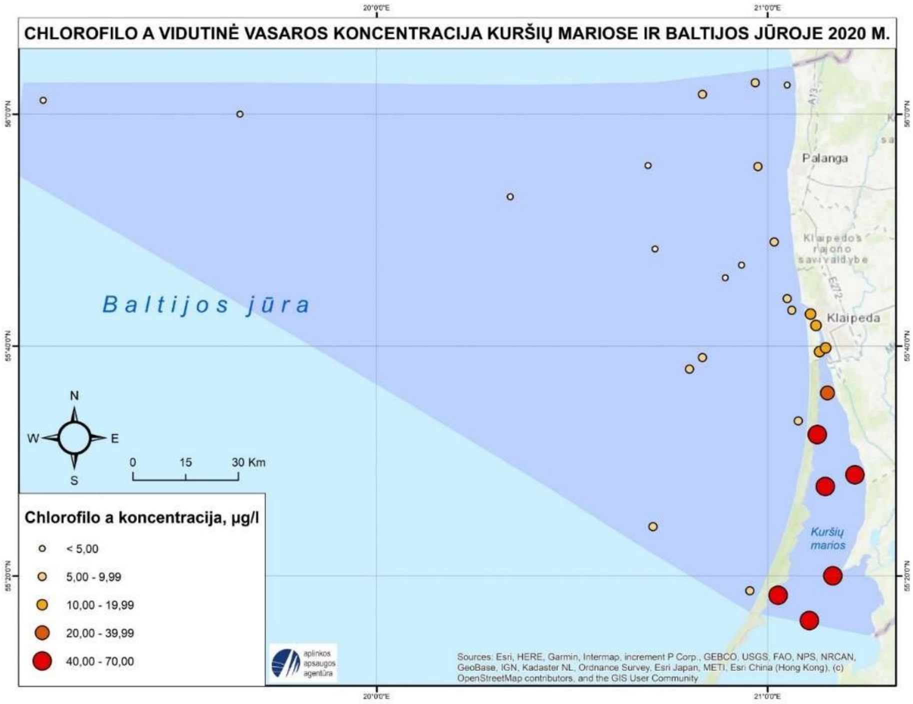
4.1.1.4 Fig. Distribution of indicator values across different ecological status classes (%) 2017–2019 [32]

Ecological status of the Curonian Lagoon and the Baltic Sea in 2020

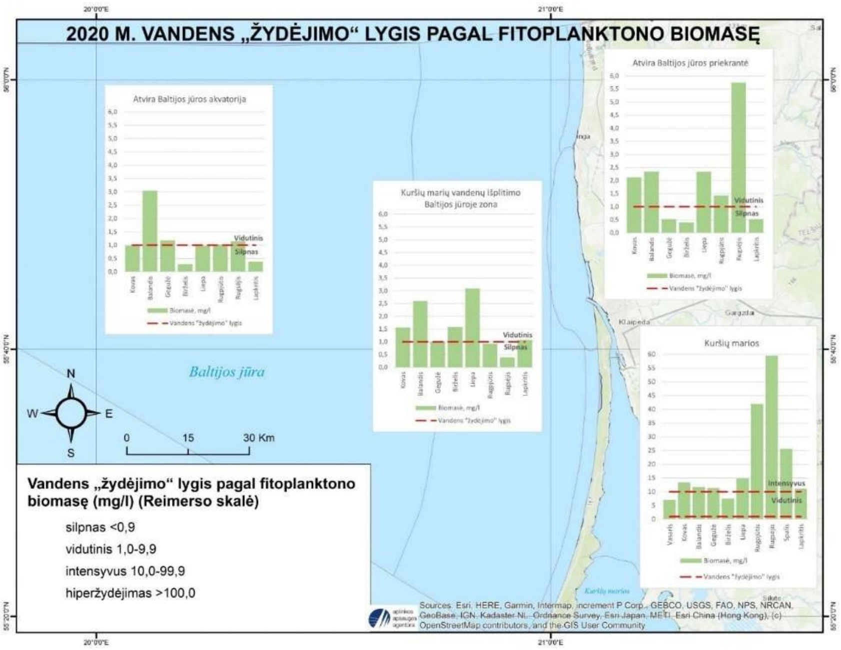
In 2020, the water status in the Curonian Lagoon, as indicated by macroinvertebrate indices, did not meet the criteria for good water status (Fig. 4.1.1.5), chlorophyll a concentrations at six monitoring sites ranged from 40.0 to 70.0 µ/l (Fig. 4.1.1.6), and the level of 'blooming' based on phytoplankton biomass is shown in Fig. 4.1.1.7.



4.1.1.5 Fig. The state of the Curonian Lagoon and the Baltic Sea in 2020 based on macroinvertebrate indicators [34]



4.1.1.6 Fig. Chlorophyll a concentration in the Curonian Lagoon and the Baltic Sea in 2020 [34]

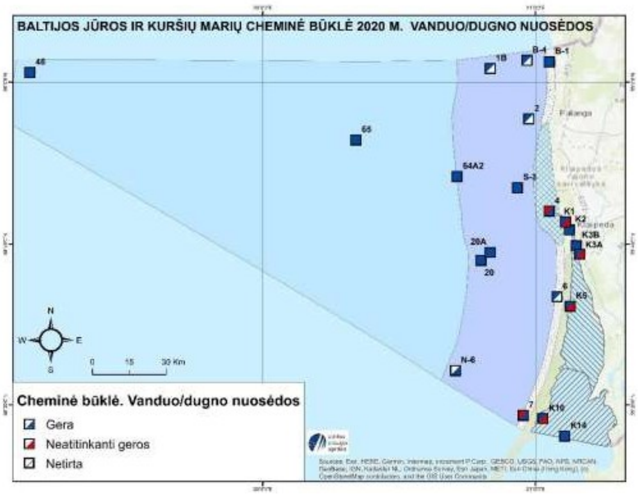


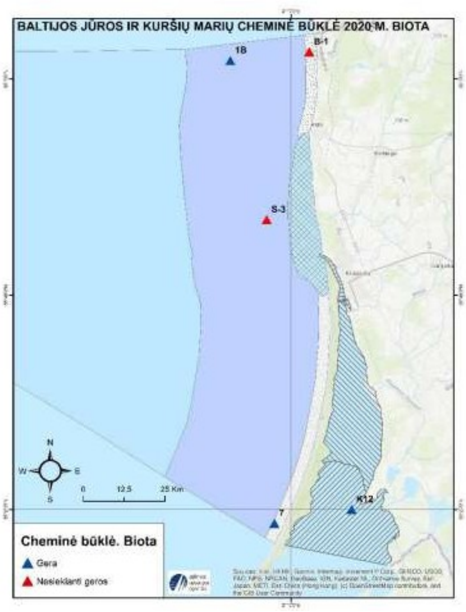
4.1.1.7 Fig. Level of water ‘blooming’ in 2020 based on phytoplankton biomass [34]

Chemical status of the Curonian Lagoon and the Baltic Sea in 2020 [33]

In 2020, tests for hazardous substances and specific pollutants in water and bottom sediments were carried out at 7 monitoring sites in the Curonian Lagoon and 14 in the Baltic Sea; tests on biota (molluscs and fish) were conducted at one site in the Curonian Lagoon and four in the Baltic Sea. According to the 2020 monitoring results for the Curonian Lagoon and the Baltic Sea, the following did not meet the criteria for good chemical status: all four water bodies in the transitional category, two water bodies in the coastal category, and the territorial sea. Heavy metals in the seabed sediments of the Curonian Lagoon

, polycyclic aromatic hydrocarbons in the waters of the Baltic Sea, and mercury concentrations in fish in the Baltic Sea [33].



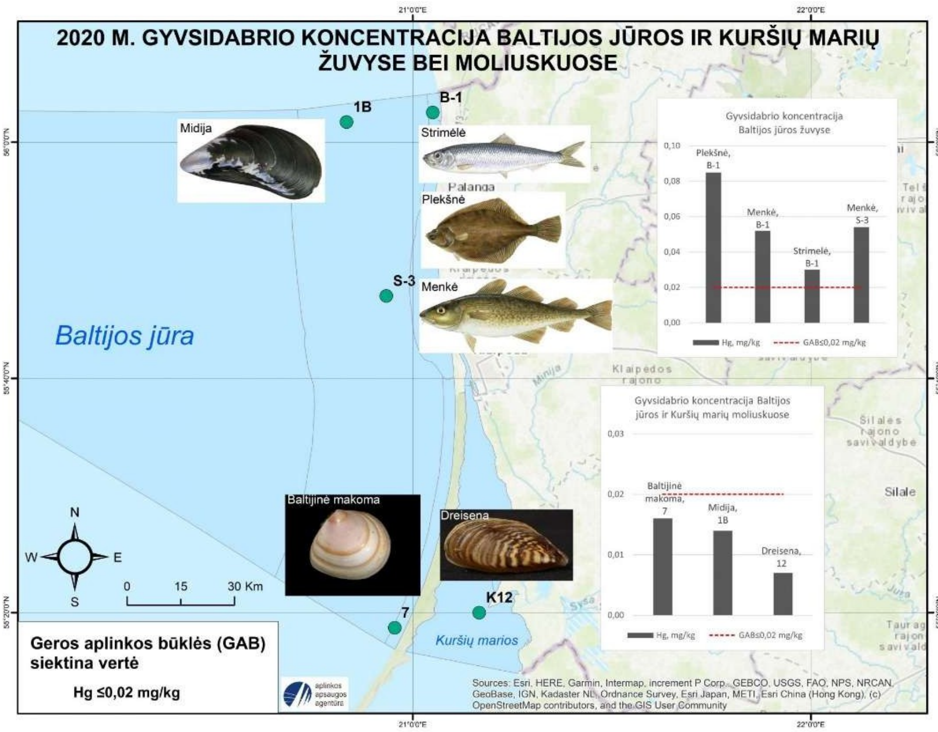


4.1.1.8 Fig. Chemical status of the Curonian Lagoon and the Baltic Sea in 2020: a) water and bottom sediments;

b) biota [33]

Studies of hazardous substances in biota showed that mercury concentrations in fish muscle significantly exceeded the established EQS for biota (20 µg/kg wet weight). Based on the results of biota studies in 2020, the part of the Baltic Sea belonging to Lithuania did not achieve good chemical status due to mercury; however, in the Curonian Lagoon, mercury concentrations in Dreissena mussels did not exceed the AKS (Fig. 4.1.1.9).

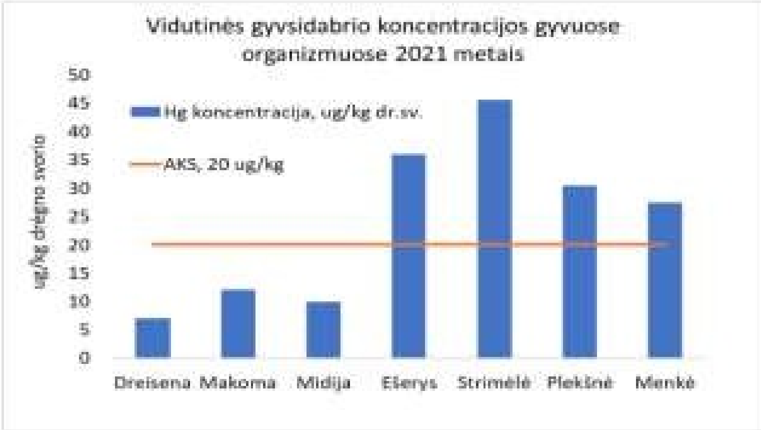
The northern part of the Curonian Lagoon is intensively used to meet the needs of the city and the Klaipėda State Seaport. One of the sources of point source pollution in the Klaipėda Strait (Curonian Lagoon) is the effluent discharged by companies operating in the port. According to the Integrated Pollution Prevention and Control (IPPC)/Pollution Permits (PP) issued by the Environmental Protection Agency, in 2020, 21 companies discharged wastewater into the Klaipėda Port water area via 67 discharge points: 53 surface outfalls, 8 industrial outfalls (including cooling water) and 6 domestic outfalls. An assessment of the quantities of pollutants discharged by companies in 2020 estimated that 191.10 tonnes of suspended solids, 161.65 tonnes of BOD_7, 133.40 tonnes of total nitrogen and 8.15 tonnes of total phosphorus were discharged. The total amount of other pollutants (petroleum products, heavy metals, etc.) amounted to 5.57 tonnes per year. Hazardous priority substances were found in the wastewater, the discharge of which must be stopped [33].



4.1.1.9 Fig. Mercury concentrations in fish and shellfish in the Baltic Sea and the Curonian Lagoon in 2020 [33]

Chemical status of the Curonian Lagoon and the Baltic Sea in 2021

In 2021, as part of the State Environmental Monitoring Programme, tests for hazardous substances in water and bottom sediments were carried out at 7 monitoring sites in the Curonian Lagoon and 12 in the Baltic Sea, and in biota (molluscs and fish) at two sites in the Curonian Lagoon and four in the Baltic Sea. In 2021, all monitoring sites in the Curonian Lagoon and the Baltic Sea met the criteria for good chemical status, i.e. concentrations did not exceed the specified EQS and in 95% of measurements, concentrations were below the limits of quantification (not detected). A total of 11 hazardous substances were identified, for which EQS must be applied in biota and the chemical status assessed. Studies of hazardous substances in the biota showed that mercury concentrations in fish muscle reached, and in some cases significantly exceeded, the established EQS in the biota (20 µg/kg wet weight). In the Curonian Lagoon, mercury concentrations in perch muscle tissue exceeded the EQS, whilst in the mollusc Dreisena they did not reach the EQS (Fig. 4.1.1.10). Based on the results of the 2021 biota surveys, the Lithuanian sector of the Baltic Sea did not achieve good chemical status due to concentrations of mercury and brominated diphenyl ethers. Based on the Good Environmental Status (GES) criteria for pollutants in bottom sediments, nickel most frequently exceeded GES values in bottom sediments (at a total of 5 monitoring sites). Most exceedances of GES values were found in the Klaipėda Strait (stations K1, K3A and K3B) and in bottom sediments collected in the Curonian Lagoon near Nida (sampling site LTK10). The sampling sites where exceedances were found in bottom sediments are located near areas of human activity and pollution sources (companies carrying out cargo handling, ship repair and construction works, surface (rainwater) discharge outlets in Malkų Bay and the port of Nida). However, pollutants tend to accumulate at these sites also due to the prevalence of fine-grained bottom sediments and slower hydrodynamic processes in the bay [34].



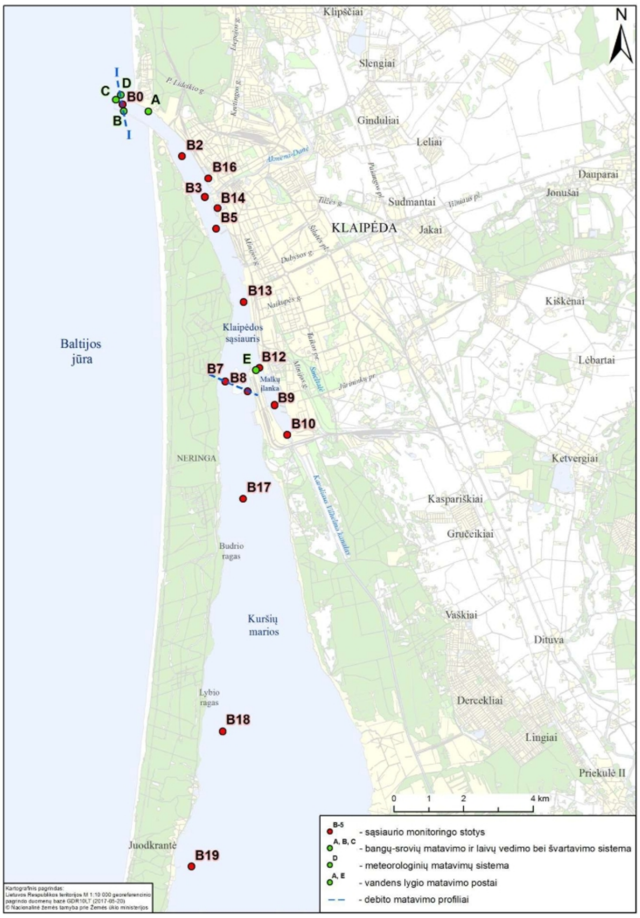
4.1.1.10 Fig. Average mercury concentrations in living organisms in the Curonian Lagoon and the Baltic Sea in 2021.

In accordance with the agreed KVJU 2021–2025 environmental monitoring programme, environmental monitoring of the Klaipėda State Seaport is carried out annually on behalf of the Port Authority [26–30]. Observations of water flow velocity and direction, temperature, salinity, suspended matter (concentrations), transparency and water discharge in the surface and bottom water layers of the Curonian Lagoon are carried out at 15 stations – B0, B2, B3, B5, B7, B8, B9, B10, B12, B13, B14, B16, B17, B18, B19 (Fig. 4.1.1.12) [30], two of which are located in both channels near Kiaulės Nugaros Island: the eastern (B8) and western (B7) channels (Fig. 4.1.1.11) and are particularly important for recording changes in the contact zone between the Klaipėda Strait and the Curonian Lagoon.

In the Klaipėda Port water area, meteorological parameters are measured by automatic measuring stations E and F, located on the northern and southern breakwaters of Klaipėda Port. The layout of these stations is shown in Fig. 4.1.1.13. Station E measures wind speed and direction, whilst Station F, in addition to wind speed and direction, also measures air temperature and atmospheric pressure.

The most significant changes in water temperature between 2019 and 2022 were due to seasonal variations in air temperature. The lowest water temperatures in the Port of Klaipėda and the Curonian Lagoon were recorded in February, and the highest in August. The greatest temperature difference between the surface and bottom layers was observed in May [27, 28]. Measurements taken on 6 August 2021 showed that water temperatures at monitoring stations in the Curonian Lagoon ranged from 19.2°C at the bottom horizon of station B12 to 22.8°C at the bottom horizon of station B13 [29]. Measurements taken on 10 February 2022 showed that water temperatures at monitoring stations in the Curonian Lagoon ranged from 1.1°C at the bottom horizon of stations B0 and B18 to 3.9°C at the surface horizon of station B3, and according to measurements taken on 20 May 2022 – from 10.1°C at the surface horizon of station B10 to 12.7°C at the bottom horizon of station B18 [30].

In 2020, the highest water transparency values in both the Klaipėda Strait and the Curonian Lagoon were recorded in May. In 2020, the concentration of suspended solids in the Port of Klaipėda and the Curonian Lagoon ranged from 1.9 mg/l to 65 mg/l [28]. In 2021, water transparency in the Curonian Lagoon was 3.0 m at all stations; the concentration of suspended solids in the Curonian Lagoon ranged from 0.5 mg/l at the surface horizons of stations B8 and B16, and at the bottom horizon of station B2, to 36 mg/l at the surface horizon of station B1 [29]. On 10 February 2022, water transparency in the Curonian Lagoon ranged from 1.5 m at stations B17, B18 and B19 to 3.5 m at station B0. On 10 February 2022, the concentration of suspended solids in the Curonian Lagoon ranged from 10.8 mg/l at the bottom horizon of station B2 to 102.8 mg/l at the bottom horizon of station B0 [30].



4.1.1.11 Fig. KVJU surface water monitoring stations [29]

4.1.1.12 Fig. Layout of automatic meteorological measuring stations E and F

Hydrogen ion concentration (pH) values in the water column of the Klaipėda Strait in 2019 ranged from 7.36 to 8.97, whilst in the Curonian Lagoon, pH fluctuated between 8.02 and 8.99. A significant increase in pH was observed during the warm season. The observed changes in pH values in all cases indicated an alkaline water environment and were consistent with the limit values applicable to surface water bodies in which freshwater fish can live and breed: pH from 6 to 9 [27]. In 2020, pH values in the water column of the Klaipėda Strait ranged from 7.7 to 8.8, whilst in the Curonian Lagoon, pH fluctuated between 8.1 and 8.8. A significant increase in pH was again observed during the warm season [28]. In 2021, the pH in the Curonian Lagoon ranged from 7.5 at stations B3, B7, B13 and B18 in the bottom layer to 8.1 at stations B8 and B19 in the bottom layer [29].

In 2019, the concentration of dissolved oxygen in the waters of the Klaipėda Strait ranged from 4.1 to 11.97 mg/l, with an average of 7.53 mg/l, whilst in the Curonian Lagoon it fluctuated between 4.75 mg/l and 8.31 mg/l. During the summer season, the concentration of dissolved O_2 was below the threshold value (≥7 mg/l) for cyprinid habitats at all water depth stations in the Klaipėda Strait and the Curonian Lagoon, but did not reach the minimum value of 4 mg/l at any station. Compared with data from previous studies, the O_2 concentration has decreased significantly: the annual average in 2019 was 7.53 mg/l, whereas in 2018 this figure was higher than 10 mg/l, and in 2007 it reached 10.12 mg/l. Minimum oxygen concentrations in the Klaipėda Strait are also significantly lower than in previous years: the lowest value in 2019 was 4.1 mg/l, whereas in 2007 it was 7.27 mg/l and in 2018 – 9.09 mg/l [27]. In 2020, the concentration of dissolved oxygen in the waters of the Klaipėda Strait ranged from 5.5 to 8.6 mg/l O_2 and averaged 7.2 mg/l. The minimum O_2 concentration recorded in summer approached the minimum value of 4 mg/l O_2 [28]. In 2021, the O_2 concentration in the Curonian Lagoon ranged from 8.0 mg/l at the surface horizon of station B16 to 12.2 mg/l at the bottom horizon of stations B0 and B14 [29].

In 2019, the concentration of total nitrogen (N(b)) in the waters of the Klaipėda Strait ranged from 0.33 mg/l to 3.02 mg/l. The highest average concentration of total nitrogen was recorded in February, with the lowest values observed in May. In the Curonian Lagoon, the concentration of total nitrogen ranged from 0.77 to 1.36 mg/l [27]. In 2020, the concentration of total nitrogen (N(b)) in the waters of the Klaipėda Strait ranged from 0.29 mg/l to 3.1 mg/l, averaging 0.92 mg/l. In the Curonian Lagoon, the concentration of total nitrogen ranged from 0.45 to 1.62 mg/l. The highest average concentration of total nitrogen in both the port and the lagoon was recorded in February, with the lowest values detected in May [28]. Total nitrogen (N(b)) pollution is most pronounced in the northern part of the port's water area (B2, B14), at stations B18 and in Malkų Bay (B9, B10).

In 2019, phosphate concentrations in the Klaipėda Strait and the Curonian Lagoon ranged from <0.005 mg P/l to 0.135 mg P/l. The limit value was exceeded only in November at station B9. During the warm season, average phosphate concentrations in the strait did not reach the method's detection limit. In the waters of the Klaipėda Strait, the concentration of total phosphorus in 2019 ranged from 0.014 to 0.139 mg P/l [27], and in 2020 – in the range of 0.018–0.048 mgP/l, averaging 0.028 mgP/l. Higher total phosphorus values were observed during the cold season. In the Curonian Lagoon, the highest concentrations of total phosphorus were recorded in August and November [28]. In 2021, the concentration of phosphates (PO_4^{3-}) in the Curonian Lagoon ranged from 0.066 mg/l in the bottom horizon at station B18 to 0.156 mg/l in the bottom horizon at station B10. The concentration of total phosphorus (P(b)) in the Curonian Lagoon in 2021 ranged from 0.050 mg/l at the surface and bottom horizons of station B0 to 0.163 mg/l at the surface horizon of station B10. The assessment criterion (< 0.015 mg/l) is the target value set for transitional waters to meet the indicators of the 'very good' ecological status class. According to this criterion, the water in the Curonian Lagoon, as measured by total phosphorus at the monitoring stations, met the indicators of the 'very poor' ecological status class [29]. On 10 February 2022, the concentration of total phosphorus P(b) in the Curonian Lagoon ranged from 0.088 mg/l at the B5 station's bottom horizon to 0.216 mg/l at the B3 station's bottom horizon. The assessment criterion (< 0.060 mg/l) is the target value set for transitional waters to meet the indicators of the 'very good' ecological status class. According to this criterion, the water of the Curonian Lagoon in Q1 met the following criteria for total phosphorus at the monitoring stations: the average ecological status class was met at stations B0, B3, B5, B10, B12, B13 and B17 in the surface water layer, and B0, B2, B5, B10, B12 and B16 in the bottom water layer; the poor ecological status class was met at stations B2, B7, B9, B14, B16 and B18 stations in the surface water layer and at stations B3, B7, B9, B13, B14, B17 and B18 in the bottom water layer [30].

The concentration of ammonium ions (N/NH_4^+) in the water column of the Klaipėda Strait in 2019 ranged from below the method detection limit to 0.51 mgN/l. In the Curonian Lagoon, N/NH_4^+ ranged from <0.05 to 0.25 mgN/l. Over the course of the year, the limit value (0.78 mgN/l) was not exceeded at any of the stations in the strait or the lagoon. The lowest ammonium ion values were recorded during the cold season, whilst the highest values were observed in August. Compared with data from previous years, the concentration of ammonium ions has decreased [27]. The concentration of ammonium in the Curonian Lagoon ranged from 0.248 mg/l at the surface horizon of station B5 to 0.479 mg/l at the bottom horizon of station B18. The assessment criterion (< 0.13 mg/l) is the target value set for transitional waters to meet the indicators of the 'very good' ecological status class. According to this criterion, the water of the Curonian Lagoon, based on total nitrogen, corresponded to the 'very poor' ecological status class [29].

In 2019, the highest levels of organic matter, based on BOD_7 values, were recorded in the waters of the Klaipėda Strait and the Curonian Lagoon in August. Particularly high BOD_7 values were recorded in the waters of the Curonian Lagoon during the summer – at all stations in the Curonian Lagoon, both in the surface and bottom layers, biochemical oxygen demand was higher than the limit value set for carp-fishing waters (6 mgO2/l). The influence of the Curonian Lagoon was also felt in the strait: in August, maximum concentrations exceeding 6 mgO2/l were also observed at stations B7 and B8 in the strait, which are located within the lagoon's influence zone. At other stations in the strait, increased values were recorded in summer, but these did not reach 6 mgO2/l. In 2020, the highest levels of organic matter, based on BDS_7 indicator values, were recorded in the waters of the Klaipėda Strait and the Curonian Lagoon in August. Over the course of the year, the threshold value of 6 mgO2/l for carp-fishing waters was not exceeded at any of the stations [28]. In 2021

, the concentration of biological oxygen demand in the Curonian Lagoon ranged from 0.52 mg/l at the bottom horizon of stations B10 and B18 to 1.76 mg/l at the bottom horizon of station B10 [29].

The highest ChDSCr values in 2019 were recorded in August [27]. The highest ChDSCr values in 2020 were recorded in February, whilst the lowest organic matter content according to this indicator was recorded in November [28]. In 2021, the ChDSCr concentration in the Curonian Lagoon ranged from 8.7 mg/l in the bottom layer at station B0 to 15.5 mg/l in the surface layer at station B18 [29]. On 20 May 2022, the ChDSCr concentration in the Curonian Lagoon ranged from 8.1 mg/l at the surface horizon of station B14 to 19.8 mg/l at the surface horizon of station B9 [30].

Concentrations of petroleum hydrocarbons in water during all seasons from 2019 to 2021, both in the Klaipėda Strait and in the Curonian Lagoon, did not exceed the MPC for petroleum hydrocarbons (200 µg/l) [27]. Pollution by petroleum hydrocarbons and heavy metals (excluding Hg) was negligible in 2022. In the northern part of the port basin, near the AB Baltijos shipyard (B14) and in Malkų Bay (B10), mercury pollution exceeding the MPC-AKS was recorded [30].

In 2019–2020, concentrations of the heavy metals Cd, Cr, Ni, Pb and Zn in the waters of the Klaipėda Strait and the Curonian Lagoon did not exceed the environmental quality standards and maximum permissible concentrations set for hazardous substances. In the Klaipėda Strait and the Curonian Lagoon, trends in water concentrations of Cd, Cr, Ni, Pb and Zn were similar to those in 2018. In 2019, a consistent exceedance of the MPC for copper was recorded in the waters of the Klaipėda Strait (in the Winter Port basin). In 2019, mercury concentrations only occasionally exceeded the MCL in the waters of the Klaipėda Strait near the mouth of the Vilhelmo Canal, near the mouth of the Danė River and at the Port Gates [27]. In 2021, zinc (Zn) concentrations in the Curonian Lagoon were below the detection limit at all stations, and were below the MCL (0.1 mg/l) in the receiving water body; nickel (Ni) concentrations in the Curonian Lagoon were below the detection limit at all stations, and were below the MCL (34 µg/l) in the receiving water body; lead (Pb) concentrations in the Curonian Lagoon at all stations were below the limit of detection, and were below the MCL (14 µg/l) in the receiving water body; Chromium (Cr) concentrations in the Curonian Lagoon ranged from below the limit of detection at most stations to 1.9 µg/l at the surface horizon of station B0, which was lower than the MCL in the receiving water body (10 µg/l). Cadmium (Cd) concentrations in the Curonian Lagoon were below the limit of detection at all stations and met the assessment criteria for the class, taking into account water hardness at specific stations. The concentration of mercury (Hg) in the Curonian Lagoon at all stations was below the limit of detection and was lower than the MCL-AKS [29].

In 2020, sandy bottom sediments predominated in the Baltic Sea. Fine sand dominated at coastal stations; in areas of soil subsidence, bottom sediments ranged from moraine and coarse gravel/pebbles to sand sediments of various granulometric composition and sandy silt. In the second and fourth quarters of 2020, concentrations of heavy metals (Cu, Pb, Zn, Cr, Cd, As, Hg and petroleum hydrocarbons in the Baltic Sea seabed sediments did not exceed the limit values set for the lowest contamination classes for sands (Class I) and muds (Class II) (LAND 46A-2002) in any of the cases at all monitoring stations. The concentration of tin was below the method's detection limit, while that of vanadium

Concentrations ranged from 4.1 to 14.1 mg/kg. According to data from studies conducted between 2017 and 2020, a decline in average copper concentrations has been observed in recent years. Average concentrations of lead and zinc increased slightly at some stations in 2019, but did not exceed the limit values, and a decrease in the concentrations of these metals was again recorded in 2020. Average concentrations of Ni and Cr increased in 2019 and, at some soil sampling sites (St. J0, St. J1, St. J2, St. J12, St. J14, St. J15) had already exceeded the lowest limit values set for the pollution class; however, in 2020, the decreased and did not exceed the limit values. During the 2017–2020 study period, the average concentration of mercury only exceeded the limit value for sand by an average of 2 times in soil sampling area IV (St. 17) and in the foreshore, on average, twice the limit value for sand; in all other cases, Hg values were lower and, in most cases, did not reach the method detection limit. The concentration of petroleum hydrocarbons (PHCs) in spring 2020 did not reach the method detection limit at any of the Baltic Sea stations, whilst in autumn, concentrations detected in sedimentation zones III and IV reached 34 mg/kg and 23 mg/kg respectively, and, as in 2017–2019, did not exceed the limit values at any location. In 2020, PAA concentrations in Baltic Sea bottom sediments ranged from below the detection limit to 0.66 mg/kg, and as in 2017–2019, PAH values at no station reached the limit value set for the lowest (I) contamination class (LAND 46A-2002). In 2020, PCB concentrations in Baltic Sea bottom sediments, as in 2017–2019, did not reach the method detection limit at any station. In the second quarter of 2020, the concentrations of tributyltin (TBA) measured at stations J1 (0.00119 mg/kg) and J17 (0.00591 mg/kg) did not reach the limit values; in the fourth quarter of 2020, the TBA concentration at station J0 was 0.0184 mg/kg. The TBA concentrations recently detected in Baltic Sea bottom sediments highlight the relevance of investigating these pollutants in the dredging area [28].

According to data from granulometric composition studies of seabed sediments carried out in the port's water area in 2021, fine sand predominates in the seabed sediments of the Curonian Lagoon. In the northern part of the Klaipėda Strait, aleuritic sand sediments predominated, whilst sandy silt dominated in the central part of the strait and in the semi-enclosed bays. In the second quarter of 2021, concentrations of Cu, Pb, Zn, Ni, Cr, Cd, Hg, As in the bottom sediments of the Klaipėda Strait and the Curonian Lagoon did not exceed the limit values set for the lowest contamination classes for sands (Class I) and muds (Class II) at any of the monitoring stations (LAND 46A-2002). Vanadium concentrations ranged from 2.39 to 20.1 mg/kg, whilst Sn varied

<0.5 – 1.08 mg/kg. The concentration of petroleum hydrocarbons (PHCs) in bottom sediments at the Port of Klaipėda and the Curonian Lagoon ranged from <20 to 105 mg/kg. The highest PHC concentration, corresponding to pollution class II for mud, was detected at station B14. In the second quarter of 2021, the concentration of PAA in bottom sediments exceeded the lowest limit values set for pollution classes (LAND 46A-2002) only in the water area of AB 'Baltijos' shipyard (Station B14). In all other cases, PAA concentrations did not reach the limit values set for the lowest pollution classes for sand (Class I) and silt (Class II) (LAND 46A-2002). In 2021, PCB concentrations in bottom sediments did not reach the method detection limit at any station. The concentration of organic tributyltin (TBA) did not reach the limit values set for the lowest contamination classes for sand (Class I) and silt (Class II) (LAND 46A-2002) at stations B2, B8, B16 and B17. Based on the TBA concentrations determined (LAND 46A-2002), bottom sediments at station B14 are classified as soil contamination class II, at stations B10 and B12 as soil contamination class III, whilst the bottom sediments analysed at station B9 exhibited a concentration exceeding the limit value set for the highest contamination class (0.1 mg/kg dry weight). According to data from granulometric composition studies of bottom sediments conducted in 2021, fine sand predominates in the Baltic Sea bottom sediments. In the second quarter of 2021, the concentrations of Cu, Pb, Zn, Cr, Cd and Hg in Baltic Sea bottom sediments at all sampling stations did not exceed the limit values set for the lowest pollution classes for sands (Class I) (LAND 46A-2002). Concentrations of Ni and As only slightly (1.1 times) exceeded the limit value set for the lowest contamination class in the third sedimentation zone and at only one station (J0); in all other cases, the concentrations of nickel and arsenic were lower. The concentration of tin was below the limit of quantification, whilst the concentration of vanadium ranged from 4.14 to 17.4 mg/kg. The highest concentrations of heavy metals were recorded in the bottom sediments at station J0 in the third sedimentation zone. The concentration of petroleum hydrocarbons (PHCs) did not reach the method's limit of quantification at any of the Baltic Sea stations. The concentration of PAHs in Baltic Sea bottom sediments was below the limit of detection in all cases and did not

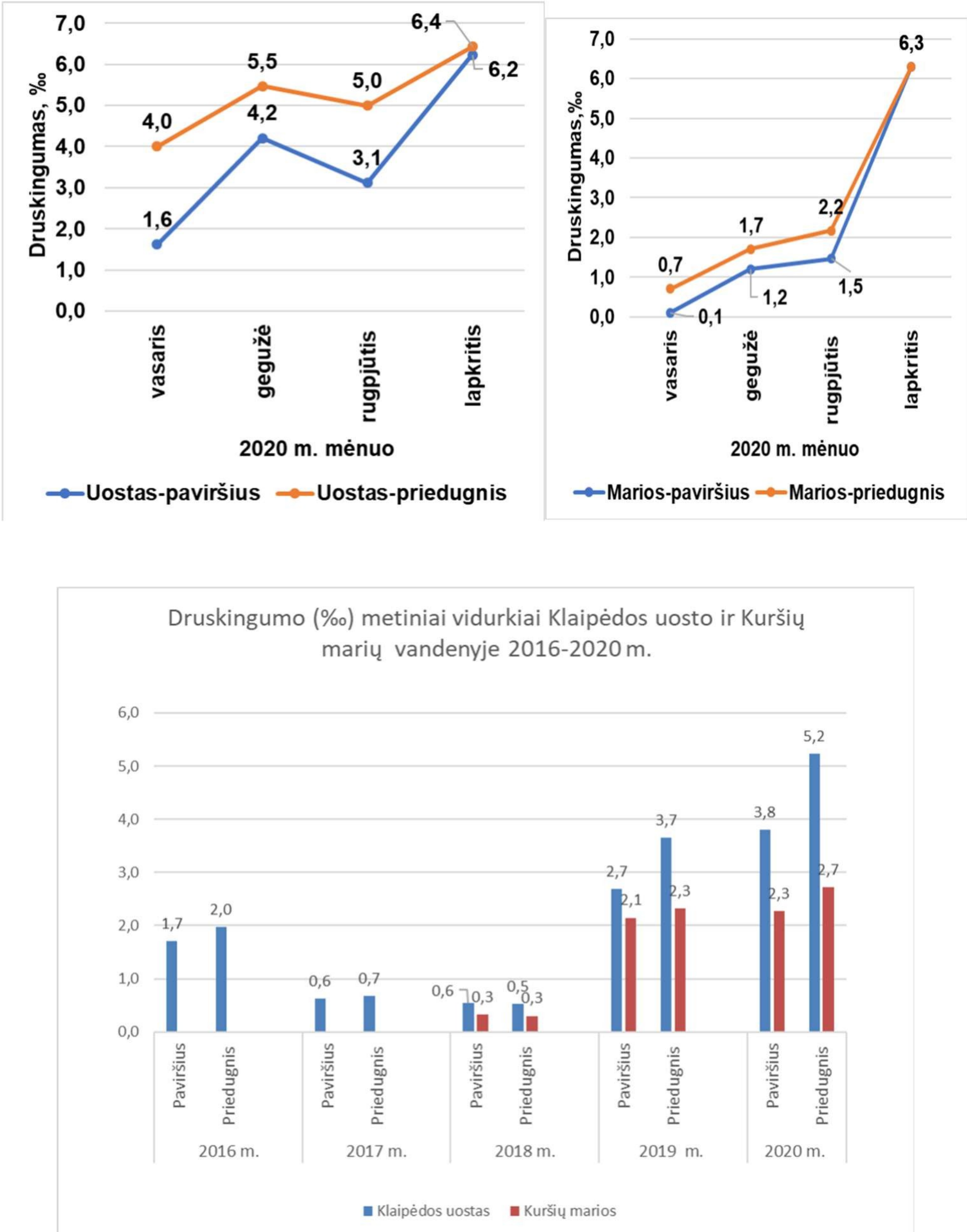
at any station did they reach the limit value for the lowest contamination class (Class I) set for sand (LAND 46A-2002). The concentration of PCBs did not reach the detection limit at any station (Table 5.13), whereas TBA was detected at station J0, but the concentration found was lower than the lowest limit value for sand. Contamination with polyaromatic hydrocarbons, polychlorinated biphenyls and tributyltin was negligible [29].

According to data from granulometric composition studies of bottom sediments carried out in the port's water area in Q2 2022, fine sand predominates in the bottom sediments of the Curonian Lagoon. In the northern part of the Klaipėda Strait, aleuritic sand bottom sediments predominated, whilst sandy silt dominated in the central part of the strait and in the semi-enclosed bays. In the second quarter of 2022, the concentrations of Cu, Pb, Zn, Ni, Cr, Cd, Hg, As in the bottom sediments of the Klaipėda Strait and the Curonian Lagoon did not exceed the limit values set for the lowest contamination classes for sands (Classes I and II) and muds (Class II) (LAND 46A-2002) at any of the monitoring stations, with the exception of: copper (Cu), whose concentration at measurement points B9 (50.9 mg/kg) and B10 (55.3 mg/kg) corresponds to soil contamination class III; and zinc (Zn), whose concentration at measurement point B10 (126.0 mg/kg) also corresponds to soil contamination class III; the concentration of vanadium (V) ranged from 3.7 to 25.0 mg/kg, whilst tin (Sn) varied
in the range of <0.6–0.7 mg/kg. The concentration of petroleum hydrocarbons (PH) in the bottom sediments of the Port of Klaipėda and the Curonian Lagoon ranged from <30 to 162 mg/kg. The highest PH concentration, corresponding to pollution class II for mud, was detected at station B9. In the second quarter of 2022, PAA concentrations in bottom sediments did not reach the limit values set for the lowest contamination classes for sand (Class I) and mud (Class II) (LAND 46A2002) in any case. In the second quarter of 2022, PCB concentrations in bottom sediments did not reach the method detection limit at any station. The concentration of organic tributyltin (TBA) did not reach the limit values set for the lowest contamination classes for sand (Class I) and silt (Class II) (LAND 46A-2002) at stations B2, B8, B14 and B17. Based on the TBA concentrations determined (LAND 46A-2002), the bottom sediments at stations B12 and B16 are classified as soil contamination class II, whilst the bottom sediments analysed at stations B9 and B10 exhibited concentrations exceeding the limit value set for the highest contamination class (0.1 mg/kg dry weight). According to data from granulometric composition analyses of bottom sediments carried out in the second quarter of 2022, fine sand predominates in the Baltic Sea bottom sediments. In the second quarter of 2022, the concentrations of Cu, Pb, Zn, Ni, Cr, Cd, Hg and As in Baltic Sea bottom sediments at all monitoring stations did not exceed the limit values set for the lowest pollution classes for sands (Class I) (LAND 46A-2002). The concentration of petroleum hydrocarbons (PHCs) in Baltic Sea bottom sediments ranged from <30 to 54.5 mg/kg. The highest PHC concentration, corresponding to pollution class II for mud, was detected at station J15. In the second quarter of 2022, PAA concentrations in Baltic Sea bottom sediments were below the limit of detection in all cases and did not reach the limit value for the lowest contamination class (Class I) set for sand (LAND 46A-2002) at any station. PCB concentrations did not reach the detection limit at any station, whilst TBA was detected at station J17; the bottom sediments analysed at this station exhibited concentrations exceeding the limit value set for the highest contamination class (0.1 mg/kg dry weight). Contamination with polyaromatic hydrocarbons and polychlorinated biphenyls is negligible [30].

Water salinity

In 2019, water salinity in the Klaipėda Port and Curonian Lagoon water area ranged from 0.1 to 6.9 ‰. The salinity of the waters of the Port of Klaipėda and the Curonian Lagoon depends on the inflow of saline water from the Baltic Sea and tends to decrease with distance from the port entrance and increase with increasing depth. The lowest inflow of saline water was recorded in winter, whereas in May, saline water had spread throughout the water column in the strait and the Curonian Lagoon [27].

In 2020, salinity in the waters of Klaipėda Port and the Curonian Lagoon ranged from 1.6 to 6.4 ‰. The salinity of the waters in the Port of Klaipėda and the Curonian Lagoon depends on the inflow of saline water from the Baltic Sea and tends to decrease with distance from the port entrance and increase with increasing depth. The lowest saline water inflow was recorded in winter, and the highest in November [28].



4.1.1.13 Fig. Average water salinity during seasonal observations in the surface and bottom water layers of the Klaipėda Port and Curonian Lagoon water areas, and annual salinity averages for 2016–2020 [28]

Measurements taken on 6 August 2021 showed that salinity in the Curonian Lagoon ranged from 1.2 ‰ in the bottom layer at station B19 to 2.2 ‰ in the surface and bottom layers at station B2. The average salinity of the Curonian Lagoon was 1.95 ‰ [29].

On 10 February 2022, salinity in the Curonian Lagoon ranged from 2.0 ‰ at the bottom horizons of stations B7, B8, B13 and B19 and the surface horizons of stations B9 and B10 to 4.8 ‰ at the bottom horizon of station B0. The average salinity of the Curonian Lagoon was 2.44 ‰ [30].

In summary, based on the data on water salinity obtained during the ongoing environmental monitoring, it can be stated that the overall distribution of saline water in the northern part of the Curonian Lagoon is periodic and directly depends on meteorological and hydrodynamic environmental conditions. The observation stations under review show relatively stable periods in terms of changes in water salinity, with peaks typically occurring during the autumn and/or spring seasons. Compared to the start of observations, the monitoring results do not indicate any significant changes in water salinity in the northern part of the Curonian Lagoon outside the port's water area that could be linked to the measures implemented and activities carried out within the port's water area (for more details, see Section 4.1.2).

4.1.2 Expected significant impact

Impact during the construction of the PŪV facilities

During the construction/implementation of the PŪV (dredging of the water area, dredging of part of Kiaulės Nugaros Island, construction and reconstruction of quays and piers, installation of slope stabilisation measures, dredging and disposal of soil, filling of the water area, laying of underwater cables, etc.), the impact on surface water is likely to occur in the following aspects:

- Increased turbidity (due to dredging, drilling, hammering, submergence of excavated soil, and filling of the water area with soil at the project sites).
- Chemical pollution (due to the dispersion of pollutants settled in water bodies and accumulated in silt during dredging/excavation/filling/submerging).

Impact due to increased water turbidity during ongoing works (excavation, drilling, dredging, and the disposal of excavated soil)

The impact of increased water turbidity resulting from the works being carried out (excavation, drilling, hammering, and the dumping and submergence of excavated soil) will be felt throughout the entire duration of the works; however, its distribution will be localised and sporadic, and will depend on the specific location and timing of the works. When discharging soil at the project sites (land reclamation areas) and at soil disposal sites (dumps), the majority of the soil would quickly settle on the seabed at the discharge point, whilst some fine-grained particles would disperse in the water, forming a temporary cloud of suspended matter. This impact would be temporary and would occur only during the dumping of soil. Hydrological and hydrodynamic conditions at the dumping sites, as well as the particle size of the soil being removed, determine the intensity of the dispersion of fine-grained material and the pollutants accumulated within it [19]. The most intense dispersion is characteristic of silty soils. Over time, some fine clay and silt particles may be washed out of the dredged moraine rocks, which may be resuspended. The environmental conditions in the water areas of the PŪV sites in the Curonian Lagoon south of Kiaulės Nugaros Island vary (in terms of depths, current speeds and directions). In the PŪV water area south of Kiaulės Nugaros Island, the prevailing depth is approximately 0.8–2 m; therefore, the dispersion of fine-grained particles in the water during dredging would be very localised.

In the event of the implementation of the PŪV solutions, depending on the PŪV alternative, approximately 11.68–12.3 million $^{m^3}$ of soil would need to be excavated, and depending on the PŪV alternative, approximately 31.5–45.4% would need to be deposited at the PŪV construction sites, with the remainder to be deposited in soil disposal sites (dumps) or used for shoreline management purposes. Likely temporary impacts (local water turbidity, resuspension and transport of sediments, changes to the seabed topography, etc.), which are typical of similar works carried out in the vicinity of dumping sites.

Impact due to chemical pollution

During the implementation of the project solutions, chemical pollution of the water body is possible due to the dispersion of pollutants settled in the water body and accumulated in the silt during dredging/excavation. This situation could occur in those parts of the water area where no dredging works have been carried out to date and where intensive economic activity has taken place. Such water areas include, for example, Malkų Bay and Žiemos Harbour. No dredging is planned in the aforementioned water areas. In the event of dredging, the water area with the highest level of technogenic contamination would be near the LNG terminal and quays Nos. 149–151. Studies carried out in the planned southern port entrance water area beyond Kiaulės Nugaros Island have established that the contamination of the soil and sediments falls within Contamination Class I (i.e. uncontaminated).

When carrying out periodic dredging of the harbour basin seabed to remove accumulated sediments during the operation of the LNG terminal, once the project solutions have been implemented, the soil must be dredged/pumped, discharged and managed/disposed of in accordance with the requirements of the regulatory document LAND 46A-2002 ‘Rules for dredging in sea and seaport water areas and for the management of dredged material’ [16].

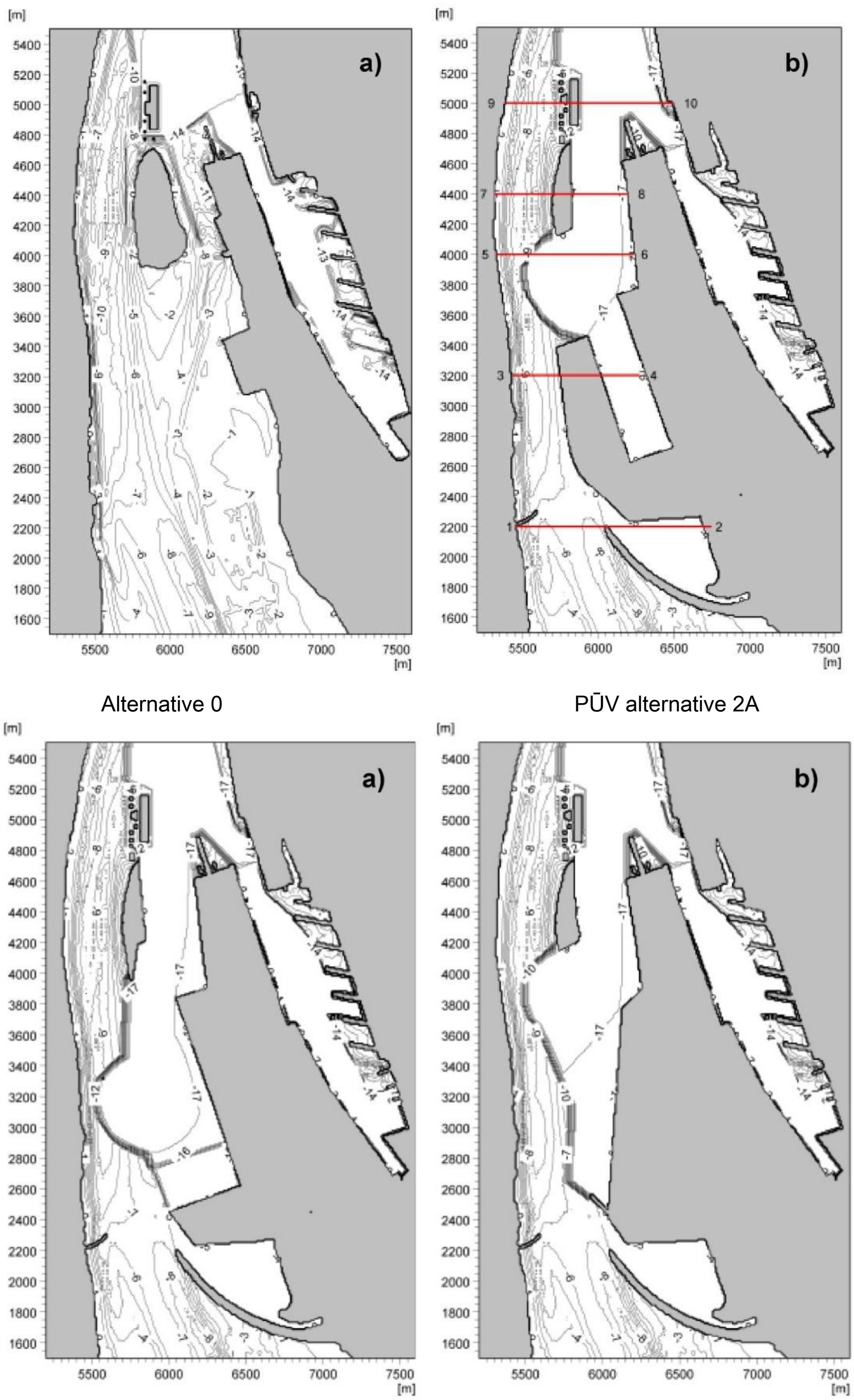
Impact during the operation of the PŪV facilities

The PŪV solutions will have an impact on:

- changes in the hydrodynamic environment;
- changes in the sediment balance (bedload and suspended sediment);
- changes in wave propagation;
- changes in the salinity balance and chemical composition of the water.

Modelling and assessment of hydrodynamic conditions, sediment transport, saltwater dispersion and wave dynamics in the PŪV water area and its surroundings for all PŪV alternatives were carried out by specialists from the Hydrology Laboratory of the Lithuanian Energy Institute [18]. The full assessment report is presented in Textual Annex 3. For modelling the influence of the hydrodynamic regime and ice cover on the flow regime, the HD hydrodynamic model of the MIKE 21 digital modelling system, developed by the Danish Hydraulic Institute [18], was used; The MIKE 21 ST (sediment transport) and MD (suspended sediment transport) models were used to model changes in sediment flow and balance [18]. The MIKE 21 BW (Boussinesq Wave Module) wave model (MIKE 21..., 2012), whilst the characteristics of saltwater dispersion were modelled and assessed using the MIKE 21 AD (advection–dispersion) model.

It should be noted that all the aforementioned simulations were carried out for three PŪV alternatives (alternatives 2A, 3A and 4A) in comparison with Alternative 0 (Fig. 4.1.2.1).



Alternative 0 | PŪV alternative 2A

PŪV alternative 3A | PŪV alternative 4A

4.1.2.1 Fig. Modelled PŪV alternatives and assessment sections

Changes in the hydrodynamic environment

Changes in the flow capacity of the Klaipėda Strait

The assessment of changes in the flow capacity of the Klaipėda Strait was carried out by LEI specialists [25]. Changes in the flow capacity of the Klaipėda Strait were determined by comparing the current state of the Klaipėda Strait and the northern part of the Curonian Lagoon within the KVJU boundaries (Alternative 0) with the planned state. Water flows in the Klaipėda Strait were calculated for all alternatives, where the flow runs from the Curonian Lagoon to the Baltic Sea and from the Baltic Sea to the Curonian Lagoon. Select three water level differences□ h between the Curonian Lagoon and the Baltic Sea based on the boundary conditions of the hydrodynamic model (0.11 m, 0.29 m, and 0.64 m). With these level differences, flows of 1,620, 2,700 and 4,210 m³/s will pass through the strait, respectively, according to Alternative 0. When the flow is in the opposite direction, from the Baltic Sea to the Curonian Lagoon, and the level differences are 0.15 m and 0.66 m, the flow rates through the strait will be 1,725 and 3,206 m³/s, respectively, according to Alternative 0.

The flow rates in the Klaipėda Strait have been selected taking into account the objectives to be achieved and the tasks to be solved. When the flow is directed from the Curonian Lagoon to the Baltic Sea, a flow rate of 2,700 m³/s characterises marginal navigation conditions. The maximum flow rate of 4,200 m³/s occurs less than once every 100 years and is used to assess the channel’s resistance to erosion processes.

4.1.2.1 The comparison of PŪV alternatives presented in the table shows the greatest changes in the capacity of the Klaipėda Strait.

4.1.2.1 Table. Comparison of the Klaipėda Strait’s flow capacity according to the PŪV alternatives

Current status and PŪV alternative	Capacity of the Klaipėda Strait when the difference in water levels between the Curonian Lagoon and the Baltic Sea is		
	0.11 m	0.29 m	0.64 m
0	1620	2700	4210
2A	1470 -9.3	2432 -10.0	3754 -10.8
3A	1808 11.6	3008 11.4	4657 10.6
4A	1730 6.8	2854 5.7	4414 4.8
	The flow rate through the Klaipėda Strait when the difference in water levels between the Baltic Sea and the Curonian Lagoon is		
	0.15 m	0.66 m	
0	1725	3206	
2A	1668 -3.3	3125 -2.5	
3A	1953 13.2	3622 13.0	
4A	1923 11.5	3570 11.3	

Note: (numerator – strait flow capacity in m³/s, denominator – increase/decrease in flow capacity in %, compared to Alternative 0

Implementation of the PŪV solutions under Alternative 2A would significantly reduce the strait’s flow capacity (from -9.3% to -10.8% when the flow is from the Curonian Lagoon to the Baltic Sea, and from -2.5% to -3.3% when the flow is from the sea to the lagoon) compared to Alternative 0. The flow capacity is significantly reduced due to the narrowing of the waterway between the planned land reclamation area and the coast of the Curonian Spit.

Implementing the solutions under Alternative 3A would significantly increase the flow capacity of the Klaipėda Strait compared to the current situation. With varying water flows from the Curonian Lagoon to the Baltic Sea, the change in throughput compared to Alternative 0 would be 10.6 to 11.6% higher, whilst with flows from the Baltic Sea to the Curonian Lagoon, this change would range from 13.0 to 13.2%. This increase in the change in flow capacity is due to the significant deepening of the Curonian Lagoon water area upstream of the planned southern port gates to Kiaulės Nugaros Island and the deepening of the eastern channel adjacent to it to 17 m.

The solutions under Alternative 4A are intermediate between Alternatives 2A and 3A, as the planned land configuration opens up a wider channel for the current towards the planned southern port gates and Kiaulės Nugaros Island than under Alternative 2A. Also, under Alternative 4A, a 17-metre-deep vessel turning area would be located closer to Kiaulės Nugaros Island compared to Alternative 3A. Upon implementation of the PŪV solutions under Alternative 4A, changes in the Klaipėda Strait's capacity would be smaller compared to Alternative 3A. When the current flows from the Curonian Lagoon to the Baltic Sea, the capacity, at different flow rates, would be 4.8–5.9% higher compared to Alternative 0, and when the current flows from the sea to the lagoon, it would increase from 11.3% to 11.5%.

Conclusion:

- Upon implementation of the solutions of Alternative 2A of the PŪV, the flow capacity of the Klaipėda Strait will decrease significantly compared to Alternative 0 (from -9.3% to -10.8% when the flow is from the Curonian Lagoon to the Baltic Sea and from -2.5% to -3.3% when the flow is from the sea to the lagoon). The flow capacity will decrease due to the narrowing of the waterway between the planned southern gates of the ports and the newly formed land.
- In the case of Alternative 3A, the strait's capacity will increase significantly compared to Alternative 0 (10.6–11.6% when the flow is from the lagoon to the sea and 13.0–13.2% when the flow is from the sea to the lagoon). This increase in capacity is due to the significant deepening of the Curonian Lagoon water area upstream of the planned southern port gates towards Kiaulės Nugaros Island and the deepening of the eastern channel near Kiaulės Nugaros Island to 17 m. The solutions in Alternative 4A are intermediate between Alternatives 2A and 3A. In the case of this Alternative, when the current flows from the lagoon to the sea, the flow capacity would increase by 4.8–5.9%, and when the current flows from the sea to the lagoon – by 11.3–11.5%, compared to Alternative 0.

Changes in flow velocities within the KVJU boundaries of the flow structures in the Klaipėda Strait and the northern part of the Curonian Lagoon

Flow structures in the Klaipėda Strait and the northern part of the Curonian Lagoon within the KVJU boundaries, modelled for all analysed PŪV alternatives, with outflows of 1620, 2,700 and 4,210 m³/s from the Curonian Lagoon to the Baltic Sea, and 1,725 and 3,206 m³/s from the Baltic Sea to the Curonian Lagoon.

With different discharge rates from the lagoon to the sea (and vice versa), a similar flow structure is formed for PŪV alternatives A, B and C, with only the absolute values of the flow velocities differing.

With discharge rates of 1,620, 2,700 and 4,210 m³/s from the Curonian Lagoon to the Baltic Sea under Alternative 0 (Figures 4.1.2.2 a), Figs. 4.1.2.4 a) and 4.1.2.6 a)), a significant increase in flow velocities is observed in the western channel of Kiaulės Nugaros Island and in the water area off the coast of the Curonian Spit to the south of Kiaulės Nugaros Island. Only the values of the flow velocities differ: at a flow rate of 1,620 m³/s in the strait, flow velocities in the Curonian Lagoon will not exceed 0.55 m/s; at 2,700 m³/s – 0.90 m/s; and at 4,200 m³/s – 1.3 m/s. At flow rates of 1,725 and 3,206 m³/s from the Baltic Sea into the Curonian Lagoon under Alternative 0 (Figs. 5.7a and 5.9a), an increase in flow velocities has also been observed in the western and eastern channels of Kiaulės Nugaros Island and in the water area off the Curonian Spit coast south of Kiaulės Nugaros Island. With a flow rate of 1725 m³/s in the strait, flow velocities will not exceed 0.6 m/s, and with a flow rate of 3206 m³/s – 1.1 m/s.

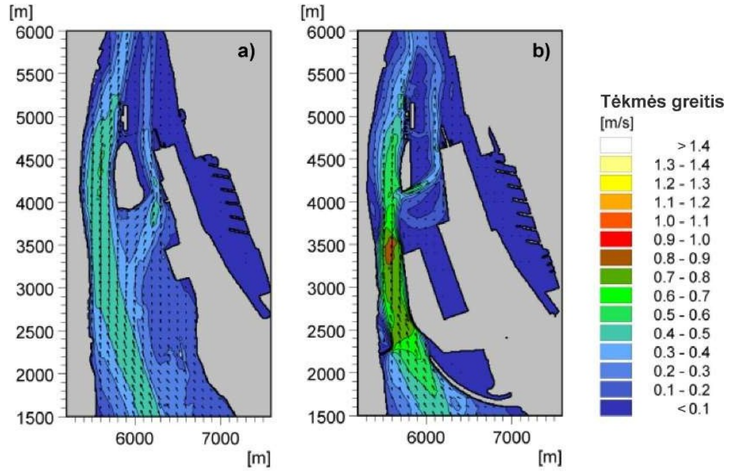
Figs. 4.1.2.4–4.1.2.5 provide a detailed comparison of the flow velocity distributions for the different alternatives at a discharge of 2700 m³/s from the lagoon to the sea. A comparison of Alternative 2A with Alternative 0 revealed that in the northern part of the lagoon, following the construction of the previously planned southern harbour gates and the extension of the inner navigation channel between the reclaimed land and the coast of the Curonian Spit, flow velocities will increase significantly in the water area off the Curonian Spit coast from the southern gates to Kiaulės Nugaros Island and in the western channel (Fig. 4.1.2.4 b). Bottom erosion is possible between the planned southern port gates and the Curonian Spit coast. In the newly planned vessel turning area in the water area near Kiaulės Nugaros Island, low-velocity eddy currents will be observed, which could lead to sediment accumulation processes.

Upon implementation of the solutions under Alternative 3A, current velocities will also increase significantly compared to Alternative 0 in the water area from the planned southern port gates towards Kiaulės Nugaros Island (over a stretch of approximately 0.6 km) and in the eastern channel. In the newly planned vessel turning areas in the water area, located 0.6–1.2 km from the planned southern port gates towards Kiaulės Nugaros Island, a reduction in flow velocities and turbulent flow patterns will be observed, which could create additional areas of sediment accumulation in the aforementioned water area.

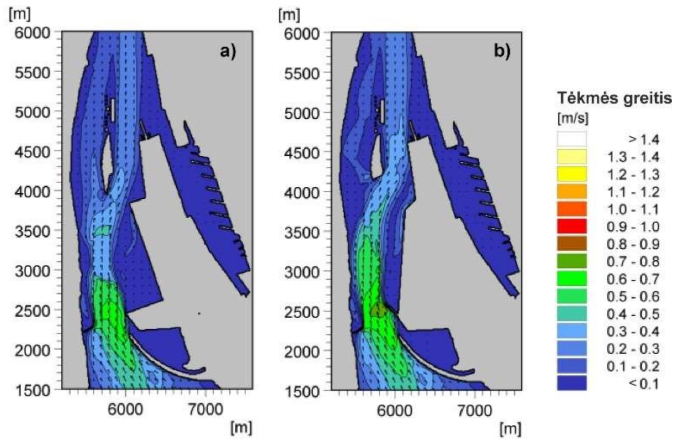
When comparing Alternatives 4A and 0, the nature of the current velocity distribution is similar to that of Alternative 3A. Current velocities, when comparing Alternative 4A with Alternative 0, will also increase significantly in a larger area of the waterway from the planned southern port gates towards Kiaulės Nugaros Island (over a stretch of approximately 1.2 km) and in the eastern channel. In the newly planned turning area for vessels within the water area, located near Kiaulės Nugaros Island towards the planned southern port gates, a reduction in current speeds and eddy flow will be observed. Sediment accumulation processes could occur in this water area.

We will compare the changes in flow in more detail across the alternatives, assuming a flow from the Baltic Sea into the Curonian Lagoon and a flow rate of 1,725 m³/s through the strait (Figures 4.1.2.8 – 4.1.2.9). When comparing all three alternatives with Alternative 0, similar trends in changes in flow velocity were observed in the LNG terminal water area and in the channels of Kiaulės Nugaros Island. Current velocities will be higher in the eastern channel due to its dredging to a depth of 17 m. The distribution of current velocities from Kiaulės Nugaros Island towards the planned southern port gates depends on the location of the vessel turning area. In these areas, under Alternatives 2A, 3A and 4A, current speeds could increase by up to 0.4 m/s. The greatest changes in current speeds are possible in the water area of the planned southern port gates. A comparison of Alternative 2A with Alternative 0 has shown that in the northern part of the Curonian Lagoon, following the construction of the southern port gates and the creation of a channel between the reclaimed land and the Curonian Spit coastline, current velocities will increase significantly in a 2 km long water area from the planned southern port entrance towards Kiaulės Nugaros Island (Fig. 4.1.2.8b). Under Alternatives 3A and 4A, the area of increased flow velocities will be significantly more localised, covering the area between the planned southern port gate piers and the environmental protection dyke at Alksnynas near the Curonian Spit coast (Fig. 4.1.2.9). A significant increase in current velocities between the planned southern port gates and the Curonian Spit coast may cause seabed erosion in the aforementioned water area.

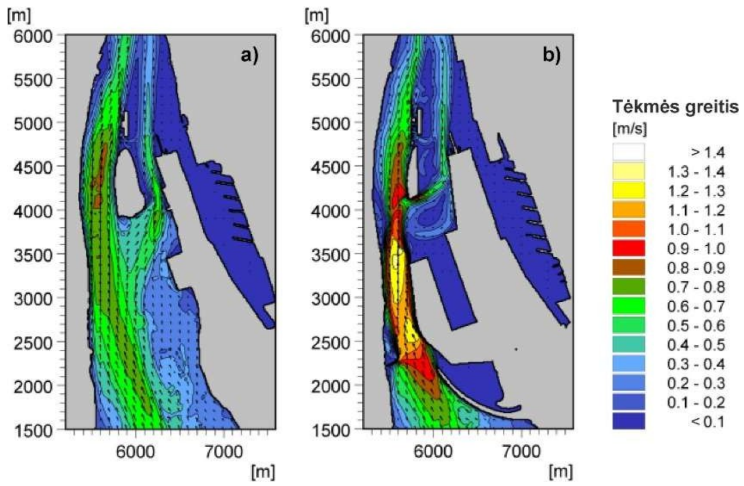
Changes in the depth of the Klaipėda Port water area and environmental protection measures for the analysed PŪV alternatives alter the distribution of flow velocities in the cross-sections of the Curonian Lagoon and the strait. The distribution of flow velocities was investigated in more detail in 5 cross-sections, where the cross-sections differ significantly depending on the studied PŪV alternatives (Fig. 4.1.2.1). Cross-sections 1–2 of the port water area, located near the southern breakwater of the planned southern port entrance, were selected for analysis. The other cross-sections selected are: cross-sections 3–4, located 1 km from the planned southern port gates towards Kiaulės Nugaros Island; Cross-section 5-6 near Kiaulės Nugaros Island; cross-section 7-8 through the western and eastern channels of Kiaulės Nugaros Island; and cross-section 9-10 in the LNG terminal water area in the Klaipėda Strait. In all cross-sections, flow velocities calculated for the three PŪV solution alternatives and compared with flow velocities according to Alternative 0.



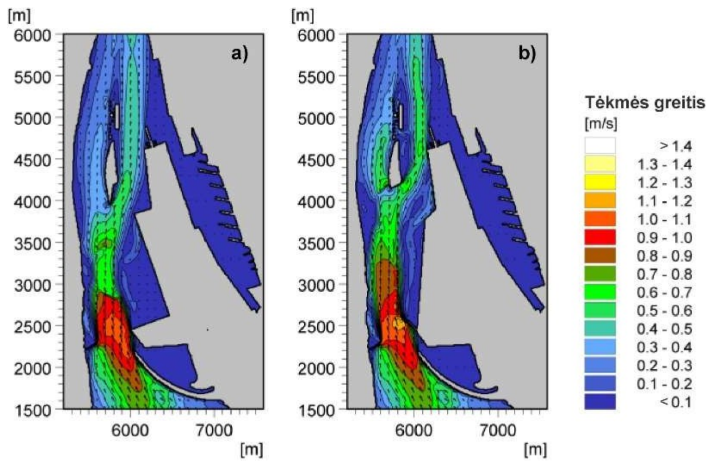
4.1.2.2 Fig. Flow structure in the Klaipėda Port water area for Alternatives 0 (a) and 2A (b), with a flow rate of 1,620 m³/s from the Curonian Lagoon to the Baltic Sea through the strait



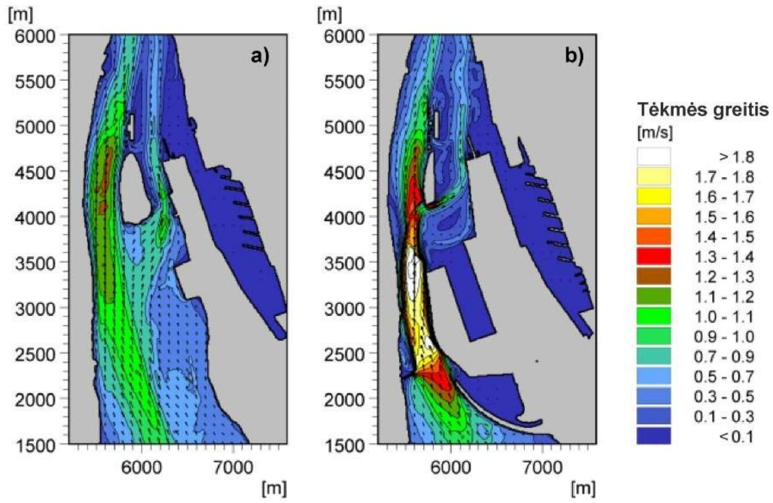
4.1.2.3 Fig. Flow pattern in the Klaipėda Port basin for alternatives 3A (a) and 4A (b), with a flow rate of 1,620 m³/s through the narrows from the Curonian Lagoon to the Baltic Sea



4.1.2.4 Fig. Flow structure in the Klaipėda Port basin for Alternatives 0 (a) and 2A (b), with a flow rate of 2,700 m³/s through the strait from the Curonian Lagoon to the Baltic Sea

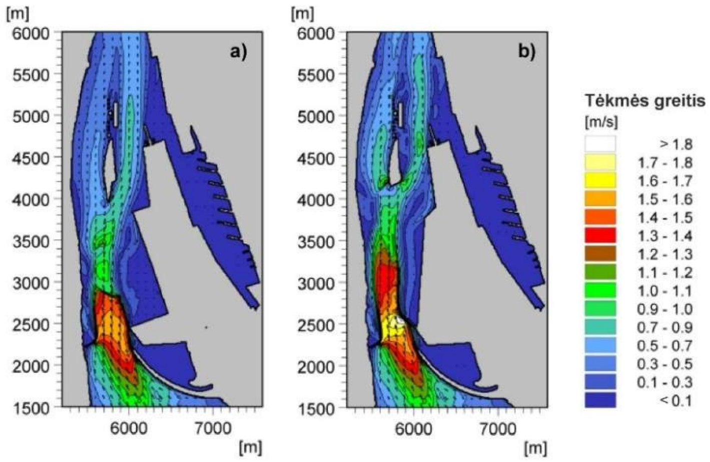


4.1.2.5 Fig. Flow structure in the Klaipėda Port water area for Alternatives 3A (a) and 4A (b), when a flow rate of 2700 m³/s flows through the strait from the Curonian Lagoon into the

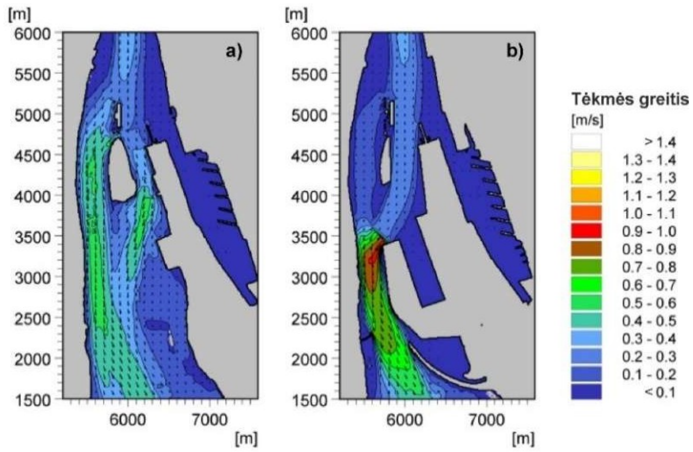


Baltic Sea

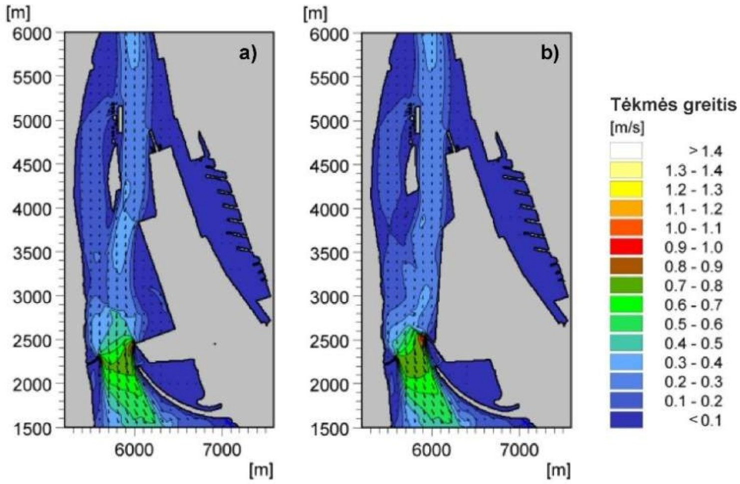
4.1.2.6 Fig. Flow structure in the Klaipėda Port water area for Alternatives 0 (a) and 2A (b), when a flow rate of 4,210 m³/s flows through the strait from the Curonian Lagoon into the Baltic Sea



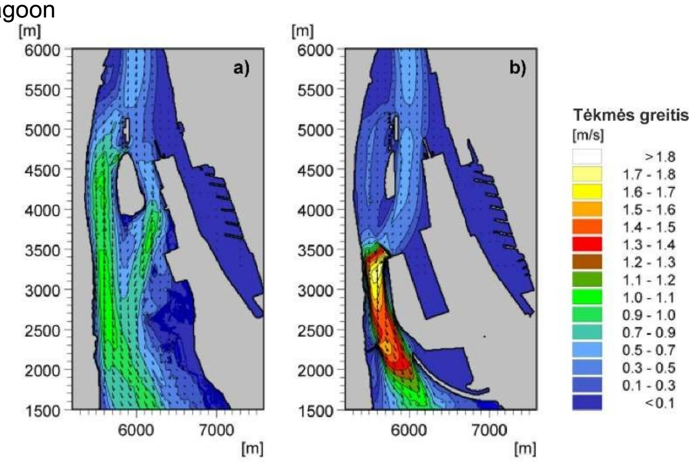
4.1.2.7 Fig. Flow structure in the Klaipėda Port water area for Alternatives 3A (a) and 4A (b), when a flow rate of 4,210 m³/s flows through the strait from the Curonian Lagoon into the Baltic Sea



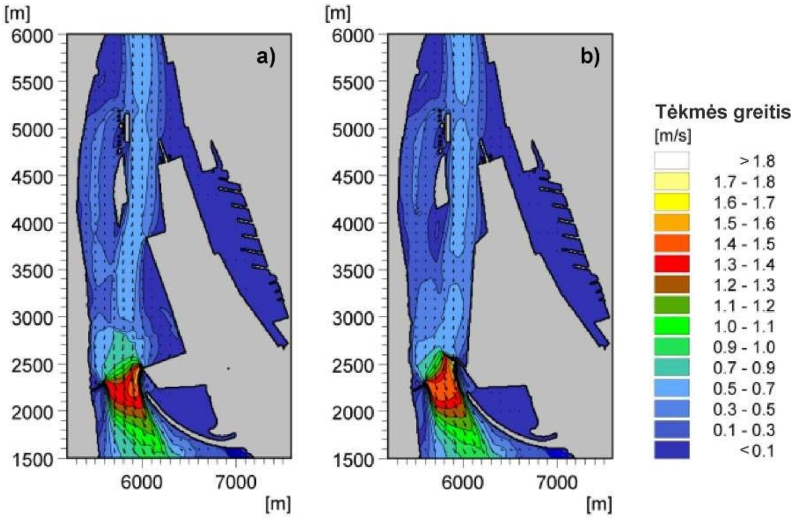
4.1.2.8 Fig. Flow structure in the Klaipėda Port water area for Alternatives 0 (a) and 2A (b), when a flow rate of 1725 m^3/s flows through the strait from the Baltic Sea into the Curonian Lagoon



4.1.2.9 Fig. Flow structure of the Klaipėda Port water area for Alternatives 3A (a) and 4A (b), when a flow rate of 1725 m^3/s flows through the strait from the Baltic Sea into the Curonian Lagoon



4.1.2.10 Fig. Flow structure in the Klaipėda Port water area for Alternatives 0 (a) and 2A (b), when a flow rate of 3206 m^3/s flows through the strait from the Baltic Sea into the Curonian Lagoon



4.1.2.11 Fig. Flow structure in the Klaipėda Port water area for Alternatives 3A (a) and 4A (b), when a flow rate of 3206 m³/s flows through the strait from the Baltic Sea into the Curonian Lagoon

With flow rates of 1620, 2700 and 4210 m³/s from the Curonian Lagoon into the Baltic Sea, an increase in flow velocities is observed (up to 43%, Fig. 4.1.2.16 a)) in cross-sections 1–2, when comparing all the alternatives under consideration with Alternative 0 (Figs. 4.1.2.12 a), 4.1.2.14 a) and 4.1.2.16 a)). This is due to the narrowing of the cross-section caused by the construction of the southern port gates and the environmental protection dyke near Alksnyne on the Curonian Spit coast. In the 1-2 cross-section section near the Curonian Spit coast, low flow velocities are observed for all PŪV alternatives, as this is determined by the construction of the environmental protection dam at Alksnyne.

In cross-section 3-4, located 1 km from cross-section 1-2 towards Kiaulės Nugaros Island, flow velocities are compared across all PŪV alternatives (Figs. 4.1.2.12 b), 4.1.2.14 b) and 4.1.2.16 b)). The greatest increase in flow velocity was observed when comparing Alternative 2A with Alternative 0 (up to 68%, Fig. 4.1.2.16 5b), as a narrow channel has formed here between the new land and the coast of the Curonian Spit. Under Alternative 3A, a possible reduction in flow velocities is observed across the entire cross-section compared to Alternative 0. This is due to the significant deepening of the waterway to accommodate a turning basin. In the case of Alternative 4A, an increase in flow velocity is observed (up to 25%, Fig. 5.11b), as part of the waterway will be deepened to 16.5 m.

Cross-section 5-6 is across Kiaulės Nugaros Island and the channel adjacent to it. In this cross-section, the highest flow velocities are recorded at the eastern channel in the case of Alternative 2A (ranging from 0.58 m/s to 1.42 m/s depending on the flow rate) (Figs. 4.1.2.13a, 4.1.2.15a and 4.1.2.17a). At the western channel, flow velocities would decrease for this PŪV alternative, as the waterway will be deepened to 17 m. In the case of Alternatives 3A and 4A, higher flow velocities are observed towards the western channel. This is due to the planned turning basin, which is located closer to the planned southern port gates than to Kiaulės Nugaros Island. In the aforementioned PŪV alternatives, the current velocities in the cross-section would be lower than those in Alternative 0.

In cross-section 7–8, which covers the western and eastern channels, a redistribution of flow velocities is observed when comparing Alternatives 2A, 3A and 4A with Alternative 0 (Figs. 4.1.2.13b, 4.1.2.15b and 4.1.2.17b). The flow velocity values are most similar when comparing Alternative 2A with Alternative 0. Only in the case of Alternative 2A is an increase in flow velocity observed in the eastern channel near Kiaulės nugara Island. This could pose a risk of erosion in the aforementioned water area. In the case of Alternatives 3A and 4A, there will be a significant redistribution of current velocities in the western channel compared to Alternative 0. At a distance of approximately 250 m from

Kiaulės nugara Island towards the quays of Klaipėda Port, the increase in flow velocities (particularly under Alternative 3A) may cause additional erosion hotspots near Kiaulės nugara Island.

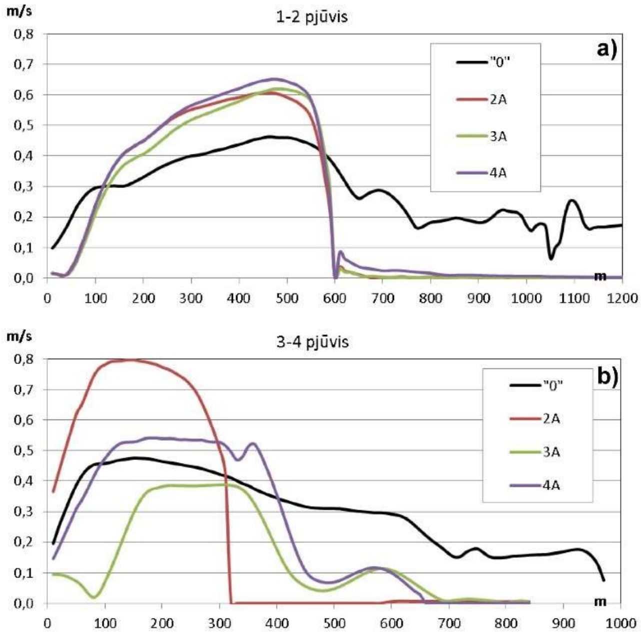
In cross-sections 9–10, which cross the LNG terminal's water area, a similar distribution of flow velocities was observed when comparing Alternative 2A with Alternative 0 (Figs. 4.1.2.13c, 4.1.2.15c and 4.1.2.17c). However, in the case of Alternatives 3A and 4A, flow velocities will decrease in the water area from the LNG terminal towards the Curonian Spit coast and increase in the water area from the LNG terminal towards the quays of the Port of Klaipėda. This could lead to a redistribution of sediment flow in the LNG terminal water area.

With discharge rates of 1,700 and 3,100 m³/s from the Baltic Sea into the Curonian Lagoon, a similar distribution of flow velocities will be observed in sections 9–10, 7–8 and 5–6 for all Alternatives 2A, 3A and 4A (Figs. 4.1.2.19 and 4.1.2.21). The flow velocities for all PŪV alternatives differ from those of Alternative 0. The observed differences in flow velocities result from the deepening of the Klaipėda Strait water area to 17 m when comparing Alternatives 2A, 3A and 4A with Alternative 0. In cross-section 3-4, located 1 km from the planned southern port gates, the influence of each PŪV alternative's design on changes in current velocities would be noticeable (Fig. 4.1.2.18b, Fig. 4.1.2.20b). In this cross-section, a particularly large increase in flow velocities (up to 88%) is observed in the western channel compared to Alternative 2A versus Alternative 0. In the case of Alternatives 3A and 4A, flow velocities will be lower than in Alternative 0 across almost the entire cross-section.

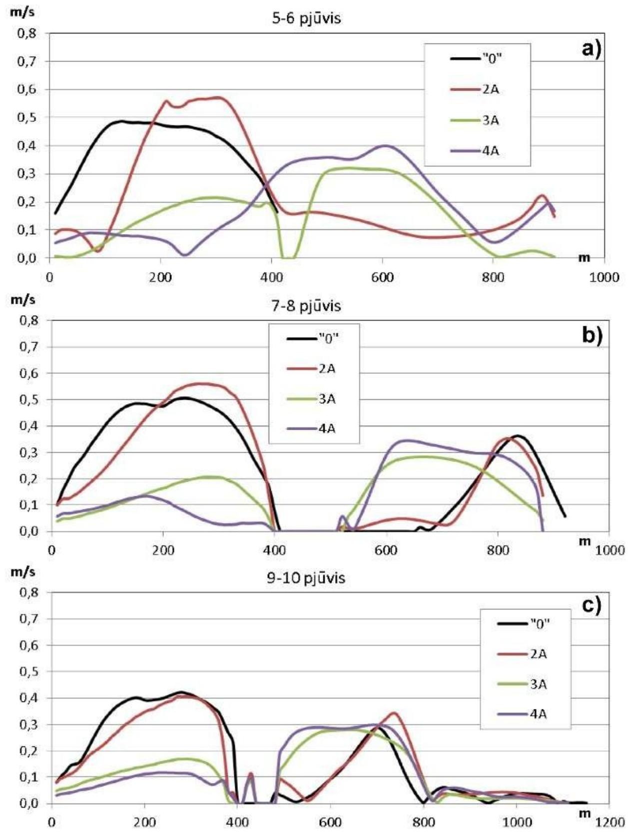
In cross-section 1-2, located at the planned southern port entrance, flow velocities will increase in the water area between the planned southern entrance pier and the environmental protection dam at Alksnyne near the Curonian Spit coast (Fig. 4.1.2.18a, Fig. 4.1.2.20a) when comparing Alternatives 2A, 3A and 4A with Alternative 0. The maximum increase in flow velocities may be 45–56% depending on the flow rate. Such a significant increase in flow velocity would be caused by the narrowing of the waterway cross-section due to the planned construction of the southern gates and the environmental protection dam at Alksnyne on the coast of the Curonian Spit.

Conclusion:

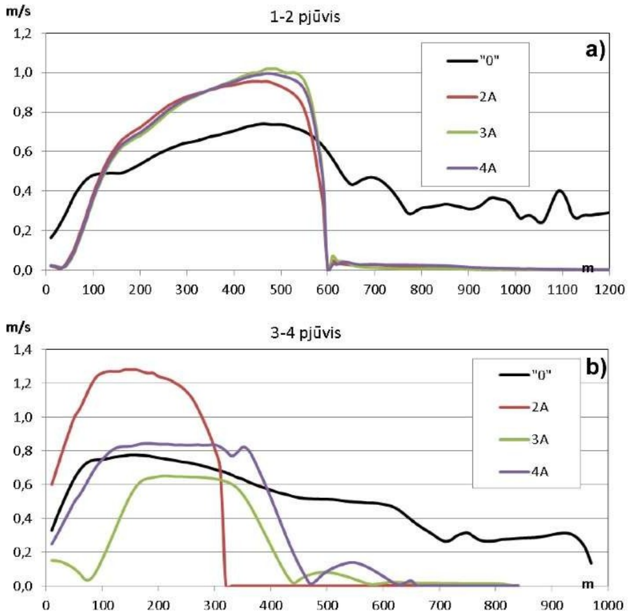
- When the current flows from the Curonian Lagoon into the Baltic Sea, in the case of Alternative 2A, current velocities will increase in the water area off the Curonian Spit coast from the planned southern port gates to the western channel of Kiaulės Nugaros Island and in the western channel, compared to Alternative 0. This will cause seabed erosion between the planned southern port gates and the Curonian Spit coast.
- Upon implementation of the solutions under Alternatives 3A and 4A, current velocities will also increase significantly compared to Alternative 0 in the water area from the planned southern port gates towards Kiaulės Nugaros Island (in 0.6 and 1.2 km long sections, respectively) and in the eastern channel. A reduction in flow velocities and eddy flow will be observed at the planned vessel turning areas. This will create additional areas for sediment accumulation in the aforementioned water area.



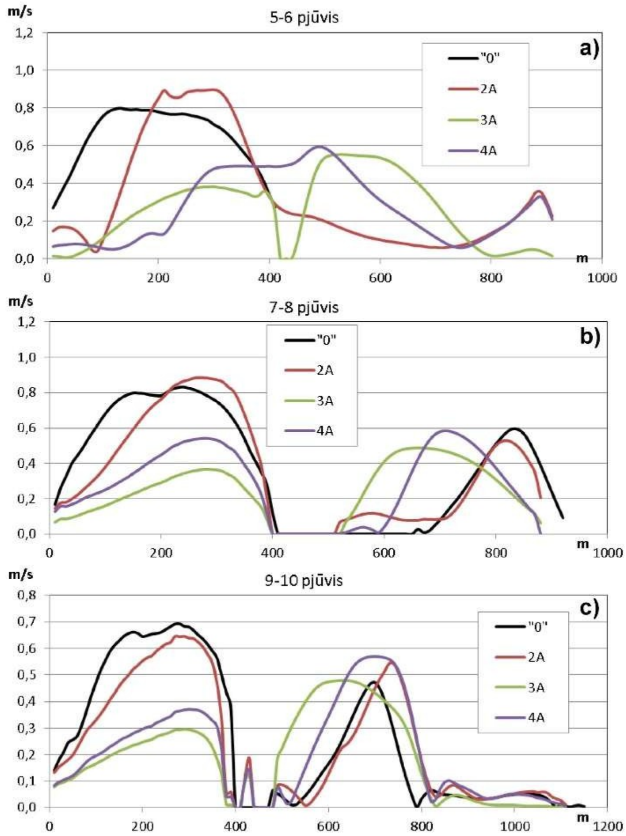
4.1.2.12 Fig. Distribution of flow velocities when a flow rate of 1620 m³/s flows through the strait from the Curonian Lagoon to the Baltic Sea: a) cross-section 1–2 (Fig. 1b), b) cross-section 3–4



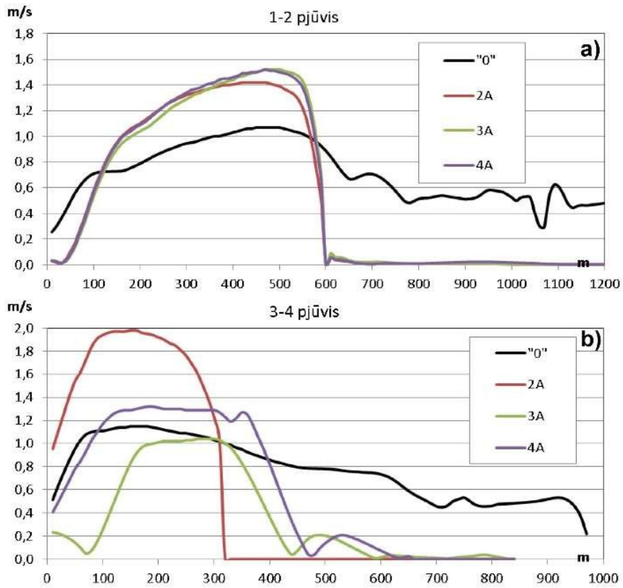
4.1.2.13 Fig. Distribution of flow velocities when a discharge of 1620 m³/s flows through the strait from the Curonian Lagoon into the Baltic Sea: a) cross-sections 5–6 (Fig. 1b), b) cross-sections 7–8, c) cross-sections 9–10



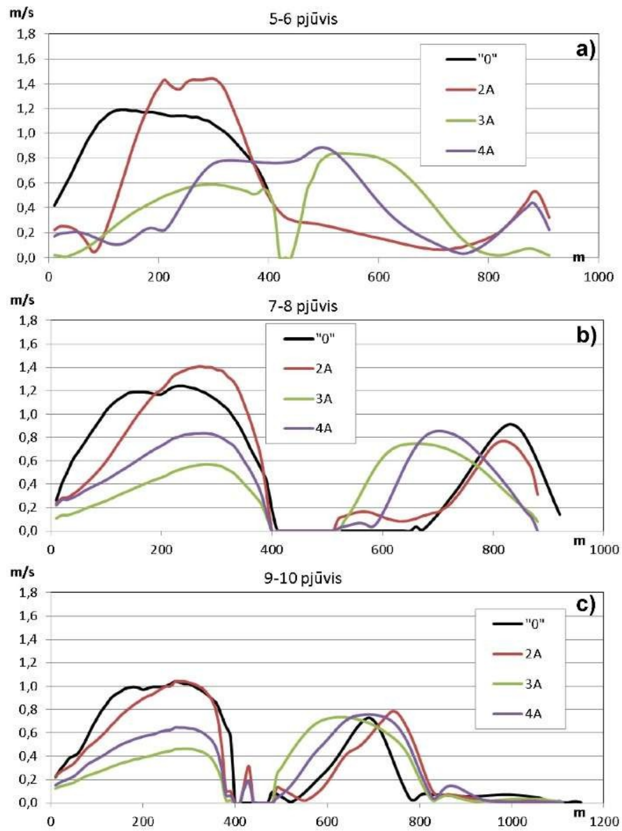
4.1.2.14 Fig. Distribution of flow velocities when a discharge of 2700 m³/s flows through the strait from the Curonian Lagoon into the Baltic Sea: a) cross-sections 1–2 (Fig. 1b), b) cross-sections 3–4



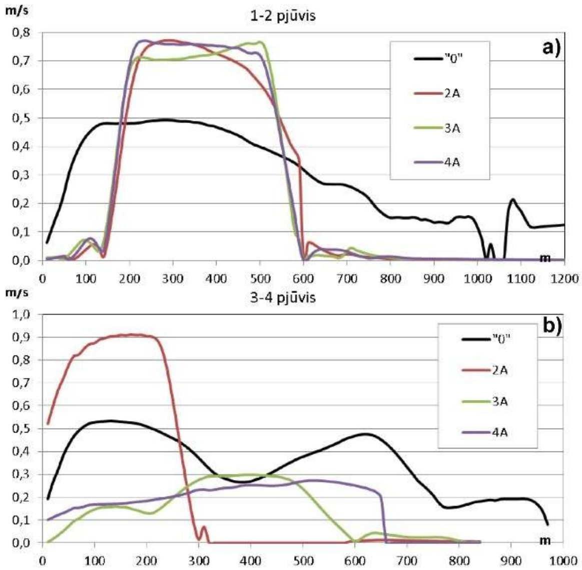
4.1.2.15 Fig. Distribution of flow velocities when a discharge of 2700 m³/s flows through the strait from the Curonian Lagoon into the Baltic Sea: a) cross-sections 5–6 (Fig. 1b), b) cross-sections 7–8, c) cross-sections 9–10



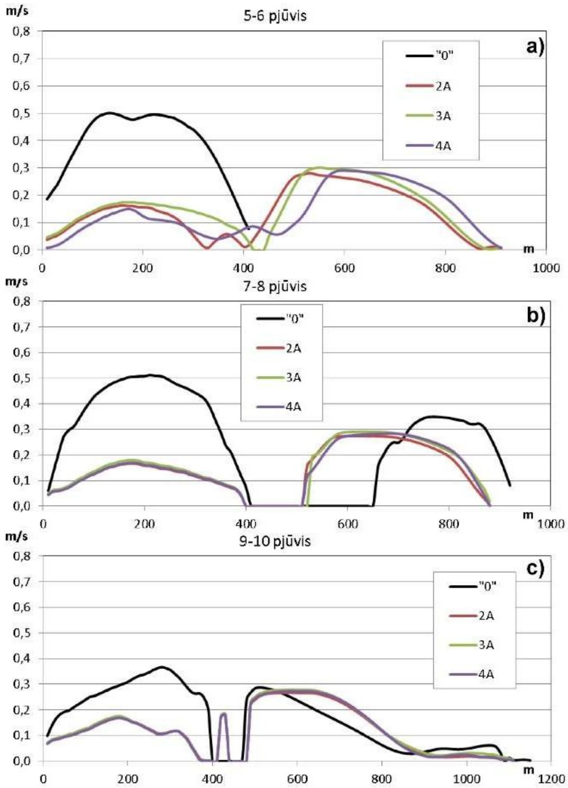
4.1.2.16 Fig. Distribution of flow velocities when a discharge of 4210 m³/s flows through the strait from the Curonian Lagoon into the Baltic Sea: a) cross-section 1–2 (Fig. 1b), b) cross-section 3–4



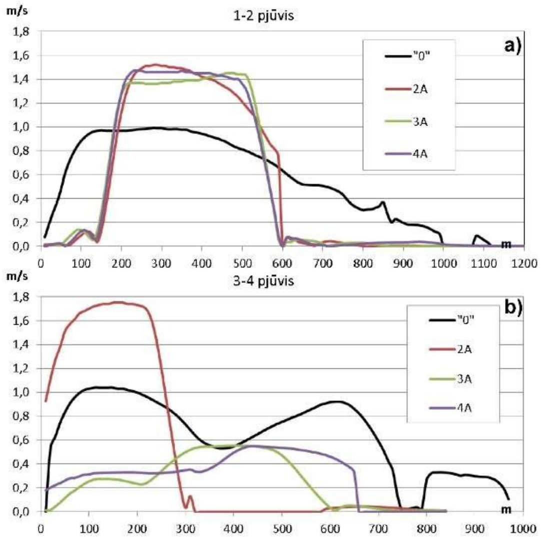
4.1.2.17 Fig. Distribution of flow velocities when a discharge of 4210 m³/s flows through the strait from the Curonian Lagoon into the Baltic Sea: a) cross-sections 5–6 (Fig. 1b), b) cross-sections 7–8, c) cross-sections 9–10



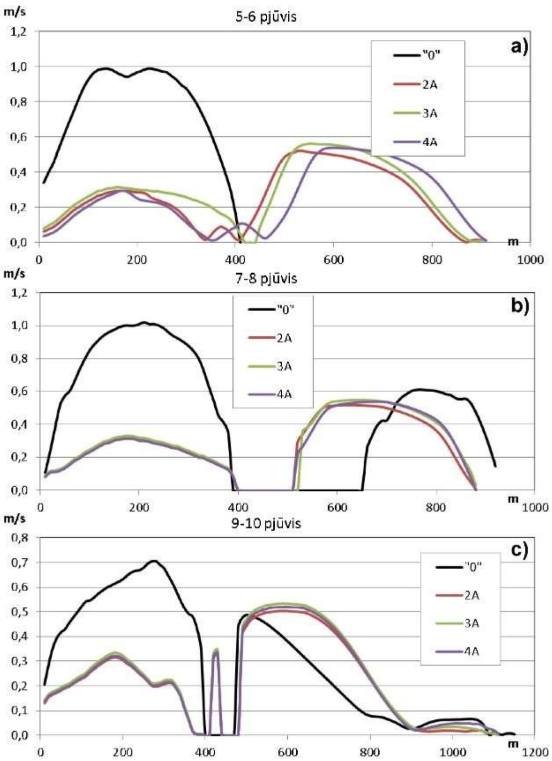
4.1.2.18 Fig. Distribution of flow velocities when a discharge of 1725 m³/s flows through the strait from the Baltic Sea into the Curonian Lagoon: a) cross-sections 1–2 (Fig. 1b), b) cross-sections 3–4



4.1.2.19 Fig. Distribution of flow velocities when a discharge of 1725 m³/s flows through the strait from the Baltic Sea into the Curonian Lagoon: a) cross-sections 5–6 (Fig. 1b), b) cross-sections 7–8, c) cross-sections 9–10



4.1.2.20 Fig. Distribution of flow velocities when a discharge of 3206 m³/s flows through the strait from the Baltic Sea into the Curonian Lagoon: a) cross-sections 1–2 (Fig. 1b), b) cross-sections 3–4



4.1.2.21 Fig. Distribution of flow velocities when a discharge of 3206 m³/s flows through the strait from the Baltic Sea into the Curonian Lagoon: a) cross-sections 5–6 (Fig. 1b), b) cross-sections 7–8, c) cross-sections 9–10

Changes in bedload (sand) transport in the Klaipėda Strait and the northern part of the Curonian Lagoon

Changes in sand transport in the Klaipėda Strait and the northern part of the Curonian Lagoon were modelled by LEI specialists. Sediment (sand) transport flows in the Klaipėda Strait were modelled for two flow regimes: a) from the Curonian Lagoon to the Baltic Sea, b) from the Baltic Sea to the Curonian Lagoon. The distribution of sediment in the strait is reflected by the unit sediment discharge (m³/year/m) characteristic. For the flow towards the Baltic Sea, unit sediment discharges were calculated for water flows of 1620, 2700 and 4210 m³/s through the strait. For the flow towards the Curonian Lagoon, modelling was carried out for water flows of 1725 and

3,206 m³/s flow rates through the strait. The distribution of unit sediment discharge was calculated for Alternative 0 and the PŪV alternatives (Figs. 4.1.2.22–4.1.2.31).

When the flow passes through the strait from the Curonian Lagoon to the Baltic Sea (Figs. 4.1.2.22–4.1.2.27), in the case of Alternative 0, high unit sediment discharges were identified in the western channel of Kiaulės Nugaros Island and in the 1–2 km stretch south of Kiaulės Nugaros Island (Figs. 4.1.2.22a, 4.1.2.24a and 4.1.2.26a). In the case of Alternative 2A, the highest unit sediment discharges were identified between the land to be reclaimed by expanding the port area and the coast of the Curonian Spit (Figs. 4.1.2.22b, 4.1.2.24b and 4.1.2.26b). As it continues to decrease, the sediment flow will move towards the western channel of Kiaulės Nugaros Island and the western channel.

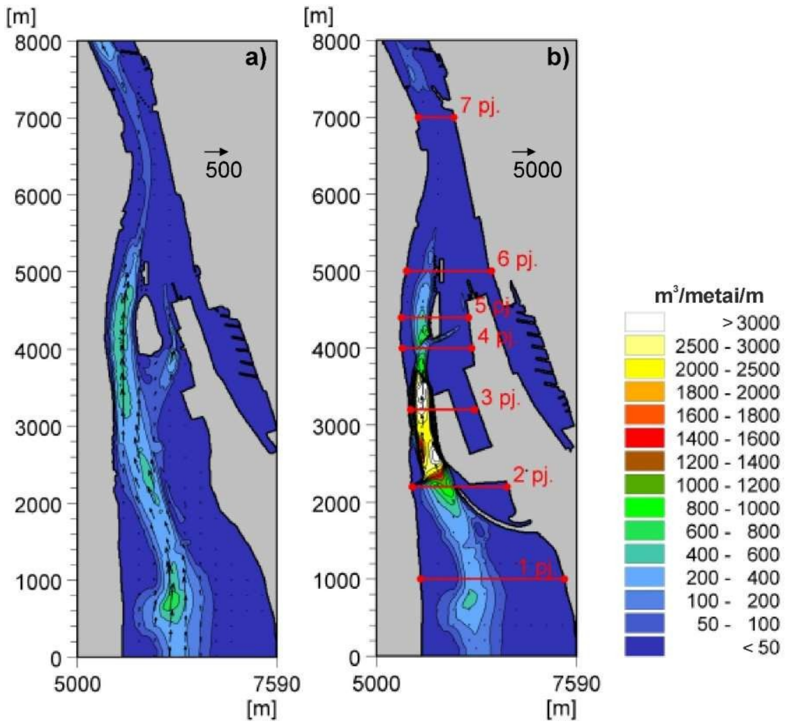
Upon implementation of the solutions under Alternative 3A, the flow of transported sediment would significantly increase in the water area from the planned southern port gates towards Kiaulės Nugaros Island (over a stretch of approximately 1 km). The sediment flow, as it flows towards Kiaulės Nugaros Island, will decrease as it approaches the eastern channel (Figs. 4.1.2.23a, 4.1.2.25a and 4.1.2.27a).

In Alternative 4A, the distribution pattern of the unit sediment flow is similar to that of the sediment flow in Alternative 3A, except that the bedload is distributed more evenly across a larger part of the water area from the planned southern port gates towards Kiaulės Nugaros Island (over a stretch of approximately 1.5 km) and in the eastern channel (Figs. 4.1.2.23b, Figs. 4.1.2.25b and 4.1.2.27b).

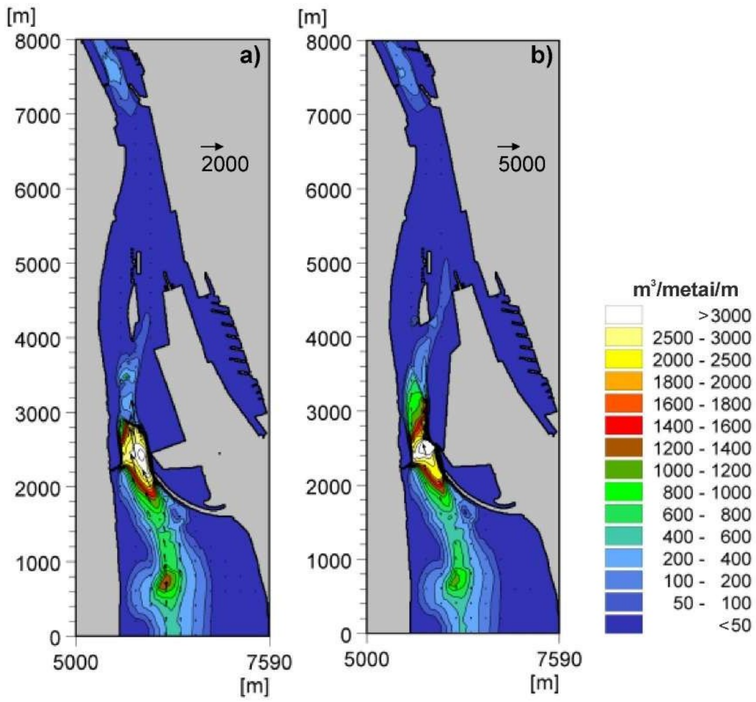
When the current flows through the strait from the Baltic Sea into the Curonian Lagoon (Figs. 4.1.2.28–4.1.2.31), in Alternative 0, the highest unit sediment discharges will occur in the western channel near Kiaulės Nugaros Island and in a 2 km stretch to the south of it (Figs. 4.1.2.28a and 4.1.2.30a). In the case of Alternative 2A, the highest unit sediment discharges are found between the land to be reclaimed as part of the port expansion and the coast of the Curonian Spit. Sediment will also flow through the eastern channel of Kiaulės Nugaros Island (Figs. 4.1.2.28b and 4.1.2.30b). Even higher sediment flows have been identified in the water area between the planned southern port gates and the Curonian Spit coastline, as well as in the eastern channel in Alternatives 3A and 4A, particularly at high flow rates (Fig. 4.1.2.31).

The nature of the sediment flow is similar for all flow rates considered within the same alternative, with only the specific flow rates differing. At flow rates < 1000 m³/s, the sediment flow of sand transport is very low, as the low flow velocities in the strait cannot carry sand particles. Depending on the flow rate, the unit discharge values of sediment vary significantly. They increase exponentially as the flow rate increases. With a flow rate of 1,620 m³/s from the Curonian Lagoon to the Baltic Sea, in Alternative 0, the unit sediment discharge varies from 0 to 771 m³/year/m; for a flow rate of 2,700 m³/s, it rises to 7,684 m³/year/m; and for a flow rate of 4,210 m³/s, it reaches 58,106 m³/year/m. In the case of Alternatives 2A, 3A and 4A, significantly higher maximum unit sediment discharges have been determined. For example, with a discharge of 1,620 m³/s from the lagoon to the sea, in the case of Alternative 4A the unit sediment discharge varies up to 7,431 m³/year/m, for a flow rate of 2,700 m³/s – up to 89,432 m³/year/m, and for a flow rate of 4,210 m³/s – up to 763,304 m³/year/m. This is due to the significant narrowing of the port basin between the planned southern port gates and the Curonian Spit coast as a result of the PŪV. With a flow rate of 1,725 m³/s from the Baltic Sea into the Curonian Lagoon, the unit sediment discharge in Alternative 0 varies up to 1,521 m³/year/m, and with a flow rate of 3,100 m³/s – up to 83,418 m³/year/m. Significantly higher maximum unit discharges of bedload have been determined for all remaining PŪV alternatives. With a flow rate of 1,725 m³/s into the lagoon, the unit sediment discharge for Alternative 2A would increase to 38,544 m³/year/m, and with a flow rate of 3,100 m³/s – to 1,000,290 m³/year/m. Such significant increases in sediment flow would occur only in the planned southern port entrance basin for all PŪV alternatives.

Upon implementation of the solutions for Alternatives 2A, 3A and 4A, the increased sediment flow in the western channel and in the water area from the planned southern port entrance to the western channel may cause erosion of the seabed and banks, whilst the reduced sediment flow in the water area beyond Kiaulės Nugaros Island may influence sediment accumulation processes. For a more detailed analysis of transported sediments in the Klaipėda Strait and the northern part of the lagoon, seven characteristic cross-sections were selected (Fig. 4.1.2.22b), in which sediment (sand) discharge rates (m³/day) were calculated from the characteristics of unit sediment discharge. The selected cross-sections of the strait analysed are: cross-section 1 – at the southern boundary of the Klaipėda port water area, Cross-section 2 – at the centre of the planned entrance channel to the marina for pleasure and small craft (at the southern port gates), Cross-section 3 – 1 km north of the planned southern port gates, Cross-section 4 – near Kiaulės Nugaros Island, Cross-section 5 – intersecting the eastern and western channels, Cross-section 6 – across the LNG terminal water area, and Cross-section 7 – in the Klaipėda Strait, 2 km from the LNG terminal water area.

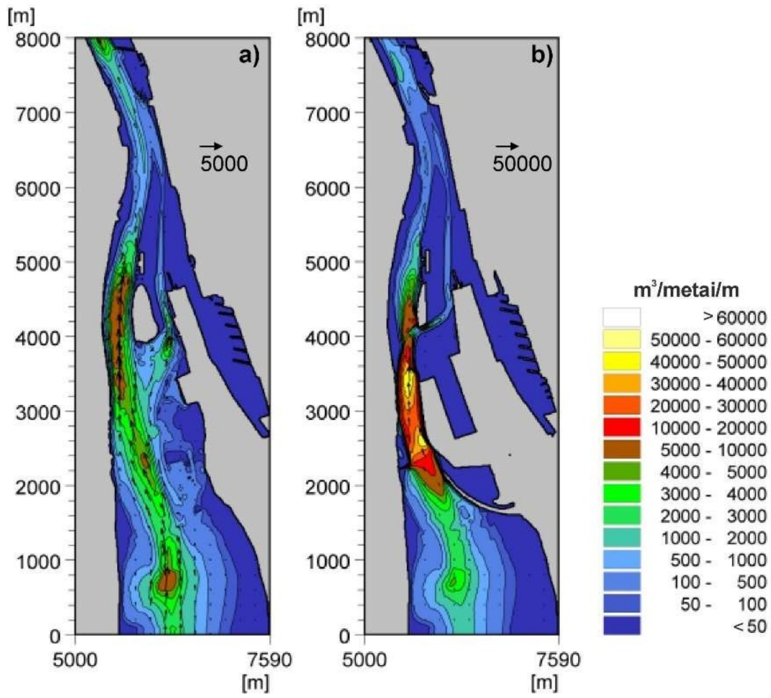


4.1.2.22 Fig. Distribution of unit flow of suspended sediments in the Klaipėda Strait and the northern part of the Curonian Lagoon for alternatives 0 (a) and 2A (b), where 1,620 m³/s flow from the Curonian Lagoon to the Baltic Sea



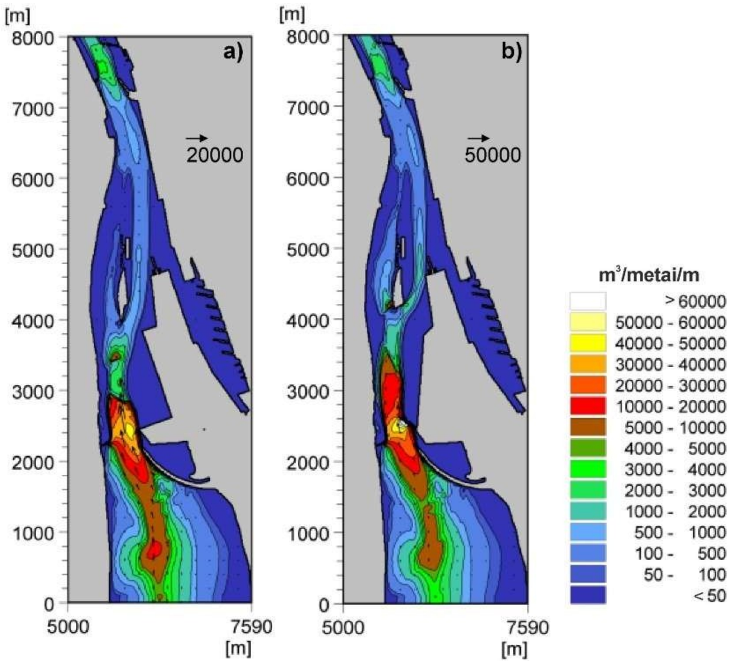
4.1.2.23 Fig. Distribution of unit discharge of bedload in the Klaipėda Strait and the northern part of the Curonian Lagoon for alternatives 3A (a) and 4A (b), when 1620 m³/s flows through the strait

flow from the Curonian Lagoon to the Baltic Sea



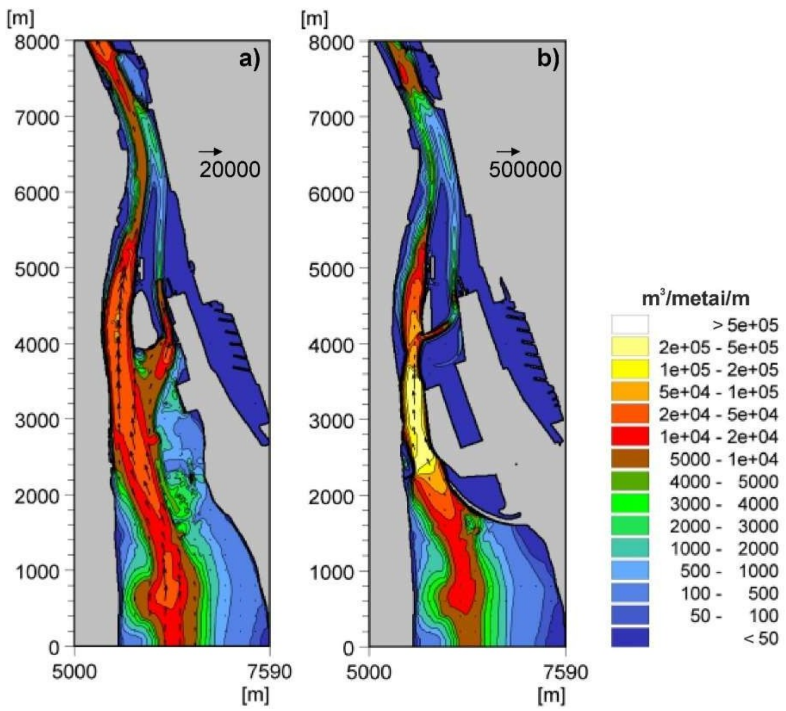
4.1.2.24 Fig. Distribution of unit discharge of bedload in the Klaipėda Strait and the northern part of the Curonian Lagoon in Alternatives 0 (a) and 2A (b), when a discharge of 2700 m³/s flows through the strait

from the Curonian Lagoon to the Baltic Sea

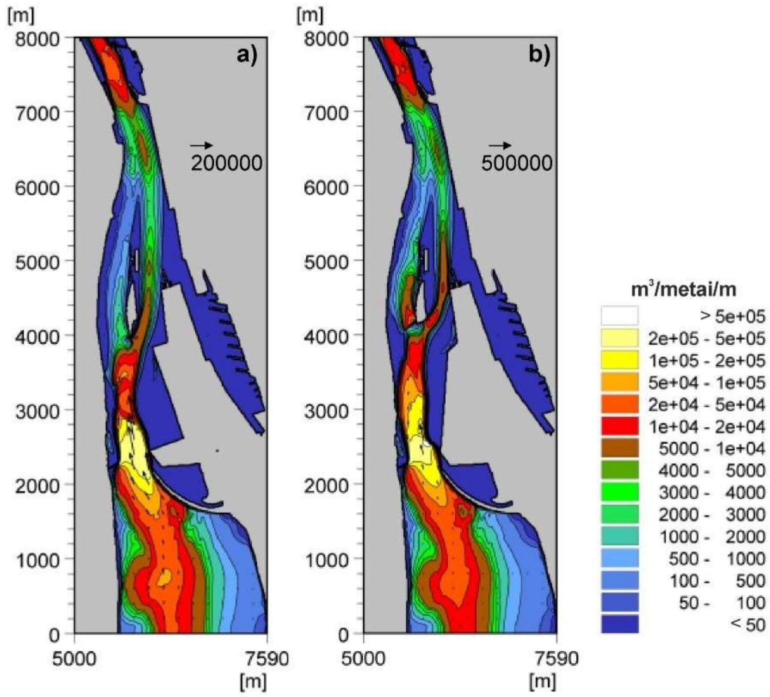


4.1.2.25 Fig. Distribution of unit discharge of bedload in the Klaipėda Strait and the northern part of the Curonian Lagoon in Alternatives 3A (a) and 4A (b), when a flow of 2700 m³/s passes through the strait

flow from the Curonian Lagoon to the Baltic Sea

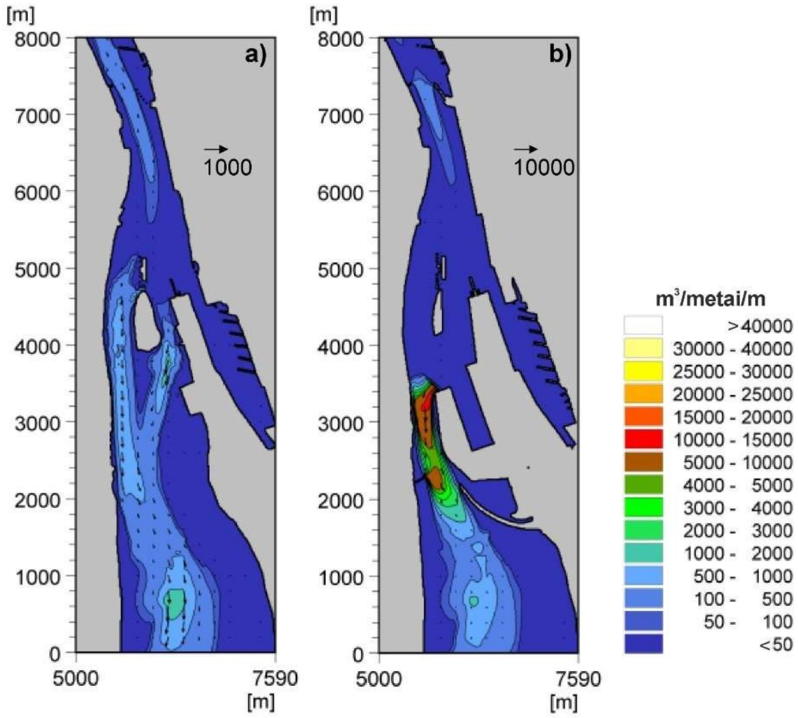


4.1.2.26 Fig. Distribution of unit discharge of bedload in the Klaipėda Strait and the northern part of the Curonian Lagoon in Alternatives 0 (a) and 2A (b), when the flow rate through the strait is 4210 m³/s from the Curonian Lagoon to the Baltic Sea



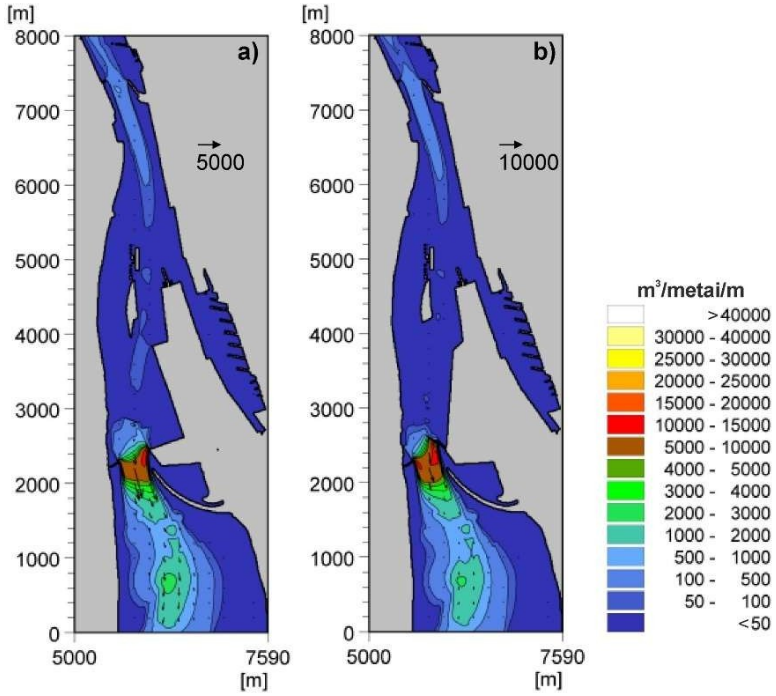
4.1.2.27 Fig. Distribution of unit discharge of bedload in the Klaipėda Strait and the northern part of the Curonian Lagoon in Alternatives 3A (a) and 4A (b), when a flow of 4210 m³/s passes through the strait

flow from the Curonian Lagoon to the Baltic Sea



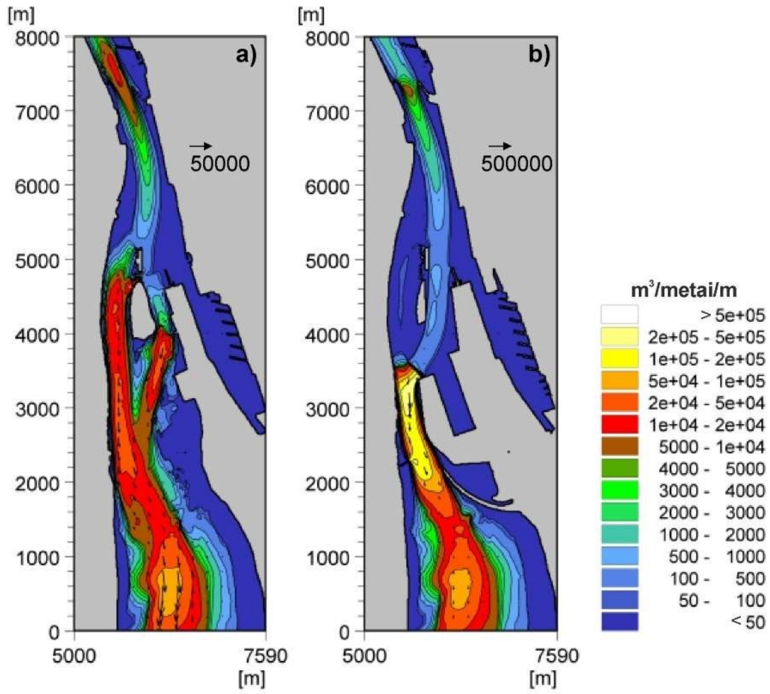
4.1.2.28 Fig. Distribution of the unit discharge of dredged material in the Klaipėda Strait and the northern part of the Curonian Lagoon in Alternatives 0 (a) and 2A (b), with a discharge of 1,725 m³/s flowing through the strait

from the Baltic Sea into the Curonian Lagoon



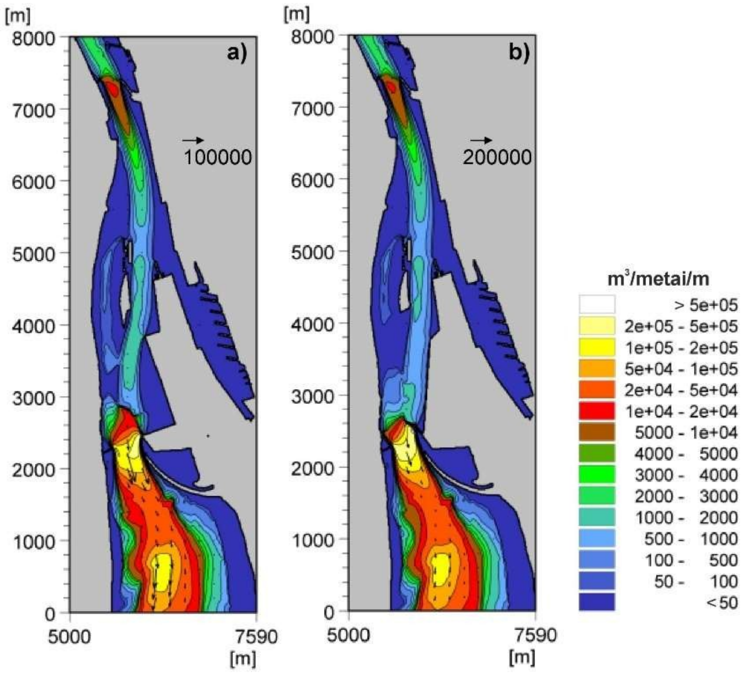
4.1.2.29 Fig. Distribution of unit discharge of bedload in the Klaipėda Strait and the northern part of the Curonian Lagoon for Alternatives 3A (a) and 4A (b), when a discharge of 1725 m³/s flows through the strait

flow from the Baltic Sea into the Curonian Lagoon



4.1.2.30 Fig. Distribution of unit discharge of bedload in the Klaipėda Strait and the northern part of the Curonian Lagoon for Alternatives 0 (a) and 2A (b), when 3206 m3/s flows through the strait

flow from the Baltic Sea into the Curonian Lagoon



4.1.2.31 Fig. Distribution of unit flow of bedload in the Klaipėda Strait and the northern part of the Curonian Lagoon in Alternatives 3A (a) and 4A (b), when 3206 m³/s flows through the strait flow from the Baltic Sea to the Curonian Lagoon

4.1.2.32 Fig. shows the variation in sediment flow rate (m³/day) at selected cross-sections of the port basin when flow rates of 1620, 2700 and 4210 m³/s flow through the strait from the Curonian Lagoon to the Baltic Sea. If the sediment discharge between cross-sections is negative, this means that the sediment discharge is increasing and erosion processes will occur in the harbour basin between the cross-sections. Conversely, when the sediment discharge between cross-sections decreases, accumulation processes will occur in the harbour basin. With various discharge rates flowing from the Curonian Lagoon into the Baltic Sea, the lowest sediment discharge rates were found in the case of Alternative 0. The largest negative changes in sediment discharge rates are between cross-sections 6 and 5 (Fig. 4.1.2.32). This means that the sediment flow, influenced by high current velocities in the western and eastern channels, will enter the water area beyond Kiaulės Nugaros Island, where sediment accumulation will occur in the LNG terminal water area due to a decrease in current velocities. Differences in sediment discharge across cross-sections depend on the flow rate through the strait: at a flow rate of 1,620 m³/s through the strait, the difference in sediment discharge between cross-sections 5 and 6 will be 208 m³/day; at 2,700 m³/s – 2,463 m³/day; and for a flow rate of 4,210 m³/s – as much as 19,080 m³/day. An exponential relationship between water flow rate and sediment flow rate has been established.

A different distribution of sediment discharge was found for the PŪV alternatives (Fig. 6.12). In the water area between cross-sections 1 and 3, an increase in bedload flow rates was observed for Alternative 2A, as flow velocities increase significantly in the narrow channel of the planned southern harbour entrance. Consequently, areas of bottom erosion are possible in the planned southern port entrance water area. The flow of sediment passing through the channel narrowed due to economic activity (Cross-section 3) will decrease by the time it reaches Kiaulės Nugaros Island (Cross-section 4), so significant sediment accumulation is possible in the water area between these cross-sections. The differences in sediment discharge between cross-sections 3 and 4, when flows of 1,620, 2,700 and 4,210 m³/s are flowing from the lagoon to the sea, will be 1,618, 19,330 and 154,711 m³/day respectively. Significant sediment accumulation is possible when high discharge flows from the lagoon to the sea (during the spring flood on the Nemunas River). A slightly different distribution of sediment flow in the northern part of the Curonian Lagoon will occur in the case of Alternatives 3A and 4A. The specific features of the distribution are determined by the size and configuration of the planned port development’s land area. In the case of

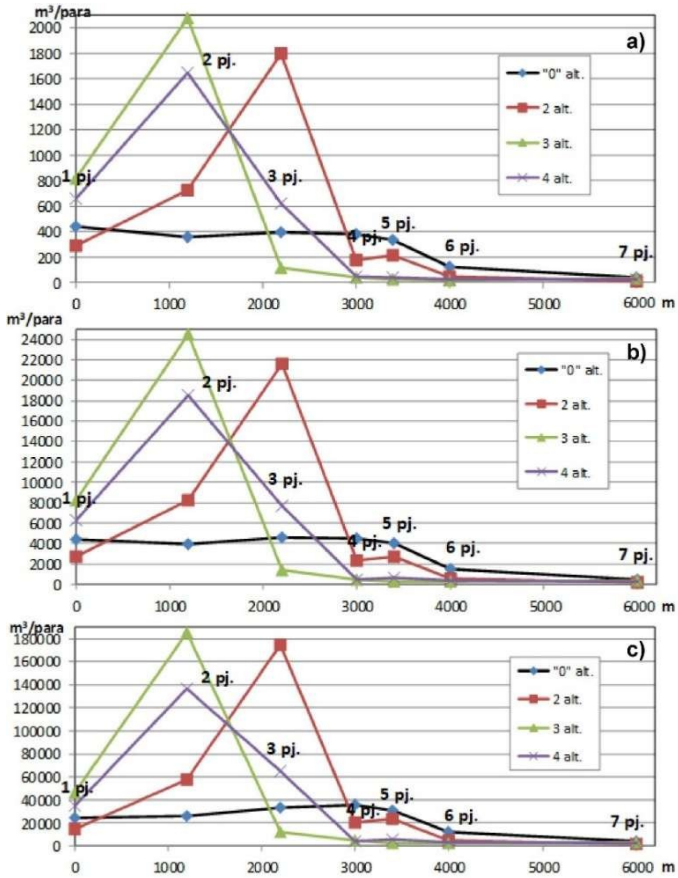
Alternative 3A, the planned land

is the smallest; therefore, the sediment flow passing through the planned southern port gates begins to decrease rapidly by cross-section 3, causing sediment accumulation over a 1 km stretch. The differences in sediment discharge between cross-sections 2 and 3, with discharge rates of 1,620, 2,700 and 4,210 m³/s from the lagoon to the sea, will be 1,963, 23,075 and 173,226 m³/day respectively. In the case of Alternative 4A, a decrease in sediment discharge has been observed in the larger part of the water area up to Kiaulės Nugaros Island (from cross-sections 2 to 4). Between these cross-sections, the reduction in sediment discharge at flow rates of 1,620, 2,700 and 4,210 m³/s from the lagoon to the sea will be 1,597, 18,048 and 132,947 m³/day respectively. In the case of Alternative 4A, a lower amount of suspended sediment accumulation was observed in the larger water area. The southern expansion of the port will have almost no effect on the distribution of sediment flow in the Klaipėda Strait from the LNG terminal towards the northern port gates compared to Alternative 0.

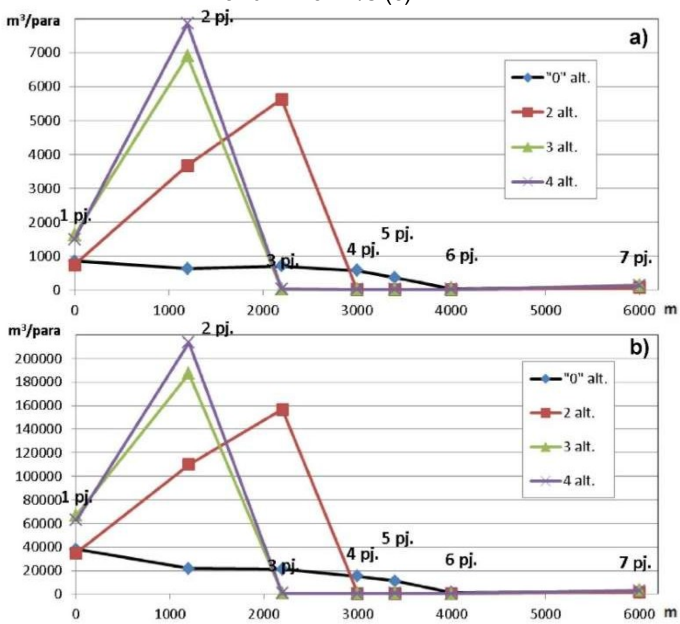
A similar distribution of sediment flow is also observed when the current flows from the Baltic Sea into the Curonian Lagoon (Fig. 6.13). In the case of Alternative 0, the sediment flow rate will increase slightly after passing through the channel of Kiaulės Nugaros Island and will flow through the northern part of the lagoon with almost no change. In all cases of the PŪV alternatives, it has been established that a redistribution of sediment flow will occur in the northern part of the lagoon. In the case of Alternative 2A, bottom erosion processes may begin as early as in the water area south of Kiaulės Nugaros Island (Cross-section 4) towards the narrowed channel at the planned southern gate pier of the port, as an increase in sediment flow is observed in this water area. The sediment flow, having passed through the narrowed channel, will begin to decrease, so sediment accumulation is possible further south (up to cross-section 1). In the case of alternatives 3A and 4A, sediment redistribution will occur in a smaller part of the lagoon's water area (from cross-section 3 to 1): erosion of the lagoon bed and banks from cross-section 3 to 2, and sediment accumulation from cross-section 2 to 1 (south of the planned southern port gates).

Having assessed changes in sediment (sand) flow for different project alternatives, it has been established that the zones of sediment accumulation and seabed erosion may vary depending on the direction of the current in the strait. In the same water area, erosion processes occurring when the current flows from the lagoon to the sea may turn into sediment accumulation when the current is directed from the sea into the lagoon. For all PŪV alternatives, the greatest changes in sediment flow are possible in the northern part of the Curonian Lagoon, in the water area south or north of the planned southern port gates. In the case of Alternative 4A, the change in sediment discharge in the cross-sections studied is slightly smaller than in the cases of Alternatives 2A and 3A. Therefore, upon implementation of the solutions of Alternative 4A, there is a possibility of reduced sediment accumulation and seabed erosion in the northern part of the lagoon. In the northern part of the navigation channel (the Klaipėda Strait), we observe only a slight redistribution of sediments in all PŪV alternatives.

The sediment discharge curves plotted for selected cross-sections of the harbour basin (Figs. 4.1.2.32–4.1.2.33) have been used to calculate changes in the sediment balance within the harbour basin during years with varying water levels.



4.1.2.32 Fig. Variation in sediment discharge (m³/day) in the port basin (the locations of the 7 cross-sections are shown in Fig. 4.1.2.22b) when a discharge of 1620 (a), 2700 (b) and 4210 m³/s (c)



4.1.2.33 Fig. Variation in the flow rate of the Nešmenai River (m³/day) in the port basin (the locations of the 7 cross-sections are shown in Fig. 4.1.2.22b), when a flow rate of 1725 (a), 3206 m³/s (b)