ARCTIC LNG 2 PROJECT

ENVIRONMENTAL, SOCIAL AND HEALTH IMPACT ASSESSMENT

PART 2

Prepared by:

Ramboll CIS

Date:

December, 2020

Agreement:	228 -ALNG2-2020 of 31.03.2020
Assignment:	Preparation of documentation package for the assessment and management of environmental and so Environmental, socio-economic and human health impact assessment (ESHIA) for the Arctic LNG2 Project
Version:	4
Authors:	Ivan Senchenya, Sergey Charnyansky, Alexander Ignatyev, Olga Tertitskaya, Nikolay Nazarevsky, Elena Zaika, Ilya Gulakov, Maria Petrasova

Ivan Senchenya

Project Manager/Director:

Date: 30.12.2020

This Report is prepared by Ramboll CIS in accordance with the professional standards and quality requirements of the assignment, taking into account scope of the services and the terms agreed with the Client. This Report can be used solely by the Client or his advisers, thus the company does not assume any liability to third parties who may rely on the Report or any part thereof, except upon prior agreement with Ramboll CIS. Any use of the Report materials by such third party shall be at its own risk.

Ramboll CIS does not assume any liability to the Client or other parties in relation to any matters beyond the scope of its services.

Version control record

Issue	**Description of the status**	**Date**	**Reviewer initials**	**Author(s) initials**
A	Draft for internal review	21.04.2020	IS	IS, SCh, AI, EZ, OT, NN, SD, MP
1	First draft issued to the Client	22.04.2020	IS	SCh, AI, SD, MP
2	Revision with Client's comments incorporated	01.05.2020	IT, EK, IS	SD, AI, IG, SCh, NN, OT, MP, EZ
3	Revision with comments of the Client and NOVATEK incorporated	09.05.2020	IS	SD, AI, IG, SCh, NN, OT, MP, EZ
4	Revision with addressed comments of IESC and lenders	30.12.2020	IS	SD, AI, IG, SCh, NN, OT, MP, EZ

TABLE OF CONTENTS

REPORT STRUCTURE

PART 1

1 Introduction

2 Legal Framework for Project Implementation

3 ESHIA Process

4 Stakeholder Engagement

5 Characteristics of the Planned Activity

6 Project Alternatives

PART 2

7 Environmental Baseline

8 Socio-Economic Baseline

PART 3

9 Environmental Impact Assessment

10 Social and Health Impact Assessment

PART 4

11 Decommissioning

12 Transboundary Impacts

13 Cumulative Impacts

14 Environmental and Social Management

15 Conclusion

APPENDICES

Appendix 1: Project environmental and social standards document

Appendix 2: NOVATEK Policy on Health, Safety, Environment and Social Responsibility

Appendix 3: List of identified sacred sites of the ISNP of the north in and around the Salmanovskiy (Utrenniy) license area

Appendix 4: List of waste management service providers that can be involved as subcontractors at the Arctic LNG 2 Project construction and operation stages

Appendix 5: Cumulative assessment scoping Phase I and Phase II

Appendix 6: Reference List

Appendix 7: Climate conditions at the Project site according to observation data at meteorological stations Tadebya-Yakhha, Seyakha, Tambey

Appendix 8: Assessment of possible geodynamic consequences of the development of the Salmanovskoye (Utrenneye) OGCF

Appendix 9: Proposals of consultant on prevention of exogenous geological processes and remediation of disturbed soil and vegetation cover for Arctic LNG 2 Project

Appendix 10: Disturbed land reclamation activities included in the design documentation for the field, plant and port facilities (Arctic LNG 2 project) and the Utrenniy airport

Appendix 11: Land plots in the Tazovskiy municipal district of YNAO occupied by the Salmanovskoye (Utrenneye) OGCF facilities setup (Arctic LNG 2 Project)

Appendix 12: Land plots in the Tazovskiy municipal district of YNAO and water areas within the Ob estuary occupied by the plant and port facilities (Arctic LNG 2 Project)

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AANII	Arctic and Antarctic Research Institute
AEPS	Arctic Environmental Protection Strategy
AEWA	African-Eurasian Migratory Waterbirds
AGRU	Acid Gas Removal Unit
AIDS	Acquired Immune Deficiency Syndrome
AIIB	Asian Infrastructure Investment Bank
AIS	Automatic Identification System
ALP	Artificial Land Plot
AMAP	Arctic Monitoring and Assessment Programme
AoI	Area of Influence
AP	Action Plan
AS	Anionic Surfactants
AWOU	Automated Wireless Observer Unit
AZRF	Arctic Zone of Russian Federation
BAP	Benz[a]pyrene, Biodiversity Action Plan
BAT	Best Available Technologies
BCC	Biodiversity Conservation Centre
BIMS	Brash Ice Management System
BOD	Biochemical Oxygen Demand
CAFF	Conservation of Arctic Flora and Fauna
CDP	Carbon Disclosure Project
CGTP	Complex Gas Treatment Plant
CIA	Cumulative Impact Assessment
CIS	Commonwealth of Independent States
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CL	Combustible Liquids
CMP	Construction Management Plan
CNODC	China National Oil and Gas Exploration and Development Company
CNOOC	China National Offshore Oil Corporation
CNPC	China National Petroleum Corporation
COD	Chemical Oxygen Demand
CPS	Compressor Pumping Station
CRA	Cryogenic Risk Assessment
CRZ	Conservation Reserve Zone
CS	Compressor Station
DCA	Detrended Correspondence Analysis
DCM	Dispersion Calculation Methods
DEGP&HP	Dangerous Exogenous Geological Processes and Hydrological Phenomena

DPP	Diesel Power Plant
DPRR YNAO	Representatives of YNAO Government
DWW	Drilling Wastewater
E&RA	Evacuation and Rescue Analysis
EBRD	European Bank for Reconstruction and Development
EBSA	Ecologically and Biologically Significant Areas
ECA	Export Credit Agency
EDPS	Emergency Diesel Power Station
EEZ	Exclusive Economic Zone
EGP	Exogenous Geological Process
EHS	Environmental, Health, and Safety
EIA	Environmental Impact Assessment
EP	Equator Principles
EPDR	Emergency Prevention, Preparedness and Response
EPF	Early Phase Facilities
EPFI	Equator Principles Financial Institutions
ERA	Explosion Risk Analysis
ERC	Emergency Response Centre
ERIS	Effluents Re-Injection Site
ESHIA	Environmental, Social and Health Impact Assessment
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESP	Environmental and Social Policy
ESS	Environmental and Social Standards
ESSA	Emergency Systems Survivability Analysis
EU	European Union
EWE	Extreme Weather Events
FAF	Federal Agency for Fishery
FC	Field Camp
FEED	Front-end Engineering Design
FPIC	Free, Prior, and Informed Consent
FRA	Fire Risk Analysis
FSBSI	Federal State Funded Research Institution
FWCC	Federal Waste Classification Catalogue
GBIF	Global Biodiversity Information Facility
GBS	Gravity-Based Structures
GFN	Good Faith Negotiation
GGN	Gas-Gathering Network

GHG	Greenhouse Gases
GIIP	Good International Industry Practice
GIS	Geographical Information System
GN	Hygiene Standards
GOST	State Specific Standard
GPH	Good Practice Handbook
GRP	Gross Regional Product
GT	Gas Turbine
GTCPP	Gas Turbine Compressor Power Plant
GTG	Gas Turbine Generator
GTPP	Gas Turbine Power Plant
GWP	Gas Well Pad
HADCRUT4	Hadley Centre and University of East Anglia
HAZOP	HAZard and Operability
HC	Hydrocarbons
HFL	Highly Flammable Liquid
HIF	Hazardous Industrial Facilities
HIV	Human Immunodeficiency Virus
HNS	Hazardous and Noxious Substances
HOB	Hydrocarbon-Oxidizing Bacteria
HRA	Health Risk Assessment
HSE	Health, Safety & Environmental
HSES	Health, Safety, Environmental and Social Protection
HVAC	Heating, Ventilation and Air Conditioning
ICAO	International Civil Aviation Organisation
ICAO	International Civil Aviation Organisation
ICES	International Council for the Exploration of the Seas
ICP	Informed Consultation and Participation
IEM	Industrial Environmental Monitoring
IEMC	Integrated Emergency Management Course, Industrial Environmental Monitoring and Control
IEP	Integrated Environmental Permit
IFC	International Financial Corporation
IFI	International Financial Institutions
ILO	International Labour Organisation
IMO	International Maritime Organization
IMS	Integrated Management System, Ice Management System
IPCC	Intergovernmental Panel on Climate Change
IPDP	Indigenous People Development Plan
ISPN	Indigenous Small-Numbered Peoples of the North

ITS	Information and Technical Reference Documents
ITSO TB	Transport Safety System Facilities
IUCN	International Union for Conservation of Nature
JBIC	Japan Bank for International Cooperation
JOGMEC	Japan Oil, Gas and Metals National Corporation
KBA	Key Biodiversity Areas
KOT	Key Ornithological Territories
LA	License Area
LDAR	Leak Detection and Repair
LEM	Local Environmental Monitoring
LEPM	List of Environmental Protection Measures
LFG	Liquefied Flammable Gases
LLC	Limited Liability Company
LNG	Liquefied Natural Gas
LOC	Loss of Containment
LTS	Low-Temperature Sepatration
MAC	Maximum Allowable Concentrations
MAE	Maximum Allowable Emission
MAL	Maximum Allowable Levels
MARPOL	International Convention for the Prevention of Pollution from Ships
MDEA	Methyldiethanolamine
MIA	Ministry of Internal Affairs
MMC	Marine Mammal Council
MPC	Maximum Permissible Concentrations
MTPA	Million Tonnes Per Annum
NLR	Northern Latitudinal Railway
NSR	Northern Sea Route
NSR	Northern Sea Route
NTS	Non-technical Summary
OBM	Oil-Based Clay Drilling Mud
OCC	Operations control Complex
OCS	Operations Control System
OEC	Operational Environmental Control/Monitoring
OECD	Organization for Economic Cooperation and Development
OGCF	Oil-Gas Condensate Field
OHS	Occupational Health and Safety
OSCY	Offshore Superfacility Construction Centre
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OSPRP	Oil Spill Prevention and Response Plan

OST	Industry Specific Standard
PAH	Polyaromatic Hydrocarbons
PAME	Protection of the Arctic Marine Environment
PCB	Polychlorinated Biphenyls
PFHI	Publicly Funded Health Institution
PGTP	Primary Gas Treatment Plant
PHN	Content of Phenols
PJSC	Public Joint Stock Company
POL	Petroleum, Oil and Lubricants
PR	Permafrost Rocks
PS	Performance Standard, Project Standards
PSR	Project Specific Requirements
PSZ	Protective Sanitary Zones
PTS	Package Transformer Substation
QRA	Quantitative Risk Assessment
RC	Reinforced Concrete
RCIA	Rapid Cumulative Impact Assessment
RD	Reference Documents
RF	Russian Federation
SanPiN	Sanitary-Epidemiological Rules and Norms
SC	Startup Complex
SCWQI	Specific-Combinatorial Water Quality Index
SDM	Spent Oil-Based Clay Drilling Mud
SDWG	Sustainable Development Working Group
SEP	Stakeholder Engagement Plan
SGC	Stabilized Gas Condensate
SIL	Safety Integrity Level
SMCIW DS	Solid Municipal, Construction and Industrial Waste Disposal Site
SNiP	Civil Engineering Norms and Rules
SOLAS	International Convention for the Safety of Life at Sea
SP	Code of Rules
SPI	State Public Institution
SPNA	Specially Protected Natural Areas
SPZ	Sanitary Protection Zone
SR	Scoping Report
STD	Sexually Transmitted Diseases
STF	Sewage Treatment Facility
STGCF	South-Tambey Gas-Condensate Field
STL	Seasonally Thawed Layer

TAC	Temporary Accommodation Camp
TEA	Turbo-Expanding Assembly
TFCD	Task Force on Climate-Related Financial Disclosures
TLC	Takeoff-Landing Cycle
TPS	Territorial Planning Scheme
TRTF	Transmitting Radiotechnical Facilities
TS	Topside Structures
TSF	Temporary Site Facilities
TTS	Thermal Treatment System
UNCLOS	United Nations Convention on the Law of the Sea
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
URZ	Use-restricted Zone
USA	United States of America
USSR	Union of Soviet Socialist Republic
VEC	Valuable Environmental and Social Components
VOC	Volatile Organic Compounds
WBM	Water-Based Clay Drilling Mud
WITF	Water Intake and Treatment Facilities
WPZ	Water Protection Zone
WTF	Water Treatment Facilities
WWF	World Wildlife Fund
WWTP	Wastewater Treatment Plant
YNAO	Yamalo-Nenets Autonomous Okrug

BASIC TERMS AND DEFINITIONS

Customer, Company	Arctic LNG 2, LLC
Consultant	Ramboll CIS LLC, an independent environmental and social consultant
Project Operator	The organization responsible for managing the project at the construction, commissioning, operation and decommissioning phases (Arctic LNG 2, LLC)
Stakeholders	Persons or groups directly or indirectly affected by the Planned activity, as well as those who may be interested in its implementation and / or are able to influence it in a favorable or unfavorable way
GBS LNG & SGC Plant (Complex)	The gravity-based structure Complex for production, storage and offloading of liquefied natural gas and stabilised gas condensate, which includes three process trains and onshore infrastructure
Process Train	The gravity-based structure Complex will include three process trains for the production, storage and offloading of liquefied natural gas (LNG) and stabilised gas condensate (SGC) with a stated annual capacity of about 6.6 million tons of LNG each. The total peak capacity of SGC production can be as much as 1.6 million tons per year
Associated facilities	Facilities that meet the following conditions: 1) they are not funded by the Project (by the planned activity); 2) they would not be built or expanded without the Project (the Planned activity fails to be implemented); 3) they ensure the viability of the Project (Planned activity)
Arctic LNG 2 Project (Project)	The Project, including, along with the GBS LNG & SGC Plant construction of the Utrenniy Terminal (Port) and development of the Salmanovskoye (Utrenneye) oil and gas condensate field (OGCF) (Project Operator – 'Arctic LNG 2' LLC)
Utrenniy Terminal (Port)	A section of the Sabetta seaport, the purpose of which is to provide offshore logistics for gas carriers and tankers for LNG and SGC offloading, reception and storage of processing and construction cargo
Salmanovskiy (Utrenniy) license area	A subsoil plot of federal importance, including the Salmanovskoye (Utrenneye) oil and gas condensate field, within which Arctic LNG 2 LLC was licensed to use the subsoil resources – License No. CFL 15745 NE dated 06.20.2014 for the exploration and production of hydrocarbons
Field	Facilities and activities involved in setting up the Salmanovskoye (Utrenneye) OGCF to ensure production and preparation of raw materials for production of LNG and SGC, and providing engineering resources to all the facilities of the Arctic LNG 2 Project
Principles of the Equator	The internationally accepted environmental and social risk management system for financial organizations, including 10 key provisions (principles)[1]
IFC Performance Standards	A set of environmental and social sustainability requirements of the International Finance Corporation which the organizations to be funded must follow throughout the lifecycle of an investment project. Available at: http://www.ifc.org/performancestandards

[1] The Equator Principles. A financial industry benchmark for determining, assessing and managing environmental and social risk in projects. The Equator Principles Association, 2019.

Environmental, social and health impact assessment (ESHIA)	In the IFC terminology, the process of identifying, predicting and assessing the significance of favorable (positive) and adverse (negative) environmental and social project impacts, including a description of the project implementation conditions, analysis of alternative options for the Planned activity, consideration of global, transboundary and cumulative impacts including their possible quantitative representation, an impact management programme. In the terminology of the International Association for Impact Assessment (IAIA[2]) - the process of identifying, predicting, assessing and mitigating environmental and social impacts, as well as other adverse effects of the Planned activity, before making a decision on its implementation
Planned activity's (Project's) area of influence[4]	The land and water area, including: 1) land plots and water area sections, within which the Planned activities are directly implemented; 2) other land and water areas used or controlled by the Project's operator and its subcontractors (contractors); 3) land and water areas where the associated facilities are sited (see the corresponding definition); 4) land and water areas that may be subjected to cumulative impacts from the Planned activity; 5) land and water areas potentially affected by impacts from unplanned but predictable developments caused by project-related activities that may occur later or at a different location. The Project's area of influence does not include the area of dispersion of impacts which can be observed with a no-project version (abandonment of the Planned activity) or without the Project
The area of influence of air pollutant emission sources[5]	For a sole air pollutant emission source it is the circumference of the largest of the two radii, the first of which is equal to ten times the distance from the source to the point of the ground level concentration of the pollutant having the greatest prevalence (among the pollutants emitted by this source), and the second one is equal to the distance from the emission source to the most distant contour line of the ground level concentration of the pollutant, equal to 0.05 one time MPC. For the totality of air pollutant emission sources it is land or water areas that include all single source influence areas within this totality, as well as the 0.05 one time MPC contour for the estimated total concentration of each pollutant emitted by the totality of sources
Areas with controlled habitat quality indicators	Areas, where the existing hygienic air standards for chemical, biological and physical factors must be strictly followed. These include areas such as residential development, cottage development, sports and children's playgrounds, landscape and recreational areas, recreation areas, resorts, sanatoriums, rest homes; horticultural partnerships, collective or individual dachas and garden plots; sports facilities; educational and childcare facilities; general medical treatment and rehabilitation facilities
Social impact area	Areas and communities that may experience positive and negative impacts of the planned (project related) and associated activities

[2] Global leader among best practice networks as regards impact assessment for informed decisions concerning policies, programs, plans, and projects (http://www.iaia.org/).

[4] The definition is consistent with the IFC terminology (IFC Policy & Performance Standards and Guidance Notes. Glossary and Terms - http://www.ifc.org/). In this and all other common cases, the term "project" is a traditional synonym of the phrase "planned activity". As applicable to the ESHIA subject, the term **Project** (capitalized in the text) covers the activity under assessment designated as "Arctic LNG 2" to include Salmanovskoye (Utrenneye) OGCF **Facilities Setup**, construction and operation of the GBS LNG & SGC Plant (LNG **Complex)**, and construction and operation of the **Port** (Utrenniy Terminal).

[5] In the terminology of MRR-2017 (Dispersion Modeling of Harmful Air Pollutants. Approved by the Russian Ministry of Nature Order 273 dated June 006, 2017).

7. ENVIRONMENTAL BASELINE

7.1 Historical Studies of the Natural Environment in the Project Area. Environmental Baseline

Until recently, the Gydan Peninsula was one of the less studied territories of the Russian Arctic, which is largely due to lack of development and inaccessibility. Systematic studies of the natural environment in the area began with the work of the Gydan expedition of the USSR Academy of Sciences (Gorodkov, 1928, 1932, 1944, etc.), the Russian Geographical Society (Sapozhnikov, Nikitina, 1923, etc.) and the Russian Botanical Society (Tolmachev, 1926). The economic importance of the Gydan ecosystems of that time was limited to ensuring the productivity of reindeer pastures (Govorukhin, 1933).

Kara Sea surrounding the Gydan Peninsula has been systematically studies since the end of 19th century. Originally, the studies were focused on navigation conditions and development of coastal areas (hydrographic, meteorological and climate studies, forecasting ice conditions); the marine biological and radiation-ecological studies started in second half of 20th century.

A new page in the history of studies of the peninsula landscapes and surrounding water areas was turned by large-scale explorations, which were carried out here in the 1960-70s through the joint efforts of oil and gas companies and specialized research institutes. Between 1975 and 1993, 13 hydrocarbon fields were discovered and explored within Gydan, eight of which are gas fields – Gydanskoye, Antipayutinskoe, Toto-Yakhinskoye, Minkhovskoye, Mostochno-Minkhovskoye, Vostochno-Bugornoye, Trekhbugornoye, and Shtormovoye fields, and two are oil and gas condensate fields – Utrenneye and Geofizicheskoye.

The associated environmental and geographical studies complemented and updated the results of the previous work and collected new data on the peninsula and the the Ob Estuary of the Kara Sea. As of the mid-1990s, the total human-induced disturbance of the Gydan's landscapes was estimated at hundredths of a percent (Agbalyan, 2015); that is, this large land mass remained nearly pristine. Kara Sea, in contrast, has long been exposed to anthropogenic impacts of disposal of wastes and nuclear testing, extensive navigation, import and accumulation of large quantities of pollutants carried by river flows (Matishov et al., 2017)[3], and in the Ob Estuary – also fishery impacts.

In the 2000-2010s, in the context of a growing overall interest in the Arctic and in the development of its resources, a series of comprehensive expeditions were organized to carry out ecosystem surveys and take samples of the natural environments for substance analysis. In addition, as regards the areas of construction and operation of engineering structures, the knowledge of the land and water areas is complemented by the data obtained through operational environmental monitoring.

In particular, to assess the impact of the pipeline corridor connecting the Nakhodkinskoye field to the Yamburgskaya compressor station (with a 22-kilometer two-pipe underwater crossing through the Taz Estuary), hydrogeochemical surveys were carried out on the Messoyakha and Monguiribei rivers (Moskovtchenko, 2003). The baseline and operational environmental self-monitoring of PiterGaz LLC of 2010 contributed to a much better understanding of the aquatic ecosystems of the Taz Estuary within the boundaries of the Tota-Yakhinsky and Antipayutinsky subsoil areas. FGBOU VPO Tyumen State University carried out detailed surveys on the peninsula lakes (Kremleva et al., 2012). The "Gazflot" LLC (2000-2009) and the Northern UGMS ("Yamal-Arctic – 2013") expeditions collected extensive data on the Ob Estuary ecosystems.

[3] G. G. Matishov et al. Kara Sea Studies at the present stage of development of the Arctic // The Arctic: Ecology and Economy. 2013. No.1 (9). pp. 4-11.

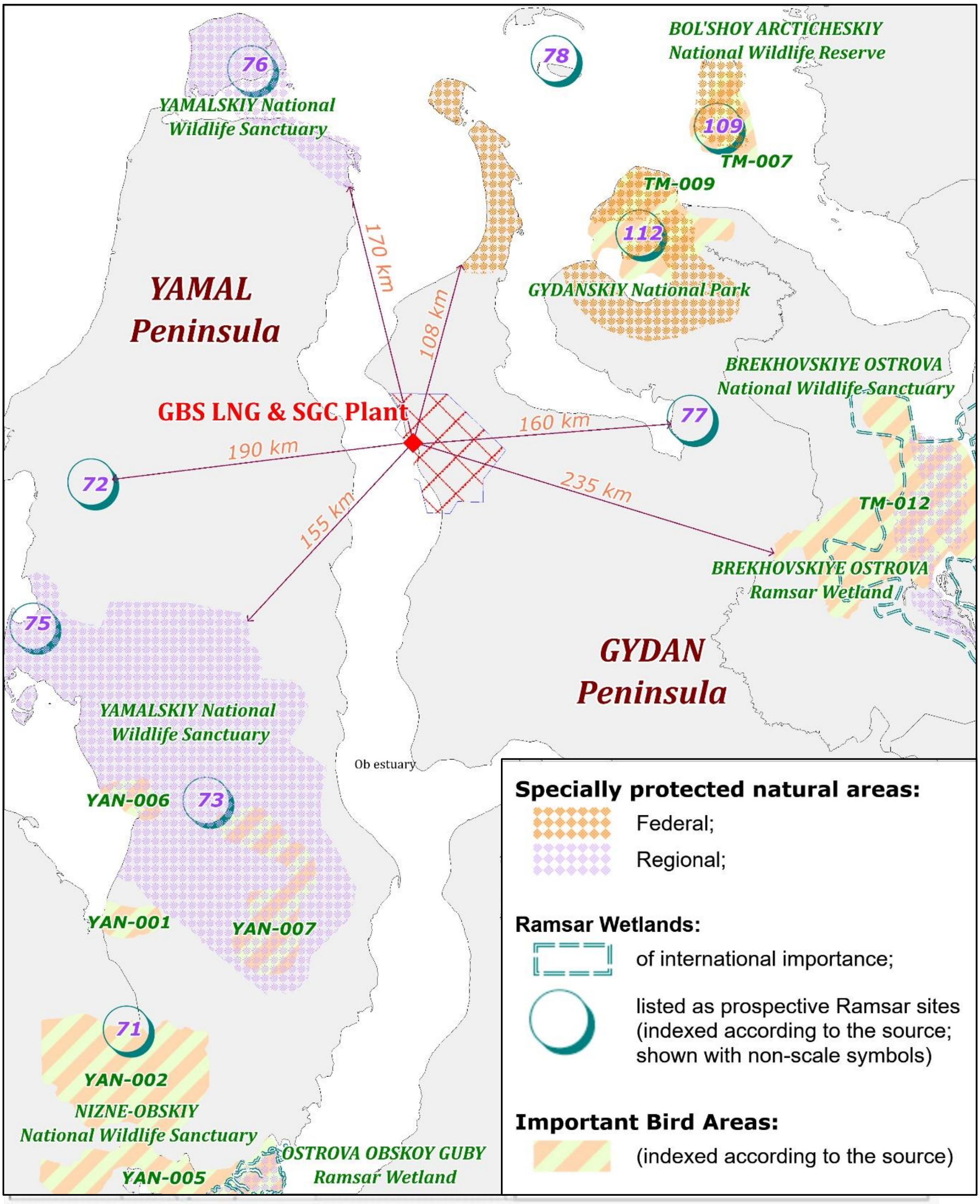


Figure 7.1.1: Location of the designed site of the Plant and Port, and the Salmanovskiy (Utrenniy) LA in relation to the nearest territories with special conservation status[4]

---

[4] Referenced sources:

Wetlands of Russia - WWF, The Wetlands International's Program for Russia. Official Internet Site at http://www.fesk.ru/

Wetlands of Russia. Volume 3. Prospective Ramsar Wetlands. - M . :Wetlands International Global Series No. 3 , 2000.490 p.

Master Plan and Land Use Regulations for Inter-settlement Areas – Dept. of Infrastructure, Construction and Residential Policy, Tazovskiy Municipal District Council. 2015.

Important Bird Areas. Volume 2. Western Siberian IBA of International Importance – Moscow: Russian Bird Conservation Union (RBCU), 2006. 334 p.

Designated Conservation Areas of Russia: Present-Day and Prospective Status. Eds.: V.G. Krever, M.S. Stishov, I.A. Onufrenya - WWF Russia, 2009.

Russian Bird Conservation Union (RBCU). Official website at http://www.rbcu.ru/

The Atlas issued recently by Arctic Research Center LLC (2016) with the support of Rosneft was a major compilation of a large array of data on the Kara Sea ecosystems and their resistance to anthropogenic impacts.

A number of comprehensive studies were devoted to Gydan's population centers and addressed medical, ecological and epidemiological issues. The results of the studies were published by specialists of Scientific Center for Arctic Exploration (YNAO, Salekhard), Research Institute of Medical Problems of the Far North (YNAO, Nadym), Department of Hospital Pediatrics of the St. Petersburg Pediatric Medical Academy and the Institute of Cytology and Genetics of the Siberian Branch of the Russian Academy of Sciences (Novosibirsk).

In recent years, much attention has been paid to the conservation of biological diversity of the Gydan tundra landscapes, and to this end, in addition to the existing protected areas, of which the one nearest to the proposed Plant site is the Gydan Reserve (108 km to the north-northeast), it is planned to establish Yuribey protected natural landscape of municipal significance (70 km to the southeast of the future LNG and SGC Plant and Terminal, refer to Figure 7.1.1). The territory of the planned DCA has been subjected to detailed environmental studies (Gudovskikh et al., 2016), which demonstrated the need to assign conservation status to this area, to preserve unique complexes of hypoarctic tundra, fish breeding grounds, wildlife nesting sites, and to prevent poaching.

In 2016, the Government of the Yamal-Nenets Autonomous Okrug launched a comprehensive study program for the Gydan Peninsula, the main goal of which was to avoid mistakes during the first wave of the district's industrial development (first and foremost the Yamal Peninsula) and to collect comprehensive background data on Gydan before the start of large-scale development of its hydrocarbon fields. The five-year research program was prepared by the Arctic Research Centre together with the Research Institute of Ecology and Sustainable Use of Natural Resources of the Tyumen State University, Institute of Water and Ecology, Institute of Earth Cryosphere of the Siberian Branch of the Russian Academy of Sciences, Roshydromet's Arctic and Antarctic Research Institute and other research centers and institutes of Moscow, St. Petersburg, Tyumen, Novosibirsk and Irkutsk. Along with integrated ecological-landscape research, the Program provides for the reinstatement of the state environmental monitoring network in Gydan.

Information in this section refers to the published results of the above-listed scientific and applied environmental studies in the Gydan Peninsula and in the water area of the Ob Estuary, but the main attention was paid to the results of pre-FEED engineering survey. The onshore part of the survey was conducted in stages for the territory of the Salmanovskiy (Utrenniy) License Area (FSUE PINRO, 2012), the early field development facilities sites (RusGazEngineering LLC, 2014; EnergoGazEngineering LLC, 2017), the areas of the proposed site of the Plant (together with the area of the required 1,000 m sanitary protection zone) and the Port (TsGEI LLC and Uralgeoproekt LLC, 2017), and for the sites of the field and airport facilities (PurGeoCom LLC, 2017-2019). The borders of the corresponding work sites are shown in Figure 7.1.2. Findings of the above studies are supplemented nowadays by the operational (local) environmental monitoring in the whole license area conducted by IEPI JSC (2018 – to date).

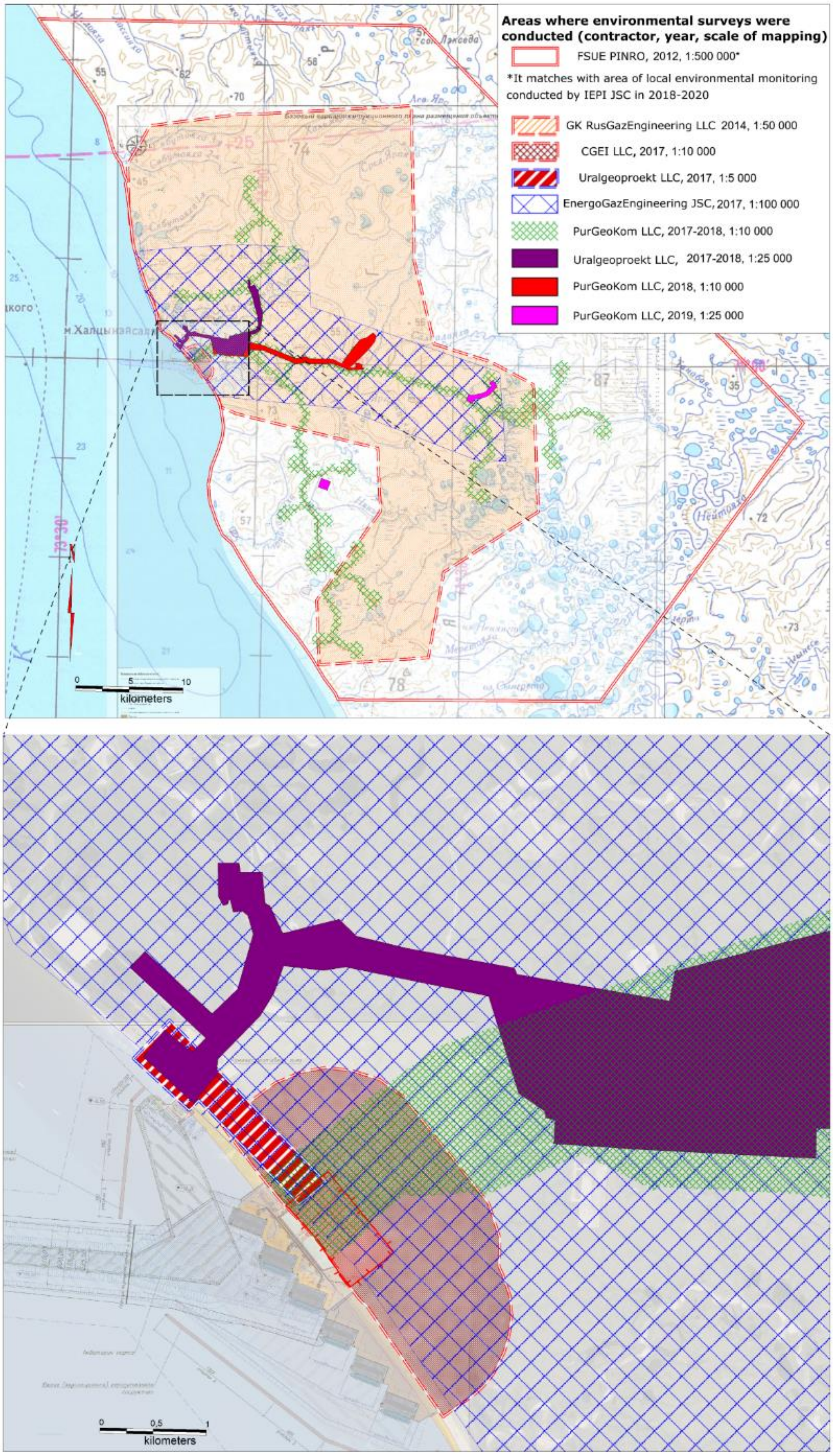


Figure 7.1.2: Borders of survey sites in the Gydan Peninsula

Not less attention is being paid to studying and conservation of aquatic ecosystems of the Kara Sea. In particular, the World Wildlife Fund (WWF) organized comprehensive studies to identify priority areas of the marine environment within the Russian sector of the Arctic for conservation of biodiversity. The first published results of this work provide information on the availability of biodiversity data for specific water areas along the Northern Sea Route: Figure 7.1.3 shows the index map of products of multiplication of the number of independent data sources by the data quality factor.

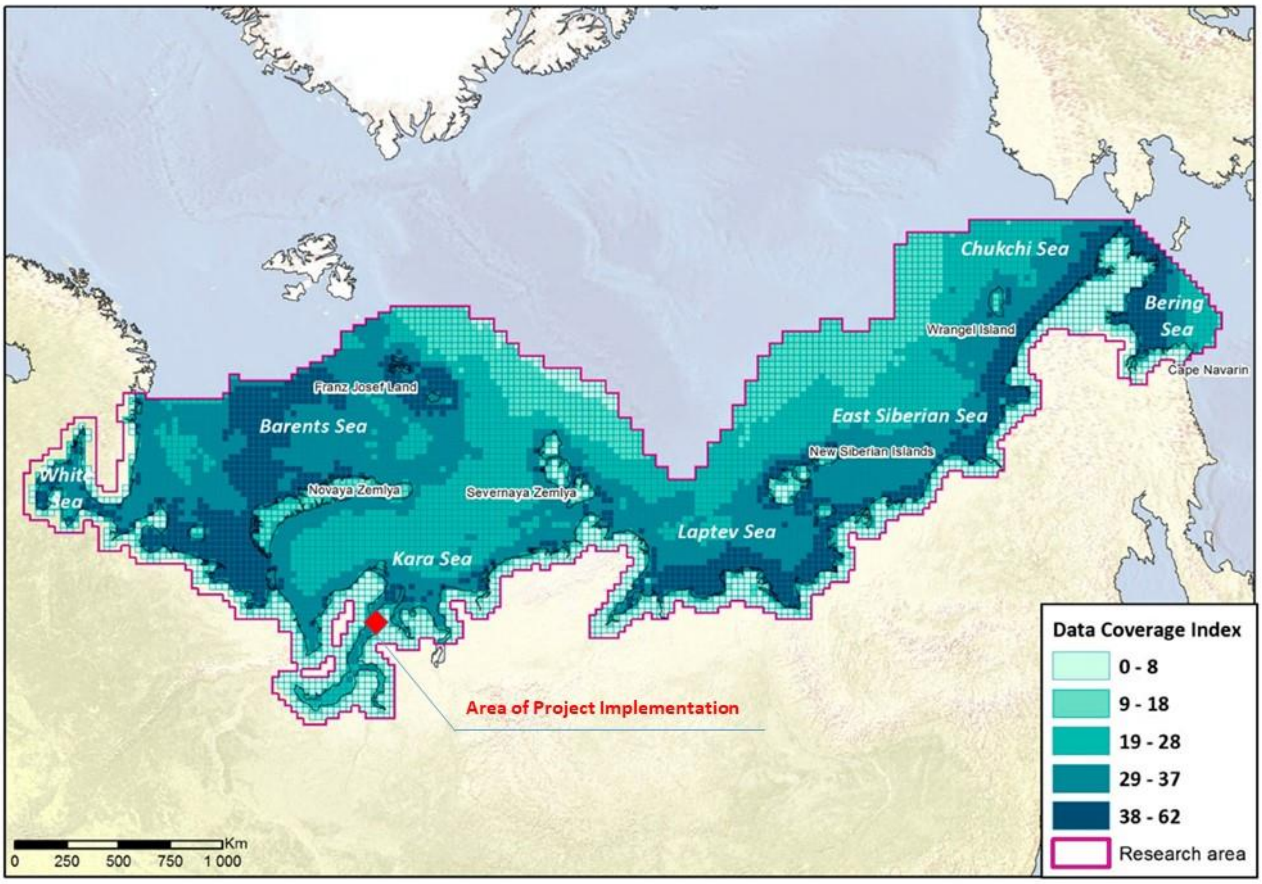


Figure 7.1.3: Availability of biodiversity data for the marine ecosystems of the Russian sector of the Arctic[5]

It can be seen that the level of knowledge about the ecology of the Ob Estuary and outer area of the Ob-Yenisei estuarial system is high compared to other sections of the Kara Sea, and this information is currently supplemented by a significant body of detailed data collected through the environmental surveys and ecological monitoring for the NOVATEK's projects (Figure 7.1.4).

Specifically for the Arctic LNG 2 Project, the offshore part of the survey was conducted by FSUE PINRO FSUE (2012) for the water area of the Ob Estuary within the license area, by EcoExpressService LLC (2013) – for the quayside construction area, by NPF DIEM (2014) – for two alternative Plant location sites, InzhGeo LLC (2017) – for the proposed locations of the Plant facilities, Fertoing LLC (2017) – for the dredging and dumping sites, FPFI AANII (2017) – for the extensive part of the water area including the Plant and Port facilities and extending upstream about 15 km (Figure 7.1.3).

[5] Solovyev B., et al. Identifying a network of priority areas for conservation in the Arctic seas: Practical lessons from Russia // Aquatic Conserv: Mar Freshw Ecosyst. 2017;27(S1):30–51.

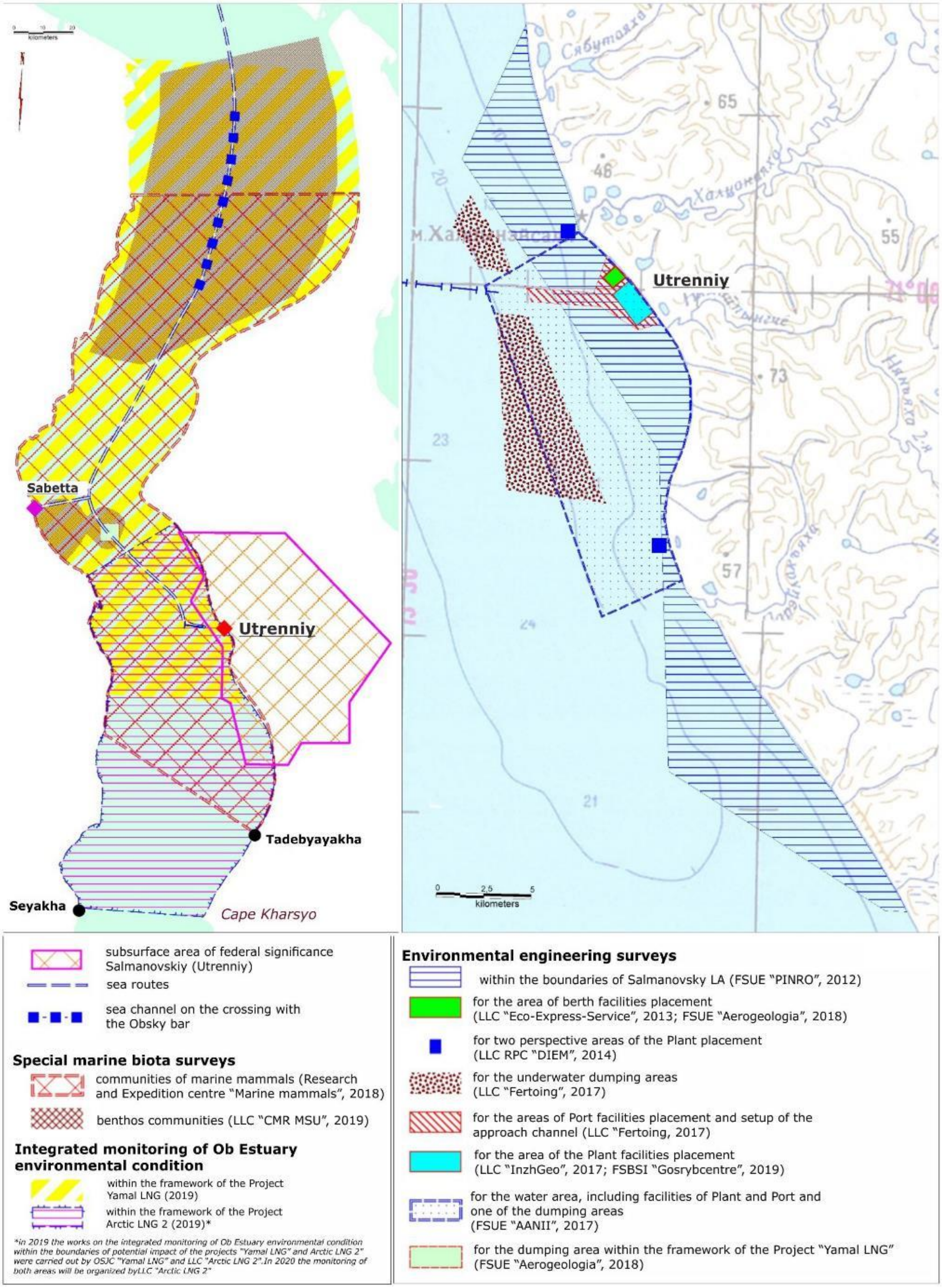


Figure 7.1.4: Boundaries of environmental surveys and ecological monitoring areas in the Ob Estuary

The supplementary studies were focused on the benthic communities in the areas of underwater technical operations (ZMI MGU LLC, 2019), as well as marine mammals communities in vast areas within the Ob Estuary (Marine Mammals Scientific Expedition Center NEZ "Morskiye Mlekopitajushchiye, 2018).

In 2018-2019 two projects with partially overlapping areas – Yamal LNG and Arctic LNG 2 – simultaneously launched the comprehensive monitoring programme for marine ecosystems of the Ob Estuary. The monitoring activities are conducted by FRECOM LLC and IEPI JSC supported by other companies (boundaries of the study areas are shown in Figure 7.1.4). The first results that are available by present are included in this Section. The Operators – OJSC "Yamal LNG" and LLC "Arctic LNG 2" – have agreed the marine environmental monitoring program that they will conduct in turns within the combined area of influence of the two projects; in the current year, LLC "Arctic LNG 2" is responsible for the monitoring.

7.2 Atmospheric Conditions

7.2.1 Climate

According to the Köppen-Geiger classification of climates the proposed site of the Plant and associated facilities is characterized by tundra climate, denoted by the international index "ET"[6]. The B.P. Alisov climatological system[7] adopted in Russia classifies the region as an area with polar climate of Arctic variety, which southern border (the transition to subarctic climate) is defined by the average perennial position of the Arctic atmospheric front and lies 100-200 km south of the Arctic LNG 2 Project sites.

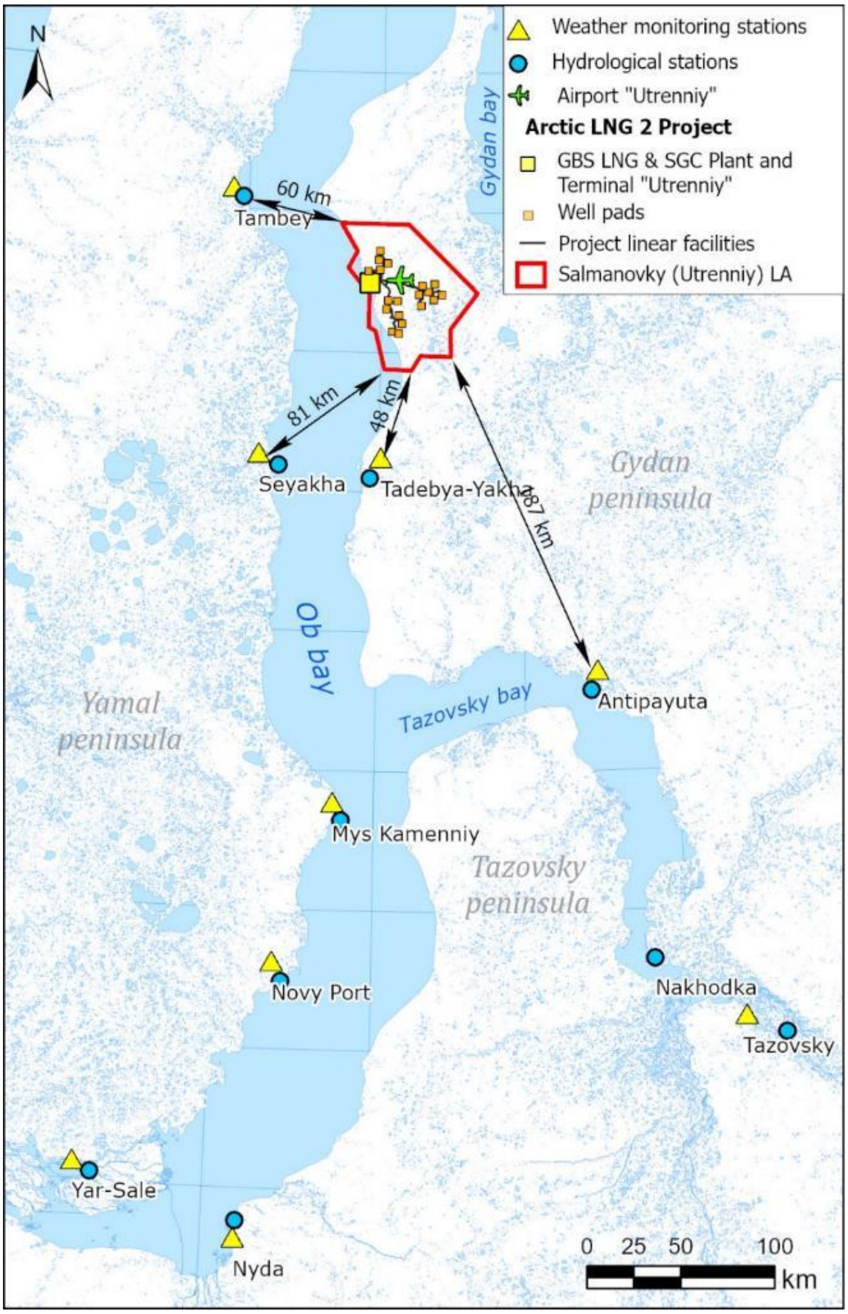


Figure 7.2.1: Weather monitoring stations in the Project area (location of the GBS LNG & SGC Plant is shown for orientation)

The quantitative data on the meteorological conditions of the area under review were recorded over the past 70–80 years by the network of hydrometeorological stations, of which the ones nearest the designated borders of Plant and Port sites are Tadebya-Yakha (70 km south), Seyakha (100 km south-west) and

[6] L. McKnight, Darrel Hess. Climate Zones and Types: The Köppen System // Physical Geography: A Landscape Appreciation. — Upper Saddle River, NJ : Prentice Hall, 2000. — P. 200—201.

7 B. P. Alisov. Geographic types of climates // Meteorology and Hydrology. 1936. No. 6.

Tambey (100 km north-west), see Figure 7.2.1. All three observation points, like the main facilities of the Arctic LNG 2 Project, are located on the coast of the Ob Estuary, which ensures the similarity of their climatic conditions and the possibility of extrapolation of meteorological data.

Common to the climate of the entire Arctic belt is the dominance of Arctic air masses with low temperatures, low absolute and high relative moisture content, and high transparency. The high-latitude geographical position of the region (71° north) determines the low level and pronounced irregularity of solar radiation input depending on the season, and therefore the underlying surface conditions are unsupportive of warming the near-ground atmosphere. Orographic obstacles to the movement of air are practically non-existent, and the relief's impact on the atmospheric circulation can mainly be felt at the micro level. The fact that the Arctic LNG 2 Project is located in the Atlantic sector of the Arctic Region results in its periodic exposure to Atlantic air masses, which is most noticeable during the warm season.

In the context of the ESHIA, the most important climate characteristics are:

- *low temperatures*: the prevalence throughout the year of freezing temperatures in near-ground air with an absolute minimum of approximately minus 52°C; extremely rare recurrence of stable periods with temperatures above 10°C (they are considered active vegetation periods) with the average temperature of the warmest month, August, of around 7.5°C and the absolute historical maximum of 30.1°C; the duration of the frost-free period does not exceed 50-70 days – the standard duration of the heating period is 292 days[8].
- *excessive atmospheric humidity:* the value of the annual humidity factor, defined as the ratio of precipitation and evaporation, is greater than 1.5; about 330 mm of precipitation falls annually, with 43 mm falling in September – the annual maximum;
- *accumulation of bulk precipitation in the snow cover*, average thickness of which at the beginning of the snow-melting period reaches 30-35 cm, and the accumulation period lasts from September to May;
- *seasonal long-term soil freezing* which limits the subsurface runoff and removal of mobile compounds from the active layer with a thickness of 0.2–0.3 m in icy peat to 1.5–1.8 m in sands with low ice content;
- *atmospheric circulation similar to monsoon type* with the prevalence of northerly winds in summer and southerly winds in winter, constantly high air humidity, low frequency of thunderstorms and calm periods, high frequency of cloudiness and advective fogs;
- *high wind loads on the earth's surface* causing a redistribution of snow masses over the relief elements during the cold period of the year and creating favourable conditions for the development of aeolian processes during the short warm period;
- *seasonal alternation of constantly high and constantly low illumination* of the earth's surface.

The conditions listed above ensure a high self-purification capacity of atmospheric air in the proposed location area of the Arctic LNG 2 Project.

7.2.2 Air quality

The main source of information on air quality in the Yamal-Nenets Autonomous Okrug is the state monitoring data published in the form of annual reports "On the environmental situation in the Yamal-Nenets Autonomous Okrug". Samples of near-ground air are taken and tested on a regular basis by two organizations: Center for Hygiene and Epidemiology in YNAO – in Noyabrsk, Nadym, Novy Urengoi, Tarko-Sale, Muravlenko, Salekhard and Labytnangi, and the complex laboratory for monitoring environmental pollution of the Yamal-Nenets Center for Hydrometeorology and Environmental Monitoring – at a single stationary post in the city of Salekhard. The results of their long-term observations show that the air at the sampling sites is in general hygienically safe, and the levels of polluting substances are within the permissible limits.

All posts of the state network for monitoring air quality are located several hundreds of kilometers away from the Plant and Port sites, and cannot serve as a source of background pollutant concentrations for assessing the impact of the planned activity. During preparation of the design documentation, these concentrations were officially requested from the territorial office of Roshydromet, determined by calculation and presented in the form of an information letter (Table 7.2.1).

[8] Territorial Planning Scheme of Tazovskiy Municipal District. - Approve by Resolution of the District Duma of the Tazovskiy Municipal District No. 7-8-91 dated December 16, 2009 (as amended in 2017)

Table 7.2.1: Background and maximum allowable concentrations (mg/m^3) of pollutants in the Arctic LNG 2 Project area

Substances	Background concentration, mg/m^3	Hazard class	MAC $_{o.t./m.d.}$[9]
Dust (suspended particles)	0.195	3	0.5/0.15
Nitrogen dioxide	0.054	3	0.2/0.04
Nitrogen oxide	0.024	3	0.4/0.06
Sulphur dioxide	0.013	3	0.5/0.05
Carbon monoxide	2.4	4	5.0/3.0
Hydrogen sulphide	0.004	2	0.008/ N/a
Benz[a]pyrene	$0.15\cdot10^{-6}$	1	N/a /$1\cdot10^{-6}$

The large concentration of sources of impact on air quality nearest the Plant and Port sites (70 km north-west) is the site of Yamal LNG project facilities including a natural gas liquefaction facility, offshore terminal, airport, residential quarters, and gas field. Environmental monitoring within their area of influence did not reveal any exceedance of MACs and TSELs for a wide range of controlled compounds.

Air sampling and analysis was conducted in 2019 under the local environmental monitoring and operational environmental control programs for different facilities of the Arctic LNG 2 Project including:

- Onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF[10];
- Berth structures at the Salmanovskoye (Utrenneye) OGCF[11];
- Power supply complex No. 2 and gas flow-line from GWP No.16 to Power supply complex No.2[12];
- Producing well stock of GWP No.16 and well No.304P[13].

The program of operational environmental control and local environmental monitoring included spot sampling of air and testing of the following pollutants:

- Nitrogen dioxide;
- Nitrogen monoxide;
- Sulphur dioxide;
- Carbon monoxide;
- Hydrogen sulphide;
- Carbon char (soot);
- Particulate matter;
- Formaldehyde;
- Methanol;
- Ethylbenzene;
- Methane and methane hydrocarbons, etc.

The air quality results of the operational and local environmental monitoring demonstrated that in June, August and September 2019, ground-level concentrations of all controlled components at all sampling points were below the lower detection thresholds of the respective measurement methods (Table 7.2.2), and below the maximum allowable concentrations for air quality in residential areas.

---

[9] One time maximum (o.t.) - short-term exposure limit, and mean daily (m.d.) - annual average limit set in GN 2.1.6.3492-17 for air pollution in urban and rural settlements

[10] Local environmental monitoring of the onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF and operational environmental control of the operational sites. Phase 3.1. Final Report on the environmental monitoring of the Salmanovskoye (Utrenneye) oil, gas and condensate field in 2019. Institute of Environmental Survey, Planning and Assessment (IEPI), M, 2020

[11] LLC "Arctic LNG 2" Report 2019 on the organization and results of the operational environmental control of the Berth structures infrastructure at the Salmanovskoye (Utrenneye) OGCF, IEPI, M, 2020

[12] LLC "Arctic LNG 2" Report 2019 on the organization and results of the operational environmental control of the negative impact facilities (NIF) - Power supply complex No.2, gas flow-line from GWP No.16 to Power supply complex No.2. IEPI, M, 2020

[13] LLC "Arctic LNG 2" Report 2019 on the organization and results of the operational environmental control of the producing well stock, IEPI, M, 2020

Table 7.2.2: Air pollutant detection thresholds and maximum allowable concentrations

Controlled pollutants	Detection threshold	MACo.t.[14]	MACm.d.	Allowable level[15]
Particulate matter	<0.26	0.5	0.15	-
Benz[a]pyrene	<0.0005	-	$1{\cdot}10^{-6}$	
CH_4, % vol.	<0.005			0.0075
CO, mg/m^3	<0.1	5.0	3.0	-
NO, mg/m^3	<0.1	0.4	0.06	-
NO_2, mg/m^3	<0.1	0.2	0.04	-
SO_2, mg/m^3	<0.1	0.5	0.05	
NH_3, mg/m^3	<0.2	0.2	0.04	

7.2.3 Harmful physical impacts

Adverse physical impacts regulated in Russia include ionizing radiation of all known types, noise, vibration, and non-ionizing electromagnetic radiation of various frequency ranges. Due to the fact that the land and water area selected for the Arctic LNG 2 Project consists of undisturbed landscape characterized by localized and low-intensity development, remoteness and low density of sources of harmful physical impacts, the measurements of noise levels under the operational control and local environmental monitoring program in 2018 were conducted at the operational and construction sites of the Arctic LNG 2 Project facilities.

Acoustic conditions in the location area of the Arctic LNG 2 Project are determined by a combination of natural and technogenic sources of sonic vibrations. Among the first, the main role is played by near-ground air movements and wind-caused noises of contacting media – water bodies, vegetation, snow cover, etc. The main anthropogenic source of noise for the land and water area are currently the berth structures and related operations – particularly transport, as well as Power Supply Complex No.2 and well pads. Construction work at the Project facilities also contributes to the acoustic conditions.

The levels of noise measured at two points under the operational environmental control program during three days in 2018 during the maintenance dredging activities in the water area of Utrenniy LNG & SGC Terminal[16] did not exceed the noise limits for residential areas at day and night time (55 dBA and 45 dBA, respectively).

In 2019, the operational environmental monitoring included measurements of noise levels within the scope of the OEC program of the Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup[17]. The measurements were conducted during the construction activity one time during 6 days, at the day and night time. The noise impacts were monitored at two stations in the TSF area (sanitary facilities) at the construction sites of GWP No.16 and the Power Supply Complex, where presence of construction workforce is expected.

Equivalent noise levels within the range of 60.1-67.2 dBA were recorded at the construction site of GWP No.16, with the maximum levels at 72.4-77.8 dBA. Higher levels of noise are reported at the site of Power Supply Complex No.2 – 75.4-79.4 dBA and 86.3-92.4 dBA, respectively. During the whole period of the measurements, the noise levels never exceeded the MAL level for all types of permanent workplaces in industrial premises and territories, which is set at 80 dBA (equivalent sound level) and 95 dBA (maximum sound level). The main components of the sound pressure are the technogenic noises from operational systems.

---

[14] GN 2.1.6.3492-17 "Maximum allowable concentrations (MACs) of polluting substances in air in urban and rural settlements"

[15] GN 2.1.6.2309-07. Outdoor and indoor air, health safety of air. Tentative safe exposure levels (TSEL) of pollutants in the atmospheric air of populated areas. Hygienic standards

[16] Operational Environmental Control Report in relation to dredging activities in the water area of Utrenniy LNG & SGC Terminal, Federal State Unitary R&D Enterprise "AeroGeologia", M. 2018

[17] Local environmental monitoring of the onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF and operational environmental control of the operational sites. Phase 3.3. Final Report on the Operational Environmental Control of the Salmanovskoye oil, gas, and condensate field facilities setup. Gas supply for the power supply facilities to support construction, hydraulic filling and drilling operations. Book 1. Explanatory note. IEPI JSC, M., 2020

Physical factors monitoring during construction of the Utrenniy Terminal facilities was conducted in August and September 2019, at eight points[18].

The main sources of noise were man-caused - operating plant at the berth structures (loading cranes, etc.), watercraft, road traffic, adjacent construction sites, helicopter noise. The resulting noise is a totality of continuous and intermittent fluctuating and pulse noises. The detected natural noises were caused by movement of near-surface air, waves and voices of birds, and their contribution was much smaller.

The levels of noise recorded during different periods are similar. Equivalent noise levels were within the range of 40.2-47.5 dBA, maximum – 52.3-64.7 dBA. The level of noise never exceeded the permissible standard during all periods of measurements.

Radiation-ecological conditions at the designed locations of the Field, Plant and Port are generally favourable and environmentally safe.

The program of all engineering surveys conducted in 2012-2017 included on-foot gamma survey of the territory and a number of related measurements. The total of 630 point measurements of gamma activity and 315 measurements of radon flux density (alpha radioactivity) were carried out within the designated borders of the Plant's onshore facilities. The obtained values are typical for uncontaminated areas with strong Quaternary sediments: γ- activity at 2.9 µR/h corresponds to the ambient dose equivalent of 0.08-0.15 µSv/h and radon flux density not exceeding 25 MBq/m^2·s. Local gamma background anomalies are low-intensity (up to 22 µR/h) and lithogenous: they have been found to be associated with lenses of dark-coloured sands with a relatively high content of radioactive elements.

Similar characteristics of the radiation-ecological situation were obtained in the course of surveys of the onshore Port facilities and the Field, which indicates their homogeneity across a vast area without pronounced radiation anomalies.

In 2018, the environmental monitoring of the Salmanovskoye (Utrenneye) oil, gas and condensate field included radiation-ecological studies[19] comprising:

- Gamma-radiation survey in the key sections with the total area of 6.1 ha within the construction sites and adjacent territory;
- Determination of gamma-ray external dose equivalent (GRDE) at 62 control points.

Samples of soil, water and sediments were subjected to gamma spectrometry analysis in laboratory:

- Determination of specific activity of natural radioactive nuclides (potassium-40, radium-226, thorium-232) and cesium -137, effective specific activity of natural radioactive nuclides in samples of soil and bottom sediments;
- Determination of volumetric activity of cesium-137, total alpha activity, and beta activity in water samples.

Intensity values of background gamma radiation within the whole area of 6.1 ha vary between 0.05 and 0.13 µSv/h, with the average level of 0.09 µSv/h. The gamma-radiation survey did not identify any zones where radiometer readings would exceed the average level for the area by two or more times; the gamma radiation rate is within 0.3 µSv/h. Therefore, no local radiation anomalies are present within the surveyed area, in accordance with p. 5.2.3 of MU 2.6.1.2398-08.

The rate of gamma-ray ambient dose equivalent at the control points within the monitoring area is within the range of 0.07-0.13 µSv/h. Thus, in accordance with the criterion of p.5.8 in MU 2.6.1.2398-08, the surveyed areas meet the sanitary and hygienic safety standards in terms of gamma radiation exposure rates for construction of any facilities without restrictions.

Results of gamma spectrometry analysis of samples of **soil and ground** indicate low activity of natural and technogenic radionuclides (Table 7.2.3).

[18] Local environmental monitoring of the onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF and operational environmental control of the operational sites. Phase 3.2. Operational environmental control of the berth structures infrastructure at the Salmanovskoye (Utrenneye) OGCF. Final Report by IEPI JSC, M., 2019

[19] LLC "Arctic LNG 2" Report 2019 on the organization and results of the operational environmental control of the Berth structures infrastructure at the Salmanovskoye (Utrenneye) OGCF, IEPI, M, 2020

Table 7.2.3: Specific activity of natural radioactive nuclides (NRN) and cesium-137 in samples of soil

Sampling point	Specific activity of natural radioactive nuclides (NRN), Bq/kg			Eff. spec. act., Bq/kg	Cs-137, Bq/kg
	K-40	Ra-226	Th-232		
11-1p	330	14	10	56	less than 3
11-2p	290	10	14	55	less than 3
11-3p	80	less than 8	less than 8	less than 22	less than 3
12-2p	212	17	12	52	3
2-1p	230	9	18	53	less than 3
8-1p	244	less than 8	13	46	less than 3
3-1p	260	12	8	45	less than 3
Background within the Salmanovskiy License Area	522.8	13.6	12.5	-	3

Effective specific activity of NRNs in tested soil varies within the range of 22 to 56 Bq/kg. The measured average and maximum levels of Aeff are by far lower than thresholds for intervention (370 Bq/kg for construction materials for public buildings and facilities in accordance with SanPiN 2.6.1.2523-09 and p. 5.1.5 of SP 2.6.1.2612-10). The maximum measured activity of NRNs does not trigger any restrictions on handling and use of soil. The measured values match the weighted average level of NRN activity characteristic of the whole area of the Yamal-Nenets Autonomous Okrug.

In accordance with the Instruction on gamma-spectrometric determination of technogenic radionuclides in soil samples, the measured specific activity of technogenic isotope ^{137}Cs was compared with the background global precipitation on the earth's surface being 5-15 Bq/kg. Specific activity of ^{137}Cs in soil within the surveyed area does not exceed 3 Bq/kg.

Measured specific activity of NRNs in samples of **bottom sediments** was as follows: less than 9-16 Bq/kg for ^{226}Ra, less than 10-16 Bq/kg for ^{232}Th, 210-370 Bq/kg for 40K.

Effective specific activity of NRNs in tested bottom sediments varies within the range of 31 to 62 Bq/kg. The measured average and maximum levels of Aeff are by far lower than thresholds for intervention (370 Bq/kg for construction materials for public buildings and facilities).

Samples of water from surface water bodies within the surveyed area were sent for spectrometric testing for determination of activity of radioisotopes. Specific total alpha activity varies from less than 0.02 to 0.14 Bq/l, total beta activity is from less than 0.1 to 0.37 Bq/l. These values are by multiple times smaller than threshold levels in p.4.3.2 of SanPiN 2.6.1.2800-10 (0.2 and 1.0 Bq/kg), therefore, further examination of isotopic composition of the waters is unnecessary.

Non-ionizing electromagnetic field of industrial frequency and other frequency ranges within the designated Project sites was not investigated, but, as in the case of the acoustic field, we can assume its natural and non-anomalous character with localized low-intensity disturbances only in the immediate vicinity of the power plants, transformers, power transmission lines and other similar sources located near the wharf, on the sites intended for material and technical resources and personnel.

7.2.4 Conclusions

1. The climate of the area under review is one of the most uncomfortable in Russia due to the high (up to 30%) rate of recurrence of the combination of low temperatures, high humidity and high wind speed; low natural illumination during the polar night; deficit of ultraviolet radiation over 5-6 months; dangerous weather phenomena throughout the year (negative air temperatures, intense precipitation, blizzards, icing, squalls, fogs).
2. The climatic conditions ensure high self-purification capacity of atmospheric air in the proposed location area of the Arctic LNG 2 Project.

3. The level of harmful physical impacts within the Salmanovskiy (Utrenniy) License Area is mainly determined by natural factors and by the operation of the existing Field facilities.
4. In the absence of local technogenic sources of ionizing radiation, the corresponding indicators for the land and water areas under review also correspond to natural values and, to a lesser extent, to the impact of remote sources. Surveys within the designated borders of the Plant, Port and Field did not reveal any anomalies in gamma background or other ionizing radiation parameters, which current level is determined by the presence of gamma-ray sources scattered throughout the soil cover and the geological environment, as well as their influx with cosmic radiation and the presence of radioactive elements of different origin in atmospheric aerosols.
5. In general, it can be concluded that background level of air pollution and harmful physical impacts in the area of the Arctic LNG 2 Project facilities is safe for humans and biota.

7.3 Surface Water

7.3.1 The Ob Estuary

7.3.1.1 General

The Ob Estuary is the largest among the bays of the Kara Sea and at the same time the closing waterbody of the Ob River basin which is the inundable (liman-type), microtidal and heavily stratified estuary. The estuary is around 800 km long and from 30 to 75 km wide whereas its depths are relatively small and vary from 10-12 m in the south to 20-22 m in the north.

The total water area of the Ob Estuary is 40,800 km^2 with average water capacity of about 400 km^3. A close value – 400-450 km^3/year – is typical for the annual river water inflow to the Arctic Ocean from the Ob basin. The Ob River accounts roughly for 75 % of this volume and the rest is delivered to the Ob Estuary by tributaries, groundwater, and atmospheric precipitation. The fresh-water area is about 30,000 km^2. The Ob Estuary drains the onshore areas and also acts as a heat sink, therefore, its water is diluted with fresh water and relatively well warmed.

The Ob ranks first in Russia by the catchment area and stretches through a few natural zones, highlands and lowlands. The largest part of the watershed is represented by the weakly drained and heavily waterlogged West Siberian Plain that functions as a natural regulator of river flow and determines water and bottom sediment chemistry, including near the mouth. The Ob Estuary features a variety of soil types: sandy and sandy-silt soils prevail in the delta area; all nearshore areas of the Estuary are covered with sand that gradually becomes silted with increasing water depth; bluish-grey silts cover the bottom in the deep-water areas. There are no pebble or rocky soils in the Ob Estuary.

The Ob Estuary is entirely situated in the tundra zone characteristic of the harsh arctic and subarctic climate; in the central and northern parts, it drains areas with ubiquitous permafrost occurrence. At that, the waterbody is distinguished with intricate hydrodynamic behavior resulting from the interplay of sea and river waters against the background of the multidirectional tidal and wind-driven circulation, various ice events, and complex coastline lithodynamics.

The hydrological regime of the Ob Estuary is non-uniform because of its long stretch in the meridional direction and related differences of hydrological, hydrochemical, and hydrobiological characteristics. Therefore, it is commonly accepted to divide the Ob Estuary into three parts with respect to natural conditions: river (southern) – from the Ob River mouth to the line of 70^o NL , central – from parallel 70^o NL down to the line connecting the Tambey River mouth (Yamal peninsula) and Cape Taran on Gydanskiy peninsula (the Port and Plant's location), and northern – from Cape Taran as far as the outlet to the Kara Sea (Figure 7.3.1). Processes in the "river" part that does not contact saline sea water are defined by the river flow. In the "sea" part with the southern boundary drawn by isohaline 0.5 ‰, river and sea waters are mixed. Between these two parts, there is an intermediate area exposed to intermittent influences of the mixing zone through the tidal and wind-driven circulation (IEPI, 2020)[20].

Information provided in this Section largely refers to the central and northern parts of the Ob Estuary and to the water area that either will be engaged in the planned activity or will be exposed to its impacts (Figure 7.3.1).

[20] Final Report on the Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas, Phase 3. Book 2. IEPI, Moscow, 2020.

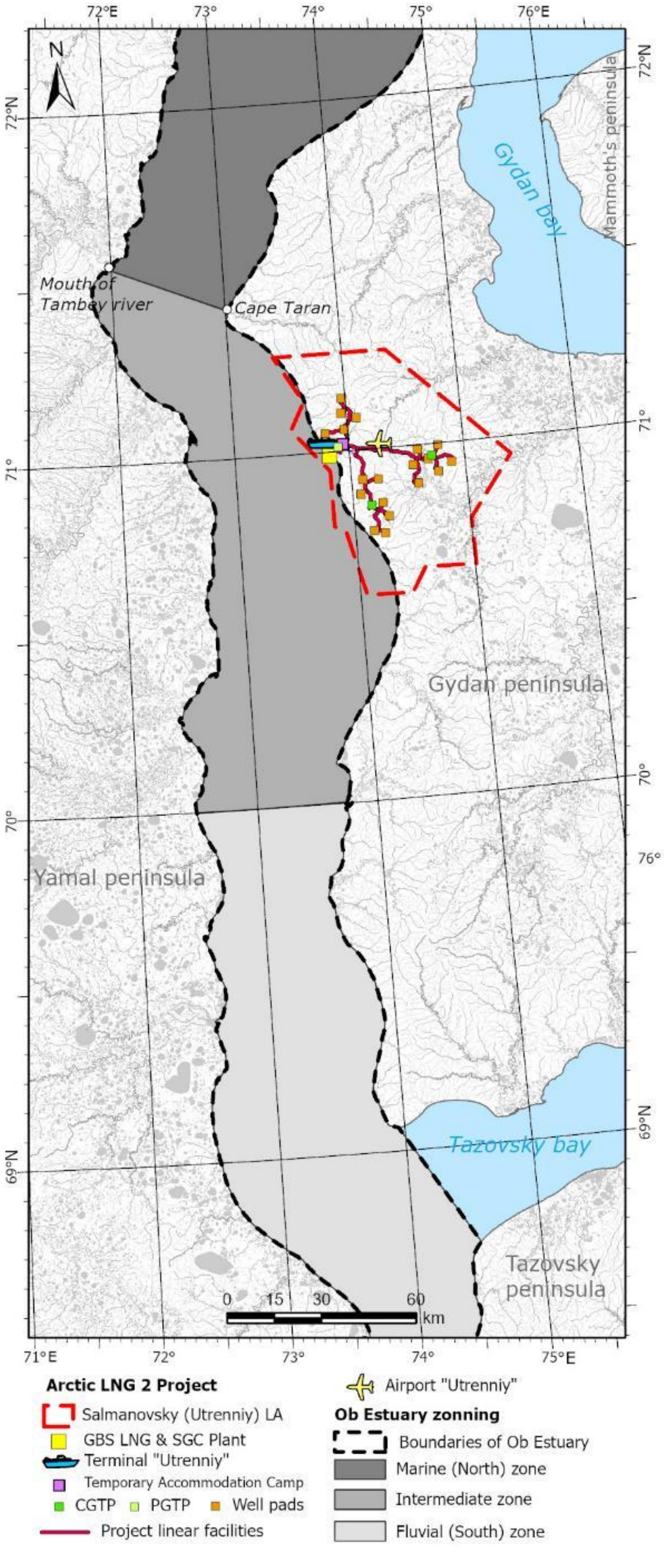


Figure 7.3.1: Hydrological and thermohaline zoning of the Ob Estuary

Source: IEPI 2020

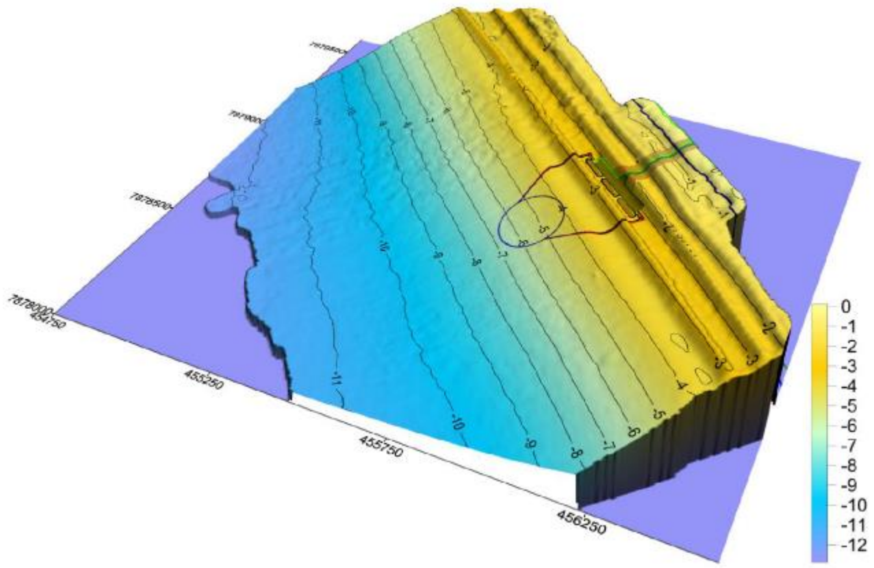


Figure 7.3.2: Bathymetric data of the Ob Estuary water area in the area of the existing berth structures (1 km north from the Plant's boundary)

Source: LNG NOVAENGINEERING LLC, 2018[21]

7.3.1.2 Hydrologic and ice conditions of the Ob Estuary

The river flow is a major and permanent factor that persistently affects water and ice patterns of the Ob Estuary. A branched network of tundra rivers that comprises numerous lakes supplies the estuary with additional water owing to a spacious water catchment of the West Siberian Plain. Also, the wind pattern dramatically influences hydrology of the Ob Estuary. In the summertime, winds facilitate water mixing and its saturation with oxygen. During winter seasons, winds influence tidal currents either intensifying or weakening them. In autumn, winds prevent freezing by breaking ice and carrying it away to the open spaces of the estuary.

The water level patterns of the Ob-Taz Estuary are shaped under the influence of tidal and wind-induced events and depend on morphology of the river channel and ice conditions. Tidal waves, 0.5 m high in the Kara Sea, rise 2-3 times higher at the entrance to the narrow section of the bay and then gradually come down actually to zero in the middle of the Ob delta.

The water level in the estuary drops (downsurges) during periods of long-duration winds of south bearings. Upsurges (water level rising) are induced by north, west and north-west winds. South-west winds may cause some level rising. Wind-driven level fluctuations are more intensive at the south boundary of the estuarine coastal area (Cape Yam-Sale). The highest upsurges over the observation period in the northern part of the Ob Estuary were registered at the 60-letiye VLKSM observation station – 1.10 m and at the Tambey station – 0.80 m. The highest downsurge values marked at these stations were 0.87 and 0.61 m, respectively (FPFI AANII, 2012[22]).

Water levels in the Ob Estuary have a well-pronounced seasonal trend conditioned by a strong influence of spring flood runoff from local catchments of influent rivers. Commonly, mean monthly levels recorded at almost all stations are higher in May–July than in other months and lower over March-April periods. An elevated water table nearby the north boundary of the estuary is also marked in December–February.

Mean, maximum and minimum water levels according to monitoring data of the marine hydrometeorological station Tambey are:

- Mean multi-year water level – minus 29 cm BSD-77 (Baltic Sea Datum);
- Maximal design annual level with 100-year frequency – 128 cm BSD;
- Maximal design annual level with 50-year frequency – 118 cm BSD;
- Maximal design annual level with 20-year frequency – minus 147 cm BSD.

[21] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Technical report on results of environmental survey. Subsection 1. Offshore facilities. 2017-423-M-02-ИЭИ1.1 (3000-P-NE-SRV-04.01.01.00.00-00). LNG NOVAENGINEERING LLC, 2018

22 Technical Memo "Summary of Archive and Field Data on Hydrometeorological and Ice Conditions in the Area of the Salmanovskoye Field (northern part of the Ob Estuary) in Support of Pre-Project Development of the Material Offloading Facility Concept". – FPFI ANII, 2012.

During field studies in the vicinity of the Salmanovskiy (Utrenniy) license area (AANII, 2017[23]) in April-June 2017, a span of water level fluctuations near the berth structures was 127 cm. Level variations caused by wind-driven events ranged up to 91.4 cm.

Permanent, tidal and wind currents are observed in the Ob Estuary. Permanent currents originate from the Ob flow and are directed northward; their velocity does not excel 0.05-0.1 m/s. Tidal currents with a velocity up to 0.6-0.7 m/s occur in the far north-western section of the Ob Estuary. Wind currents are associated with north and south winds.

Velocity of summary currents in the surface layer is as high as 1.4 m/s. Maximum velocity in the bottom layer (20 m) is 0.48 m/s. Maximum frequency of summary currents is marked in the surface layer in the north and south directions.

Analysis of the spatial and time variations of current velocities in the middle and northern zones of the Ob Estuary (Final Report on the Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas, IEPI 2020) showed that north-bound transport process is observed throughout the eastern part of the Ob Estuary (at the right shore), mainly due to the permanent current generated by the rivers discharging into the southern sections of the Ob and Taz Estuaries. In the studied area, permanent currents follow north-eastern direction, however in general they are defined by the configuration and orientation of the coastline.

Significant influx of water from the Kara Sea is observed in the bottom layer in the northern and middle sections of the Ob Estuary. Average monthly velocity of such currents is generally as low as few centimeters. The influx onsets at the western shore and further develops along the central channel through the deepest sections.

Wind waves in the Ob Estuary are generated during the ice-free season (July-October). Stronger wind waves in the water area are generated under the action of north and south winds. Nature and intensity of the wave agitation largely depend on the ice situation in the Kara Sea, because it determines wave fetch, and on wind conditions. Stronger wind waves are generated under the action of steady north and south winds. Frequency of waves 1 m in height and less is 50-60% during the overall navigation period. At a wind speed of 10-15 m/s, average wave heights are between 1.0 m and 1.5 m. The number of days with storms in the Ob Estuary is about 40% (Table 7.3.1). Waves sometimes may be as high as 4 to 5 m.

Table 7.3.1: Wave conditions recurrence in the Ob section of the Kara Sea

Wave height, m	Wave conditions recurrence by months, %				
	July	August	September	October	July-October
<1	66	65	57	52	60
1-2	23	23	25	22	23
2-3	10.5	11.5	17	25	16
3-5	0.5	0.5	1	1	1

Source: FPFI AANII, 2012[24]

Easterly and westerly winds give rise to the formation of big hummocks along the estuary coastline.

The natural navigable period in the estuary is as short as 70-90 days and can be merely extended using icebreakers. By monitoring data of the Tambey station, the ice season duration in the Ob Estuary is from 275 to 290 days. Its maximum was recorded in the vicinity of Tambey settlement (322 days). The duration minimum of 271 days was registered at the Tambey monitoring station, and 266 days at other stations. The estuary is free of ice between July and October. Ice cover is at its maximum in April-May and a mean thickness of fast ice is 150 cm during these months. The maximum ice thickness is 240 cm. Measurements taken near the berth structures in April 2017 indicated that the ice thickness varied from 94 cm to 200 cm and was 140 cm on an average.

First ice appears at the end of the autumn cooling period. Water freezing starts with young coastal ice in near-shore areas that gradually develops into fast ice. Over the entire ice season, tidal cracks develop along the estuary shoreline at a 20-180 m distance from the shore. Hummocks may build shore-parallel ridges, three and more in number, along the cracks.

23 Utrenniy Liquefied Natural Gas and Stabilised Gas Condensate Terminal. Technical Report on results of the engineering and hydrometeorological survey (processing and review of monitoring data collected during field studies in the 2016/2017 ice season). vol. 5.3. FPFI AANII, 2017

24 Technical Memo "Summary of Archive and Field Data on Hydrometeorological and Ice Conditions in the Area of the Salmanovskoye Field in Support of Pre-Project Development of the Material Offloading Facility Concept". FPFI AANII, 2012

Ice ridging in the Ob Estuary intensifies from south to north. Moreover, depending on the wind speed and direction during the ice drifting period, heavily ridged ice sections (patches) may stretch forth for dozens of kilometers. A higher measured height of the "sail" portion of ice ridges is 300 cm and constituent ice blocks are 140 cm thick.

Ice exaration processes are common within the surveyed area. Grounded ice hummocks (so-called stamukhas) are usually located on land-fast ice at depths of more than 6-8 m. Ice exaration was studied in the area of the Plant siting in 2014. The studies revealed that the seabed was densely covered with gouges at depths of more than 9-10 m. At 8-15 m depths, there is a likelihood of gouges of up to 1.5 m in depth and 3-5 km in length. The alongshore direction of gouges predominates. Gouging is pervasive at 11-22 m depths; dominating are gouges of 1-2 m in depth and above 7 km in length.

An inherent feature of the May-July ice pattern in the northern part of the estuary is presence of the flaw polynya. Its boundary changes the position both throughout the year and from year to year depending on the severity of winter.

According to the weather monitoring data, ice completely disappears in the studied section of the Ob Estuary by the third decade of July, on an average.

In summer, water temperature on the estuary surface follows the air temperature trend and tends to dropping from south to north. Near-bottom water temperature in the northern part of the estuary may be below 0° C. In winter, freshwater temperature is around 0° C and takes negative values in the north of the estuary.

The salinity interface (halocline brought about by a strong vertical salinity gradient in the water column) in the northern part of the estuary is bent towards the estuary in near-bottom layers and exposed to significant migrations. Intra-annual river flow fluctuations contribute at most to this section shifting. In the summertime, seawater with 30% salinity permeates through the estuary for around 10 km. Saline water spreads inwards the estuary at a distance of 210 km in autumn and up to 340 km in winter. In winter, salinity in the northern part of the Ob Estuary has vertical distribution: it is 8.0-9.0‰ near the surface and up to 18.0-19.0‰ near the bottom. A difference in salinity between the surface and bottom layers in the summer season is not that pronounced: surface water salinity is 1-2‰ in July and 5‰ in September. In summer, salinity is 6-9‰ at a depth of 8 m.

The waters in the southern section of the Ob Estuary are fresh. In winter, water salinity in the middle part of the Ob Estuary slightly increases. In the northern section, the diluted water flows upon layers of salty sea water, i.e. only one third part at the top of the water column is fresh. Water salinity measurements in the estuary within the Salmanovsky (Utrenny) license area performed by SPG ENGINEERING in 2018 demonstrated homogeneity of the thermohaline parameters of water column in summer, due to the strong impact of fresh-water river flow. E.g., average measured salinity in the surface and bottom layers was 1 permille and 1.22 permille, respectively. In winter, when river flow is minimal, the difference in salinity between the surface and bottom layers of water can be as large as 20 permille.

Table 7.3.2 summarises data on salinity of the Ob Estuary water area within the water area of the Plant and Port construction.

Table 7.3.2: Average and extreme water salinity levels at the standard depths in the area of the Salmanovskoye (Utrenneye) OGCF during the periods with and without ice, permille

Water layer, м	Summer (July-September, 2012-2017)			Winter (February-April, 2012 & 2017-2018)		
	Minimum	Average	Maximum	Minimum	Average	Maximum
0	0,04	0,99	1,26	2,43	4,68	4,86
5	0,04	1,00	1,26	2,50	4,73	5,43
10	0,04	1,09	1,31	3,0	8,73	14,8
Bottom layer	0,04	1,22	1,59	8,68	11,89	25,09

Source: LNG NOVAENGINEERING LLC, 2018[25]

In 2019, the Institute of Environmental Survey, Planning and Assessment (IEPI JSC) conducted marine survey within the scope of the Comprehensive environmental studies of the Ob Estuary in the area of

[25] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Design documentation. Section 3. Technical report on results of hydrometeorological survey. Subsection 1. Offshore facilities. Book 1. Text part. Explanatory note. Document code 2017-423-M-02-ИГМИ1.1. VOL. 3.1.1 LNG NOVAENGINEERING LLC, 2018.

potential impact of the Arctic LNG 2 Project and adjacent water areas, and determined the following parameters:

- Vertical distribution of water temperature, salinity and turbidity;
- Velocity and direction of currents;
- Water transparency.

The marine ecology survey was conducted during 17-22 September 2019, concurrently with construction of the Utrenniy Terminal and maintenance dredging activities in the Port water area.

Conclusion from survey:

- Spatial variations of water temperature and salinity are small, whereas temperature of the surface layer is only slightly higher than at the bottom.
- In terms of salinity distribution, situation is quite the opposite: average salinity in the bottom layer is higher than at the surface, which reflects the natural hydrological conditions of the Ob Estuary.
- Turbidity in the bottom layer is also slightly higher.
- Transparency depth at all monitoring stations varied between 0.5 and 1.5 m, which is within the typical range for the Ob Estuary and correlates well with the published and historical data.

Therefore, findings of the field survey demonstrated that spatial distribution of hydrological parameters (water temperature, salinity, turbidity, as well as velocity and direction of currents) generally match the background values characteristic of the studied section of the Ob Estuary in the given period of the year.

7.3.1.3 Hydrochemical parameters of the Ob Estuary

The chemical composition of the central part of the Ob Estuary results from the dynamic interaction and contacting of freshwater flow and seawater running from the Kara Sea through the Ob bar. The transition zone, which hydrochemical parameters are prone to seasonal and yearly variability, extends for several hundreds of kilometers. By modeling and monitoring data, it almost reaches the Taz Estuary[26].

Hydrochemical characteristics of the Ob Estuary are based on the Inzhgeo LLC survey 2017 in the water area of the Plant and Port hydraulic structures, supplemented by the comprehensive studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project conducted in 2019 (IEPI, 2020)[27].

Chloride ions predominated in the salt composition; the concentration of chlorides in water varied over a range of 120.7-134.9 mg/dm³, the content of sulfates was much lower – within 2.69-2.88 mg/dm³. The content of hydrocarbonates ranged from 79.3 to 85.4 mg/dm³. Sodium and potassium varied over 71.5-81.5 mg/dm³.

Total hardness of water varied within 2.0-2.2 mg-eq/dm³, which is considerably higher than total hardness of river flows. Water in the Ob River is categorised as "very soft" whereas water in the Ob Estuary falls under the "soft" category.

Surface water of the estuary pertains to the group of neutral (6.5-7.5 pH units) and weak alkaline (7.5-8.5 pH units) compounds. Hydrogen contained in the studied samples varied from 6.98 to 7.61 units and was 7.48 pH units at an average. According to the survey conducted in 2019, water in the Ob Estuary is weak alkaline - 7.65-7.98 pH units.

The dissolved oxygen concentration in water samples – 8.2-8.8 mg O_2/dm^3 – was in conformity to regulations (6 mg/l, minimum). Absolute concentrations of dissolved oxygen measured in 2019 varied between 10.72 mg/l and 13.58 mg/l and never dropped below the standard limit.

Chemical oxygen demand (COD) in a few samples exceeded MPC (30mg O_2/dm^3; regional background – 32.8 mg O_2/dm^3) both in the surface and in the bottom layer. The exceedances fluctuated from 1.1 to 5.3 MPC. COD in other samples was either below MPC or below the sensitivity of the measuring method, i.e. less than 10 mg O_2/dm^3. Elevated COD levels (more than 30 mg/l) were recorded in a half of the samples tested in 2019. Apparently, dissolved oxygen is consumed to oxidize organic matter which is carried in abundant quantities by the Siberian rivers, and for the extensive chemical, biochemical and physicochemical processes in the mixing zone of sea and river water. The high COD levels indicate the natural conditions of the Ob Estuary rather than technogenic pollution.

---

[26] N. A. Diansky et al. Assessment of impact of the access channel to the Sabetta Port on the change of hydrology of the Ob Estuary using numerical simulation // Scientific Research in the Arctic. The Arctic: Ecology and Economy. 2015. No. 3 (19). pp. 18-28.

[27] Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas. Final Report. Phase 3. Book 1. IEPI JSC. 2020. 287 p.

Biochemical oxygen demand (BOD) varied over 3.5-5.4 mg O_2/dm^3 and was 3.7 mg O_2/dm^3 on an average, which is beyond regulatory 2.1 mg O_2/dm^3 established for fisheries. In surface water, BOD_5 values are apt to seasonal and daily fluctuations that depend on the water-dissolved oxygen concentration and on temperature. The BOD intra-annual dynamics exhibit three maximums: at the end of the ice season (March-April), in the warmest season (July), and at the beginning of the ice season (November). The maximum ingress of readily oxidisable organic matter occurs with groundwater in the late subglacial period. The summer maximum relates to the temperature rise. Higher BOD_5 levels are inherent in waterbodies fed by bogs which are abundant in the surveyed area. In 2019, BOD_5 levels in the studied water area varied within the range of 0.50-1.8 mgO_2/l and satisfied the applicable requirements.

A specific feature of West Siberian natural waters is elevated content of ammonium compounds. In the natural conditions, the concentration of ammonium compounds exhibits natural variations due to photosynthesis processes in aquatic ecosystems: their concentration decreases during spring and summer seasons as a result of assimilation by plants and increases in autumn and winter in response to the enhancing organic matter decomposition. As established by the studies performed in summer 2019, the maximum concentration of ammonium nitrogen in the Ob Estuary within the Arctic LNG 2 Project AoI was 50 µg/l and did not exceed the set MAC limit (2900 µg/l). According to the reported data, ammonium concentration varied within the range from less than 20 µg/l (2018) to 860 µg/l (2015) (IEPI, 2020).

The content of nitrite ions in the samples is within MPC and in some samples it is even lower than the sensitivity of the measuring method – below 0.003 mg/l. Nitrogen nitrite levels in the tested samples in 2019 did not exceed 0.005 mg/l. Nitrite ions were also traced at a low level from 0.7 to 4.5 mg/l, 1.6 mg/l at an average, which is considerably below regulatory 40.0 mg/l. Also, the level of nitrates in 2019 was far below the limit value.

Content of phosphates which are actively consumed by phytoplankton, phytobenthos and aquatic higher plants depends on the phase of life activity of biota in the water body. During 2012-2018, phosphate concentrations varies between 5 µg/l and 140 µg/l, without exceeding the permissible level of 150 µg/l. Concentrations measured in 2019 were consistent with the phosphate values reported by the previous studies.

Sulphate content in the tested samples varied from below the detection threshold of the measurement method (less than 25 mg/l) to 50 mg/l and never exceeded the fishery water standard of 2500 mg/l. The previous studies reported sulphate concentrations in the Ob Estuary water within the level of year 2015 – 37 mg/l. Concentration of chlorides ranges between 19 mg/l and 340 mg/l and correlates well with the historical data.

Magnesium levels in the Ob Estuary water vary from 2.5 mg/l to 26 mg/l and never exceed the limit value of 940 mg/l. According to historical data, Mg concentration in water in year 2013 did not rise above 15 mg/l. Sodium concentration in the Ob Estuary water varies within a wide range: from 5.9 mg/l to 127 mg/l. Maximum concentration of sodium in water in 2015 was 81.5 mg/l. Given the standard limit of 7100 mg/l, no excessive levels of sodium in the Ob Estuary water are ported at present or historically.

All waterbodies in the Ob-Irtysh basin feature elevated levels of total iron in water. Exceedances of the limit value for iron (0.05 mg/l) have been reported in the studied area throughout the period of previous surveys, with the exception of year 2017. The following maximum levels of iron in the Ob Estuary have been reported: in 2013 – 1.27 mg/l, in 2014 – 0.23 mg/l, in 2015 – 0.102 mg/l, in 2018 – 3.8 mg/l. The high levels of iron in water of the Ob Estuary is consistent with the geochemical background at the regional level which also exceeds MPC_{fish} by 12.6 times.

7.3.1.4 Chemical contamination of water in the Ob Estuary

Studies of the Ob Estuary water quality in the ranges of the Salmanovskoye (Utrenneye) OGCF, including in the LA offshore area, have been conducted since 2012 as part of environmental surveys for preparation of the design documentation (2013) and in the course of environmental monitoring (2015) during berth infrastructure construction, the operational environmental control and local environmental monitoring, as well as Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas (IEPI, 2019). This section of the ESHIA refers to the following sources of data:

- Operational environmental control (OEC) and local environmental monitoring (LEM) at the Salmanovskoye OGCF berth structures 2018-2019[28][29];
- IEPI JSC Final Report on the Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas;
- Technical Report of Inzhgeo LLC[30], having conducted surveys in the offshore area of the Plant in 2017, with account of data from earlier surveys that allow assessment of the Ob water quality dynamics in the studied region from 2012.

According to the Federal Agency for Fishery, the Ob Estuary is classified as water object of the top fishery category. The extent of water pollution is assessed against the maximum permissible concentrations (MPC_{fish}) of chemical elements in water bodies of fishery importance, or in absence of such limits – against the standards for water bodies used for public water supply, amenity, domestic and drinking water production. The main controlled parameters are suspended solids, phenols, petroleum products, heavy metals, surfactants, benzo[a]pyrene.

Testing results in 2013 and 2017

Background levels of suspended solids measured in 2013[31] in the Ob Estuary water within the area of the Salmanovskoye (Utrenneye) field varied within the narrow range of 14.8–17.6 mg/dm³. A maximum concentration of suspended solids, 24.8 mg/dm³ (MPCfish 10 mg/dm³), was detected in the littoral zone. Suspended solids concentrations measured during survey in August 2017 (Inzhgeo, 2017) after the dredging works varied from 40 to 970 mg/dm^3 with 311.9 mg/dm^3 on an average in the samples taken from the surface layer and 92.3 mg/dm^3 in the samples from the deeper layers.

By the results of the baseline studies of 2013, the averaged surface water sample had a 3.22-fold exceedance of MPC_{fish} by nickel and 1.08-fold exceedance by arsenic. A 1.17-fold exceedance of MPC_{fish} by nickel was detected in the averaged sample of bottom water. No seawater contamination with heavy metals was found in the samples in 2017. Contents of mercury, copper, lead and cadmium in surface layers were below the sensitivity threshold of the measuring method.

Baseline studies in 2013 included measurements of highly toxic carcinogenic substances - benzo[a]pyrene and organochlorine compounds. Benzo[a]pyrene was not found in water samples from the Ob Estuary – its concentration was below the detection threshold (0.5 ng/dm³). Concentrations of organochlorine compounds too were below the detection threshold in 100% of the samples. Survey 2017 did not detect these pollutants in the sea water either.

Petroleum products in a majority of the water samples taken from the surface and from the seabed are within the MPC_{fish} limit of 0.05 mg/dm³. The content of petroleum products on the shorefront was higher than MPC_{fish} by a factor 1.1-1.6 in some samples from the bottom layer.

During the baseline studies in 2013, concentrations of phenols, viz. products of the biochemical decomposition and transformation of organic compounds, did not exceed the background levels in the Lower Ob - 0.0005 mg/dm^3. In 2017, concentrations of phenols were slidghly higher than permissible limit (MPC_{fish} - 0.001 mg/dm³) and were 1.3*MPC_{fish} at an average and 2.4*MPC_{fish} at a maximum.

Increased levels of iron were reported by all surveys. Iron content in all samples exceeded MPC_{fish} by 15 (2013) to 20 times (2017).

Results of the operational environmental control (2018) and local environmental monitoring (2019)

Activities under **OEC 2018** included taking water samples at the point of discharge of treated wastewater into the Ob Estuary, and at three points located 500 off the discharge point (to the south-east, north-west, and south-west of the discharge outlet). The controlled parameters included BOD_5, suspended solids, petroleum products, COD, total dissolved solids, temperature, pH, dissolved oxygen, and general properties of water (odour, colour, transparency, floating matter).

---

[28] LLC "Arctic LNG 2" Report 2018 on the organization and results of the operational environmental control of the Berth structures infrastructure at the Salmanovskoye (Utrenneye) OGCF - Moscow, 2018, 130 p.

[29] Local environmental monitoring of the onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF and operational environmental control of the operational sites. Operational environmental control of the berth structures infrastructure at the Salmanovskoye (Utrenneye) OGCF. Final Report. - Moscow, 2019. 300 p.

[30] Technical Report of Inzhgeo LLC based on the environmental survey for preparation of design documentation "GBS Plant for production, storage and offloading of liquefied natural gas and stabilized gas condensate", 2017.

[31] Technical report on design survey. Environmental survey. Berth structures infrastructure at Salmanovskoye (Utrenneye) OGCF. Morstrojtechnologia LLC, 2013

No failures of the applicable standards were detected:

- Suspended solids concentrations at the discharge point met the requirement set in the Decision on the water body allocation for use (10 mg/l);
- Content of petroleum products was not greater than 0.05 mg/l;
- BOD_5 in all samples varied between less than 0.5 mgO_2/l and 0.95 mgO_2/l (standard limit is 2.1 mg/l at 20ºC);
- Total dissolved solids varied from 50 mg/l to 200 mg/l, whereas the standard limit is 1000 mg/l.

Elevated COD values were measured in two samples taken at one point (SW of the discharge point) in August and July, that exceeded the MPC value by 3.3 and 1.5 times, respectively. No exceedance was reported in September.

Water sampling for **LEM 2019** was conducted at 5 stations and covered two testing horizons (Figure 7.3.3). The monitoring stations are arranged as follows: two stations at the outer corners of the quay wall, and three stations in the marine area away from the berth. The location scheme of the sea water pollution monitoring stations is shown in Figure 7.3.4.

Sampling point coordinates, sample indices, sampling depth, and water temperature were registered at each station. In addition, records were kept of the observed colour, odour, abnormal turbidity, surface film, foam and other objects on water surface, death of fish and other aquatic organisms.

Figure 7.3.3: Taking seawater samples from boat (left) and from the quay wall (right). Source: LEM, 2019[32]

In most cases, the integral quality parameters of the tested water were within the limits set by SanPiN 2.1.5.980-00, however, with minor deviations of a number of indicators.

All samples demonstrated the odour values of between 0 (mainly in August-September) and 1 unit (mainly in July), transparency from 21 to >30 cm, and presence of colour. Hydrogen index varied between 6.8 and 7.9 units meaning that the water is neutral/weak alkaline. Based on the oxidation-reduction potential ((-50)-(-76) mV), water in all periods of testing can be characterized as reducing medium. Dissolved oxygen concentrations in water varied between 7.4 and 10 mg/dm^3. BOD_5 was within 1.4 mgO_2/dm^3. About half of the samples (13 out of 30) taken from both horizons had slightly elevated (less than twofold) COD levels (up to 28 mg/dm^3). Suspended solids concentrations in water from both horizons during all periods varied within the narrow range of 5-10 mg/dm^3.

The range of dissolved solids concentrations was wide - from <50 mg/dm^3 tp 6900 mg/dm^3. The highest values (2900-6900 mg/dm^3) were measured in all samples taken from both horizons in September 2019, mainly due to high concentration of chlorides (in excess of the limit value for fishery waters (RF Ministry of Agriculture Order No. 552 of 13.12.2016) MPC_{fish} by 4-10 times) and sulphates (exceedance of MPC_{fish} by 2-4.6 times). However, this result does signify "pollution" but rather reflects the influx of saline sea water

[32] Local environmental monitoring of the onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF and operational environmental control of the operational sites. Operational environmental control of the berth structures infrastructure at the Salmanovskoye (Utrenneye) OGCF. Final Report. - Moscow, 2019. 300 p.

into the area close by the river estuary. Testing in July and August did not find any exceendaces of this sort.

Values measured at some stations were slightly above MPC_{fish} for phosphates and ammonium-ion, and above MPC_{dom} for silicon. Total nitrogen concentration in all samples was below the detection threshold of the QCA method (10 mg/dm^3). Phosphorus concentrations in water varied between < 0.02 and 0.31 mg/dm^3.

The range of variations of iron levels differed between the testing periods, the highest values were measured in August (31 to 59 times MPC_{fish}). Absence of significant differences between values measured in samples from different stations and horizons during the same period signifies alteration of hydrochemical conditions at the regional level rather than local-scale supply of the metal.

Along with elevated levels of iron in August 2019, samples from both tested horizons at all stations had slightly increased concentration of cadmium (twofold MPC_{dom}, maximum), however without exceeding MPC_{fish}; and zinc concentrations in samples from the surface layer at stations A1 and A2 were slightly (up to 1.9 times) higher than MPC_{fish}.

Concentrations of manganese and copper were above the permissible levels in 19 and 18 samples out of 30, respectively, whereas 18 samples failed both standards. Most failures were detected during the period of August-September. The greatest exceedances of copper standard are 7-fold MPC_{fish}. The most significant exceedances of MPC_{fish} for manganese (by 48-51 times) were reported in September at stations A2, A4 and A5.

Concentrations of other heavy metals (cobalt, nickel, lead, chromium, mercury) and arsenic in all samples were below the limits set by all regulatory documents.

No excessive concentrations of petroleum products were found in the water samples. The only exception is petroleum products concentration of 1.1*MPC_{fish} in surface water layer at station A5 in July.

Slightly elevated content of phenols (up to 2.4 times MPC_{fish}) were found in six samples over the whole period of testing. Seven samples had excessive concentration of benzo[a]pyrene (up to 4.6 times MPC_{fish}).

In terms of bacteriological quality, all samples demonstrated either absence of controlled organisms or (for total coliform bacteria) their presence in quantities by 10 and more times smaller than the permissible limit set in SanPiN 2.1.5.980-00.

Figure 7.3.4: Location scheme of marine water pollution monitoring stations, 2019

Source: LEM, 2019[33]

[33] Local environmental monitoring of the onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF and operational environmental control of the operational sites. Operational environmental control of the berth structures infrastructure at the Salmanovskoye (Utrenneye) OGCF. Final Report. - Moscow, 2019. 300 p.

Results of the Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas (IEPI, 2020).

The total of 104 samples were taken for hydrochemical testing at 45 stations including at the soil dumping site. Samples at stations in the areas with water depths greater than 10 m were taken from three horizons (surface, intermediate and bottom); in shallower locations only bottom and surface layers were tested. Besides the integrated marine monitoring stations, the survey used four stations in the coastal area – in estuarian sections of Nyaday-Pynche and Khaltsyney-Yakha Rivers.

The results of testing of the main hydrochemical parameters of sea water (salinity, transparency, suspended solids, concentration of dissolved oxygen, COD, BOD_5, iron, nitrates, nitrites, phosphates, chlorides, etc.) are shown in sub-section 7.5.1.3. Information on the content in sea water of the main pollutants that can be toxic to aquatic life (heavy metals, petroleum products, phenols, synthetic surfactants) is summarised below.

Heavy metals. None of the samples contained nickel, cadmium, lead or chromium in excess of the applicable standards for fishery water quality. Concentrations of zinc, mercury and cobalt in the surveyed water area of the Ob Estuary were below the detection threshold.

In 2019, concentrations of copper varied from below the detection threshold of the measuring method (less than 0.001 mg/l) to 0.005 mg/l in the middle horizon at the dumping site. None of the samples failed the copper standard of 0.005 mg/l for fishery water, and only in one sample concentration of copper was 1*MPC.

Minor exceedances of MPC for manganese by up to 1.2 times (the permissible level is 0.05 mg/l) were found in three samples taken from the bottom layer in the dumping area.

Phenols. Phenol concentrations in the tested samples were below the detection threshold (less than 0.0005 mg/l), whereas MPC_{fish} is 0.001 mg/l. No failures of the standard were detected.

Petroleum products. Maximum permissible concentration of petroleum products in waterbodies of fishery significance is 0.05 mg/l. Survey 2019 demonstrated petroleum products concentrations in the studied water area of the Ob Estuary below the threshold level of the measuring method (less than 0.04 mg/l).

Synthetic surfactants. As a result of laboratory testing of water samples from all stations in the Ob Estuary, concentrations of synthetic surfactants were below the threshold level of the measuring method (less than 0.01 mg/l) and never exceeded the permissible limit.

The general conclusion of the integral assessment of water in the studied area of the Ob Estuary is that the water can be characterized as very clean and clean (Figure 7.3.5). 75% of all tested samples of water fall under water quality Class II – "clean". In the zone close by the water area of the Utrenniy Terminal, water quality is classified as "very clean" and "clean". In the area close by the dumping site, water quality in 29 out of 30 samples taken from the Ob Estuary is characterised as "clean", whereas concentrations of iron are elevated as high as 1.9*MPC.

Summary

Studies of sea water quality that were conducted in 2013-2019 in the Ob Estuary area exposed to potential impact of the Arctic LNG 2 Project demonstrated that the sea water pollution is mainly of natural origin, due to the geochemical features of the territory reflecting the regional geochemical background.

In some years, elevated concentrations of phenols and ammonium nitrogen were found in surface water layer of the Ob Estuary. There is a likelihood it could be a consequence of the pollutants transport by the Ob River and its tributaries from the vast catchment of the Ob basin with intensive production of hydrocarbons.

Above-MPC concentrations of iron, copper and manganese are primarily associated with natural specificity of the tundra region.

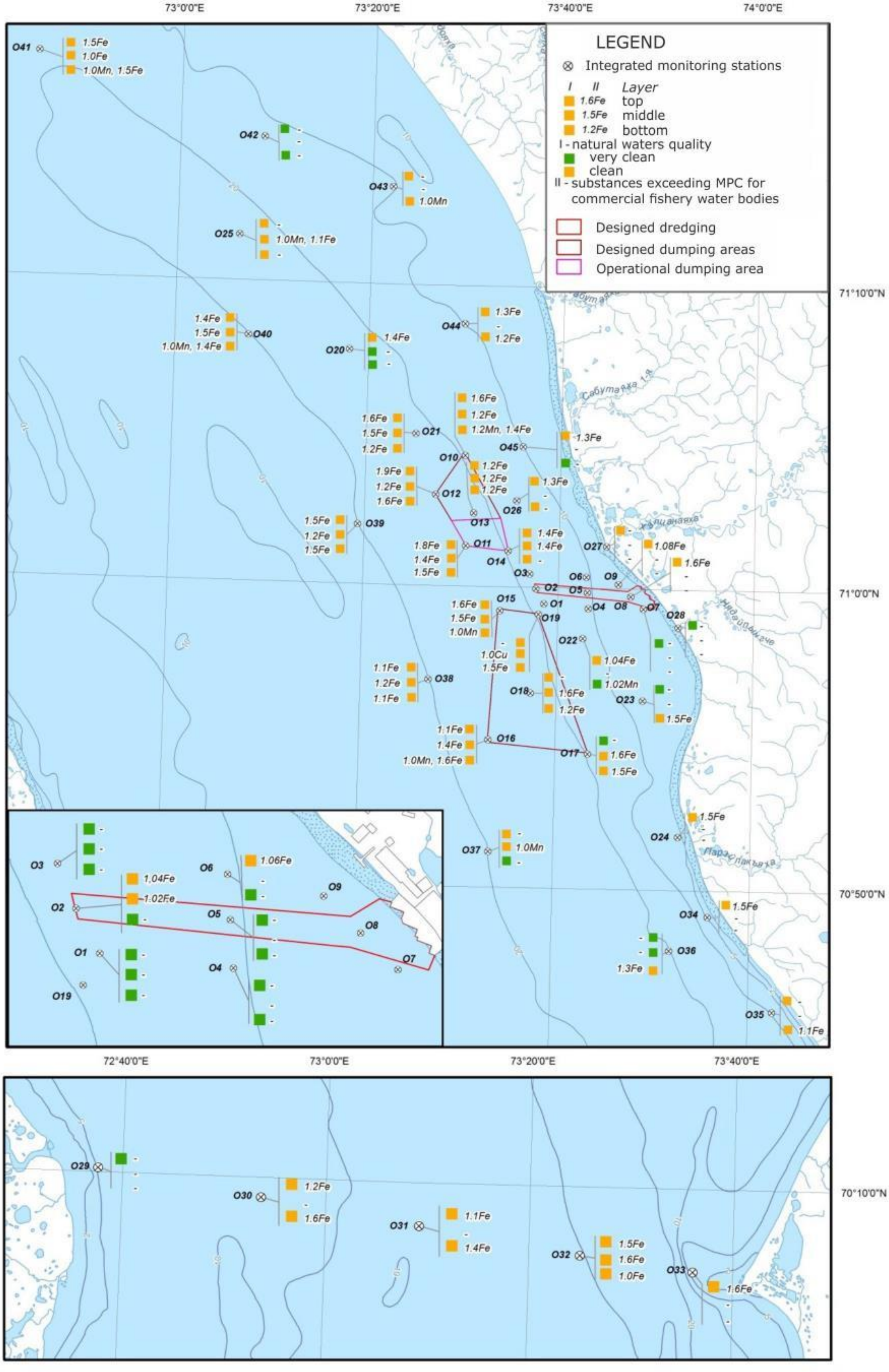


Figure 7.3.5: Sea water quality reported as a result of field studies in 2019

Source: Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas. Final Report. IEPI JSC. 2020

7.3.2 Rivers

7.3.2.1 General

Hydrographic network in the territory of the Salmanovskoye (Utrenneye) oil, gas and condensate field belongs to the drainage area of the Ob and Gydan Estuaries within the catchment area of the Kara Sea. It is composed of numerous rivers with perennial flow, intermittent streams, and small lakes (Figure 7.3.6). The river network density in the studied area is 1.41 km/km^2. Its most developed sections are located within the water catchment area of the Ob Estuary (Environmental Survey, 2017[34]).

Rivers within the catchment basin of the Ob Estuary:

- Khaltsyney-Yakha River with tributaries - Lerui-Yakha and Saabri-Yakha Rivers; Syabuta-Yakha 1st River; Syabuta-Yakha 2nd River; Syabuta-Yakha 3rd River; Nyaday-Pynche River; Parejlaga-Yakha River; Lutigan-Yakha River; Ngara-Khorty-Yakha River with tributaries - Ngarakha-Yakha and Nado-Yakha Rivers, as well as 34 unnamed streams. All above rivers and streams can be described as small, with drainage areas of less than 1000 km^2 (Environmental Survey 2012[35]) and length is 100 km or shorter;

Rivers within the catchment basin of the Gydan Estuary:

- Najta-Yakha, Yara-Yakha, Mange-Yakha, Yesya-Yakha, Yaromichu-Yakha, Nyaulata-Yakha, Salpada-Yakha Rivers are medium-sized rivers with drainage areas larger than 1000 km^2 but smaller than 50000 km^2, and their tributaries are small rivers with drainage areas of less than 1000 km^2.

As a rule, rivers in the tundra zone are small lowland streams. Rivers of the first and second order are characterised by high sinuosity. Smaller tributaries are often just fes kilometers long, and less sinous. The downward gradient is usually insignificant, the flow is slow, with the highest values recorded during the spring flood period.

Mineral content in the rivers' waters is extremely low, due to the weak chemical erosion of soil. In summer, lowland rivers demonstrate a weak acidic reaction. According to the existing classification, surface waters in the Gydan Peninsula fall under the category of ultra fresh and environmentally clean water objects.

Knowledge on the hydrology and ice conditions of rivers in the Gydan Peninsula attributed to the right shore of the Ob Estuary is hardly available, and not a single monitoring station has been provided for hydrological observations on the rivers. Monitoring post MG-2 Tadebeyakha functioned during 1950-1994 at the point located 70 km to the north of the Syadaj-Yakha River mouth, however it was intended for monitoring hydrological and ice conditions in the Ob Estuary, but not in the rivers (Figure 7.3.7).

[34] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Design documentation. Section 4. Technical report on results of environmental survey. Part 2. Onshore facilities. Book 1. Text part. Explanatory note. Document code 2017-423-M-02-ИЭИ2.1. Vol. 4.2.1. – TsGEI LLC, 2017. 254 p.

[35] Assessment of Background (Baseline) Status of Environmental Components of Onshore and Offshore Areas of the Salmanovskiy (Utrenniy) License Area (Yamal-Nenets Autonomous Okrug) Based on Results of the Environmental Survey. Technical Report. – Arkhangelsk, FSSUE PINRO, 2012. 297 p.

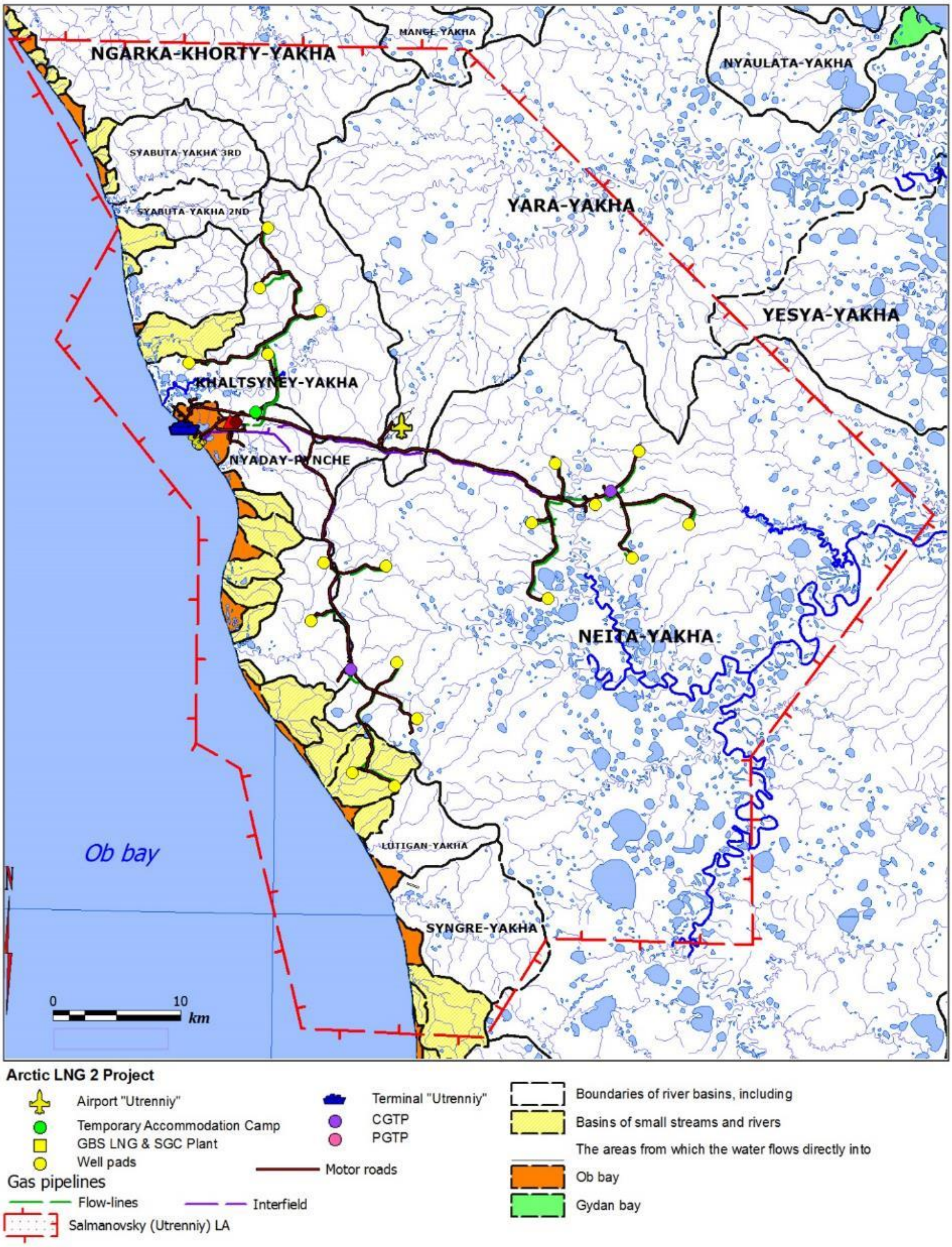


Figure 7.3.6: River drainage basins in the territory of the Salmanovskiy (Utrenniy) License Area

Source: Ramboll, 2020

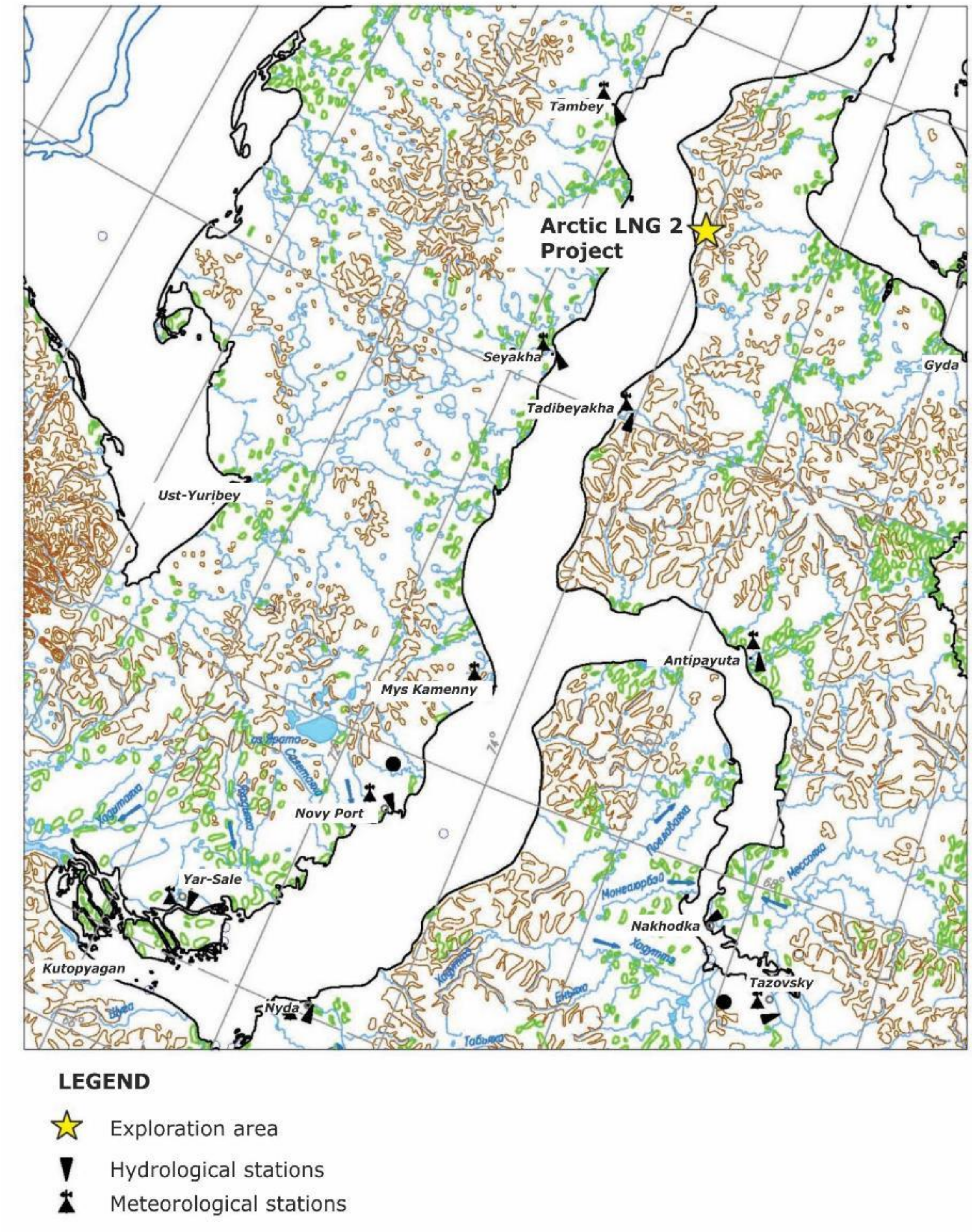


Figure 7.3.7: Hydrological observations map of the Yamal and Gydan Peninsulas

Source: IGMI, 2017[36]

7.3.2.2 Hydrographic and hydrometric characterisation of rivers

Owing to plain-type terrain and permafrost occurrence close to the ground surface local watercourses have shoaly valleys, shallow sinuous river channels, low banks, insignificant longitudinal gradients, and sluggish currents. Channels of small rivers are connected by a system of lakes and bogs. Above-floodplain terraces are waterlogged and abundant in oxbow lakes and ancient natural levees.

[36] Utrenniy Liquefied Natural Gas and Stabilised Gas Condensate Terminal. Technical report on results of hydrometeorological survey. Uralgeoproekt LLC, 2017. 49 p.

A current velocity is typically from 0.05 to 0.3 m/s. In the river head, it can be as high as 2.0 m/s during floods and freshets. A channel width of larger rivers varies from 30 to 60 m and depth from 0.2 to 2.0 m. Gradients are usually minor – not more than 2%.

Commonly, river channels are weakly incised and have a trough shape owing to the predominance of lateral erosion. Thermoerosional impact of river waters is responsible not only for substantial reshaping in the river channel per se but also for its fast migrations within the floodplain due to banks washout and wearing away. The most extensive bank destruction and bottom sediment migration occur during the spring flood season when the river water content and current velocities increase.

Hydrographic characteristics of major watercourses and their tributaries in the territory of the Salmanovskiy (Utrenniy) LA are shown in the table below.

Table 7.3.3: Hydrographic and hydrometric characteristics of surface water bodies in the territory of the Salmanovskiy (Utrenniy) LA

No.	Name	Basin	Discharges to	Length, km	Drainage area, km²	Width, m	Depth, m
1	Ob Estuary	Kara Sea	Kara Sea	800		30-80 km	<25
2	Khaltsyney-Yakha River	Ob Estuary	Ob Estuary	54.5	209.5	7-30	0.15-1.2
3	Nyaday-Pynche River			21.6	65		
4	Syabuta-Yakha 1st River			16.6	51.7	2-9.5	0.25-0.4
5	Syabuta-Yakha 2nd River			19			
6	Syabuta-Yakha 3rd River			19			
7	Stream 7			4.4		9	0.6
8	Stream 6			1.5		3	0.4
9	Sabri-Yakha River		Khaltsyney-Yakha River	15			
10	Lerui-Yakha River			15.5	31.9	4	0.3
11	Stream 5		Lake Unnamed stream	0.8		0.5	0.41
12	Stream 8			3.0		5	0.5
13	Stream 1			1.5		2.82	0.08
14	Ngara-Khorty-Yakha River		Ob Estuary	93			
15	Nado-Yakha River		Ngara-Khorty-Yakha River	32			
16	Lassi-Yakha River			28			
17	Yaram-Khaleta-Yakha River			25			
18	Peru-Yakha River			16			
19	Parejlaga-Yakha River			22			
20	Lutigan-Yakha River			15			
21	Najta-Yakha River	Gydan Estuary	Salpada-Yakha River	255	3730		
22	Yesya-Yakha River			183	1760		
23	Mange-Yakha River			178	1020		
24	Salpada-Yakha River		Gydan Estuary	74	188.41		
25	Right Yara-Yakha River		Salpada-Yakha River	68.2	232.8	3.4	1.5
26	Yaromichu-Yakha River			47.5	375	1.9-58	0.43-0.8
27	Stream 4			13.7		14.7	0.24
28	Serako-Ya-Yakha River			8.7	17.7	2	0.6
29	Stream 3			6.57		0.4	0.2
30	Yabtarmasyo River			4.7	25.8	7.2	0.7
31	Middle Yara-Yakha River		Left Yara-Yakha River	27.9	71.4	0.5	-
32	Stream 2		Right Yara-Yakha River	1.3		1.3	0.21
33	Stream 9		Unnamed stream	2.5		1.3	0.4

Source: GK RusGasEngineering CJSC, 2014[37] ; TsGEI LLC, 2017[38], NIPIGAZ JSC, 2018[39]

[37] Early development facilities at the Salmanovskoye (Utrenneye) oil, gas, and condensate field. Technical report on environmental survey. Document code 143.01.00-02-196-ИЭЛ1, Vol. 4.1. - GK RusGazEngineering CJSC, 2014. 340 p.

[38] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Design documentation. Section 4. Technical report on results of environmental survey. Part 2. Onshore facilities. Book 1. Text part. Explanatory note. Document code 2017-423-M-02-ИЭИ2.1. Vol. 4.2.1. – TsGEI LLC, 2017. 254 p.

[39] Salmanovskoye (Utrenneye) OGCF Facilities Setup, Phase 5. Technical report on results of environmental survey. Part 2. Task area of PurGeoCom LLC. Book 1. Text part. NIPIgaspererabotka JSC, 2018.

The largest watercourses that drain the Salmanovskiy (Utrenniy) license area to the Ob Estuary are the Khaltsyney-Yakha and Nyaday-Pynche rivers (Figures 7.3.8, 7.3.9). Their detailed description is provided below.

The Khaltsyney-Yakha River originates from the south-eastern part of stow Nyadasoty. Its total length is 54.5 km. Total catchment area is 210 km^2. The catchment sits entirely within the Salmanovskoye (Utrenneye) OGCF in the typical Arctic tundra zone. The river has many tributaries, among which larger are the Lerui-Yakha and the Sabri-Yakha. The total river network density is 1.55 km/km^2. The river channel is winding and freely meandering. An average gradient of the lateral river profile is 1.1 %. Relief is flat with numerous gulches, gullies and streams that cut through the catchment area towards the main river channel. Watersheds are 30-40 m above the water level. The valley is trough-shaped and 0.5-2.5 km in width. There are many small lakes within the catchment which are mostly located near the main channel in middle and lower catchment sections. A few lakes situated at the valley bottom in the estuarine part have surface area of more than 0.2 km^2. A total lake percentage is around 1.69%. Most of the lakes are roundish. River banks are predominantly represented by sandy soils, which is why deflation processes and different variants of mass wasting under the gravity are common on slopes and edges. Figure 7.3.8 shows a general view of the Khaltsyney-Yakha River valley.

The Lerui-Yakha River is the right-bank tributary of Khaltsyney-Yakha River, with a discharge point 21 km upstream the estuary. The river is 15.5 km in length, with indistinct valley of approximately 0.8-0.9 km in width. The slopes are gentle, overgrown with grass and low shrubs. Waterlogged lows are also present. The floodplain is low, dual-sided, 100-150 m in width, overgrown with moss and grass. The river channel in the studied area is moderately sinuous. The river has sandy bed and shores. The left bank is gentler, while the right one is bluff and rises to the height of 0.6-0.7 m. At the time of survey (NIPIGAZ, 2018), the depths varied within the range from 0.2 m to 1 m. The main channel width is 4-23 m. In the left-bank floodplain, there is an arm 15 m off the main channel.

Figure 7.3.8: Valley of the Khaltsyney-Yakha River

Source: Report by IEPI JSC, 2020[40]

---

2. Salmanovskoye (Utrenneye) OGCF Facilities Setup, Phase 5. Technical report on results of environmental survey. Part 2. Task area of Uralgeoproekt LLC. Book 1. Text part. NIPIgaspererabotka JSC, 2018

[40] Local environmental monitoring of the onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF and operational environmental control of the operational sites. Phase 3.1. Final Report on the environmental monitoring of the Salmanovskoye (Utrenneye) oil, gas and condensate field in 2019. - Moscow, IEPI JSC, 2020. 187 p.

Total length of *Nyaday-Pynche River* (Figure 7.3.9) is 20 km, section width is 2.7 m. The widest section within the license area is 10.6 m, and the narrowest is 1.92 m. Maximum depth in the monitoring section is 0.47 m. Depth at the pool is 0.36 m, at the rapids 0.1 m. The catchment area of the Nyaday-Pynche River covers the total area of 65 km^2 within the License Area. It extends from east to west for 13 km. The catchment sits entirely within the typical tundra region. The river catchment area is occupied by moss and grass vegetation, with dwarf willows of 0.1 m in height on the banks. The Nyaday-Pynche and its tributaries are characterised by high sinuosity. Relief is flat with numerous gulches, gullies and streams that cut through the catchment area towards the main river channel. A total river network density is 1.61 km/km^2. A gradient of the Nyaday-Pynche is 2.72 $^0/_{00}$. The river valley is asymmetric, V-shaped. The right-hand and left-hand slopes of the valley are flat and turfed. The floodplain is dual-sided, symmetric. The river channel in the studied area is clearly expressed, sinuous. Small lakes located near the main channel in the lower catchment are roundish. Total lake percentage is below 1%. Banks are steep – up to 1.5 m.

Figure 7.3.9: Valley of the Nyaday-Pynche River

Source: Report by PurGeoCom LLC, 2019[41]

The largest river in the Salmanovskiy (Utrenniy) LA that discharges into the Gydan Estuary is *Salpada-Yakha.* The river length is 74 km, catchment area – 188.41 km^2. The river catchment area is occupied by moss and grass vegetation with dwarf willows on the banks.

The river valley is asymmetric, box-shaped. The floodplain is wide, asymmetric: the right-hand side is up to 800 m in width, the left-hand side is up to 80 m (Figure 7.3.10). The widest section of the river within the studied area is 28 m, the narrowest is 7.5 m. Maximum depth at the pool is 1 m, at the rapids 0.2 m. Bottom sediments are composed of sand.

[41] Utrenniy Airport Technical report on results of environmental survey - Tyumen: PurGeoCom LLC, 2019

Figure 7.3.10: Valley of the Salpada-Yakha River

Source: Report by NIPIgaspererabotka JSC, 2018[42]

Stream No. 1. The stream originates at lake No.3 and discharges to the Ob Estuary (Figure 7.3.12). The watershed elevation is just above 40 m (BSD). The stream is 1 km in length. Its catchment area of 3.88 km^2 features an undulating upland terrain with gullies that cut through the catchment area towards the main channel. The symmetric catchment area is 1.6 in its widest section and stretches from west to east. The catchment sits entirely within the arctic tundra region. The river network density is 1.0 km/km^2. The channel is sinuous. The edge of the stream valley is elevated by maximum 1 m above the waterline. The stream channel edge elevation above the water line is 10-30 cm. The channel width varies between 1 m and 7 m in different sections of the stream valley. The stream channel in the upper and middle reaches is relatively shallow-cut, with the maximum depth of 1 m, with the bottom consisting of sand and silt. In meanders, water depth of 2 m can be observed during tides. In the upstream section, average flow velocity was 0.20 m/s, maximum – 0.29 m/s. The flow rate was 0.014 m^3/s, at the width of 2.0 m and maximum depth of 0.15 m. The stream water surface gradient between the source and section No.2 was 2.2 ‰.

Stream No. 2. The stream originates at lake No.6 and discharges to the Ob Estuary (Figure 7.3.12). The watershed elevation is just above 40 m (BSD). The stream is 0.82 km in length. Its catchment area is 4.49 km^2. The symmetric catchment area is 2.6 in its widest section and stretches from south-west to north-east. The catchment sits entirely within the arctic tundra region. The terrain is plain. Total bog percentage in the catchment area is approximately 8 %. The river network density is 1.07 km/km$^{2.}$ The channel is sinuous. The edge of the stream valley is elevated by maximum 1.5 m above the waterline. The stream channel edge elevation above the water line is 20-50 cm. The channel width variations range is fairly broad – from 2.5 m to 25 m. The stream bed is fairly deep-cut (for the permafrost zone), with depths varying between 0.5 m and 1.6 m and bottom consisting of sand and silt. The flow rate measurements were conducted during low water. In the downstream section, the flow rate was 0.024 m^3/s, at the average velocity of 0.15 ms, width 2.4 m, maximum depth 0.12 m. The stream water surface gradient between the source and downstream section was small and constant 0.05 ‰.

7.3.2.3 Flow and level patterns of watercourses

The river's hydrology is characterized by prevailing surface runoff with an extremely small proportion of groundwater feed.

Rainwater inflow is significantly smaller than that of snow, however its contribution is still larger than inflow from underground sources. The major water source for rivers is winter precipitation. Rain precipitation contributes about 15% to the annual flow. Feed from soil is hardly present, because of permafrost.

The watercourses have clearly pronounced periods of spring-summer floods and summer-autumn and winter low water. The summer-autumn low water level is disturbed by rainfall floods with water levels and flow rates not higher than those of spring floods.

[42] Salmanovskoye (Utrenneye) OGCF Facilities Setup. Phase 5. Technical report on results of environmental survey. Part 2. Task area of PurGeoCom LLC. Book 1. Text part. NIPIgazpererabotka JSC. 2018. 274 p.

Floods on watercourses in the Project area are characteristic of rather high and sharp waves induced by rapid surface water runoff and weak influence of the floodplain, river bed and lake regulation. Spring floods on local rivers begin in early June. Snow melting is irregular: it first occurs at watersheds and later in river valleys and depressions. Water runs by river channels frozen through to the bottom above ice gradually eroding it. In the phase of flood upsurge, floodplains and river and stream channels are partially filled with packed snow which, to a great extent, constrains water streams and is responsible for the additional water level elevation. The flood reaches its peak around mid-June approximately in two weeks after its onset. A water level rise is 2-5 m; it is accompanied by large river overflows and plain flooding. Spring-summer flood accounts for 70-80% of the annual discharge of local rivers and for as high as 90-95% at smaller streams. The flood depletion is lengthy and extends for 35 days on an average, though it may last from 15 to 50 days. Water level declines slowly, due to the poor filterability of frozen ground. The flood termination is not clearly expressed since its discharge smoothly transits into summer-autumn low water.

The summer-autumn seasonal level is retained after a spring flood decline until late September on small rivers and until mid-October on medium and large rivers of the Gydan Peninsula. The water content in the rivers reduces during this period and discharge volume is 20-30% of the annual total. Summer-autumn low water is occasionally interrupted by rainfall freshets. These are related both to rainfall and to melting of packed drift snow in basins at higher air temperatures. Another factor that influences the river flow build-up is melt water from underground ice thawing. Rainfall freshets are sporadic during the summertime whereas in autumn they occur in series. By monitoring data, the watercourses with catchments less than 1 km in area may dry out in the summer.

The most long-lasting and low water hydrological season is the winter low water period that can last for up to 8.5 months. Soil, which is the single water source during this time, depletes and the flow rate continuously drops early at the beginning of steady negative temperatures. Whereas water levels in the rivers and streams normally rise due to ice that obstructs the free flow area. In some years, flow decreases so intensively that hanging ice, sometimes arranged in several tiers, remains on streams. There is a likelihood of an emergence of ice mounds, which are rather small on shallow streams – less than 0.5 m, on crossed-over watercourses in the first months of winter low water (October-November). Ice glaze 0.3 m thick may form in ravines resulting from freezing of water coming out to the surface from the soil-ground layer that was not completely frozen.

Large ice mounds formed by relatively constant runoff at the beginning of winter low water may emerge on the rivers Khaltsyney-Yakha and Nyaday-Pynche. A majority of the rivers get completely frozen in the second half of October. No ice drift is observed on streams and river heads. Ice melts and is washed out right there. Sometime ice drift may occur on the Khaltsyney-Yakha causing a drastic increase in water turbidity.

7.3.2.4 Ice regime of watercourses

The longest and most shallow-water hydrological season on the rivers of Gydan Peninsula is the winter low-water period that starts after the air temperature transition through 0° C and extends for 8.5 months.

Ice formations would normally appear in the local rivers after October 10, i.e soon after the air temperature transition through 0°C, in the form of coastal ice, slush ice, and sometimes grease ice (only on larger and medium rivers). Coastal ice is persistent and is observed every year. The periods of coastal ice on rivers can differ in duration. In case of sharp fall in temperatures and early onset of winter, coastal ice is observed during one or few days, but protracted freezing period can extend presence of coastal ice by several weeks. Floating-ice drift on small and medium rivers is a very seldom or non-existent phenomenon. Ice cover appears when coastal ice closes up. The fast-ice period in the surveyed area begins on October 15. The freeze-up duration is 210-250 days.

The ice cover thickness varies within a wide range, depending on severity of the winter and on local influencing factors. Its average value is 150-200 cm, while the maximum thickness of ice is about 250 cm. In winter, permafrost fully blocks additional feed for smaller rivers, which cuts down their flows in winter and results in complete freezing of the rivers.

The time of disappearance of the ice cover in spring vary between 2-4 June (early spring) and 7-8 July (late spring) depending on specific features of the river and weather conditions. On small rivers, ice melts down in the same place. Medium and large rivers develop torrential flows that break ice blocks off the frozen-through sections, and ice jams buildup[43].

Ice jams build up during the 3 to 5-days period of maximum water levels with the most intensive motion of ice. Jam centers on rivers gravitate to narrower channel sections and multiple bends. Ice concentrations and jam centers do not extend long.

7.3.2.5 Transport of sediments

Rivers receive large quantity of loose material from eroding channel and denudating banks and valley slopes, which results in a sharp increase of water turbidity.

At first, water flows on top of ice and snow and quantity of mineral material transported from the catchment area is insignificant. As a rule, river water washes out snow scarps on concave banks before the snow course is fully degraded. This results in denudation of landslide sections in the places where river channels contact valley walls, and intensive scouring by flow of melt water. Therefore, even though rivers flow mostly in snow banks they carry significant quantity of suspended solids. The above process is responsible for transport of a large mass of suspended and traction sediment load. As a result, during the period of existence of snow course, and especially after its disappearance, the flow bed (surface of ice) is covered with 20-30 cm layer of sediments.

Transport of suspended solids starts when ice breaks off the river bed. Water turbidity in rivers peaks at the decline of high water period, as channel scouring intensifies and ground thawing starts - this process is responsible for washing material from the catchment area surface down to the river bed. The observation data show that 99% of annual discharge of suspended solids occurs in spring, i.e. spring high water accounts for almost whole annual quantity of suspended solids transport. The lowest turbidity is reported in late summer.

Average turbidity level in rivers with predominantly sandy banks is about 25 g/m^3, in rivers with significant quantity of clayey fractions in valley walls - about 900 mg/m^3 (NIPIgaspererabotka, 2018).

7.3.3 Lakes

The Salmanovskiy (Utrenniy) license area is characterised by a rather high abundance of lakes (about 5%). Shallow and small lakes with water surface area of not more than 0.1 km^2 (93% of the total lake area) predominate. Lakes with more than 0.5 km^2 water surface area account for less than 1%. Almost all lakes pertain to water catchments of rivers running into the Gydan Estuary. These are lakes Njolyako-Yambto (F = 0.5 km^2), Vytjorto (F = 0.7 km^2), Yabtarmato (F = 1.7 km^2), Nenyagto (F = 1.8 km^2), Tangusumto (F = 2.1 km^2), Syngrjoto (F = 6.3 km*2*), and 27 nameless lakes with surface area from 0.5 km to1 km, and six nameless lakes of more than 1 km^2 in area (Environmental Survey, 2012)[44]..

A rather dense lacustrine network was formed in the conditions of a low heat amount and excessive moisture on spacious flatlands with a permeability barrier formed by frozen rock. Lakes occupy up to 40% of area in some sections such as laidas and river valleys.

Almost all lakes pertain to water catchments of rivers running into the Gydan Estuary. The lakes have low shores witch are largely overgrown, and sticky bottom. Lakes, for the most part, are shallow and freeze through to the bed.

Lakes within the LA boundaries can be assigned, on the basis of basin origin, to the following genetic types (IGMI, 2015[45]):

- glacial accumulative lakes formed within a distribution range of fluvioglacial features and located in low-lying sections of terrain;
- thermokarst lakes originated from permafrost thawing;
- water-erosion lakes to include river-made ones; and

[43] Early development facilities at the Salmanovskoye (Utrenneye) oil, gas, and condensate field. Technical report on environmental survey. Document code 143.01.00-02-196-ИЭЛ1, Vol. 4.1. - GK RusGazEngineering CJSC, 2014. 340 p.

2. Salmanovskoye (Utrenneye) OGCF Facilities Setup. Phase 5. Technical report on results of environmental survey. Part 1. Task area of Uralgeoproekt LLC. Book 1. Text part. NIPIgazpererabotka JSC. 2019. 272 p.

[44] Assessment of Background (Baseline) Status of Environmental Components of Onshore and Offshore Areas of the Salmanovskiy (Utrenniy) License Area (Yamal-Nenets Autonomous Okrug) Based on Results of the Environmental Survey. Technical Report. – Arkhangelsk, FSSUE PINRO, 2012. 297 p.

[45] Early development facilities at the Salmanovskoye (Utrenneye) oil, gas, and condensate field, Vol. 1.3 Technical Report on hydrometeorological survey. Urengoygeoprom LLC, Novy Urengoy, 2015. 106 p.

- lagoon lakes.

Erosion waterbodies preponderate in river valleys whereas thermokarst lakes prevail at interfluves. Many lakes are interconnected by meandering rivers and have discharge. Larger flow-through lakes connected with the sea by rivers are located on upper sections of the watershed.

Floodplain lakes are formed in widened river bottomlands as a result of erosion-accumulative activity of rivers or filling of floodplain depressions with melt water. Such lakes dominate in the territory of the Salmanovskiy (Utrenniy) license area. They are rather small in area and shallow, freeze through to the bottom in the winter season and have subdued bed relief.

Oxbow and salt lakes of water-erosion origin pertain to the relict category. They are usually small and reside on floodplain and above-floodplain terraces. Contours of lakes reshape stepwise from the crescent to elliptical form depending on the river terrace height and distance from the shore. Salt lakes are more shallow and irregularly shaped. They are abundant on floodplain terraces and in widened and estuarial areas of river valleys.

Larger lakes are of thermokarst origin. Their basins were formed as a result of permafrost thawing. In the studied area, such lakes are Nyanto (Figure 7.3.11), Tangusumto and Yabtarmato.

Figure 7.3.11: The Nyanto Lake

Source: Report by NIPIGAZ, 2018[46]

7.3.3.1 Lake regime

A key water feed source for lakes, like for rivers, is melt water. To a less extent, they are replenished by rainwater. The role of groundwater is insignificant and its inflow occurs merely during the warm season.

Melt water flows to almost all open and closed lakes from water catchments confined by slopes of lake basins. An exception is open lakes to which waters ingress from basins of inflowing tributaries.

Discharge from most of open lakes takes place over the warm season. Some lakes discharge only during the snow melting period, in temporary streams by hollows. In the wintertime, runoff from lakes, except for channel ones, stops because outflowing rivers are completely frozen.

Tundra lakes are characteristic of a short open water period (2-2.5 months). Ice breaks up in June – early July. They get covered with ice at the end of September and sometimes even earlier. The ice cover thickness reaches 3-3.5 m.

Maximum water levels of lakes confined to watersheds are observed in the middle of June-beginning of July in five or six days after mean daily air temperatures transit through 0° C. Melt water is accumulated above ice and, after snow bridges in marshes and streams are destroyed, intensive runoff starts and the

[46] Salmanovskoye (Utrenneye) OGCF Facilities Setup. Phase 5. Technical report on results of environmental survey. Part 2. Task area of PurGeoCom LLC. Book 1. Text part. NIPIgazpererabotka JSC. 2018. 274 p.

water level drops drastically. A yearly level amplitude on watershed lakes normally is 0.2-0.3 m. It may rise up to 0.5-0.6 m on the lakes having a rather large catchment area. Spring discharge from lakes proceeds on the surface of streams and marshes because soil is still frozen. As the level drops and marshes melt, discharge from a majority of the lakes occurs inside the soil body.

The period of summer-autumn low water which, as a rule, is interrupted by rainfall freshets begins after the flood. The period starts in the first half of August and lasts until mid-September for around 40 days. Minimum levels of lakes fall at July-August. Then the level somewhat rises because of rainfalls and reduction of evaporation from the water surface. During the winter onset, streams and marshes freeze up and lake drainage ceases.

Principal features of the thermal regime of Gydan Peninsula lakes are insignificant heating of water mass in the summertime, its fast cooling in autumn, and low water temperatures over the ice period. An annual water temperature mean for lakes is 1.5-2° C and a temperature maximum in the surface layer in summer is not more than 15-20° C.

7.3.3.2 Ice regime

Lakes within the license area are covered with ice during 8.5-9 months per year. Shallow waters in lakes contribute to their rapid freezing. Generally, ice cover forms on lakes of various size at the same time, namely in 1-2 days after a stable transition of mean daily temperatures through 0° C; however, larger lakes may freeze 3-5 days later due to intensive winds.

An average ice accumulation rate at the beginning of the winter season (October-November) is 1.0-1.5 cm/day and then it drops to 0.6 cm/day. An average thickness of ice is estimated at 157 cm and in some years it may be as thick as 190 cm. Most of the lakes freeze up entirely by early March even during warm winters owing to shallow water. Relatively small quantities of non-frozen water remain only in deeper lakes (3.5 m and more) because the ice thickness usually does not go beyond this value.

Melt water in the spring season covers ice with a 0.2-0.3 cm layer. As regards small lakes, ice does not float up to the surface there and melts without breaking loose from the bottom. On larger lakes, ice floats up in central parts when the water level rises and flange ice emerges. Ice persists on lakes for 15-20 days after the water level sets at a maximum; meanwhile, as the lake size reduces and its flow-through capacity increases, the ice breaking rate grows (IEI, 2012)[47].

7.3.4 Bogs

The Gydan Peninsula pertains to the zone of polygonal and Arctic mineral sedge bogs and is located within the Arctic tundra subzone. The northern part of the zone is predominantly represented by polygonal ridge-hollow and ridge-lake complexes (low shrub-sedge-green moss vegetation on ridges and sedge-hypnum in hollows). The southern part is dominated by polygonally jointed complexes. Polygons are characteristic of low shrubs, green mosses and lichens along with sphagnum or hypnum species.

Polygonal bogs are abundant in river and stream valleys, on sea coasts as well as encountered on poorly drained sections of river watersheds. Their typical morphological characteristic is a net structure of the surface formed by frost-splitting of frozen peaty soils into tetragonal, pentagonal and hexagonal blocks. In individual cases, polygons take on a roundish or oval shape given their smooth angles. Cross dimensions of the polygons vary from 5-10 m to 25 m. In the oldest cracks, ice blocks covered with 20-80 cm layer of peat reach through the whole peat layer and penetrate into the underlying mineral bog soil.

Relatively flattened and poorly broken watersheds with closed lakes and bogs have restricted distribution and are located mainly at a distance of more than 20-30 km from the Ob Estuary shoreline. Low waterlogged sections are distributed by strips along river valley bottoms and on the periodically flooded Ob Estuary shore.

Bogging starts where soil is over-moistened by surface and ground waters. The process is under the influence of bog vegetation such as sedge and moss and is characteristic of gleying of the mineral part of soils as well as of peat formation.

Peat deposit of polygonal bogs is in a frozen state because its seasonal thawing depth does not go beyond 0.5-1.0 m even in the warmest years. Peat deposit thickness in such bogs varies over a broad range,

[47] Assessment of Background (Baseline) Status of Environmental Components of Onshore and Offshore Areas of the Salmanovskiy (Utrenniy) License Area (Yamal-Nenets Autonomous Okrug) Based on Results of the Environmental Survey. Technical Report. – Arkhangelsk, FSSUE PINRO, 2012. 297 p.

depending on the location: it is around 0.2-0.5 m on flood plains and terraces and typically 1-2 m, although sometimes 3-5 m, in depressions of watershed spaces (Environmental Survey, 2015)[48].

The hydrological pattern of the studied area has not been investigated. The principal feed source for the bogs is melt water; storm water merely accounts for 20 %. The bogs are completely frozen for a larger part of the year (7-8 months).

Hydrological conditions of the area are characterised by a presence of a suprapermafrost groundwater aquifer linked with an active layer (0.6-1.5 m in the time of the surveys) which thaws in the summertime and completely freezes in the winter season; its lower permeability barrier is formed by permafrost soils.

7.3.5 Surface water quality

7.3.5.1 Common features

Nature of soils and a bogging degree of river basin will be determinant factors for the chemical composition of surface water in the Salmanovskiy (Utrenniy) license area. Peaty soils in the studied area are well developed. The most pronounced feature of tundra soils is their low mineralisation in all water regime phases because readily soluble salts such as chlorides and sulfates are washed out by atmospheric precipitation. Also, weak water permeability of frozen soils and grounds is beneficial for forming waters with a very low content of salts.

The by-season chemical composition of water depends on the origin of inflowing waters. During spring floods, these are basically overland and topsoil runoffs generated by snow melting.

Minimum mineralisation of below 15 mg/l occurs at the flood peak. Decomposition products of both vegetative and animal origin are leached out during spring floods from peaty-boggy soils and sphagnum mosses of the upper peat layer and waters are enriched with humus organics, in particular, organic acids. It is manifested in more intensive color, lower pH and a less pronounced hydrocarbonate profile of water, which results in a relative increase of the content of sulfate (or chloride) anions in ionic water.

Water feed of rivers changes over a period between the flood and summer low water after melting of the snow bulk. Waters from the soil mass and upper strata of grounds migrate to river channels. These waters are distinguished with slightly elevated mineralisation.

Maximum concentrations, however not above 200 mg/l, are marked during the winter low water period. During this period, its value varies notably as function of the water content differentiated by years.

7.3.5.2 Assessment of water quality in the territory of the Salmanovskoye (Utrenneye) OGCF

Materials used for surface water quality assessment for the Salmanovskiy (Utrenniy) LA are listed below:

- Materials of the local environmental monitoring at the Salmanovskoye OGCF (IEPI JSC, 2020)[49] including analysis of water samples from the inland and coastal water bodies within the Salmanovskoye (Utrenneye) OGCF;
- Materials of the operational environmental control of construction of the early development facilities at the Salmanovskoye (Utrenneye) OGCF (IEPI JSC, 2018)[50];
- Materials of environmental survey (TsGEI LLC, 2017)[51] which included testing of water samples from the location area of the GBS LNG & SGC Plant onshore facilities and its sanitary protection zone: two nameless streams (Streams Nos. 1 and 2), 4 waterlogged sections within the site boundary (Nos. 1, 2, 7, and 8), and 4 nameless lakes in the Plant's area of influence (Lakes Nos. 3, 4, 5, and 6. Figure 7.3.12);

[48] Salmanovskoye (Utrenneye) OGCF Facilities Setup. Phase 5. Technical report on results of environmental survey. Part 1. Task area of Uralgeoproekt LLC. Book 1. Text part. NIPIgaspererabotka JSC, 2018. 272 p.

[49] Local environmental monitoring of the onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF and operational environmental control of the operational sites. Phase 3.1. Final Report on the environmental monitoring of the Salmanovskoye (Utrenneye) oil, gas and condensate field in 2019. - Moscow, IEPI JSC, 2020. 187 p.

[50] Operational environmental control of construction of the early development facilities at the Salmanovskoye (Utrenneye) oil, gas and condensate field. Final Report. Book 1. Explanatory note. - Moscow, IEPI JSC, 2018. 146 p.

[51] GBS Plant for production, storage and offloading of liquefied natural gas and stabilized gas condensate. Design documentation. Section 4. Technical report on results of environmental survey. Part 2. Onshore facilities. Book 1. Text part. Explanatory note. Document code 2017-423-M-02-ИЭИ2.1. Vol. 4.2.1. – TsGEI LLC, 2017. 254 p.

- Materials of environmental survey (NIPIgaspererabotka JSC, 2018)[52] including testing of samples from 38 waterbodies, including those affected by the utility corridors, falling within the area of influence, and designated for use as sources of water supply;
- Materials of environmental survey (GK RusGasEngineering CJSC, 2014)[53] which included surface water sampling (35 samples) from watercourses and large waterbodies crossed by projected routes and located in close proximity to the Plant and Port facilities; and
- Materials of environmental survey (FSUE PINRO, 2012)[54] which provide general characterisation of the baseline environmental status at the Salmanovskoye (Utrenneye) oil and gas condensate field, including surface waterbodies.

Location area of the Salmanovskoye (Utrenneye) OGCF Facilities Setup

The 2012 studies conducted in the territory of the Salmanovskoye (Utrenneye) OGCF characterise the surface water quality in seven local waterbodies and watercourses. The tested waterbodies at that period exhibited high concentrations of iron compounds – above 12*MPC_{fish} at some points, of copper – up to 2.1*MPC_{fis}h, and zinc – up to 2.4*MPC_{fish}. Concentrations of petroleum products, surfactants and phenols were found to be varying from the analytical detection limit to 0.5 – 0.6*MPC_{fish}. Measurements of low molecular chlorinated hydrocarbons indicated that their content in surface water was low (by orders of magnitude lower than regulatory values for public water supply, drinking, and amenity and domestic uses).

Environmental survey 2018 included testing water samples in the Salmanovskiy (Utrenniy) license area by two contractors of NIPIgaspererabotka JSC in two areas. Studies in the territory of the Northern dome were conducted by Uralgeoproekt LLC, and in the territory of the Southern and Central domes - by PurGeoCom LLC. The testing program covered 38 surface water bodies including 25 watercourses crossed by the utility corridors, 8 water bodies falling within the area of influence of the Project facilities, and 2 unnamed lakes designated for use as sources of water supply (water intake facilities Nos 3.1 and 3.2. Figure 7.3.12), and 1 unnamed lake considered as a temporary source of water supply for the period of construction (temporary water intake facility No 9g. Figure 7.3.12).

Survey in the location area of the Field Northern dome (NIPIgaspererabotka JSC, 2018, task area of Uralgeoproekt LLC) identified concentrations of petroleum products in excess of MPC_{fish}:

- from 2 to 4.2 times MPC_{fish} in samples from unnamed lakes within the system of lagoon lakes in the coastal zone of the Ob Estuary;
- up to 3*MPC_{fish} in unnamed streams (right-hand tributaries of the Khaltsyney-Yakha River), at the design location of well pad No.15;
- 2*MPC_{fish}in the Lerui-Yakha River (right-hand tributaries of the Khaltsyney-Yakha River), 3 km from the designed location of gas well pad No.17, and 1.6*MPC_{fish} in unnamed stream, tributary of the Lerui-Yakha River;
- 3*MPC_{fish} in the Nyaday-Pynche River.

In Khaltsyney-Yakha River, petroleum products concentrations were within the permissible limits; the petroleum products content corresponds to 0.005 mg/dm^3.

At the surface water quality monitoring station at the unnamed lake (designed temporary water intake, quarry No.9g), exceedance of MPC_{fish} limits were reported for iron (3.3 MPC) and petroleum products (3 MPC).

The unnamed lakes (planned water intake facilities No.3.1 and 3.2) are located near the floodplain of Khaltsyney-Yakha River, 1.3 km north of the berth of the Salmanovskoye (Utrenneye) OFCF facilities. The samples failed the MPC_{dom} standards for BOD (up to 5*MPC) and COD (1.2*MPC).

By the microbiological and parasitological criteria, the lake water (water intake facilities Nos. 9g, 3.1 and 3.2) is characterised as pure: no presence of intestinal infection agents, viable helminth eggs,

[52] Salmanovskoye (Utrenneye) OGCF Facilities Setup. Technical report on results of environmental survey. Part 1. Task area of Uralgeoproekt LLC. Book 1. Text part. NIPIgazpererabotka JSC. 2018. 272 p.

2. Salmanovskoye (Utrenneye) OGCF Facilities Setup. Technical report on results of environmental survey. Part 1. Task area of PurGeoCom LLC. Book 1. Text part. NIPIgazpererabotka JSC. 2018. 274 p.

[53] Early development facilities at the Salmanovskoye (Utrenneye) oil, gas, and condensate field. Technical report on environmental survey. Document code 143.01.00-02-196-ИЭЛ1, Vol. 4.1. - GK RusGazEngineering CJSC, 2014. 340 p.

[54] Assessment of Background (Baseline) Status of Environmental Components of Onshore and Offshore Areas of the Salmanovskiy (Utrenniy) License Area (Yamal-Nenets Autonomous Okrug) Based on Results of the Environmental Survey. Technical Report. – Arkhangelsk, FSSUE PINRO, 2012. 297 p.

thermotolerant coliform bacteria, coliphages was detected. Measured total volumetric radionuclide activity was below the threshold.

Testing in the area of Central and Southern domes of the Salmanovskiy (Utrenniy) LA (NIPIgaspererabotka JSC, 2018, task area of PurGeoCom LLC) identified minor (up to 1.3 times MPC_{fish}) exceedances of petroleum products concentrations in the Right Yaru-Yakha River, in the unnamed river (right-hand tributary of the Salpada-Yakha River), and in the unnamed stream discharging into the Ob Estuary. No excessive levels of petroleum products were found in the Salpada-Yakha River.

In general, environmental survey 2018 of surface waters within the Salmanovskiy (Utrenniy) LA identified minor exceedance of standards for fishery waterbodies in terms of total iron (by up to 36 times), ammonium ions (by 7 times), nitrites (by 2.5 times), manganese (by 1.6 times), and in some samples - zinc (by up to 3.7 times).

Monitoring of surface water bodies within the Salmanovskoye (Utrenneye) OGCF in 2018-2019 (IEPI, 2018-2020) identified excessive levels of iron and manganese in all samples, which correlates well with findings of previous studies. It should be noted that iron and manganese are typomorphic chemical elements in the monitored landscapes. To a large extent, both elements are present in the form of compounds with organic matter. Therefore, the reported results do not signify technogenic pollution of surface waters with the concerned elements.

Measured concentrations of many components exceeded background levels (more than twofold): ammonium ion, chlorides, sulphates, nitrates, phosphates, lead, copper, nickel, zinc, phenols, and anionic surfactants. In general, compared to the previous year, the extent of surface waters pollution against background increased in the Lerui-Yakha and Nanyakha 2nd River.

In 2019, visual inspection of water surface and shores for signs of contamination with petroleum products and other technogenic pollutants identified signs of contamination (remains of drilling mud and litter) only on the north-eastern shore of the Yabtarmato Lake, 70 km to the west of well No.265. As compared to the monitoring results in 2018, surface water in the Yabtarmato Lake, besides the typomorphic elements (iron and manganese), still contained elevated concentrations of nickel, lead, copper, zinc, phosphates and phenols. This anomaly is due to technogenic causes and is a result of historical contamination identified by the previous monitoring activities.

Studies in the location area of Plant and Port

The chemical composition and contamination of water (10 samples) in surface waterbodies and watercourses in the territory of the GBS LNG & SGC Plant were tested in the course of engineering surveys and environmental studies (TsGEI LLC, 2017) under the Arctic LNG 2 Project. The mapped sampling points on water bodies and streams are marked in Figure 7.3.12.

Generally, the 2014-2017 surveys identified a few distinctive features of waterbodies in the area of the sea Port and Plant. Water in the explored streams and lakes is ultra fresh, soft and with a rather low color intensity and suspended particulate concentration. The content of major water anions and cations let ascribe water of the studied waterbodies to the chloride-hydrocarbonate type of sodium, magnesium and calcium groups; by hydrogen ion concentration, they are categorised as neutral or weak acidic.

Hydrochemical analysis data (Table 7.3.4) indicate that water in rivers, streams and lakes in the surveyed area is within the MPC limits for public water supply, drinking, and amenity and domestic uses by actually all chemical parameters (MPC_{dom})[55]. Exceptions are cadmium, iron and ammonium nitrogen concentrations that sometimes reach 2*MPC_{dom} (according to the Consultant, as concerns iron and ammonium ions, it is not an issue of chemical contamination but just particular natural attributes of the chemical composition of local water).

Also, a few parameters were reported to be above MPC for fishery waterbodies[56]. All of the surveyed waterbodies are indicative of concentrations exceeding regulatory limits for fishery. Concentrations of iron varied from 0.12 to 0.78 mg/l and of copper from 0.003 to 0.012 mg/l and were 8- and 12-fold higher than respective MPCs for fishery. A few waterbodies had above-MPC_{fish} incidences by manganese, lead and zinc.

[55] GN 2.1.5.1315-03 Maximum Permissible Concentrations (MPC) of Chemicals in Water Bodies Used for Public and Drinking Water Supply and for Amenity and Domestic Needs (brought into effect by the Regulation of the RF Ministry of Health No. 78 of April 30, 2003).

[56] Order of the RF Ministry of Agriculture No. 552 "On Approval of Water Quality Standards for Fishery Water Bodies, Including Maximum Permissible Concentrations of Harmful Substances in Waters of Fishery Water Bodies" of December 13, 2016.

Of special concern is mercury detected in some waterbodies in a high concentration: in most of water samples from waterlogged sections[57] and streams in the Plant area, it exceeded MPC for fishery sometimes being as high as 10-28*MPC_{fish}[58]. Materials of engineering surveys of TsGEI LLC (2017) interpret this fact as one of the chemical contamination indicators for the tested waterbodies and watercourses that gains its maximum in one of the littoral lakes (denoted as waterlogged section No. 1 in Figure 7.3.12). In the Consultant's opinion, there is no sufficient evidence to existing water contamination with mercury or associated elements and compounds in the absence of a proven source of such impact.

First, the mercury concentration in water and bottom sediments of the same waterbodies in the Plant area does not exhibit a clear correlation: particularly, the element was not detected in bottom sediment of Lake No. 1 where higher Hg concentration in water was measured (0.28 mkg/l) meanwhile in Stream No. 1 with the maximum mercury content in bottom sediment (0.015 mg/kg) the Hg concentration in water did not go beyond the low detection limit.

Second, the sensitivity of measurement procedures is very close in value to MPC for mercury. Third, many researchers of Arctic waterbodies earlier determined higher concentrations of mercury both in water and in bottom sediments and the origin of those mercury anomalies was not always unambiguously explained.

In particular, accumulation of mercury and several associated elements such as cadmium and uranium was found out in the water area of Periptaveto Lake and a number of other waterbodies on the Gydan Peninsula. It could be a result of long-standing impact of remote sources via a mercury transfer by air and its fallout with precipitation[59].

It is important to highlight that in this case elevated Hg contents were detected exactly in bottom sediments whereas the aquatic medium of lakes remained environmentally safe. A significance of the remote transfer as a factor of background pollution of Arctic landscape features with mercury has been ascertained by numerous studies in Russian and Canadian sectors[60]. The YNAO territory is marked with regionally meaningful mercury accumulation in vegetation and its migration by food chains and accumulation in reindeer[61]. Alongside with that, there are encountered local anomalies of the element confined to sites of historic economic activity – in all such instants, mercury is identified as an associated micro component of chemical contamination with petroleum products and various components of waste[62].

Apart from mercury, local anomalies in Gydan peninsula waterbodies were found for elements such as chromium, antimony and rubidium[63] which are exotic for this region. Their emergence is to be elucidated in future investigations. In the Consultant's view, above-permissible concentrations of cadmium detected in waterbodies in the Plant area (see above) should also be ascribed to this category.

A number of the measured parameters of water samples reflect the presence and composition of organic compounds in waterbodies: dissolved oxygen activity, color intensity, oxygen demand indices (BOD_5 and COD), concentrations of petroleum hydrocarbons and mono- and polyaromatic compounds.

In response to the presence of readily oxidisable organics, BOD_5 varied from <2 to 5 mgO_2/l, which is beyond the standard in most of the surveyed waterbodies. Total content of dissolved organic substances in surface water of the surveyed watercourses assessed on the basis of COD ranged within 5-19 mg/l; minor MPC exceedances were found in three waterbodies.

---

[57] Following the survey of waterbodies with reference numbers 1, 2, 7 and 8 that were described in the engineering survey materials as "lakes", it was found that they are located in the onshore area of the Ob Estuary (laida) which is exposed to flooding multiple times every year. Therefore, in the design documentation these depressions that are filled with sea water during dizygial tides and wind surge (and combination thereof) are referred to as "waterlogged sections of laida" (or just "waterlogged sections") with the same reference numbers..

[58] Maximum permissible gross concentration of mercury on inland fishery waterbodies is 0.01 mkg/l and for seawater – 0.1 mkg/l.

[59] V. Y. Khoroshavin et al. Project for the comprehensive study of lacustrine ecosystems in Tazovsky Municipal District: first findings // Scientific Bulletin of YNAO (Obdoria: Ecology of the Arctic Region). 2016. Issue 4. pp. 93-98.

[60] F. F. Pankratov. Atmospheric mercury distribution trends in the Russian Arctic on the basis of long-term monitoring results. Author's abstract of PhD thesis in Engineering - StPb: 2013.

Leitch D.R. Mercury distribution in water and permafrost of the lower Mackenzie Basin.... Master of Science Thesis. Submitted to the Univ. of Manitoba. 2006.

[61] Ye. V. Agbalyan, A. A. Listishenko. Accumulation of pollutants (mercury and cadmium) in soil, vegetation and animals // Scientific Bulletin of YNAO (Obdoria: Ecology of the Arctic Region). 2017. Issue 3. pp. 4-9.

[62] R. A. Kolesnikov et al. Current status of natural-territorial complexes and assessment of accumulated environmental damage on Vilkitsky Island // Scientific Bulletin of YNAO (Obdoria: Ecology of the Arctic Region). 2017. Issue 3. pp. 11-20.

[63] N. V. Yurkevich. Assessment of the geochemical composition of natural surface waters of the Gydan Peninsula // INTEREXPO GEO-Siberia. Novosibirsk: Publishers of Siberian State University, 2017. pp. 150-155.

Petroleum products in surface water generally varied from amounts below the detection threshold to 0.42 mg/l. For chemical analysis, oil derivatives are extracted from water using organic solvents, which is why this analytical group always includes a broad spectrum of bitumenous compounds of natural genesis. Their spectral and other characteristics are similar to those of petroleum products such as waxes, resins, lipids, oils, and humus substances. Their concentration may be up to a few milligrams per 1 L of water; in the Consultant's view, concentrations of this group of chemicals provided in the surveys and environmental monitoring materials were measured in the absence of visual signs and pollution sources, so they should be associated with a release of natural bitumoids rather than with an ingress of liquid hydrocarbons into the water environment.

Concentrations of phenols in surface water of most of the surveyed waterbodies were below the detection threshold. However, above-MPC phenol concentrations were found in the samples from Lakes Nos. 5 and 6. Of note here is that peat and other organogenic materials always contains some amount of natural organic compounds which are analytically close to phenols. The fact that phenols were detected in the samples does not attest to their being contaminated and should be regarded as an important indicator of local water.

Concentrations of benzo[a]pyrene and surfactants in all the studied waterbodies were below the detection threshold.

7.3.5.3 Integral assessment of surface water quality in the area of the Utrenniy Terminal (Port) and GBS LNG & SGC Plant

Integral assessment of waterbodies pollution was performed in accordance with the methodical guidelines set forth in RD 52.24.643-2002[64]: on the basis of laboratory data, a waterbody was categorised by pollution complexity (combinatorial aspect) and classed from times (multiplicity) of MPC exceedance, a pollution level was assessed as function of a complex of pollutants, and a water quality class was established.

[64] RD 52.24.643-2002. Methodical Guidelines.The method of integral assessment of the surface water contamination level based on hydrochemical indicators.

Table 7.3.4: Content of chemicals in surface water samples (2017)

Parameter	Waterbody (sample reference)													MPC$_{fish}$[65]	MPC$_{dom}$[66]	YNAO background[67]
	Stream 1 (Str-5)	Str-6, Stream 2	Waterlogged section 1 (L-5)	Waterlogged section 2 (L-6)	Waterlogged section - 7(L-8)	Waterlogged section - 8 (L-9)	Lake 3 (L-4)	Lake 4 (L-7)	Lake 5 (L-3)	Lake 6 (L-2a)	Water intake facility 3.1	Water intake facility 3.2	Water intake facility, quarry 9g			
BOD$_5$, mgO$_2$/l	**3**	**4**	**4**	**3**	**4**	<2	<2	<2	**3**	**5**	**11,01**	**11,08**	**8,11**	2	2	1.57
COD, mgO$_2$/l	10	**15**	**15**	9	14	5	7	6	8	**19**	**18,94**	**19,06**	13,95	15-30	15	32.8
Suspended solids, mg/dm^3	4.4	3.8	4.6	4.1	10.6	5.4	5	4.9	4.7	4.3	<0,5	<0,5	2,13	+25 to background	+25 to background	
Petroleum products, mg/dm^3	0.17	0.25	0.07	<0.05	0.05	<0.05	<0.05	0.06	<0.05	**0.42**	0,094	0,085	0,15	0.05	0.3	0.028
Surfactants, mg/dm^3	<0.01	<0.01	<0.01	<0.01	<0.01	0.012	0.011	<0.01	<0.01	<0.01	<0,025	<0,025	<0,025	0.1	0.5	0.032
Phenols, mg/dm^3	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	**0.001**	**0.0018**	<0,0005	<0,0005	<0,0005	0.001	0.001	0.0006
NH_4^+, mg/dm^3	0.15	0.24	0.36	0.2	0.23	0.14	0.15	0.14	0.16	0.29	-	-	-	0.5	1.5	
NO_3^-, mg/dm^3	0.15	<0.1	0.32	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.19	<0,10	<0,10	< 0,1	40	45	0.52
PO_4, mg/dm^3	0.015	0.019	0.012	0.017	0.014	0.014	0.016	0.017	0.019	0.022	<0,05	<0,05	< 0,05	0.05/0.15/0.2	-	0.038
Ni, mg/dm^3	0.002	<0.0002	<0.0002	0.003	0.003	<0.0002	0.003	<0.0002	<0.0002	<0.0002	<0,005	<0,005	<0,005	0.01	0.02	0.0029
Zn, mg/dm^3	0.002	0.011	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,0078	0,007	<0,005	0.01	1	0.0095
Fe, mg/dm^3	**0.6**	**0.78**	0.29	0.23	**0.34**	0.22	**0.12**	0.087	0.24	**0.36**	0,112	0,098	**0,33**	0.1	0.3	0.63
Cu, mg/dm^3	0.008	0.012	0.01	0.003	0.004	0.005	0.003	0.008	0.005	0.004	0,001	0,001	0,003	0.001	1	0.0013
Mn, mg/dm^3	0.029	0.092	0.003	0.005	0.021	0.006	0.002	0.004	0.002	0.022	0,006	0,005	0,007	0.01	0.1	0.041
Pb, mg/dm^3	0.009	0.003	0.006	0.005	0.009	<0.0002	<0.0002	0.001	<0.0002	0.009	<0,002	<0,002	<0,002	0.006	0.01	0.0017
NO_2^-, mg/dm^3	0.027	0.03	<0.02	0.026	0.033	0.026	<0.02	0.031	<0.02	0.047	-	-	-	0.08	3.3	0.017
SO_4^{2-}, mg/dm^3	7.5	7.2	<2.0	6.8	<2.0	13	11.9	8.4	8.6	10.6	15,90	27,14	20,72	100	500	1.98
Cl^-, mg/dm^3	16	55	10	11	14	19	22	22	22	61	39,17	49,65	42,54	300	350	7.64
F^-, mg/dm^3	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	-	-	-	0.75	1.5	-
Si, mg/dm^3	0.31	0.22	0.22	0.27	0.24	0.18	0.21	0.15	0.18	0.26	1,4	1,7	<0,50	10	10	-
HCO_3^-, mg/dm^3	12.2	30.5	12.2	12.2	21.4	21.4	18.3	18.3	<10	33.6	-	-	48,80	-	-	-
Ca^{2+} mg/dm^3	3	8	4	3	4.01	4	4	5	4	8	70,14	74,15	70,14-	180	-	-
Mg^{2+}, mg/dm^3	1.82	6.1	2.43	1.82	2.43	3.03	3.64	3.04	2.43	7.3	28,580	29,790	13,38	40	50	-
Na^+, mg/dm^3	5.2	47	2.9	3.6	5.2	4.4	4.7	5.3	4.5	46	41,400	33,700	31,30	120	200	-
K^+, mg/dm^3	<1	1.28	<1	<1	<1	<1	<1	1.13	<1	1.32	1,250	1,110	2,60	50	-	-
Cd, mg/dm^3	0.001	**0.002**	0.001	0.001,	0.001	**0.002**	**0.002**	**0.003**	<0.00001	0.001	<0,002	<0,002	<0,002	0.005	0.001	-
Hg, mg/dm^3	**0.00009**	<0.00001	**0.00028**	**0.00015**	**0.00015**	<0.00001	<0.00001	**0.00018**	**0.00011**	<0.00001	<0,1	<0,1	<0,1	0.00001	0.00005	-
As, mg/dm^3	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0,005	<0,005	<0,005	0.05	0.01	-
Odour, points	0	1	1	1	0	0	0	0	1	1	1	1	1	-	-	-
Taste, points	0	1	1	1	0	0	0	0	1	1			-	-	-	-
Color, degrees	13	20	26	17	25	13	12	11	14	23	9,1	8,9	49,7	-	-	-
Total hardness, degrees	0.3	0.9	0.4	0.3	0.4	0.45	0.5	0.5	0.4	1	-	-	-	-	-	-
Dry residue, mg/dm^3	<50	97	<50	<50	<50	<50	<50	<50	<50	100	210	220	140	-	1000	-
benzo[a]pyrene µg/dm^3	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0,0005	<0,0005	<0,0005	-	0.01	-

Legend: Red – exceedance of MPC for fishery; Yellow – exceedance of background pollution indicators for YNAO rivers; **Bold type** – exceedance of MPC for utility and domestic water uses. Dash «-« denotes unavailable data or regulatory value/standard.
Source: TsGEI LLC, 2017[68]

[65] Order of the RF Ministry of Agriculture No. 552 "On Approval of Water Quality Standards for Fishery Water Bodies, Including Maximum Permissible Concentrations of Harmful Substances in Waters of Fishery Water Bodies" of December 13, 2016.

[66] GN 2.1.5.1315-03 Maximum Permissible Concentrations (MPC) of Chemicals in Water Bodies Used for Public and Drinking Water Supply and for Amenity and Domestic Needs (brought into effect by the Regulation of the RF Ministry of Health No. 78 of April 30, 2003)

[67] Reference Guide on the application of average regional content values for monitored components at monitoring sites when assessing the state and level of environmental pollution in the Yamal-Nenets Autonomous District. - Bratsk: YNAO Department of Natural Resources Regulation, Forest Relations and the Development of the Oil and Gas Complex, 2014. 19 p.

[68] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Design documentation. Section 4. Technical report on results of environmental survey. Part 2. Onshore facilities. Book 2. Text appendixes. Document code 2017-423-M-02-ИЭИ2.2. Vol. 4.2.2. – TsGEI LLC, 2017. 314 p.

The most informative tools of integral water quality assessment are specific-combinatorial water quality index (SCWQI) and water quality class (a water quality level established within an interval of numeric values representing individual properties and composition of water which characterise its suitability for a certain user type).

SCWQI is evaluated from frequency and multiplicity of MPC exceedance by a few parameters and may fluctuate from 1 to 16 (0 for clean water) depending on the water pollution level. A higher index corresponds to a lower water quality. The SCWQI-based water quality classification suggests 5 classes of surface water (Table 7.3.5).

Table 7.3.5: Classification of water quality in waterbodies based on the specific combinatorial water quality index (SCWQI)

Class and subclass	Characterisation of the water pollution condition	SCWQI without account for critical pollution indices (CPI)	SCWQI at k=0.9 (1 CPI)
Class 1	Conditionally clean	1	0.9
Class 2	Weakly polluted	(1; 2]	(0.9; 1.8]
Class 3	Polluted	(2; 4]	(1.8; 3.6]
subclass "a"	Polluted	(2; 3]	(1.8; 2.7]
subclass "b"	Heavily polluted	(3; 4]	(2.7; 3.6]
Class 4	Dirty	(4; 11]	(3.6; 9.9]
subclass "a"	Dirty	(4; 6]	(3.6; 5.4]
subclass "b"	Dirty	(6; 8]	(5.4; 7.2]
subclass "c"	Very dirty	(8; 10]	(7.2; 9.0]
subclass "d"	Very dirty	(8; 11]	(9.0; 9.9]
Class 5	Extremely dirty	(11; ∞]	(9.9; ∞]

Results of the integral assessment of water pollution in streams and lakes are summarised in Table 7.3.6. Also, integral pollution indices are depicted in the schematic map showing the current environmental status of surface waters (Figure 7.3.12).

Typical pollutants for virtually all waterbodies are iron, copper, and, less frequently, manganese.

- A majority of the local waterbodies and watercourses are characteristic of heavy pollution and fall under class 3b. The key pollutant in such lakes and streams is mercury in extremely high quantities. It could be a result of long-standing impact of remote sources via a mercury transfer by air and its fallout with precipitation[69]. Significance of the remote transfer as a factor of background pollution of Arctic landscape features with mercury has been ascertained by numerous studies in Russian and Canadian sectors[70]. The YNAO territory is marked with regionally meaningful mercury accumulation in vegetation and its migration by food chains and accumulation in reindeer[71]. Also, there are local anomalies of the element confined to sites of historic economic activity – in all such instants, mercury is identified as an associated micro component of chemical contamination with petroleum products and various components of waste[72].

A few waterbodies in the area are characterised as weakly polluted and conventionally clean; however, some above-MPC concentrations of copper and iron have been detected.

No relationship between the water quality and location within the surveyed territory has been established. In the Consultant's view, chemical composition parameters of the surveyed waterbodies in the Plant area determined in the course of the engineering surveys largely reflect their natural status rather than technogenic pollution; therefore, water quality assessment in wording of RD 52.24.643-2002 (Table 7.3.6) shows only how water chemistry measures up to regulatory standards set for waterbodies of domestic and of fishery uses.

[69] V. Y. Khoroshavin et al. Project for the comprehensive study of lacustrine ecosystems in Tazovsky Municipal District: first findings // Scientific Bulletin of YNAO (Obdoria: Ecology of the Arctic Region). 2016. Issue 4. pp. 93-98.

[70] F. F. Pankratov. Atmospheric mercury distribution trends in the Russian Arctic on the basis of long-term monitoring results. Author's abstract of PhD thesis in Engineering - StPb: 2013.Leitch D.R. Mercury distribution in water and permafrost of the lower Mackenzie Basin.... Master of Science Thesis. Submitted to the Univ. of Manitoba. 2006.

[71] Ye. V. Agbalyan, A. A. Listishenko. Accumulation of pollutants (mercury and cadmium) in soil, vegetation and animals // Scientific Bulletin of YNAO (Obdoria: Ecology of the Arctic Region). 2017. Issue 3. pp. 4-9.

[72] R. A. Kolesnikov et al. Current status of natural-territorial complexes and assessment of accumulated environmental damage on Vilkitsky Island // Scientific Bulletin of YNAO (Obdoria: Ecology of the Arctic Region). 2017. Issue 3. pp. 11-20.

Table 7.3.6: Summary data on surface water contamination level

Number of sample and waterbody	Assessment by RD 52.24.643-2002						
	Complexity of water pollution	Classification of water quality based on WQI and SCWQI		Characterisation of the water pollution level based on multiplicity of MPC exceedance (parameters above MPC)			
	Water category and pollution data characteristic, complexity factor (%)	Class and subclass	Characterisation of the water pollution condition	Low	Medium	High	Extremely high
Site of the onshore facilities of the GBS LNG & SGC Plant and Utrenniy Terminal							
Stream 1 (Str-5)	II, by several ingredients and parameters (37 %)	3b	Heavily polluted	BOD_5, Pb	Cu, Mn, Fe, petroleum products	-	Hg
Stream 2 (Str-6)	II, by several ingredients and parameters (37 %)	3b	Heavily polluted	Zn, COD	BOD_5, Cu, Mn, Fe, petroleum products	-	-
Waterlogged section 1 (L-5)	II, by several ingredients and parameters (37 %)	3b	Heavily polluted	COD, Pb, petroleum products	BOD_5, Cu, Fe	-	Hg
Waterlogged section 2 (L-6)	II, by several ingredients and parameters (21 %)	3a	Polluted	BOD_5	Cu, Fe	-	Hg
Waterlogged section 7 (L-8)	III, by a complex of ingredients and parameters (42 %)	3b	Heavily polluted	O_2, Pb, petroleum products	BOD_5, Cu, Mn, Fe		Hg
Waterlogged section 8 (L-9)	II, by several ingredients and parameters (11 %)	1	Conventionally clean	-	Cu, Fe	-	-
Area of influence							
Lake 3 (L-4)	II, by several ingredients and parameters (11 %)	1	Conventionally clean	Fe	Cu	-	-
Lake 4 (L-7)	II, by several ingredients and parameters (25 %)	2	Weakly polluted	O_2, petroleum products	Cu	-	Hg
Lake 5 (L-3)	II, by several ingredients and parameters (25 %)	3a	Polluted	phenol	BOD_5, Cu, Fe	-	
Lake 6 (L-2a)	III, by a complex of ingredients and parameters (42%)	3b	Heavily polluted	phenols, COD, Pb	BOD_5, Cu, Mn, Fe, petroleum products	-	-

Source: GK RusGasEngineering CJSC, 2014[73] ; TsGEI LLC, 2017[74]

[73] Early development facilities at the Salmanovskoye (Utrenneye) oil, gas, and condensate field. Technical report on environmental survey. Document code 143.01.00-02-196-ИЭЛ1, Vol. 4.1. - GK RusGazEngineering CJSC, 2014. 340 p.

[74] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Design documentation. Section 4. Technical report on results of environmental survey. Part 2. Onshore facilities. Book 1. Text part. Explanatory note. Document code 2017-423-M-02-ИЭИ2.1. Vol. 4.2.1. – TsGEI LLC, 2017. 254 p.

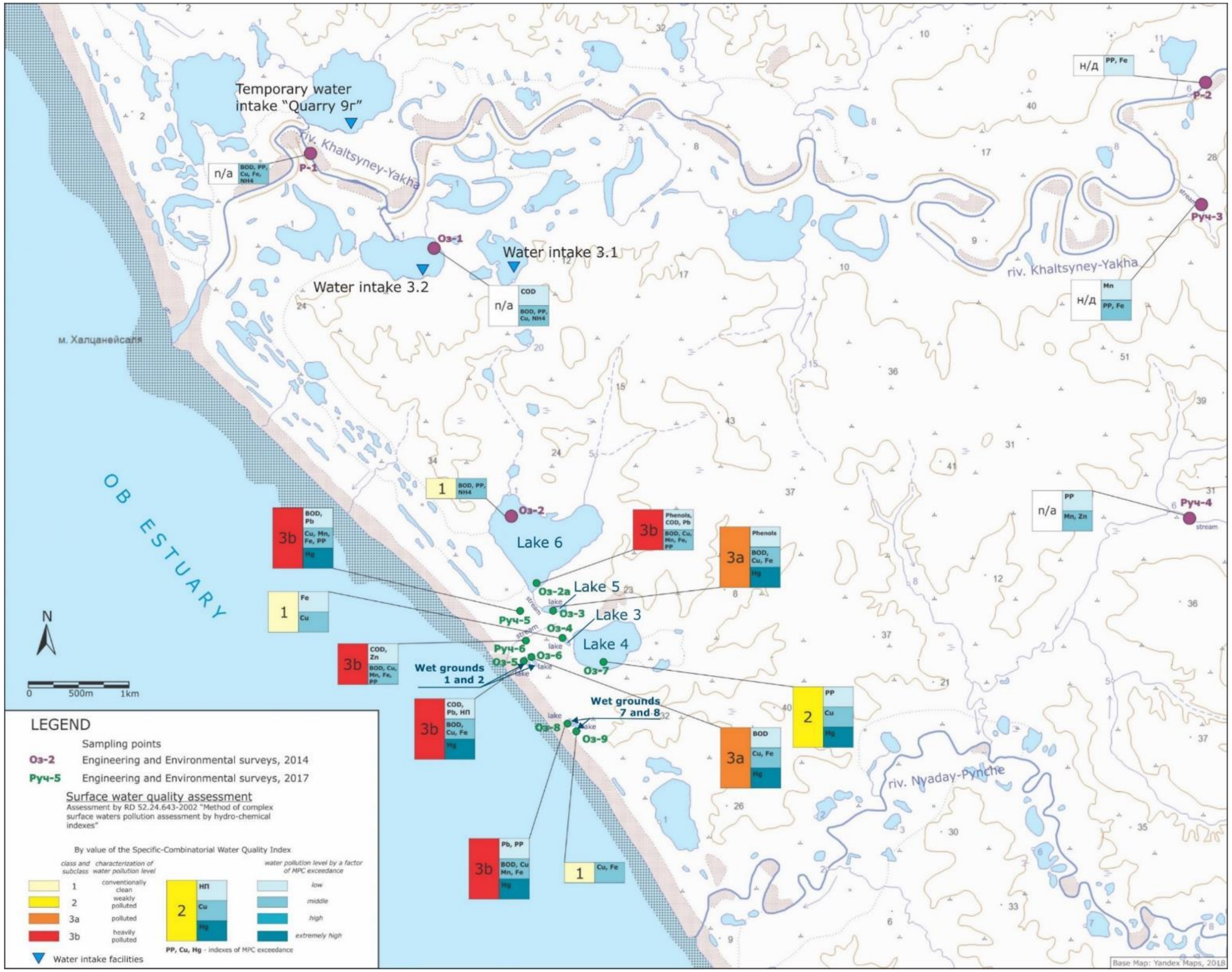


Figure 7.3.12: Surface water quality in the area of the Utrenniy Terminal and GBS LNG & SGC Plant

Source: GK RusGasEngineering CJSC, 2014[75]; TsGEI LLC, 2017[76]; NIPIGAZ JSC, 2018[77]

---

[75] Early development facilities at the Salmanovskoye (Utrenneye) oil, gas, and condensate field. Technical report on environmental survey. Document code 143.01.00-02-196-ИЭЛ1, Vol. 4.1. - GK RusGazEngineering CJSC, 2014. 340 p.

[76] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Design documentation. Section 4. Technical report on results of environmental survey. Part 2. Onshore facilities. Book 3. Text appendixes, graphic appendixes. Document code 2017-423-M-02-ИЭИ2.3. Vol. 4.2.3. – TsGEI LLC, 2017. 132 p.

[77] Salmanovskoye (Utrenneye) OGCF Facilities Setup. Technical report on results of environmental survey. Part 1. Task area of Uralgeoproekt LLC. Book 1. Text part. NIPIGAZ JSC. 2018. 272 p.

7.3.6 Nature use restrictions pertinent to surface waterbodies

7.3.6.1 Water protection zones and coastal protection belts

In compliance with Article 65 of the Water Code of the Russian Federation, water protection zones are set up around waterbodies adjacent to the shoreline (boundaries of a waterbody) of rivers, streams, channels, lakes, and water reservoirs in order to prevent contamination, littering, silting and water depletion of surface waterbodies and conserve the habitat of aquatic biological resources and other flora and fauna species[78]. Special conditions of economic or other activities are established in water protection zones.

Coastal protection belts are provided within water protection zones where additional restrictions apply to economic or other activities. A width of the coastal protection belt is defined depending on the inclination of the shore slope of a water body and is thirty meters for counter or zero gradient slopes, forty meters for slopes with inclination below 3 degrees, and fifty meters for slopes inclined at three or more degrees.

Widths of water protection zones and coastal protection belts of rivers, streams, channels, lakes, and water reservoirs situated outside cities and other populated localities are determined from the waterbody's boundary.

Sizes of water protection zones of the main watercourses in the surveyed area (pursuant to Article 65, Section 4, p. 3 of the RF Water Code) are listed in the Table 7.3.7.

Table 7.3.7: Dimensions of restricted use territories/zones set up for surface waterbodies

No.	Name	Watercourse length, km / waterbody area, km^2	Minimal water protection zone width, m	Coastal protection belt width, m
1	Ob Estuary	800 km	500	50
2	Salpada-Yakha River	74 km	200	50
3	Right Yara-Yakha River	68 km	200	50
4	Khaltsyney-Yakha River	55 km	200	50
5	Yaromichu-Yakha River	44 km	100	50
6	Middle Yara-Yakha River	28 km	100	50
7	Nyaday-Pynche River	21.1 km	100	50
8	Syabuta-Yakha 1st River	16 km	100	50
9	Lerui-Yakha River	15 km	100	50
10	Serako-Ya-Yakha River	8.7 km	50	50
11	Stream 9	5 km	50	50
12	Stream 10	4.8 km	50	50
13	Yabtarmasyo River	4.7 km	50	50
14	Stream 4	3.4 km	50	50
15	Stream 7	1.1 km	50	50
16	Stream 6	0.57 km	50	50
17	Stream 5	0.56 km	50	50
18	Stream 3	0.46 km	50	50
19	Stream 8	0.23 km	50	50
20	Yabtarmato Lake	0.5 km^2	50	-
21	Waterlogged section 1	0.22 km^2	n/a	
22	Waterlogged section 2	0.45 km^2		
23	Lake 3	0.015 km^2		
24	Lake 4	0.003 km^2		
25	Lake 5	0.0048 km^2		
26	Lake 6	0.00425 km^2		
27	Waterlogged section 7	0.18 km^2		
28	Waterlogged section 8	0.0013 km^2		
29	Lake 9	0.001 km^2		
30	Lake 10	less than 0.5 km^2		
31	Lake 11	0.007 km^2		

Source: Environmental Survey 2014[79]; fishery characteristics Nos. 1[80], 148[81], and 361[82]

[78] Water Code of the Russian Federation No. 74-FZ of 03.06.2006 (with amendments and additions in force from 01.01.2016)

[79] Early development facilities at the Salmanovskoye (Utrenneye) oil, gas, and condensate field. Technical report on environmental survey. Document code 143.01.00-02-196-ИЭЛ1, Vol. 4.1. - GK RusGazEngineering CJSC, 2014. 340 p.

[80] Fishery characteristic No. 1 for lakes and nameless streams in Tazovsky Municipal District of YNAO of Tyumen Region as of 11.01.2018, Lower Ob Branch of FPFI GlavRybVod

[81] Fishery characteristic No. 148 for the Khaltsyney-Yakha and Salpada-Yakha Rivers and Yabtarmato Lake in Tazovsky Municipal District of YNAO as of 26.11.2013, FPFI Nizhneob'rybvod

[82] Fishery characteristic No. 361 for the Khaltsyney-Yakha and Lerey-Yyakha Rivers, nameless streams and nameless lakes in Tazovsky Municipal District of YNAO of Tyumen Region as of 21.12.2017, Lower Ob Branch of FPFI GlavRybVod

The water protection zone for watercourses having a length of less than ten kilometres from the source to the mouth coincides with the coastal protection belt (CPB of Streams 1, 2 and others-50 m); a CPB width for the Ob Estuary is 50 m.

Designing, constructing, reconstructing, commissioning, and operating economic and other facilities within water protection zones are permitted given that they are adequately equipped to ensure protection of water bodies from contamination, littering, silting, and water depletion. Such facilities shall be selected taking into account environmental regulations such as maximum permissible discharges of pollutants and other substances and microorganisms.

Activities prohibited within water protection zones:

1) use of wastewater for soil fertility control;
2) arrangement of graveyards, animal burial sites, disposal sites for industrial and domestic wastes, chemicals, explosives, toxicants, venomous and poisoning agents, and burial sites for radioactive waste;
3) aerial pest control;
4) vehicular traffic and parking (except special transport vehicles, traffic on paved roads and parking in special areas with hard pavement);
5) location of fueling stations, fuel and lubricants stores (with an exception of refueling stations and fuel stores at port sites, shipyards, and inlandwaterways infrastructure, subject to compliance with the environmental regulations and the RF Water Code), as well as technical maintenance workshops used for technical inspection, repair, and washing of motor vehicles;
6) arranging of storage facilities for pesticides and agrichemicals, and application of pesticides and agrichemicals;
7) discharge of wastewater, including drainage water; and
8) prospecting and production of commonly occurring mineral resources (except for prospecting and production of commonly occurring mineral resources by subsoil users within the boundaries of the mining allotment and (or) geological allotment allocated to such users in compliance with the Russian Federation law on the basis of the approved technical design in accordance with the Federal Law "On Subsoil" No. 2395-1 of February 21, 1992).

Further restrictions within coastal protection belts prohibit:

1) land ploughing; and
2) arrangement of erodible soil banks.

7.3.6.2 Fishery characteristics of surface waters

Watercourses and waterbodies in the Project area are assigned to different fishery categories on the basis of regulatory fishery characteristics Nos.1[83], 148[84] and 361[85] in compliance with the Order of the Federal Agency for Fishery No. 818 of 17.09.2009 "On Establishing Categories of Fishery Water Bodies and Specific Features of Capture Production (Catch) of Aquatic Biological Resources Inhabiting them and Assigned to Fishery Sites" (Table 7.3.8).

Table 7.3.8: Fishery categorisation of waterbodies in the Plant area

Waterbody name	Fishery category[86]
Ob Estuary	Top
Khaltsyney-Yakha River	
Nyaday-Pynche River	
Salpada-Yakha River	
Lerui-Yakha River	
Lake 1	
Lake 2	
Lake 7	
Yabtarmato Lake	First
Stream 5	

[83] Fishery characteristic No. 1 for lakes and streams in Tazovsky Municipal District of YNAO of Tyumen Region as of 14.01.2018, Lower Ob Branch of FPFI GlavRybVod

[84] Fishery characteristic No. 148 for the Khaltsyney-Yakha and Salpada-Yakha Rivers and Yabtarmato Lakes in Tazovsky Municipal District of YNAO of Tyumen Region as of 06.11.2013, Federal Agency for Fishery, Lower Ob Area Department

[85] Fishery characteristic No. 361 for the Khaltsyney-Yakha and Lerey-Yakha Rivers, nameless streams and nameless lakes in Tazovsky Municipal District of YNAO of Tyumen Region as of 21.12.2017, Lower Ob Branch of FPFI GlavRybVod

[86] In accordance with the Order No. 818 of the Federal Agency for Fishery, dated 17 September, 2009, "On Establishing Categories of Fishery Water Bodies and Specific Features of Capture Production (Catch) of Aquatic Biological Resources Inhabiting them and Assigned to Fishery Sites"

Waterbody name	Fishery category[86]
Stream 6	First
Stream 7	Second
Stream 8	
Lake 4	
Lake 5	
Lake 6	
Lake 9	
Lake 11	

Source: Fishery characteristics Nos. 1[87], 148[88], 361[89]

7.3.6.3 Standards of permissible impact on surface water

In accordance with Russian environmental law[90], specific impact limits (IL) are established for each waterbody which then serve as a basis for calculation of permitted volume of abstraction of natural water under the Water Use Agreement. The IL calculation methodology is approved by the RF MNR Order No.328 of 12.12.2007 "On approval of guideline methodology for development of impact limits for waterbodies".

This methodology provides for adoption of impact limits for abstraction of water (ILabst) to be established as constant values and applied starting from the calculation base year with certain probability, so as to **prevent in any significant change in the waterbody parameters beyond the long-term natural seasonal variations.** The limits are established for each waterbody at different sections, and for the whole catchment area, so that sufficient water resource is always available for the terminal waterbody in the river basin to maintain its ecosystem. Intake (abstraction) of water resources is characterised by the total volume of permanent abstraction of water from a water management section of waterbody over certain period of time (year, season, month) in the most critical water availability conditions (95% probability), depending on the prevailing uses of the water resource (irrigation, drinking water supply, etc.). For rivers with unregulated flow, so called "environmental flow" (EF) is defined as an environmentally safe flow rate in specific section that supports normal functioning of the aquatic and near-water ecosystems at the permanent abstraction of permissible volume of water from the river.

In accordance with the Integrated Water Management Scheme (IWMS) for the Taz River basin (approved by the Lower Ob Basin Authority, Order of 04.08.2014 No.265), impact limits (IL) have been established for the water management section 15.05.00.002 comprising the catchment areas of the rivers that discharge into the Kara Sea between the Taz Estuary and the border of the basin of Yenisei Estuary. The Project area is located within this section.

The IL values provided the basis for establishing the limit of **16,355.24 M m^3 per year** for water management section (WMS) No. 15.05.00.002 – i.e. the maximum volume of water that can be abstracted from the WMS without damaging the natural environment and designated function of the waterbody.

The limit for wastewater discharge into surface waterbodies is set at **14,718.20 M m^3 per year**.

7.3.7 Bottom sediments

7.3.7.1 General

Bottom sediments are among the most stable components of aquatic ecosystems which reflect basic physicochemical and biological processes occurring inside waterbodies. They play a crucial part in the turnover of chemical elements and are kind of a water pollution indicator since substances precipitate from water and accumulate in bottom sediment in a concentrated state. Content of all substances is normally much higher in bottom sediments than in water. Bottom sediments fixate results of long-standing anthropogenic exposure of a water basin. In the conditions where sediment-related physicochemical parameters such as pH, dissolved oxygen and bacterial activity are changeable, pollutants are likely to dissolve in water and become a source of secondary seawater pollution.

Regulations for rating pollutant concentrations in bottom sediments are unavailable in Russia. Previously, so-called Dutch lists which provide data on pollutant concentrations and levels of hazard, including that of

[87] Fishery characteristic No. 1 for lakes and nameless streams in Tazovsky Municipal District of YNAO of Tyumen Region as of 11.01.2018, Lower Ob Branch of FPFI GlavRybVod

[88] Fishery characteristic No. 148 for the Khaltsyney-Yakha and Salpada-Yakha Rivers and Yabtarmato Lakes in Tazovsky Municipal District of YNAO as of 26.11.2013, FPFI Nizhneob'rybvod

[89] Fishery characteristic No. 361 for the Khaltsyney-Yakha and Lerey-Yyakha Rivers, nameless streams and nameless lakes in Tazovsky Municipal District of YNAO of Tyumen Region as of 21.12.2017, Lower Ob Branch of FPFI GlavRybVod

[90] RF Government Resolution No. 881 of 30.12.2006 "On procedure for adoption of impact limits for waterbodies"

remediation urgency, were applied to assess pollution against international standards. In the Netherlands, conventional assessment criteria for bottom sediments fell from practice after a procedure for assessing the bottom sediment quality had been brought into compliance with the EU Groundwater Directive under the Water Framework Directive. For that reason, no comparison of results of bottom sediment testing, carried out for the Project's territory, with regulatory values was made.

According to the guidelines of RD 52.24.609-2013 "Organising and Conducting of Observations of the Content of Pollutants in Bottom Sediments of Water Bodies", bottom sediment pollution levels were assessed through a comparison of pollutant concentrations from test results with their background contents in bottom sediments.

The studies of 2017 comprised, alongside with bottom sediments, assessment of beach deposits (Figure 7.3.13) because the latter are closer to bottom sediments than to soils by their physicochemical properties and formation pathway.

Figure 7.3.13: View of coast from Station No.15

Source: INZHGEO LLC, 2017[91]

7.3.7.2 Sea bottom and beach sediments

The Ob Estuary is a typical estuarial bay where sections with soft silty bottom are infrequent; however, exactly these are characteristic of elevated concentrations of pollutants from various classes. A rate of recent sedimentation in the Ob Estuary is not high and is 0.1-0.13 cm/year on an average. More essential are water and sediment exposure to a long-range transfer of pollutants by rivers running across oil and gas production areas to which pollutants are carried by on-land and underground flows from drilling rigs and process facilities.

Bottom sediment studies in the Ob Estuary have been ongoing since 2011. This report uses the materials 2018-2019 of the operational environmental control at the berth structures of the Salmanovskoye (Utrenneye) OGCF by IEPI JSC, and findings from the survey of bottom and beach sediments in the territory of the Salmanovskoye (Utrenneye) OGCF performed in 2017 by Inzhenernaya Geologia LLC. Pollutant concentrations, taken as background values, were drawn from the 2012 Report of PINRO "Assessment of Background (Baseline) Status of Environmental Components of Onshore and Offshore Areas of the Salmanovskiy (Utrenniy) License Area (Yamal-Nenets Autonomous Okrug) Based on Results of the Environmental Survey". The results are discussed below.

By the grain-size composition, the bottom sediments are characterised by predominance of sand (94.8-95.2 %), i.e. they fall under the lithological category of pure sand. Specific gravity of bottom sediment samples varied between 3.6 and 4.7 g/cm^3.

Petroleum hydrocarbons (petroleum products) can accumulate in bottom sediment because their photochemical and biological decomposition rates at negative temperatures are very low. Both natural

[91] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Technical report on the environmental survey for preparation of design documentation. - IEI1. – InzhGeo LLC, 2017. 277 p.

decomposition processes of plant residues and industrial accidents may be sources of their occurrence in waterbodies. Studies during 2017-2019 demonstrated that the content of petroleum products actually in all bottom sediment samples is below 5.0 mg/kg (detection threshold of the method). Only one sample taken from the surface layer had a concentration of 14.63 mg/kg, which is twice higher than the background.

Phenols are products of the biochemical degradation and organic matter transformation in water and in bottom sediments. Additionally, there is a possibility of industry-associated contamination of aquatic ecosystems by these substances. Phenols were found in bottom sediments in quantities below the detection threshold (0.05 mg/kg) in actually all samples with the exception of one sample from the surface layer.

The content of **organochlorine compounds** in the analysed samples both from the surface and from the depth is below the detection threshold.

The content of **surfactants** in bottom sediments is from 2.11 to 6.4 mg/kg and 3.74 mg/kg on an average. Polycyclic aromatic hydrocarbons of technogenic origin, namely benzo[a]pyrene, are below the detection threshold (less than 0.005 mg/kg).

Concentrations of all **heavy metals** in bottom sediments in the surveyed area are within safe levels. Concentrations of the most unsafe substances (1st class of hazard) are:

- mercury – concentration in 6 samples is below the detection threshold – 0.015 mg/kg; by archive data, its background concentration is 0.012 mg/kg. Mercury concentration in those samples, where it does not go beyond the detection threshold, is slightly higher than the background and varies from 0.016 to 0.037 mg/kg;
- cadmium – concentration is from <0.01 (the detection threshold) to 0.022 mg/kg vs. the background value of 0.47 mg/kg;
- arsenic – concentration is not above 0.35 mg/kg vs. the background value of 1.23 mg/kg;
- lead – from 0.38 to 2.28 mg/kg vs. the background – 5 mg/kg; and
- zinc – maximum concentration detected was 8.3 mg/kg, which is less than the background – 22.02 mg/kg.

Concentrations of moderately hazardous metals of 2nd class of hazard – nickel and copper – do not go beyond background values. Nickel varies from 1.06 to 4.53 mg/kg, with the background being 9.6 mg/kg, and copper from 0.21 to 2.18 mg/kg vs. the background of 8.8 mg/kg.

The chromium concentration in 7 samples is higher than the background value of 1.37 mg/kg. Maximum exceedance of the background concentration by chromium is 3-fold.

The average content of low hazard (3rd class) manganese is 23.3 mg/kg, which is much lower than the background (129 mg/kg).

The concentration of **iron** is quantitatively much higher than the total content of all other metals and is above the background (417.7 mg/kg). Its concentrations range within 921-4987 mg/kg with 2204 mg/kg on an average.

The surveys of 2017 comprised a **radiation survey** of the onshore and offshore areas of Plant construction which attested to their radiation safety. The radiation background is low, uniform and without local radiation abnormalities. Contents of natural and technogenic radionuclides in bottom and beach sediments and in seawater were found to be consistent with background values and within safe levels.

Therefore, it is concluded that the level of bottom sediments pollution in the area of influence of the berth structures is very low, based on all key controlled parameters.

7.3.7.3 Bottom sediments of surface waterbodies

Pollutants content in bottom sediments in the area of the Salmanovskoye (Utrenneye) OGCF is characterised using the reports of IEPI JSC (Final Report on the environmental monitoring of the Salmanovskoye field[92], Final Report on the operational environmental control[93]). The results are discussed below.

[92] Local environmental monitoring of the onshore and offshore areas of the Salmanovskoye (Utrenneye) OGCF and operational environmental control of the operational sites. Phase 3.1. Final Report on the environmental monitoring of the Salmanovskoye (Utrenneye) oil, gas and condensate field in 2019. - Moscow, IEPI JSC, 2020. 187 p.

[93] Operational environmental control of construction of the early development facilities at the Salmanovskoye (Utrenneye) oil, gas and condensate field. Final Report. Book 1. Explanatory note. - Moscow, IEPI JSC, 2018. 146 p.

Since no official standards are available for the content of pollutants in bottom sediments, assessment of the level of sediments pollution refers to the official MPC/TAC limits for soil. The assessment also referred to the data at the regional level on concentrations of metals in bottom sediments of waterbodies in Tazovsky Municipal District (Reference Guide on the application of average regional content values for monitored components at monitoring sites when assessing the state and level of environmental pollution in the Yamal-Nenets Autonomous District).

By the mechanical composition, the bottom sediment samples consist of sand and sandy light loam. The reaction of bottom sediments aqueous extract is neutral or weak alkaline – 6.5-7.6.

Measured values of all controlled parameters in bottom sediments are below the limit levels for soil. The highest concentrations were found in peaty bottom sediments that actively sorb various substances and function as a geochemical barrier, and in the sample from the Yabtarmato Lake.

The same samples demonstrated iron, lead, chromium, zinc, copper and nickel concentrations above the background levels. Content of anionic surfactants in all samples exceeded the background by 45-130 times.

Pollution of bottom sediments in the Yabtarmato Lake and tributary of the Khaltsyney-Yakha River with heavy metals has been observed since the early stages of the monitoring activity (since year 2015). Concentrations of the controlled parameters vary between seasons, but their overall levels hardly change. All identified anomalies are related to the accumulated environmental damage in the area of old exploration well on the shore of the Yabtarmato Lake, and plugged and abandoned well No.281 on the bank of the Khaltsyney-Yakha River.

The petroleum products concentrations are within the permissible limit for soil (1000 mg/kg, in accordance with the RF MNR letter of 27 December 1993 No.04-25), with maximum levels (630 mg/kg) found in sandy sediments (sample from the north-eastern shore of the Yabtarmato Lake).

7.3.8 Summary

1. The designed location of the Project and associated facilities is in the water area of the Ob Estuary of the Kara Sea and on the Gydan Peninsula shoreline which is abundant in diverse waterbodies – rivers, streams, lakes, and bogs. Therefore, water, as well as hydrochemical and hydrobiological conditions in the affected waterbodies are of a high significance, both in terms of their exposure to the Project activities, and in the context of using the resources as sources of water supply.
2. Prior to the engineering surveys within the Salmanovsky (Utrenny) license area, rivers and lakes in the examined section of the Gydan Peninsula actually remained unexplored. The Ob Estuary, on the contrary, was thoroughly investigated, particularly for the purposes of another NOVATEK project – Yamal LNG, and in relation to associated operations for widening and deepening of the sea channel through the Ob Bar to ensure year-round navigation.
3. The Ob Estuary is the terminal element of the largest Russian water system. Its unique hydrological and hydrochemical parameters are impacted by global climate processes and demonstrate a strongly pronounced seasonality and interannual dynamics. Specific features of the Ob Estuary in the concerned section of its middle part that will receive the impacts from the planned activity are related to the long-standing (for more than 8-9 months) ice cover, unstable river flow patterns disturbed by a joint action of tidal and wind-induced events, and high bottom sediment mobility due to shallow depths, flowing water and ice impacts, and active erosion of shores.
4. The results of hydrochemical studies of waterbodies within the Salmanovskoye (Utrenneye) OGCF and the Ob Estuary sections in the area of the designed Project facilities, generally, demonstrate a low level of anthropogenic pollution. The elevated levels of total iron, copper and manganese found in most of the surveyed waterbodies are a feature of the regional background in West Siberia, rather than effect of pollution.
5. The permissible levels of impact and maximum allowed abstraction of water approved for water management section No. 15.05.00.002 in the Taz River basin indicate availability of significant surface water resources in the Project area that can be used for water supply. However, economic activity using waterbodies (water intake, discharge of wastewater, construction within the water protection zone) shall be managed taking into account the fishery category of the concerned waterbodies (Ob Estuary and major rivers within the Salmanovskoye (Utrenneye) OGCF are categorized as waterbodies of the highest fishery category), and their use by indigenous people, e.g. traditional fishing grounds.

7.4 Subsoil and Terrain

7.4.1 General stratigraphy. The genesis and composition of extracted hydrocarbons

The presence of significant hydrocarbon reserves within the Gydan Peninsula territory and the Ob Estuary water area under consideration is essential for the Project. The geological section of the West Siberian Plate, the northern part of which is occupied by the Project site, is divided into three rock complexes[94]:

- Paleozoic consolidated basement, represented by granite-gneisses and lying at a depth of more than 12-15 km;
- Triassic intermediate volcanic-sedimentary complex of variable thickness – from 1 to 5 km;
- Mesozoic-Cenozoic sedimentary cover up to 11 km thick.

It is to the latter that industrial-grade hydrocarbon deposits are confined, with natural gas prevailing within the area. Reservoirs are associated with deposits across a wide stratigraphic range - from the contact zone between the basement and the sedimentary cover to the younger deposits of the Upper Cretaceous.

According to its structural and tectonic features, the Salmanovskoe (Utrennee) field is a multi-deposit anticlinal[95] type deposit and is confined to the Pekssed dome-shaped uplift. At this stage of its study (since 1979 to date), the field has been found to include 34 hydrocarbon deposits with high quality indicators, 16 of which are gas deposits, 15 are gas condensate deposits, 2 are oil and gas condensate deposits and 1 is an oil deposit[96].

Reservoirs are associated with the Mesozoic deposits of the so-called Aptian-Albian-Cenomanian productive complex and occur at depths of up to 2 km, mainly ranging from 1 to 1.5 km. The Aptian-Albian-Cenomanian deposits of the Pokurskaya series (suite) belong to the Upper Mesozoic-Lower Cenozoic structural-formational complex of the West Siberian platform and are one of the main regional hydrocarbon reservoirs. With a total thickness of 800-1200 m, their characteristic feature is the alternation of terrigenous continental and regressive shallow-sea sediments with substantially clayey transgressive sediments of the open sea basin.

It has been established that the main source of gas saturating the reservoirs of the Pokurskaya series is the organic matter of the humus type, which is present both in a dispersed form in sandy-silty and clayey rocks, and in a huge mass of coalified residues that saturate the entire rock mass[97]. The gas is dominated by methane (97-99% mol.); the presence of its homologues, including ethane, propane, and butane, varies from traces to 0.3% mol. Of the non-hydrocarbon impurities, the most characteristic are molecular nitrogen (N2, about 0.8% mol.), carbon dioxide (CO2, about 0.1% mol.), helium (about 0.01% mol.) and hydrogen (about 0.0001% mol.)[98].

The main productive characteristics of the Salmanovskoye (Utrenneye) oil and gas condensate field, which is the largest for the two adjacent oil and gas areas, Gydan and Yamal, are given in Chapter 5 (Table 5.2), projections of deposits onto the earth's surface (the so-called deposit areas) are shown in Figure 5.1.

The reservoirs of the field are separated from the earth's surface by a thick layer of sedimentary rocks, a significant part of which are Quaternary sediments. Geologically important events that took place during the Pleistocene and Holocene were of crucial importance to their formation. Neotectonic movements and the associated transgressions and regressions of the Arctic Basin led to the formation of a complex of Late Pleistocene-Holocene terraces of marine and lagoon-marine genesis. The composition of those terrain-forming rocks is described in more detail in the following sections.

7.4.2 Terrain and exogenous geological processes

The land mass of the Gydan Peninsula is confined between two large estuaries, with the distance from the Plant and Port (Ob Estuary coast) to the nearest Gydan Estuary waterline being approximately 65 km; the

---

[94] A.A. Kurkin. Clarification of the oil and gas potential of the Eastern Yamal on the basis of a detailed model of geological development. Diss. of cand. of geol.-min. sciences. Tyumen, 2019.

[95] M. I. Paneeva Kalinina L.M. Model of the geological structure of the Gydan and Salmanovskoye fields // Geology and Geochemistry of Oil and Gas. Earth Sciences. Current State. – Materials of the 5th All-Russian School-Conf. Novosibirsk: 2018. Pp. 101-103.

[96] The development of oil or oil and gas condensate deposits is not provided for by the Project.

[97] Salmanov F.K. et al. Preconditions for the formation of large and unique gas fields on the Arctic shelf of Western Siberia // Geology of oil and gas. 2003. No. 6. Pp. 2-11.

[98] As exemplified by the composition of gas produced at the KGS 16 wells. Development of the Salmanovskoye (Utrenneye) oil and gas condensate field. Gas supply to the power supply facilities for construction needs, hydraulic soil placement and drilling. Project Documentation. Section 1. Explanatory Note. - JSC NIPIGAZ, 2019.

License Area is associated with the western, relatively elevated, coast of Gydan which is asymmetrically divided into the western and eastern parts by the watershed located 3-25 km from the Ob Estuary waterline.

The main exogenous forms within the studied area have been formed under the conditions of geological and geomorphological heterogeneity of the continental coast and high ice cover of the Kara Sea, which significantly limits the intensity of the impact of sea waves on the coast. The nearly universal distribution of permafrost is also an important condition. In general, the topography of the coastline within the selected area is characterized by flattened sea plains, which rose above sea level in late-glacial and post-glacial periods. The low-lying coast is represented by flat waterlogged laidas with an abundance of lakes.

The main stages of terrain formation in this area were associated with marine transgressions and regressions due to climatic-eustatic and tectonic reasons. As a result, the terrain has a step-structure, whose geomorphological levels (terraces) were formed mainly by marine abrasion or accumulation in the Late Pleistocene-Holocene (over the last 10–20 thousand years) in the process of intermittent lowering of the Arctic basin.

According to the classification of coasts in the Arctic region presented in the Atlas of the Kara Sea[99], the western coast of the Gydan Peninsula, at the site of the designed Plant, Port and neighbour Field facilities falls into the category of accumulative shallow, lagoonal/bay and deltaic shores with extensive laida surfaces. The bottom landscape of the water area which is planned to be used is mainly represented by a shoreface, its above-water part consists of successive surfaces of foreshore, laida, first and second marine terraces (Figure 7.4.1).

The bottom terrain of the *coastal parts of the water area* is sloped in the direction predominantly perpendicular to the coast. The 10 m isobath passes at a distance of 1.5-5.7 km from the waterline. For comparison: within the site of the Plant’s onshore installations, which are located 500-550 m from the waterline, the absolute elevations of the land surface reach 18 m, that is, the average land slope is 3-4%, whereas out in the sea it is lower by an order of magnitude, 0.2–0.7%.

The shoreface surface is represented by the rolling alongshore sand bars, complicated by gouged furrows 1.0-1.5 m deep with embankments (elevation up to 0.7 m) and pressure bars (up to 1 m high) resulting from ice action. Notably, the areal transformation of the sea floor by ice exaration within the area in question — 1,000 m from the waterline up to the depth of about 15 m — increases with distance from the coast. Exogenesis of the shoreface takes place under the conditions of maximum physical and mechanical loads of external factors and without long interruptions, in contrast to the land processes, whose intensity noticeably decreases in the conditions of winter freezing and being covered with snow-ice mass.

[99] Kara Sea. Ecological Atlas. - M.: Arctic Research Center LLC, 2016. 271 p.

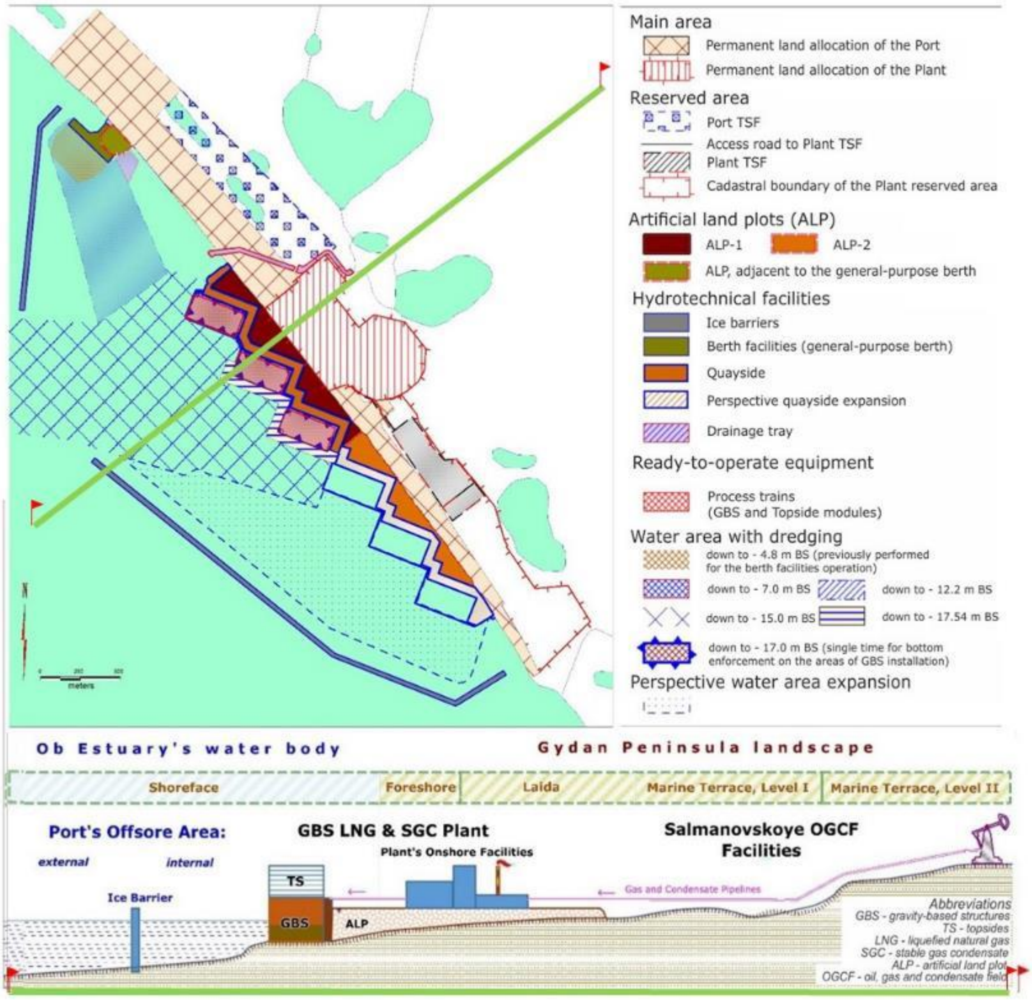


Figure 7.4.1: Ob Estuary coastline and Gydan Peninsula terrain in the vicinity of the proposed Plant and Port site and the neighboring Accommodation Facilities

The boundary between land and sea in the vicinity of the Plant and the Port is represented by a transitional foreshore zone, a wide (up to 70-100 m between the upper and lower sections of the License Area, 30-50 m, or about 10% of the area, within the proposed site of the Plant's onshore installations) gently inclined accumulative formation of fine-grained material, passively flooded by the tides and drained at low tides (Figure 7.4.2 a). Due to the gentle initial slope, low wave activity and positive asymmetry of tidal speeds, the foreshore surface within the area in question is mainly exposed to slow sedimentation processes that produce horizontally layered fine-grained sands and siltstones with marks of ripples and drainage channels of river and tidal waters. Within the zone bounded by the spread of syzygial tides, the foreshore basically corresponds to the so-called quadrature water zone with a water supply of 70-80%. The hypsometric range of sea level fluctuations is limited by the absolute marks "-1.46 m" and "+1.13 m".

Higher up the profile, within the so-called *laida*, young accumulative Holocene formations are flooded during infrequent storm surges, and subaerial processes play a significant role in the general development of the terrain. In contrast to the shoreface, higher vegetation is characteristic of the laida, and conditions in microrelief depressions are favourable for peat and sapropel accumulation. The swampiness is combined with the abundance of lakes, whose upper hypsometric level, 2-3 m abs., marks the laida boundary. Within the proposed site of onshore installations (including temporary installations), the laida accounts for approximately 50% of the area (Figure 7.4.2 b, c).

The transition from the laida to the next elevation levels - the Late Pleistocene first and second marine terraces - is underlined by a pronounced ledge, 5–10 m high, with gentle convex slopes prone to destruction by a wide range of exogenous processes: gravity-based (sinking, sloughing), downslope (solifluction, erosion) and deflationary, stimulated by cryogenic processes (congelifraction, frost heave). The impact of the sea does not exist at these levels, but the foot of the terrace ledge is exposed to seasonal flooding. Within the proposed site of the Plant's onshore installations, the most elevated is the surface area with absolute elevation of 16–18 m, located at the distance of approximately 500 m from the coast (Figure 7.4.2 d, e, f).

Figure 7.4.2: Terrain and manifestations of exogenous geological processes in the Salmanovsky (Utrenny) License Area

From left to right, from top to bottom: a - foreshore; b - sandy swells of beach deposits of the laida; c – marshy mouth of a nameless stream within the laida; d - marshy lakeshore within the first marine terrace; e - manifestations of thermokarst (depression in the lower left corner) and frost heave (knoll in the upper right corner) within the first marine terrace; f - drainage trough; g, h, i - erosion slope of the second marine terrace with cracks and deflation. – TsGEI LLC, 2017.

The valley network that connects several hypsometric levels within the proposed site of the Plant's onshore installations is poorly developed and is represented by two small troughs which drain the northern part of the allotted land and join together to form a single drain channel at the point where the laida turns into the foreshore (Figure 7.4.2 c).

The stability of the terrain in the area under review is determined by the direction and intensity of exogenous processes (Table 7.4.1). The area of the planned activity includes land and water areas with diverse manifestations of high-intensity exogenous geological processes typical for the Russian Arctic Region, their most important features being seasonality (mostly typical for land areas) and high sensitivity to technogenic impacts.

The most stable is the terrain of the laida's lacustrine-paludal complexes which may be threatened primarily by the destruction of the shores and the change in the water regime during construction. By contrast, the slopes of the second marine terrace, which are prone to gravitational, erosion and deflation, cryogenic and other exogenous processes, are very sensitive to technological impacts. The stability of the shoreface, foreshore and valley network is recognized to be low too, but unlike the stable equilibrium that is characteristic for the undisturbed slopes of the Gydan marine terraces, here the terrain features are being continuously altered by ice gouging, downcutting and lateral erosion, and by water accumulation. Intermediate stability is typical for the slightly inclined surfaces of the sea terraces, including the laida and the foreshore.

Table 7.4.1: Salmanovsky (Utrenny) License Area exogenous geological processes and terrain stability

Terrain Elements *(listed in descending order, from the highest absolute elevation to the lowest)*		**Dangerous Exogenous Geological Processes and Hydrological Phenomena (DEGP&HP)**													**Terrain stability**
		Glacial exaration	**Flooding**	**Bottom and lateral erosion, sediment redistribution**	**Underflooding**	**Waterlogging**	**Thermokarst**	**Thermal erosion**	**Planar erosion and accumulation**	**Solifluction**	**Frost cracking**	**Frost heave**	**Deflation (wind erosion and accumulation)**	**Gravitational processes (solifluction, sinking of slopes, …)**	
Second marine terrace	Main surface				Light	Light	Dark	Light	Light	Light	Dark	Dark	Dark		Moderate
	Edge							Dark	Medium	Medium	Dark	Medium	Medium	Dark	Low
	Slope							Dark	Dark	Dark	Light	Light	Medium	Medium	Low
	Foot				Medium	Light	Medium	Medium	Light	Light	Medium	Medium	Light		Moderate
Laida	Main surface	Light	Light		Dark	Light	Medium	Light	Light		Light	Light	Light		Moderate
	Lacustrine-paludal complexes	Light	Dark	Light	Dark	Dark	Dark								Moderate to High
	Valley network	Light	Dark	Dark	Dark	Medium			Medium				Light	Light	Low
Foreshore		Medium	Dark	Light	Dark										Moderate
Shoreface		Dark	Dark	Dark											Low

Relative assessment of DEGP&HP intensity:		
	Dark	Process is commonplace and plays a major role in terrain formation
	Medium	Process is typical for the element in question but does not play a major role
	Light	Process may occur in different years or locally within the element
	(blank)	Process occurrences have not been recorded and are unlikely

In general, in terms of dangerous natural processes, according to the criteria set forth in SP 115.13330.2016, the proposed site of the Plant, the Port, and the Accommodation Facilities associated with the Plant is considered to be extremely dangerous, its areal incidence of DEGP&HP being 75%. Local environmental monitoring which is being carried out by IEPI JSC since 2018 within the licensed area has revealed a number of manifestations of exogenous processes triggered by the construction of the Project facilities (Table 7.4.2).

The construction of buildings and structures of the Project is carried out on filled areas. Sands are used as fill material, which, if not sufficiently held in place by geomaterials, rubble fill or vegetation during construction, is susceptible to wind action and erosion (caused by significant precipitation or snow melting), as well as slipping (when the embankment is in the zone of seasonal flooding). The slopes of constructed embankments and temporary soil dumps may be equally subject to such processes. As a result of those processes, erosion grooves, gullies and mudslides are formed, as well as the corresponding fan cones and deluvial plumes of various morphometries, which can often spread beyond the embankment areas.

Figure 7.4.3: DEGP&HP at the Salmanovskoye OGCF

a - Development of deflation processes in the vicinity of the utilities corridor to APGU #3 (Photo by JSC NIPIGAZ, 2018). b - Development of abrasion processes along the shores of one of the lakes. c - Lateral erosion of the Khaltsiney-Yakha river channel 350 m southeast of open pit No. 9. d - Development of flooding on the surface of the marine terrace 120 m northeast of the Multi-purpose berthing facility (b-d - Photo materials by JSC IEPI, 2019)

Manifestations of such processes were observed in the course of local environmental monitoring on the slopes of road embankments, hydraulic dumps and quarry sides, at some construction sites.

In terms of area, flooding caused by blocking of surface and subsurface runoff by soil embankments (Figure 7.4.3, d) was the most widespread phenomenon.

Table 7.4.2: Register of manifestations of dangerous exogenous geological processes and hydrological phenomena, technogenically intensified or posing an engineering hazard for the Project's facilities

№ п/п	Monitored object (geomorphological reference: level / form of terrain)	DEGP&HP type	Process development intensity (active, fading, inactive)	Note
1	Khaltsinei-Yakha river bed 350 m south-east of quarry No. 9	Lateral erosion	Active	Manifestation is caused solely by natural causes. Development could be hazardous to engineering structures
2	The surface of the Khaltsiney-Yakha river floodplain, 300 m east of quarry No. 9	Flooding	Active	Triggered by the blockage of natural runoff by a road embankment
3	Laida surface 120 m NE of the berth	Flooding	Active	Flooding develops in the wake of machinery
4	Laida surface 70 m NE of the berth	Flooding	Active	Triggered by the blockage of natural runoff by a road embankment
5	Khaltsiney-Yakha river bed 150 m west of the intersection with the road to well 294	Lateral erosion	Active	Manifestation is caused solely by natural causes. Development could be hazardous to engineering structures
6	The surface of a gently sloping plain, filled site of well 281	Linear erosion	Active	Erosion develops on a filled area

№ п/п	Monitored object (geomorphological reference: level / form of terrain)	DEGP&HP type	Process development intensity (active, fading, inactive)	Note
7	The surface of a gently sloping plain, the eastern part of the rotation camp.	Flooding	Active	Caused by the blockage of runoff by the rotation camp embankment
8	The surface of the laida confined to the south-eastern slope of the 2H quarry hydraulic dump.	Flooding	Active	Caused by an additional influx of water from the hydraulic dump and pressure from the road embankment
9	The surface of the Khaltsyney-Yakha river valley floor between the SW slope of the 25N quarry hydraulic dump and the road embankment	Flooding	Active	Caused by an additional influx of water from the hydraulic dump and pressure from the road embankment
10	The surface of the interfluve hollow adjacent to the southeast corner of the well pad No. 16	Flooding	Active	Intensification as a result of disturbances in the soil-vegetable cover connected with vehicle traffic
11	The interfluve surface between well pad №16 and the road embankment	Flooding	Active	due to insufficient throughput of the culvert in the road embankment
12	The upper reaches of the hollow crossing the EC-2-APGU road 300 m west of EC-2	Flooding	Active	due to insufficient throughput of the culvert in the road embankment
13	The surface of the laida 50m NW of the workers camp and quarry №51N	Flooding	Active	intensification as a result of disturbances in the soil-vegetable cover connected with vehicle traffic
14	The surface of the laida adjacent to the hydraulic dump of quarry No. 10	Flooding	Active	Caused by an additional influx of water from the hydraulic dump surface
15	Salpadayakha river valley floor 30m NW of the hydraulic dump of quarry № 37N	Flooding	Active	intensification as a result of disturbances in the soil-vegetable cover connected with vehicle traffic

Source: JSC IEPI, 2019

The embankments themselves are subject to destruction not only by water-erosion processes, but also by deflation (Figure 7.4.3, a). The latter is not included in the register of hazardous manifestations of DEGP&HP, but is almost ubiquitous and leads to the gradual transfer of sandy and silty material of soil embankments to the adjacent undisturbed territories. In some cases, over time, aeolian landforms may take shape – deflation basins, small dunes and ridges, sand accumulations in terrain depressions.

DEGP&HP manifestations, which pose a threat to engineering structures, are primarily associated with channel erosion (including the so-called thermal erosion and coastal thermal abrasion). In particular, the active erosion of the banks of the river Khaltsinei-Yakha (Figure 7.4.3, c) can pose a hazard to the highways and pipelines located on the floodplain (Points 1 and 5 of the DEGP&HP Register).

In general, the 2019 observations showed the absence of large-scale impacts of the construction work on the intensity and focus of DEGP&HP in the Salmanovsky (Utrenny) license area. Anthropogenic activation of exogenous processes has caused few occasional manifestations and is localized in the immediate vicinity of the facilities under construction. The company has kept a unified register of hazardous manifestations of exogenous geological processes recorded in the license area (Table 7.4.2) and ensures the continuity of environmental monitoring.

A schematic map of DEGP&HP manifestations identified during the 2019 monitoring is shown in Figure 7.4.4. The construction of new Project facilities is being designed and implemented taking into account the data obtained in relation to the development of DEGP&HP.

7.4.3 *Ob Estuary seafloor topography and cryolithodynamics*[100]

At present, the Ob Estuary is a gently sloped shallow-water abrasion-accumulative delta of an estuarine type with sluggish water current. Its bottom topography is complicated by the troughs stretched along the

[100] Based on materials by V.V. Motychko, A.Yu. Opekunov, V.M. Konstantinov, L.F. Andrianov. The main features of morpholithogenesis in the northern part of the Ob Estuary // Vestnik SPbGU. Series 7. 2011. Issue. 1

axis of the gulf, which, apparently, are pradolinas of the Ob. Large sand spits, bars and ridges up to 5-7 m high and up to 15 km long form in the vicinity of nearly all the large capes exposed to alongshore alluvial flows. The transfer of sedimentary material in the central part of the gulf is caused by the alluvial flow of the river. On the subsea portion of the shoreface (at the depth of 8–10 m or more) within the zone exposed to wave action, the movement of material by alongshore alluvial flows proceeds mainly in the reverse direction, southward, which is caused by north winds prevailing in the ice-free period. At the same time, leeward sections of the coast are characterized by the transfer of material northward. In the areas of convergence of alongshore alluvial flows, they are unloaded to form various accumulative forms. Accumulation of material is also observed in the mouths of the rivers flowing into the Ob Estuary.

The coast in the vicinity of the proposed site of the Plant and the Port belongs to the abrasion-accumulative type, which is characterized by the existence of coastal ridges of ice hummocks and piles, which leads to the formation of two to five ice bars of hummocks. Coastal areas are periodically flooded by tides and surges, as well as during seasonal floods.

7.4.4 Subsoil

The terrain described in Sub-section 7.4.1 consists of a thick, up to several hundred meters, complex of quaternary formations represented by dispersed grounds (soils), from gravel to clay, with a predominance of clayey loam, sandy loam, fine sand and silt. Different geological and genetic complexes of sediments are generally characterized by a set of certain types of dispersed materials: as a rule, clays are most typical for rock formations of marine origin; coastal-marine, lagoonal-marine and alluvial formations are characterized by a sandier composition.

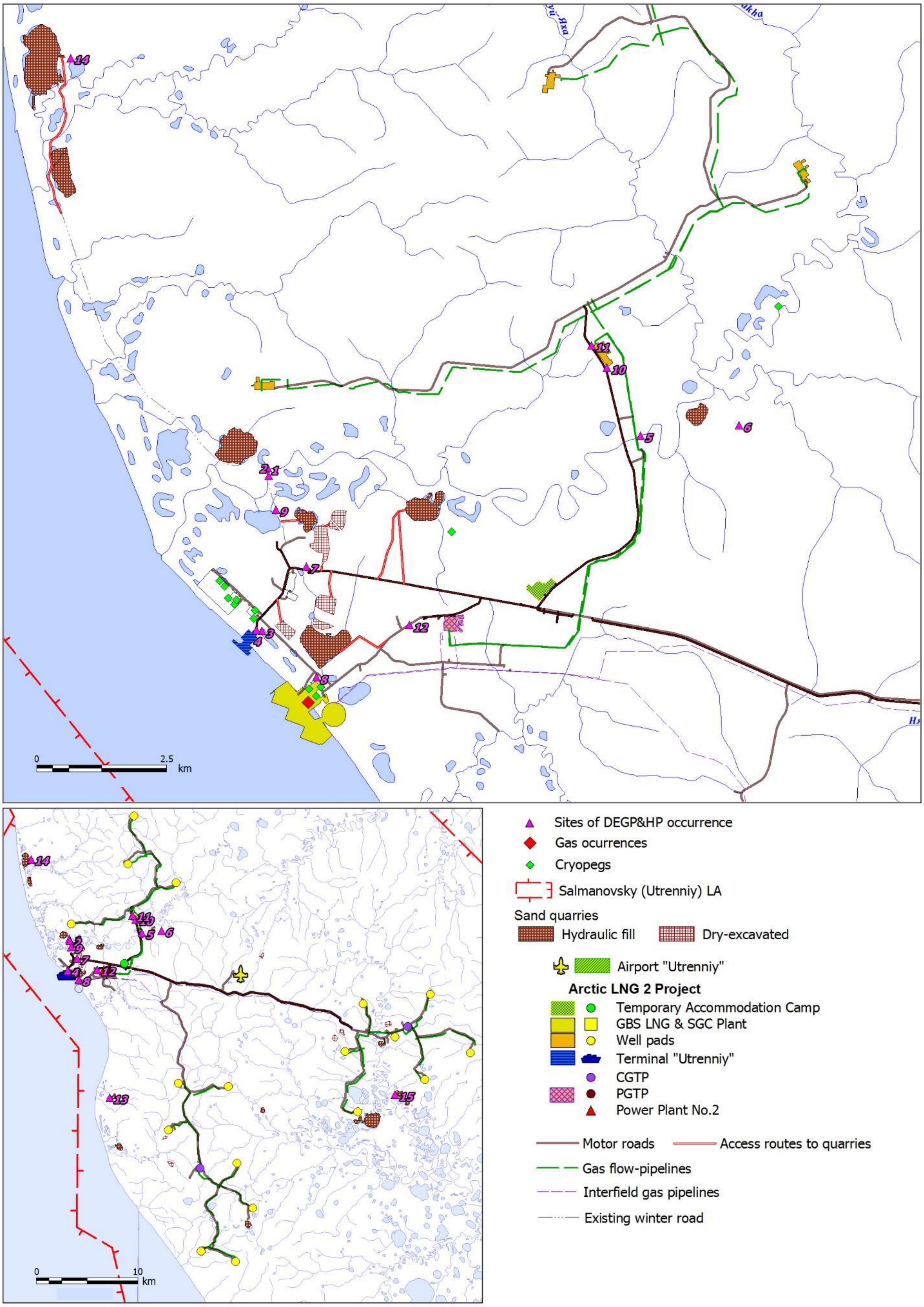


Figure 7.4.4: Schematic map of DEGP&HP manifestations identified by environmental monitoring in the Salmanovskoye (Utrenneye) OGCF (the numbers correspond to those indicated in Table 7.4.2), and the position of gas showings and cryopegs identified during pre-design engineering surveys

The surfaces of the terraces, floodplains, and the laida were exposed to exogenous geological processes (frost cracking, the formation of rewired ice, thermokarst, thermodenudation, waterlogging, etc.), which in turn led to the accumulation of lacustrine-paludal sediments, including organogenic sediments.

At the depth of up to 20 m or less within the proposed site of the Plant and the Accommodation Facilities the following series of geological and genetic complexes of deposits has been identified (in age-descending order):

- lagoonal-marine Upper Pleistocene sediments of the second marine terrace (lmQIII);
- alluvial Upper Pleistocene–Holocene deposits of the first terraces above the floodplain (aIII–IV);
- alluvial-deluvial Upper-Pleistocene-Holocene sediments of the valleys of small watercourses (adIII-IV);
- lacustrine-paludal Upper-Pleistocene-Holocene deposits on the surface of the coastal plain, the lagoonal-marine terrace and the terrace above the floodplain (lbIII-IV);
- lagoonal-marine Holocene sediments of the marine laida (lmIV);
- alluvial-marine Holocene sediments in lower floodplains of rivers (amQIV);
- alluvial Holocene sediments in floodplains of rivers (aIV);
- lacustrine-paludal Holocene sediments on the surfaces of the laida and the floodplains (lbIV).

Each of the lithological complexes is briefly described below.

The complex of Upper Pleistocene lagoon-marine deposits ($ImIII_{2-3}$) of the second marine terrace with a thickness of up to 15 m is mainly represented by silty and fine sands. Sandy loam and clayey loam have a much smaller development and are found in the form of lenses and interlayers.

The complex of Upper Pleistocene–Holocene alluvial deposits (aIII – IV) of the first terrace above the floodplain occurs fragmentarily. By its structure, the terrace is erosive-accumulative, its base is composed of Upper Pleistocene lagoonal-marine sediments ($lmIII_{3-4}$). By its composition, the deposits of the complex are represented by two types of sections: 1) sands with interlayers and lenses of sandy loam and clayey loam, 2) interbedding of sand, sandy loam, less often clayey loam. Sands are fine and silty, heterogeneous, with admixture of organic substances, interlayers of gravelly sands are found in places of contact with underlying sediments. The total thickness of the complex's sediments is 3-5 m.

The complex of the Upper Pleistocene-Holocene alluvial-deluvial deposits (adlll – IV) is widely developed on watershed surfaces within the entire territory of the Salmanovskoye (Utrenneye) Field and is confined to the valleys of small rivers and streams. It consists of two types of subsoil strata sections: 1) the alternation of sandy loam, sand, and clayey loam; 2) clayey loam with interlayers and lenses of sand, sandy loam, clay. The composition of the alluvial-deluvial deposits is determined by the composition of the enclosing strata forming adjacent watersheds and slopes. The total thickness of the complex's sediments is 2-10 m.

The complex of Holocene lagoon-marine deposits of the laida (ImlV) is distributed locally, stretching in a narrow strip 200-250 m wide along the coast of the Ob Estuary. In terms of composition, the deposits of the complex are represented by two main types of sections: a) sands and sandy loams with interlayers of clayey loam; b) interlayering of sandy loams, sands, clayey loams, underlain by loam from the depth of 8 m. As a rule, the upper horizons of type one sections, to the depth of 3-4 m, are composed of sands, from fine to silty, less often of a surface layer of sandy loam or clayey loam. The total thickness of the laida sediments is 3-5 m.

The complex of Holocene alluvial-marine sediments (amlV) is confined to the floodplains of the lower reaches of rivers (Khaltsyney-Yakha, Nyaday-Pynche, etc.). The formation of these sediments is directly related to the ingression of the Ob Estuary onto the rivers in the Holocene as well as with the present-day wind-induced and tidal phenomena. It consists of two basic types of sections: 1) sands with lenses of sandy loam and clayey loam; 2) interbedded sands, sandy loams, clayey loams, less often, clays. In general, fine and dusty sands are dominant in the sections. Across the entire section, deposits often contain inclusions of plant residues. The total thickness of the complex's sediments does not exceed 3-10 m.

The complex of Holocene alluvial deposits (alV) forms floodplains and channels in the valleys of large rivers within the area in question. During the Holocene Climate Optimum, as a result of thermo-denudation processes, the area occupied by river floodplains increased due to the destruction of low above-floodplain terraces and adjacent lower slopes and the formation of a single floodplain surface with elevations of 2.5-5 m above the waterline. The deposits of the complex are represented by three main types of sections in different parts of the floodplain. Maned floodplains and river shoals are composed of sands with lenses of sandy loam and clayey loam; the section of levelled and poorly drained floodplains is represented by interlaying sands, sandy loams, clayey loams, less often, clays. In depressions, sandy–loamy sediments are often overlain by a layer of peat up to 0.5 m thick.

In general, the river valleys are characterized by lateral transition from sandy section (alluvium in the channel) to predominantly sandy-loamy section in the leveled rear parts of the floodplain (floodplain alluvium). Channel alluvium (channel facie) is represented by fine and silty homogeneous sands. Channel alluvium is characterized by a clear oblique and lenticular lamination due to variation in the dispersion and color of the rocks. Floodplain facies are mainly characterized by clayey loam and sandy loam with iron interlayers, numerous non-decomposed plant residues. Floodplain facies are distinguished by the persistence of individual layers. The total thickness of floodplain sediments is 3-15 m.

The complexes of the Upper Pleistocene-Holocene and Holocene lacustrine-paludal sediments (lbIII-IV, lbIV) are widely spread throughout the second lagoon-marine terrace, river floodplains and on large fragments of the first above-floodplain terrace and, less widely, on the Eemian coastal plain and the laida. Lacustrine-paludal sediments are confined to flat, undifferentiated, poorly drained parts of watersheds, to the rear parts of the floodplains and the first above-floodplain terrace, they fill lakeside hollows, khasyrey, runoff channels and other depressions in the terrain. Overlying peat deposits mostly occur at the depths of 0.5-1.0 m from the surface, however, some wells on watersheds have sections with the peat layer thickness of up to 2.0-2.5 m. In most cases, peat is moderately decomposed. For irregularly drained maned floodplains the thickness of the peat layer can reach 0.8-1.3 m. Peat sediments of small thickness (up to 0.5 m) are underlain by peaty materials of various texture - from sands and sandy loams to clayey loams and, less often, clays. The total thickness of the complex’s sediments does not exceed 3 m in most cases.

7.4.5 Permafrost

The Project implementation site is characterized by the continuous distribution of permafrost rocks (PR) with the thickness of up to 200-500 m[101] and low values of their average annual temperatures. Continuity of the frozen strata is broken from the surface only under water bodies - by taliks under lakes and river channels; and on the laida and in the mouths of the rivers flowing into the Ob Estuary – by sections where cooled saline rocks have been developing.

The rock temperature is determined by a large number of natural factors. Within the area in question low air temperature is an important factor, together with such factors as local geological and geographical situation, terrain, snow and the degree of surface drainage. The snow cover and the conditions determining its distribution over the area (the terrain, the direction and speed of winter winds) have a decisive impact on the temperature regime of the soils and subsoil ground materials within the surveyed area.

The lithological composition of permafrost rocks is predominantly sand, with medium ice content (0.2-0.4), the rocks have a layered-mesh and massive texture with thick synergetic and ice-soil veins. Salinity type is chloride, degree ranges from weak (0.05-0.2%) to medium (0.5-1.0%). Seasonal thawing of permafrost rock is shallow, reaching the depth of 0.6-0.8 m.

The average annual temperature of permafrost rocks inside taliks ranges from minus 8 to 0°C, with the average value ranging between minus 5 and minus 6.5 °C. Very cold frozen rocks with temperatures reaching minus 9°C belong to the most elevated barren areas. On marshy watersheds, the temperature of the rocks is somewhat higher (from minus 5 to minus 7°C). The highest temperature (between minus 1, and minus 2°C) is usually typical for snowy areas, such as gullies, ravines, talwegs, and also at the edges of dry lake basins and floodplains overgrown with brush. For beach sediments in the Ob Estuary the temperature of permafrost rocks is minus 3-4°C.

Directly within the proposed site of the Plant’s onshore installations the temperature of permafrost rocks is minus 3,7±0,5°C on the average, reaching minus 5-6°C at the depth of 25 m. The seasonal thawing of these soils starts on June 10-15; the maximum thickness of the seasonally thawed layer has been recorded on August 10-20. Freezing usually starts on October 1-5 and ends by October 25-30 (during which period congelifraction processes are most intense).

The permafrost rock stratum is heterogeneous and sometimes contains cryopegs (see Section 7.4.7) and gas hydrates (7.4.6). The latter may cause emergency situations, since they may give rise to the explosive deformation of rocks and the formation of deep craters. In the affected coastal area of the Ob Estuary and in the mainland Gydan Peninsula (within the license area), their manifestations are unlikely and none were found during engineering surveys. Those phenomena and processes are discussed in more detail in the following section in relation to the entire territory of the Salmanovsky (Utrenny) license area.

[101] Their lower boundary has not been identified by surveys

7.4.6 *Gas showings in permafrost rocks*

Gas hydrates (mainly methane hydrates) are one of the most important regionally significant engineering risk factors for the territory under review. Due to the phenomenon of self-conservation, some of them remain in a "suspended" state in the upper horizons of the geological environment even after a climatically conditioned lowering of the roof of a continuous low-temperature zone, i.e. they are relics of previous geological eras. The technological hazard of such gas hydrates, described as metastable, is due to their sensitivity to temperature, pressure, chemical and mechanical impacts (when, for example, drilling fluids or artificially injected wastewater and gas mixtures enter the reservoir), and global warming reduces their temperature while increasing gas hazard of their enclosing strata. The decomposition (dissociation) of gas hydrates followed by the release of large volumes of gas and an increase in in-situ pressure may occur either suddenly or over a long period of time as the heat wave spreads from engineering structures, the earth's surface or water bodies.

During the geological study of the territory of the Yamal oil and gas region (OGR), to which the Salmanovskoye (Utrenneye) field has recently been assigned, the bulk of metastable gas hydrates (the abbreviation MHZ is used in special literature for the zone containing them) was reported in the depth range between 60 and 120 m below the modern earth's surface, and therefore this problem is of greatest relevance for drilling exploration and production wells for hydrocarbons. On the gas hazard map of the permafrost zone (Figure 7.4.3), the entire territory of the Salmanovsky (Utrenny) license area belongs to the distribution zone of metastable gas hydrates of the so-called "non-fusing" type - their base is not in contact with the top of the hydrate stability zone[102].

[102] E.V. Perlova et al. Gas hydrates of the Yamal Peninsula and the adjacent shelf of the Kara Sea as a complicating factor in the development of the region // Vesti gazovoy nauki. Heading "Problems of resource support for gas producing regions of Russia". 2017. No. 3 (31). Pp. 255-262.

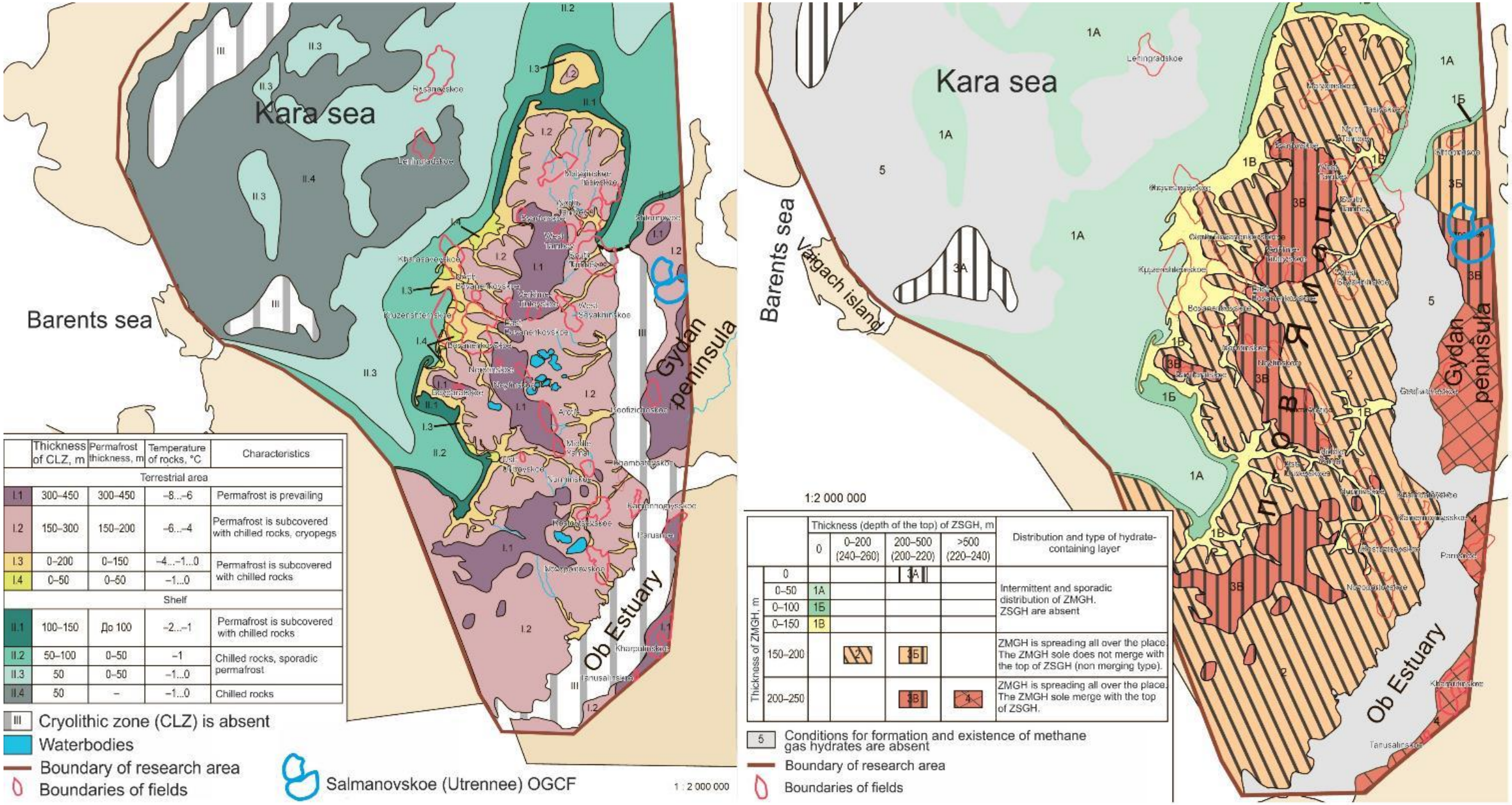


Figure 7.4.5: Salmanovskoe (Utrenneye) oil and gas condensate field on the maps of cryopeg propagation conditions (left) and gas hazard (right) of the cryolithozone of the Yamal oil and gas region (Perlova et al., 2017)

Key: PR – permafrost rocks; KLZ – cryolithozone; SGI - zone of stable gas hydrates; ZMG - zone of metastable gas hydrates

Within the bounds of this territory, one of the signs of the activity of underground gas accumulations is the formation of a peculiar micro-topography of the earth's surface with alternating heaving mounds and crater-shaped depressions[103]. Photos of some of the heaving mounds recorded during engineering surveys and environmental monitoring are shown in Figure 7.4.6.

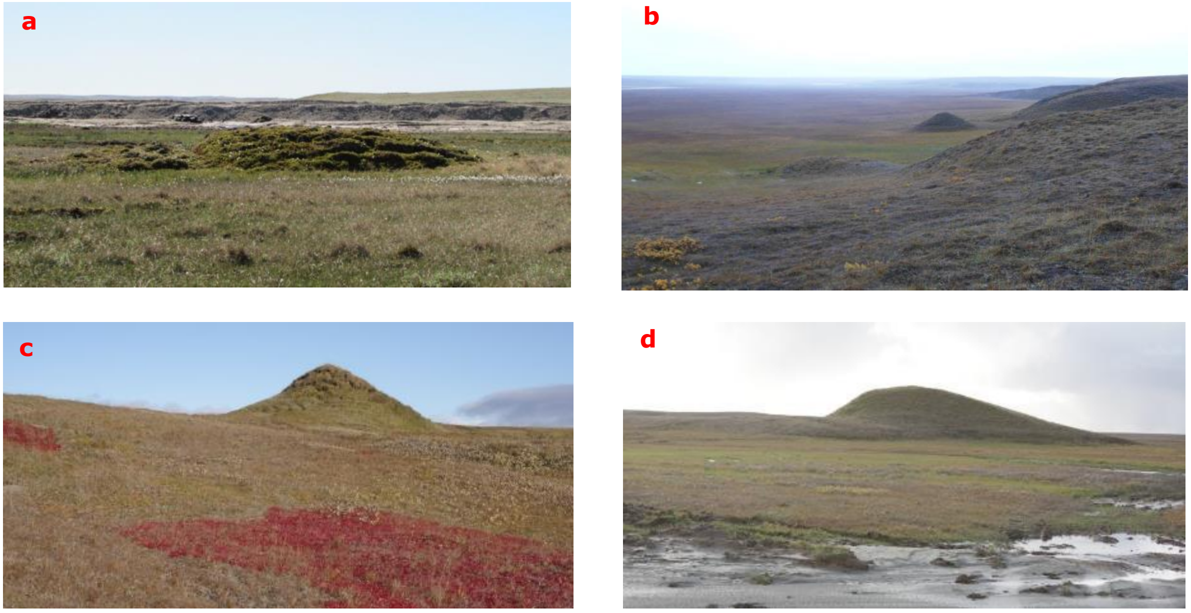


Figure 7.4.6: Heaving mounds in the Salmanovskoye OGCF

Photographs: a – JSC NIPIGAZ (2018); b – Urengoigeoprom LLC (2015); c, d – JSC IEPI (2019)

In some areas, zones of active gas showings are not associated with heaving mounds, but rather with thermokarst depressions, including lacustrine-paludal complexes, as well as river valleys and runoff troughs. In particular, using the example of the Gydan Peninsula, it is shown that the precursors of gas explosions may include changes in the color of water in lakes (for example, with the appearance of bright turquoise shades, clearly visible on satellite images), the appearance of traces of thawing along the boundaries of lakes and heaving mounds (primarily noticeable in the photographs taken in early winter), a sudden drop of the water level in lakes, active development of erosion processes along the shores of lakes, etc.[104]

In terms of intensity, gas showings are divided into the following groups (Sizov, 2015):

- gradual – slow low-intensity emission of gases from bottom sediments of lakes and rivers, bog massifs, accumulations of organic matter in soils and ground materials;
- active – occur on erosional slopes with disturbed soil cover and/or the topsoil, result in the formation of small lakes with active landslide shores; can also occur in river channels and at the bottom of lakes, which in some cases may lead to their drainage and the formation of khasyreis;
- sudden – mainly occur following a critical increase in pressure in the cores of heaving mounds; after explosions, small conical craters of regular shapes are often formed, with steep walls and piles of soil ejected outward along the periphery.

The common mechanisms of gas showings typical for the permafrost zone are shown in Figure 7.4.7. The most famous and well-studied variants of gas releases are located on the Yamal Peninsula, where large through taliks frequently form under lake basins – one of the prerequisites for their drainage, subsequent freezing and explosive gas release. In September 2013, 90 km northwest of the village of Antipayuta (Tazovsky district), a crater 15 m in diameter was discovered, which had formed as a result of a gas release in the upper reaches of a thermal erosion trough[105]. Previously, in its place there had been a heaving mound 2 m high with the base diameter of about 20 m.

[103] Khimenkov A.N., Stanilovskaya Yu.V. - Phenomenological model of the formation of gas outburst craters exemplified by the Yamal crater // Arctic and Antarctica. - 2018. - No. 3. - Pp. 1 - 25.

[104] Sizov O.V. Remote analysis of the consequences of surface gas showings in the northern part of Western Siberia // Geomatics. 2015. No. 1. Pp. 53-68.

[105] Kizyakov A.I., Sonyushkin A.V., Khomutov A.V., Dvornikov Yu.A., Leibman M.O. Assessment of the terrain-forming effect of the formation of the Antipayuta gas release crater based on satellite imagery // Modern problems of remote sensing of the Earth from space. 2017.Vol. 14., No. 4. Pp. 67-75.

It is noted by the researchers cited in this section and by others that the presence of mounds and their sizes are not a reliable and sufficient indicator for predicting gas releases, since in many cases the formation of such clusters occurs without preliminary transformation of the microtopography of the earth's surface. At the same time, the active formation of new mounds or the growth of existing ones indicates the mobility of the upper horizons of the geological environment and rather points at a higher probability of gas releases than in areas with stable terrain.

The location of the areas of gas showings[106] and cryopegs identified by engineering and environmental surveys within the Salmanovsky (Utrenny) license area is shown on the map in Figure 7.4.4. Most of them are confined to the Ob Estuary coastal area and river valleys, which corresponds well to the data cited above and to other studies. In particular, for the Yamal Peninsula, gas-hazardous areas are also primarily confined to the coastal area of the Ob Estuary. At the same time, the permafrost rocks of the Gydan Peninsula, to which most of the Salmanovsky (Utrenny) License Area is confined, are generally more stable than the Yamal permafrost; and, in particular, large perennial heaving mounds as one of the signs of high activity of modern cryogenesis are not as widespread on the Gydan peninsula as on Yamal.

The intensification of such phenomena can be facilitated by physical and mechanical disturbances in the integrity of the soil layer during excavation, construction of foundations, extraction of soil-based building materials, as well as by the degradation of permafrost caused by the construction and operation of the Project facilities or by natural causes.

When analyzing the results of the engineering surveys design organizations viewed the presence of large perennial heaving mounds as an unfavorable condition for the construction of buildings and installations, and such areas were excluded from the Project footprint. Due to the widespread occurrence of permafrost heaving processes within the territory under consideration, small mineral and peat-mineral injection-segregation mounds 1-5 m in diameter and up to 0.1-0.3 m in height constitute one of the typical forms of micro-topography. Engineering preparation of areas containing such mounds does not require any isolated measures: the general strategy is to bring the entire area affected by the construction to a uniform permafrost state through pre-construction cooling and freezing of soils and subsoil ground materials. It is achieved by periodically removing the snow cover during the winter. In the future, during excavation, it will be prohibited to level off heaving mounds.

For larger heaving mounds, special measures are provided for at the stage of engineering preparation of the site. In particular, within the design boundaries of the proposed onshore installations of the Plant, several mounds up to 0.4-0.5 m high and up to 8 m in diameter were found. The construction organization project (2017-423-M-02-POS1.1) provides for a set of protective measures for such mounds, including chipping and removal of ice (if any), primary filling of the heaving mound site with imported soil, laying heat-insulating plates on top of the primary filling, adding a finishing layer of imported fill material over heat-insulating plates until the embankment surface level reaches the design marks.

---

[106] One of them, possibly the only one, was recorded while drilling an engineering-geological well No. 3D1-18 within the site of the onshore Plant complex (Report on the engineering-geological field surveys of the site. Field geological works. Well drilling. Facility: "Plant for the production, storage, and shipment of liquefied natural gas and stable gas condensate on gravity-based structures". Stage 2.2.1. St. Petersburg: TsGEI, 2017. 126 pp.). A detailed description of this gas showing is not provided in the Report, and therefore it can be presumed to be short-lived and of low intensity.

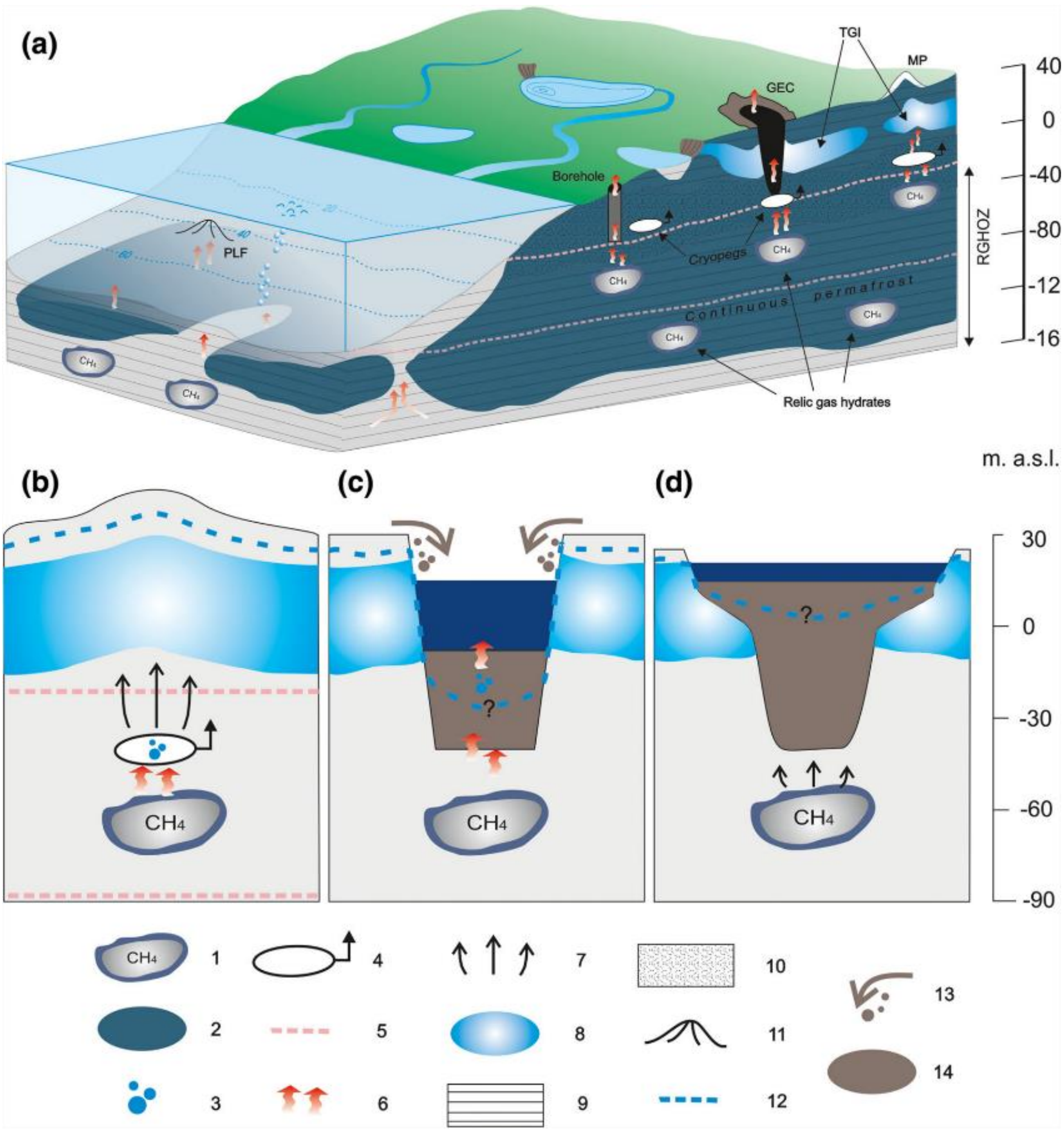


Figure 7.4.7: Mechanisms of surface gas showings of methane on mainland and coastal areas originating from gas hydrates (a) and stages of formation of gas release craters (b, c, d)[107]

Key: Relict gas hydrates (1) in the zone of relict gas hydrates of the permafrost zone, placed in permafrost conditions (2), may be a source of potential gas showings (3), confined to non-frozen cryopegs (4), widespread at the depth of 25–35 m below sea level. It is confirmed by reported gas releases from depths of 70–120 m (5) during well drilling. Gas flows (6) can create pressure (7) in areas with formation ice (8) at the "clay (9) - sand (10)" boundary, which leads to the development of a preliminary form on the earth's surface (b) and on bulgunnyakh-like objects (11), as well as documented analogues in the coastal location. An increase in the thickness of the active layer (12) may lead to the formation of gas release craters (c, 9), which are then filled (13) with sediments from crater walls (14). These new layers of sediment with a thickness of over 50 m then freeze once again (d), preventing further gas showings in permafrost rock

7.4.7 *Groundwater*

The aquifers of the geological environment of the Gydan Peninsula are practically unused, and therefore a detailed assessment of their quality has no practical interest. At the same time, the assessment of the impact of the planned activity on groundwater is a necessary part of the international ESIA procedure and, in this case, should also be supplemented with a forecast of how the geological environment will react to the proposed impacts.

[107] Gas-emission craters of the Yamal and Gydan peninsulas: A proposed mechanism for lake genesis and development of permafrost landscapes// Yury A. Dvornikov, Marina O. Leibman, Artem V. Khomutov, Alexander I. Kizyakov, Petr Semenov, Ingeborg Bussmann, Evgeny M. Babkin, Birgit Heim, Alexey Portnov, Elena A. Babkina, Irina D. Streletskaya, Antonina A. Chetverova, Anna Kozachek: 2019, Permafrost and Periglac Process. 2019;1–17. wileyonlinelibrary.com

Hydrogeological conditions of the proposed site of the Plant and its associated facilities are characterized by the presence of three groundwater aquifers in the upper 20-meter subsoil stratum, with varying sensitivity and reactions to potential technogenic impacts:

- free-flowing supra-permafrost waters of the seasonally thawed layer (STL), which undergo phase changes on the annual basis, lie directly above the roof of the frozen stratum; they are mainly replenished by precipitation; they occur at the depth of 0.1 to 1.0 m; water-bearing soils and subsoil materials consist of fine sand; they are unloaded in surface depressions; the waters are fresh (0.04–0.6 g/l) and, as regards the composition, contain chlorides and bicarbonates; they are slightly acidic or neutral, and very soft;
- low-pressure waters of modern alluvial, marine and biogenic sediments hydrologically associated with the Ob Estuary, land water bodies and watercourses; therefore, by chemical composition, they occupy an intermediate position between the supra-permafrost waters of the STL and the waters of surface water bodies; within this category, the permanently existing waters of non-through taliks, distributed along a narrow strip (up to 500 meters wide) of the Ob Estuary beach and delta zone and forming the aquifer of the alluvial coastal plain, are of particular importance; the depth of distribution of thawed water-bearing materials is approximately 7 m; the waters have a weak but constant hydrodynamic pressure; water-bearing materials consist of fine alluvial marine sands of medium density;
- intra-permafrost waters (cryopegs), found in the coastal area of the Ob Estuary at the depth of 11-17 m, in the Khaltsyney-Yakha river valley, as well as, locally, in the central part of the License Area (approximately 2 km north of the proposed AGPU No. 3) at the depth of over 20 m (see Figure 7.4.4); the hydraulic head in the aquifers was 2.3-2.7 m, the salinity of water 45-70 g/l (brines); in terms of its composition the water was chloride-sodium, sodium-magnesium-calcium, magnesium-chloride, highly aggressive in relation to concrete and cable sheaths.

In Ramboll practice, when assessing the impact of planned activity on groundwater, it is customary to distinguish 4 categories of sensitivity, where the highest category characterizes poorly protected, exploited and/or environmentally important aquifers, and the lowest category describes well-protected and, at the same time, unused aquifers non-essential for the existence of valuable ecosystems.

In this case, the sensitivity of the two above-mentioned groundwater aquifers should be assessed as medium, as, on the one hand they lack protection from penetration of pollutants, but on the other hand these waters have no practical value.

On the contrary, intra-permafrost brines are characterized by low sensitivity, but they themselves may pose a danger to the proposed buildings and installations if they break through to the surface or come into contact with underground parts of buildings and installations. Cryopegs, which are common for the entire territory of the license area, are not considered as comparable to gas hydrates in terms of engineering hazard of the cryolithozone. Nevertheless, their disturbance, either by construction work or, at a later stage, during the operation of buildings and installations can lead to local degradation of permafrost under the influence of unloading brines, emerging technogenic taliks, an increase in the deforming and corrosive action of the geological environment affecting the structure of foundations and, as a consequence, the loss of their load-bearing capacity[108].

7.4.8 Tectonics and seismicity

The Gydan peninsula territory, as well as the whole of the West-Siberian platform, has a heterogeneous foundation, a heterochronous complex and a thick Mesozoic-Cenozoic platform (ortoplatform) cover. Since the Neogene, the area in question has been tectonically stable or slowly lowering, and shortly before the Holocene a steady upward trend emerged, which is preserved to this day and complicated by differentiated block movements of lower order[109]. According to the published map of seismic zoning (GSZ-2016, SP 14.13330.2011), the magnitude of potential earthquakes does not exceed 5 points on the MSK-64 scale for the return periods of 500, 1,000, and 5,000 years.

---

[108] N.V. Kiyashko. Transformation patterns in the phase and chemical composition and thermophysical characteristics of saline rocks and cryopegs of the Yamal Peninsula in the course of their cryogenic metamorphism. - Diss. of cand. of geol.-min. sciences. Moscow: 2014.

[109] Baranskaya A.V. et al. Upper Quaternary deposits of the Gydan peninsula and the Arctic islands: changes in the relative level of the Kara Sea and vertical movements of the earth's crust over the past 50 thousand years // Vestnik MGU. Geography Series. 2017.

7.4.9 Summary

1. The project consists in the extraction and use of hydrocarbon resources of the geological environment within the Salmanovskoye (Utrenneye) oil and gas condensate field – one of the largest fields in the Yamal and Gydan oil and gas regions of the West Siberian oil and gas province. Of the explored deposits, only those gas and gas-condensate deposits will be developed that are confined to Mesozoic sedimentary rocks at the depth of 1-1.5 km. Natural gas from the field is characterized by a low content of methane homologues and non-hydrocarbon impurities.
2. The terrain of the territory in question, which emerged from the sea relatively recently, is represented by a series of marine and lagoon-laida sandy-loamy terraces, complicated by a floodplain complex of modern river valleys and a marine laida, with intense (up to several meters per year) abrasion-accumulative transformation of the coast against the general trend towards a slow tectonic uplift, complicated by differentiated block movements.
3. The territory of the license area is asymmetrically divided into a smaller western and a more extensive eastern part by a watershed with absolute elevation marks of up to 70-80 m, located 3-25 km from the Ob Estuary waterline. The predominantly flat topography with the maximum elevation marks in interfluve areas not exceeding 55-80 m above sea level (16-18 m above sea level for the coastal Plant and Port facilities), ensures the absence of orographic microclimatic effects, zonal character of climatogenic thermals and poor drainage of the territory with a relatively low intensity of development of gravitational and erosional exogenous geological processes.
4. The proposed site of the onshore facilities of the Plant and the Port is exposed to periodic flooding due to tides, wind-driven waves and river flow fluctuations as well as to waterlogging during periods of intensive snow melting and heavy rain. The shore within the area in question is flat, of accumulative type. The sandy beach is approximately 100 meters wide. The foreshore zone in the vicinity of the existing berthing facilities has the width of approximately 50 m and gradually expands to the south, in the direction of the Plant, up to 100 m.
5. The land terrain is composed of Quaternary sediments of predominantly coarse texture, predominantly laminated and binomial, with mineralogical depletion of substrates as evidenced by a very low content of easily weathered heavy and light minerals and the fragmental character of all grain fractions.
6. Uneven and generally poor drainage of the area contributes to the widespread occurrence of lacustrine-paludal complexes typical for interfluve areas, river valleys and seaside lowlands. The low rate of decomposition of organic matter due to climate and waterlogging leads to widespread peat formation.
7. The seafloor surface features in the water area of the LNG and SGC Plant on GBS include characteristic gouges with embankments and pressure walls, which arose from the impact of ice formations and can be traced to a depth of several meters from the seafloor.
8. The land and water area under review are confined to a cryolithic zone with continuous distribution of permafrost rocks which serve as a regional aquitard (the water regime of interfluve soils and subsoil materials is cryosolic and stagnant) and a geochemical barrier, have a multi-layer structure, maintain low temperatures, and reduce the filtration properties of loose sediments; they lie close to the surface and largely determine the character of modern exogenous geological processes with the leading role of waterlogging, thermokarst and thermal erosion, solifluction (especially on the slopes of river valleys and coastal areas of the Ob Estuary), frost heaving and congelifraction (in interfluve areas).
9. The onshore part of the Salmanovsky (Utrenny) license area belongs is a territory which is characterized by surface gas showings caused by transformations of gas hydrates in the permafrost strata. Gas showings are most likely along the coast of the Ob Estuary (a similar confinement to the coastal area is typical for gas showings on the Yamal Peninsula), where one of them was indeed discovered during engineering surveys. The intensification of such phenomena may be facilitated by physical or mechanical disturbances in the integrity of the soil layer during excavation, construction of foundations, extraction of soil-based building materials, as well as degradation of permafrost caused by the construction and operation of the Project facilities or by natural causes.
10. Widespread distribution of organogenic soils and soils with coarse texture in combination with high degree of water saturation is conducive to cryogenic processes and, consequently, the formation of polygonal forms of microrelief coupled with the complexity of soil structure, and, for sand masses, the development of eolian processes and the corresponding forms of micro-topography.
11. Ground waters within the License Area are not used in economic activities and are not highly sensitive to technogenesis. The shallow groundwater horizon is generally represented by fresh, free-flowing, supra-permafrost waters of the seasonally thawed layer which undergo phase changes on the annual basis. Along with waters of hydrogenous non-through taliks, which are confined to

modern alluvial, marine and biogenic sediments and hydrologically associated with surface water bodies that caused their presence, those horizons are not protected from the ingress of pollutants with surface runoff and act as a carrier medium. One hydrogeological feature found in the license area is cryopegs – intra-permafrost supercooled brines which occur at the depth of 10-20 m; their surface manifestation adds to the accident rate due to their pressure levels, high corrosivity and below-zero temperatures.

7.5 Soils

7.5.1 Salmanovskiy (Utrenniy) License Area within the system of soil-geographical zoning of the Russian Federation and the YNAO

The territory of the Salmanovskiy (Utrenniy) License Area is located on the border of the nearly circumpolar subzones of the Arctic tundra and tundra gley soils of the Subarctic Region (marked, respectively, as "Б" and "В" on the soil-ecological zoning map of the Russian Federation, Figure 7.5.1).

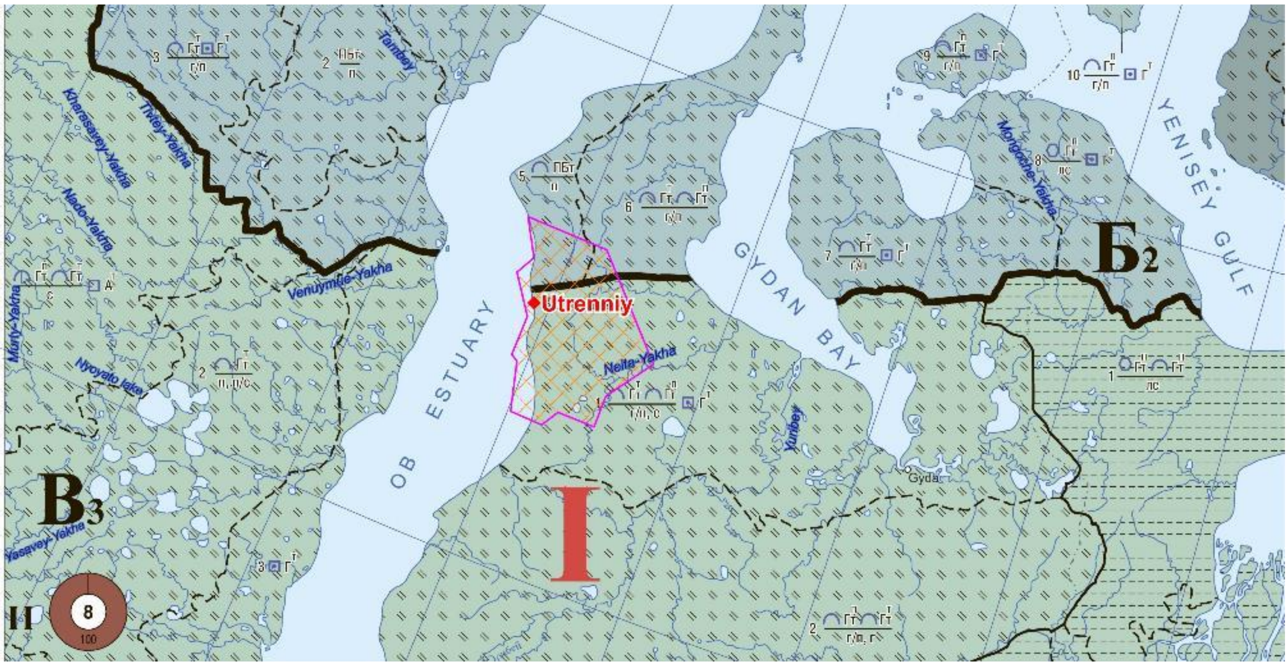


Figure 7.5.1: License Area, Plant and Port on the soil-ecological zoning map of the Russian Federation[110]

To the north of this border is the North Yamal-Gydan district of hillocky-hummocky complexes of tundra gley peat(y), peat(y)-gley paludal and clayey and loamy soils of barren patches underlain by sand and sandy loam, and low center polygonal peat(y)-gley paludal and tundra-gley peat(y) complexes and soils of permafrost fissures in marine and lacustrine-alluvial sediments belonging to the West Siberian arctic-tundra province with paludal-tundra, peat(y)-gley paludal and arctic tundra humus-gley soils (see index in Figure 7.5.1 – Б2).

The Plant and the larger part of the License Area are located further south in the West Siberian tundra province of paludal-tundra, tundra-gley humus, peat(y)-gley and peat-bog soils (В3) which is represented by Taz-Gydan district of hillocky-hummocky complexes of tundra glei peat(y), peat(y)-gley paludal soils and soils of barren patches, hillocky-hummocky complexes of tundra humus-glei soils, soils of barren patches and tundra glei-peat(y), low center polygonal complexes of peat(y)-gley paludal, tundra glei peat(y) soils and soils of cryogenic fissures with motley granulometric composition, from sandy to clayey, including binomials, on marine sediments.

The boundary between soil subzones and provinces in the Gydan Peninsula cannot be determined by the orography or lithology of soil-forming rocks or the change of vegetation type, therefore it is largely arbitrary, and therefore the zonal type of tundra gley soils does not dominate or form large areas in the structure of soils. Intrazonal and non-zonal soils, on the contrary, are diverse and cover most of the area under review.

For these reasons, the regional system of soil-geographical zoning of the Yamal-Nenets Autonomous Okrug classifies the entire territory of the Gydan Peninsula as a district of flat sandy-clayey coastal plains with intrazonal paludal-tundra and paludal soils.

Information on the soil structures prevailing within the License Area is presented in Figure 7.5.2. According to the PINRO surveys (2012), complexes of humus-gley supra-permafrost-humus soils, peaty-gley soils

---

[110] Soil-ecological zoning map of the Russian Federation. M. 1:2 500 000. M.: Faculty of Soil Science, Lomonosov Moscow State University, 2013.

and soils of barren patches, as well as complexes of peaty-gley, humus gley and peat-bog, mostly upland, soils are dominant within the area.

According to the information given in Table 7.5.1, the soil complexes in the Salmanovskiy (Utrenniy) License Area are widespread in the Yamal-Nenets Autonomous Okrug and are not unique to the proposed site of the Plant, Port and Field facilities.

7.5.2 Soils in the territory of the License Area

In the conditions typical for the territory under review, the dominant soil formation processes are the accumulation and decomposition of organic matter, subsurface weathering and gleiing; the ratio between them determines the morphological features of the soil and its categorization as a particular taxon of the Russian and international soil taxonomy.

The materials of the survey carried out for the License Area by several organizations (PINRO, RusGasEngineering, TsGEI, Uralgeoproekt, PurGeoCom) include soil and soil structures diagnostics performed on the basis of various classification systems[111], in connection with which the same soils and soil structures are presented in these materials under different names, which do not normally correspond to those indicated on the National Atlas of Soils of the Russian Federation[112], Unified State Register of Soil Resources of the Russian Federation[113], World Reference Base of Soil Resources[114] and the Unified Information and Analytical System "Environmental Protection and Environmental Safety in the Yamal-Nenets Autonomous Okrug"[115].

To fill this gap, the Consultant established a correlation between all the soils data available from the survey materials and the requirements of the abovementioned documents (Table 7.5.2). Since the most intensive impacts on soil are expected within the location area of the onshore facilities of the Plant and Port, the proposed soil systematization is linked to 12 sections of the detailed soil map compiled by TsGEI (2017) for the above area and prescribed sanitary protection zone (Figure 7.5.3). The above description of soils diversity is also applicable to the whole territory of the Salmanovskiy (Utrenniy) License Area.

---

[111] Classification and diagnostics of soils of Russia. Smolensk: Oykumena, 2004. 341 p.

Classification and diagnostics of soils of the USSR. M.: Kolos, 1977. 221 p.

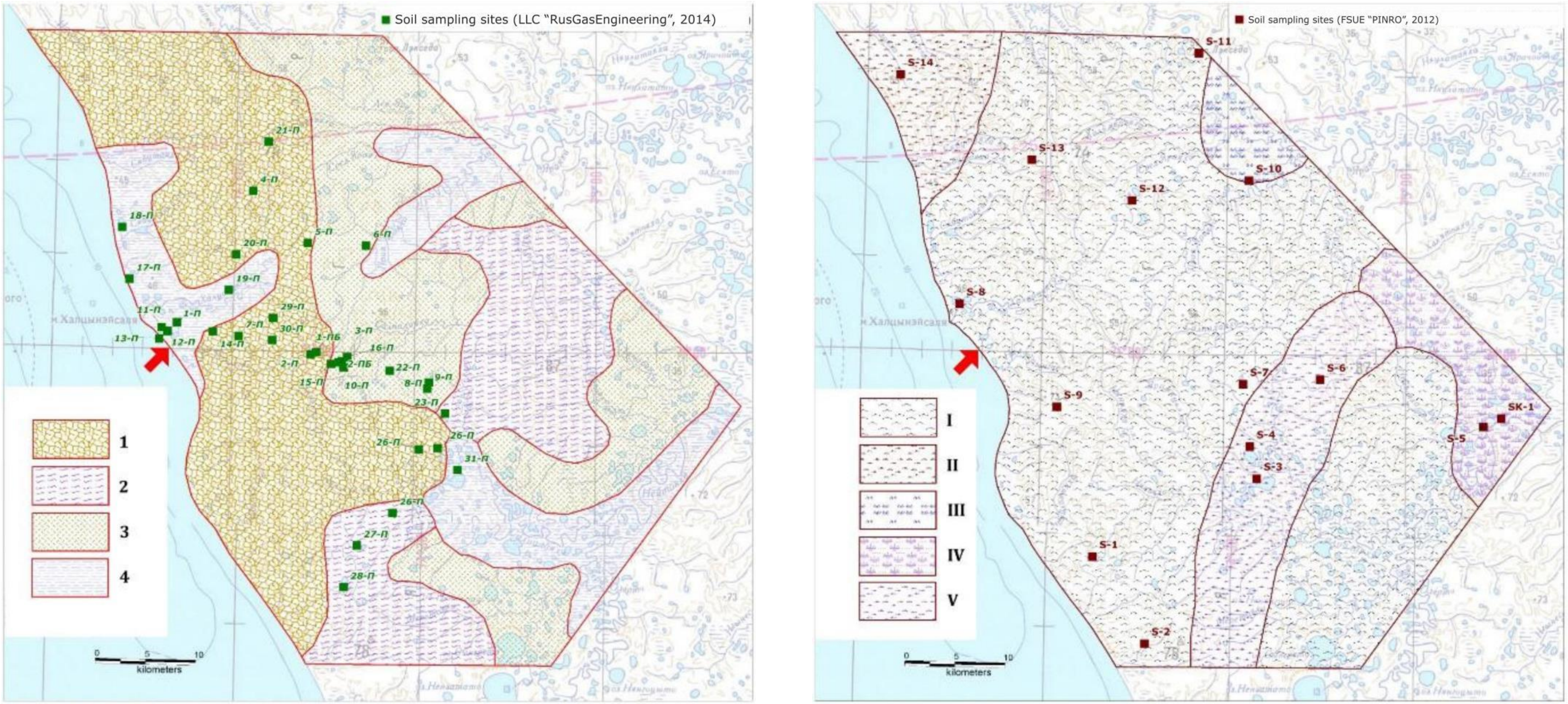
[112] National Atlas of Soils of the Russian Federation. M.: Faculty of Soil Science, Lomonosov Moscow State University. Astrel Publishers, 2011. 632 p.

[113] Unified State Register of Soil Resources of Russia. Version 1.0. M: Dokuchaev Soil Institute of the Russian Agricultural Academy, 2014. 768 p.

[114] 2014 World Abstract Soil Resource Base. International soil classification system for soil diagnostics and creation of soil map legends (WRB-2015) - Food and Agriculture Organization of the United Nations, Lomonosov Moscow State University, 2017. 216 p.

IUSS Working Group WRB. 2015. World Reference Base for Soil Resources 2014, update 2015. International soil classification system for naming soils and creating legends for soil maps. World Soil Resources Reports No. 106. FAO, Rome.

[115] Unified information-analytical system "Environmental Protection and Environmental Safety in the Yamal-Nenets Autonomous Okrug". Information and analytical system Ekopasport. - Salekhard: YNAO Department of Natural Resources Regulation, Forest Relations and the Development of the Oil and Gas Complex. Online resource at http://dprr-baz.yanao.ru/ecopass/



SOIL STRUCTURES

National Atlas of Soils of the Russian Federation (2011),

Unified State Register of Soil Resources of the Russian Federation (2014)

1	*Hillocky hummocky complexes of tundra podbur, tundra gley peaty and peat soils, soils of barren patches*
2	*Hillocky hummocky complexes of arctic-tundra humus-gley soils, soils of barren patches, tundra gley peaty and peat soils*
3	*Hillocky hummocky complexes of tundra gley peaty and peat soils, peaty and peat-gley paludal soils, soils of barren patches*
4	*Low-center polygonal complexes of peaty and-peat-gley paludal, tundra gley-peaty and peat soils, soils of permafrost fissures*

PINRO Survey Materials, 2012

I	*Combination of the complex of humus-gley supra-permafrost-humus soils, peaty-gley soils and soil of barren patches with the complex of peaty-gley, humus-gley and peat-bog, mostly upland, soils*
II	*Combination of the complex of humus-gley illuvial-humus soils, peaty-gley illuvial-humus soils and soils of barren patches with the complex of peaty-gley, humus-gley and peat-bog, mostly upland, soils*
III	*Combination of the complex of peat-bog, mostly upland, peat-bog degrading and peaty-gley illuvial-humus soils with supra-permafrost-gleyic soils*
IV	*Combinations of lowland and upland peat bog and peat bog degrading soils*
V	*Combinations of floodplain, lowland and upland peat-bog soils*

Figure 7.5.2: Soils in the Salmanovskiy (Utrenniy) License Area

The red arrow indicates the proposed Plant and Port site; underlined are the soil structures that are most common within the proposed Plant and Port site

Table 7.5.1: Representation of Salmanovskiy (Utrenniy) License Area main soil structures in the Yamal-Nenets Autonomous Okrug

Soil structures in YNAO soils according to USRSR 2014 data		% of the license area[116]	ha	YNAO	Correlation with the PINRO soil map (2012)
Hillocky hummocky complexes featuring:					
1	tundra podburs, tundra gley peaty and peat soils, soils of barren patches;	35	96580	0.3	The northern part of the contour is represented as a combination of the complex of humus-gley illuvial-humus soils, peaty-gley illuvial-humus soils and soils of barren patches with the complex of peaty-gley, humus-gley and peat-bog, mostly upland, soils. The central and southern parts of the contour are represented as combinations of the complex of humus-gley, supra-permafrost-humus soils, peaty-gley soils, and soils of barren patches with the complex of peaty-gley, humus-gley and peat-bog, mostly upland, soils.
2	Arctic-tundra humus-gley soils, soils of barren patches, tundra gley peaty and peat soils;	18	50760	6.5	The complexes are not confined to particular contours. The corresponding territories are represented by combinations of lowland and upland peat bog and peat bog degrading soils (marshlands, mostly in the northern part of the contour), combinations of floodplain, lowland and upland peat bog soils (in river valleys), complexes of humus-gley supra-permafrost-humus soils, peaty-gley soils and soils of barren patches in most of the interfluve areas
3	tundra gley peaty and peat, peaty and peat-gley paludal soils, soils of barren patches	29	81930	15.3	
Low-center polygonal complexes featuring:					
4	peaty and peat-gley paludal, tundra gley peaty and peat soils, soils of permafrost fissures	18	48790	6.5	

For the soil-mapping studies at the Field and the Utrenniy Airport sites in 2017-2019, PurGeoCom and Uralgeoproekt adopted a relatively simple classification of soils that included nine groups:

1) anthropogenically disturbed soils, i.e. all earthfills and other territories affected by industrial activity (as a rule, such territories are devoid of soil);
2) primitive sandy soils: young underdeveloped soils in sand arenas, beaches, river floodplains and man-made embankments;
3) tundra podburs: confined to small local areas that account for less than 1% of the total mapped territory, correspond to items 7, 9 and 10 in Table 7.5.2; in some areas appear in combination with tundra gley soils;
4) tundra gley soils: one of the two most common types of soils, occupy up to a half of the mapped territory; correspond to items 6 and 11 in Table 7.5.2;
5) peaty-gley soils: another most common type of soils; distinguished from tundra gley soils by more extensive accumulation of organigenic material on the surface; correspond to item 5 in Table 7.5.2;
6) complexes of tundra gley and peary-gley soils (combination of the two most common soil types characteristic of the transition zones between the respective ranges);
7) alluvial layered typical soils: soils of river valleys where fresh alluvial deposits are regularly accumulated without complete wash-out of the earlier soil development products; item 12 in Table 7.5.2;
8) alluvial peaty-gley soils: differ from the above by stagnant water conditions, waterlogging and accumulation of organogenic material on the surface; item 12 in Table 7.5.2;
9) tundra (or peaty) bog soils: the section covers the whole diversity of bog soils within the license area, items 5-8 in Table 7.5.2.

Maps illustrating distribution of these soils within the territory affected by the Project are shown in Figures 7.5.4, 7.5.5.

[116] Without the section of Ob Estuary water area being a part of the License Area

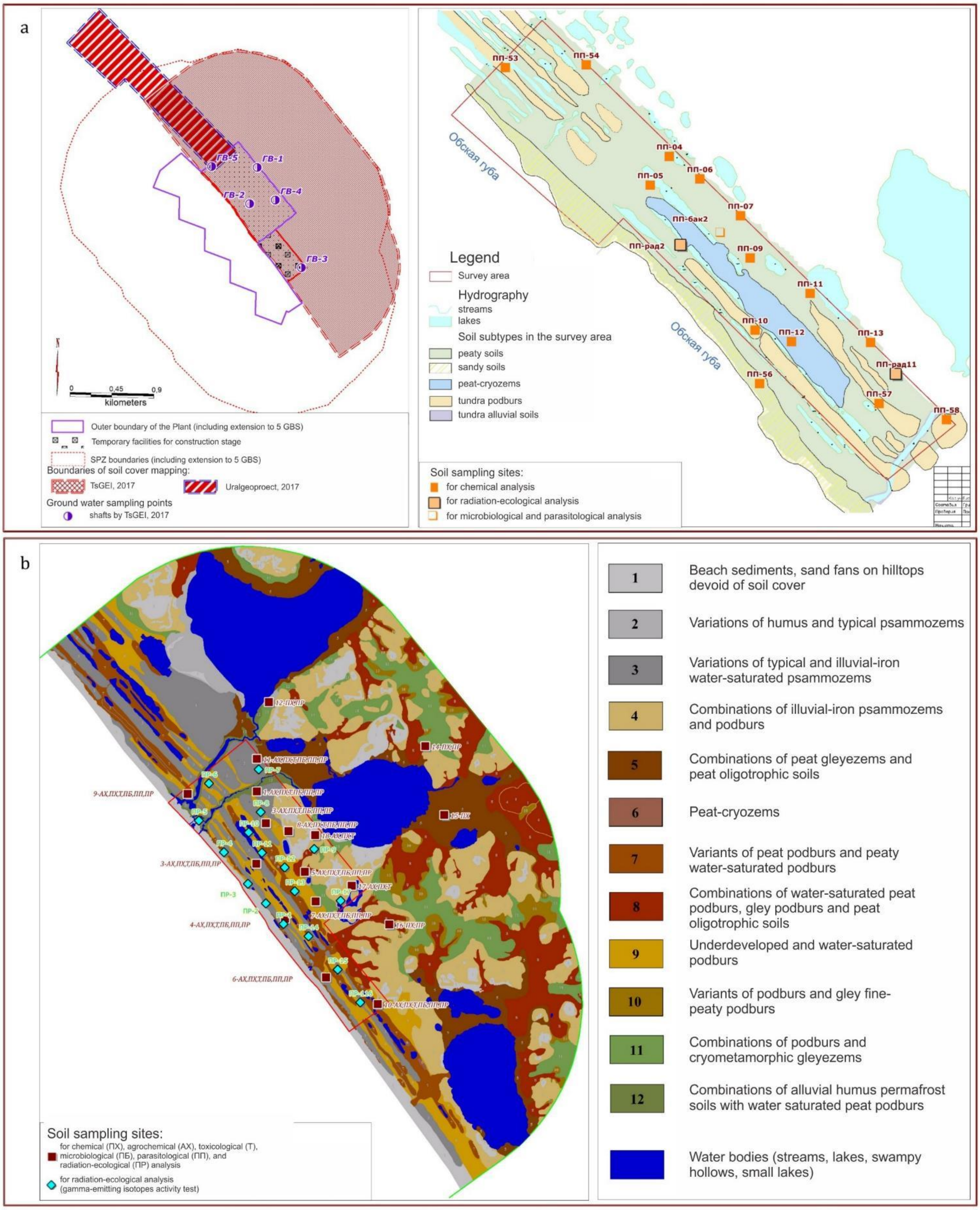


Figure 7.5.3: Soils at the proposed Port (a) and Plant (b) sites

Table 7.5.2: Soil structures and soils in the area of the projected location of the Plant and the Utrenniy Terminal (including land acquisition for the onshore facilities and regulatory SPZ) in the terminology of the official classifications of soil of YNAO, the Russian Federation and the UN

Soils, soil structures, non-soil formations according to the TsGEI (2017) terminology with the Consultant's additions and clarifications		**Nomenclature of soils and non-soil formations in the official classification systems of the Russian Federation, the Yamal-Nenets Autonomous Okrug and the UN**		
Contour index in Figure 7.5.3b	**Soil structures and non-soil formations**	**USRSR 2014: multiclassification nomenclature identifier**	**Ekopasport YNAO**	**WRB-2015**
1	Beach sediments, devoid of soil	ID 305: Sands - 0.1% ID 307: Water - 0.5%	Sands - 0.13% Water - 1.51%	Codominant: Subaquic Protic Arenosols Codominant: Tidalic Protic Arenosols
	Sand blowoffs on hilltops devoid of soil			Protic Arenosols (Aeolic)
2	Variants of humus and typical psammozems			Codominant: Haplic Arenosols Codominant: Dystric Arenosols
3	Variations of typical and illuvial-iron water-saturated psammozems			Codominant: Haplic Arenosols Codominant: Dystric Fluvic Gleyic Arenosols (Turbic)
4	Combinations of illuvial-iron psammozems and podburs			Dystric Fluvic Gleyic Arenosols (Turbic)
		ID 11: Tundra podburs - 2.9%	Tundra sod soil[117] (7 variants) - 1.88%	Spodic Cryosols (Dystric, Arenic)
5	Combinations of peat gleyezems and peat oligotrophic soils	Hillocky hummocky complexes of tundra gley peaty and peat/ peat and peaty tundra gleysols (ID 8), peaty and peat-gley paludal soils (ID 170), soils of barren patches (ID 16) - 15.3%	Complexes featuring tundra gleyic and gley soils, soils of barren patches - 3.47%	Codominant: Dystric Histic Reductic Gleysols (Turbic) Codominant: Dystric Cryic Histosols (Turbic) Associated: Histic Reductaquic Turbic Cryosols (Dystric, Arenic)
		ID 165: Peat bog transitional soils - 0.1%	Paludal transitional soils (4 variants) - 0.52% Paludal-tundra soils (4 variants) - 1.14%	Dystric Cryic Histosols (Fluvic, Turbic)
		Low-center polygonal complexes of peaty and peaty-gley bog (ID 170), tundra gley peaty and peaty soils (ID 8), soils of permafrost fissures (ID 308) - 6.5%	Tundra gley peaty soils (6 variants) - 4.63% Paludal-tundra soils (4 variants) - 1.14%	Codominant: Dystric Cryic Histosols (Fluvic, Turbic) Codominant: Dystric Histic Gleysols (Turbic) Associated: Histic Turbic Cryosols (Dystric)

[117] Note: Properties of tundra sod soils and tundra podburs are not identical, but in absence of the latter, the soil type of tundra sod soils is considered by the Consultant as the closest diagnostic analog

Soils, soil structures, non-soil formations according to the TsGEI (2017) terminology with the Consultant's additions and clarifications		Nomenclature of soils and non-soil formations in the official classification systems of the Russian Federation, the Yamal-Nenets Autonomous Okrug and the UN		
Contour index in Figure 7.5.3b	**Soil structures and non-soil formations**	**USRSR 2014: multiclassification nomenclature identifier**	**Ekopasport YNAO**	**WRB-2015**
6	Peat-cryozems	Soils of barren patches, including saline, arctic and tundra mildly biogenic destructive (ID 16) soils	Complexes featuring tundra gleyic and gley soils, soils of barren patches - 3.47%	Histic Reductaquic Turbic Cryosols (Dystric, Arenic)
		Low-center polygonal complexes of peaty and peaty-gley bog (ID 170), tundra gley peaty and peaty soils (ID 8), soils of permafrost fissures (ID 308) - 6.5%	Tundra gley peaty soils (6 variants) - 4.63% Paludal-tundra soils (4 variants) - 1.14%	Codominant: Dystric Cryic Histosols (Fluvic, Turbic) Codominant: Dystric Histic Reductic Gleysols (Turbic) Associated: Histic Turbic Cryosols (Dystric)
7	Variants of peat-podburs and peaty water-saturated podburs	ID 11: Tundra podburs - 2.9%	Tundra sod soil (7 variants) - 1.88%	Codominant: Spodic Histic Reductaquic Cryosols (Dystric) Codominant: Dystric Fluvic Spodic Histic Gleysols
8	Combinations of water-saturated peat-podburs, gley podburs and peaty oligotrophic soils	ID 165: Peat bog transitional soils - 0.1%	Paludal transitional soils (4 variants) - 0.52% Paludal-tundra soils (4 variants) - 1.14%	Codominant: Spodic Histic Reductaquic Cryosols (Dystric) Codominant: Dystric Fluvic Spodic Histic Gleysols Associated: Dystric Cryic Histosols
9	Underdeveloped water-saturated podburs	ID 11: Tundra podburs - 2.9%	Tundra sod soil (7 variants) - 1.88%	Spodic Histic Turbic Cryosols (Dystric, Arenic, Fluvic)
10	Variants of podburs and gleyic fine-peaty podburs			Codominant: Spodic Histic Cryosols (Dystric) Codominant: Dystric Spodic Histic Gleysols
11	Combinations of podburs and cryometamorphic gleysols	Hillocky hummocky complexes of tundra podburs (ID 11), tundra gley peaty and peat soils (ID 8), soils of barren patches (ID 16) - 0.3%	Complexes featuring tundra gleyic and gley typical soils, black earth, peaty and humus soils - 3.77%	Codominant: Spodic Histic Cryosols (Dystric) Codominant: Dystric Histic Gleysols (Turbic)
12	Combinations of alluvial humus permafrost soils and water-saturated peat podburs	ID 187: Floodplain acid soil - 8.1%	Alluvial sod and sod-gley soils (5 variants) - 0.5%	Codominant: Dystric Gleyic Histic Fluvisols Codominant: Dystric Gleyic Histic Fluvisols (Turbic) Associated: Subaquic Fluvisols (Arenic) Associated: Spodic Histic Reductaquic Turbic Cryosols (Dystric, Arenic, Fluvic)
		ID 192: Floodplain marshy soils - 1.6%	Alluvial marshy soil (2 variants) - 2.35%	
		ID 11: Tundra podburs - 2.9%	Tundra sod soil (7 variants) - 1.88%	

Figure 7.5.4: Soils in the designed sites of the power supply complex, PGTP No.3, GWP-16, and related utility corridors

(Uralgeoproekt, 2018)

The soils listed above significantly differ from each other both by origin and by appearance. The youngest and least developed soils within the Project's area of influence are on the coast of the Ob Estuary. The main factors of differentiation of soils in this area include the age of the surface, the water regime and the character of exogenous geological processes. A wide range of tidal, wind induced fluctuations of the sea level and wave and ice action is represented by a complex of marine sediments devoid of soil (Figure 7.5.6). The upper 30-40 cm layer of these sediments' profile is practically undifferentiated by morphology and is underlain by more dense sediments, which coloring is transformed by gleying processes, which are characteristic of the soils and also of bottom sediments in local waterbodies.

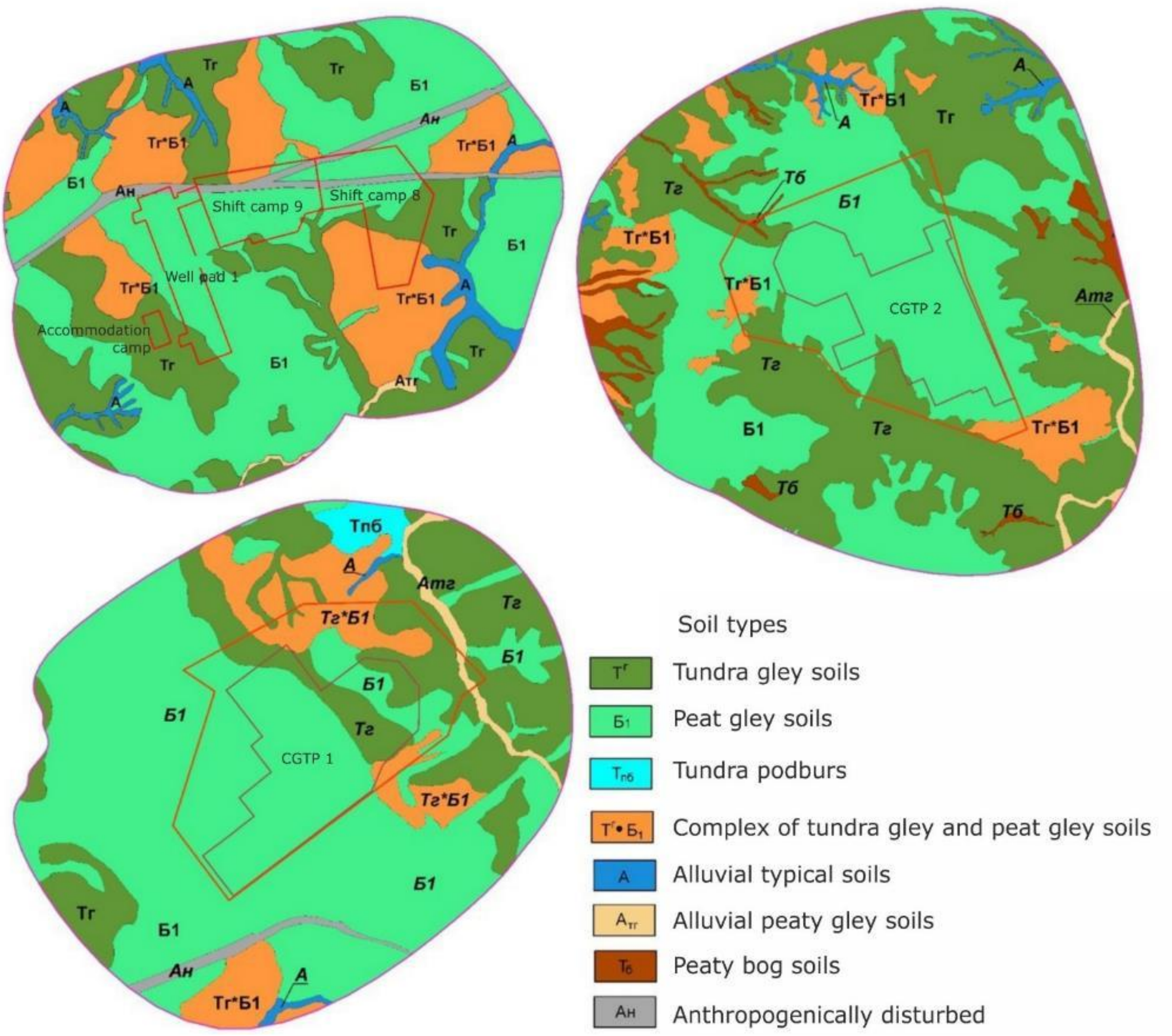


Figure 7.5.5: Soils in the designed sites of GWP-1, CGTP-1 and CGTP-2

(PurGeoCom, 2018)

Figure 7.5.6: Marine sandy sediments of the beach zone devoid of soil (photo by TsGEI, 2017)

Geomorphological stabilization of marine sands creates conditions for the formation of vegetation cover and triggers soil formation processes, consisting in the accumulation of slightly decomposed organic matter, mechanical and physicochemical transformation of the root-occupied sediment horizon under the influence of higher vegetation, algae and lichens. At the same time, gleying processes develop in the sediments, facilitated by the presence of decomposing organic matter. As a result, a soil profile is formed of the soils presented in the survey materials as psammozems (Figure 7.5.7).

In areas that are relatively well drained, the psammozem profile often acquires the typical marble-like color with the alternation of light gray and bluish areas of gleyic transformation of marine sediments, as well as of bright ocher, rust-colored and dark brown areas of accumulation of iron hydroxides in the zones of seasonal aeration of the profile. As the thickness of the organogenic horizon increases, the reduction processes become predominant, and the mineral horizons of the psammozems acquire a relatively uniform bluish-gray color, which is more typical of marshy peat-gley and tundra gley soils.

Figure 7.5.7: Psammozemes characteristic for the projected site of the Plant and Port

The age of the soil and the effectiveness of soil-forming processes — accumulation of organic matter and gleying increase from left to right

(photo by TsGEI LLC , 2017; sections Nos. 8, 59, 62 and 28)

The latter are the main zonal type of soils in the studied area. They best match the reference description at the sites located away from the coast, where ground waters occur at relatively deep levels (Figure 7.5.8). A distinct morphological feature of gleysols is marble-like pattern of their profile with alternating light-bluish-greyish and brownish-ochre fragments, depending on predominance of protoxidic or oxidic iron compounds. By grain-size composition, these soils fall under the sandy loamy or light loamy category.

Figure 7.5.8: Tundra gley soil (gleysol) in the license area close by GWP No.7

(photo by PurGeoCom, 2018)

Further development of the processes of subsurface weathering in parallel with the accumulation of coarse humus relegates psammozems and gleysols to the taxon of podburs, which main morphological feature is the distinct brown color of the upper and middle part of the profile (under the organogenic horizon and up to the depth of 15-25 cm). In waterlogged conditions associated with the proximity of permafrost rocks podburs transform into peat-podbur, which is characterized by a thick layer of peat and well-pronounced gleying in the middle of the profile (the corresponding series of soil is presented in Figure 7.5.9).

Figure 7.5.9: Podburs and peat podburs at the projected site of the Plant and Port

Hydromorphism, peat accumulation and gleying of soils increase from left to right (photo by TsGEI, 2017, Sections Nos. 27, 31, 46 and 16)

The acidic gley situation in the podbur and peat-podbur profile is favorable for the transformation of the mineral part of the lithogenic base; movable products of weathering, represented by organo-ferrous complexes, manganese compounds, and a number of related elements, migrate both along the soil profile and laterally, accumulating at the geochemical (oxygen and permafrost) barriers. The properties of podburs are most distinct in well drained sections of tundra (Figure 7.5.10). These soils provide a good substrate for lichen pastures: they are "warmer" than gleysols, better and faster warm up in summer, are well aerated and held in place by vegetation against wind and water erosion, and possess a relatively high resistance to trampling.

Figure 7.5.10: Podburs in the Salmanovskiy (Utrenniy) LA: distinct ochrish-brown colour in the middle section of the profile, sandy structure and relatively good drainage conditions

(photo by PurGeoCom, 2018)

Under the conditions of proximity of permafrost rocks to the surface, soil formation is complicated by active cryogenic processes, accompanied by periodic deformation of the diurnal surface and the formation of frost-heave mounds, as well as by the flow of waterlogged material from lower soil horizons to the surface and the appearance of so-called cryogenic spots. In areas where such processes are active, a complex layer of soil is formed, represented by peat-cryozems of mounds and leveled areas, peat bog soils of depressions (Figure 7.5.11), and underdeveloped soils of heterochronous barren patches, which are being slowly overgrown.

Figure 7.5.11: Peat-cryozem (left) and peat oligotrophic soil at the proposed site of the Plant and Port

(photo by TsGEI, 2017)

Figures 7.5.3-7.5.5 give an idea of the spatial distribution of the abovementioned soils and their combinations within the proposed site of the onshore facilities of the Plant and Port, and of the Field sites. For this ESHIA process, the Consultant provided comprehensive soil-landscape interpretation of the remote sensing materials for the whole territory of the license area. The graphic and text information on the edaphic (soil) conditions for the identified groups of plant communities is provided in this Chapter, Section 7.6. Reference is made to the international soil classification system (WRB), Table 7.5.2.

7.5.3 Agro-ecological properties of soils

The main part of the territory of the Salmanovskiy (Utrenniy) License Area, including the proposed site of the Plant, the Port and their prescribed sanitary protection zones, is classified as agricultural land, where soils are one of the conditions for providing the indigenous population of the Tazovskiy district with pasture resources and non-timber components of plant resources (wild plants) and, indirectly – by stabilizing habitats and ensuring biodiversity and water protection – also the game and fish resources.

The low productivity of tundra and associated ecosystems is combined with a low rate of biological circulation and extremely low natural soil fertility. Under the adopted system of agroecological typification of the lands of the Russian Federation, the area under review belongs to Category VI, "Lands unsuitable for cultivation of agricultural crops due to unavoidable restrictions and insignificant adaptation possibilities”[118].

The land use dominant in the contour of the onshore part of the LA is nomadic reindeer herding that does not have a regular reference to pastures: the approximate location of the nomadic routes and calving sites of reindeer herds are presented in Chapter 8 of the ESHIA materials. In these areas, pasture and associated loads on soils are expectedly higher compared to areas not affected by development. The most common forms of secondary soil degradation provoked by grazing and driving reindeer are physical and mechanical destruction under the influence of exogenous processes (cryogenic, aeolian, fluvial), waterlogging and gleeling , and transformation of the organoprofile in response to changes in the plant community. Some of these changes are irreversible; in other cases, the restoration of the soils of disturbed areas occurs exclusively in a natural way and at an extremely slow pace.

As part of the surveys conducted by PINRO (2012), RusGasEngineering (2014), TsGEI (2017), Uralgeoproekt (2017), and PurGeoCom (2018-2019) tests were performed on soils in their natural state without visual signs of physical or mechanical degradation and chemical pollution; therefore their agrochemical properties reflect the level of natural fertility of the soils within the License Area and can be used as targets for a soil reclamation effort to restore soils disturbed by construction.

Because of the high contrast of the soils in the Gydan tundra its individual elements essentially differ from each other by certain key agrochemical parameters – mineral particle-size fractions ratio, reserves of organic matter and mineral nutrients for plants, indicators of acid-base and redox conditions.

In this regard, the regional set of reference agrochemical parameters (Table 7.5.3) is tied to the granulometric composition of the soils and highlights as a separate group organogenic soils, widespread in the area under review, which contain no mineral components in their upper layers. According to the survey data, the soil layers tested at the sites of the planned activity contained 0.5 to 20 mass percent of organic matter, mostly represented by slightly decomposed remains of tundra and swamp vegetation. Humus accounted for 0.1 to 2.5% of the soil mass, depending on the soil type and soil formation conditions (TsGEI, 2017).

Table 7.5.3: Average agrochemical indicators of YNAO soils[119]

Soils by granulometric composition	Measurement unit	Average value
Acid-base conditions of aqueous suspension[120]		
Clayey and loamy	pH units	5.6
Sandy loamy		5.5
Sandy		5.5
Organogenic (peat bog)		5.2
Acid-base conditions of 1M KCl suspension		
Clayey and loamy	pH units	4.1
Sandy loamy		3.9
Sandy		4.0
Organogenic (peat bog)		3.7
Hydrolytic acidity		
Clayey and loamy	mgEq/100 g of soil	11
Sandy loamy		12
Sandy		2
Organogenic (peat bog)		49
Humus		
Clayey and loamy	%	2.7
Sandy loamy		1.9
Sandy		0.7
Organogenic (peat bog)		N/a
Ash content of peat		
Organogenic (peat bog)	%	42

[118] Methodological guidelines for agro-ecological land assessment, design of adaptive-landscape farming systems and agricultural techniques. *Ed. Acad. V. I. Kiryushin and Acad. A. L. Ivanova*. - M.: FGNU "Rosinformagrotekh", 2005. 794 p.

[119] Unified information-analytical system "Environmental Protection and Environmental Safety in the Yamal-Nenets Autonomous Okrug”. Information and analytical system Ekopasport. - Salekhard: YNAO Department of Natural Resources Regulation, Forest Relations and the Development of the Oil and Gas Complex. Online resource at http://dprr-baz.yanao.ru/ecopass/

[120] At the “soil:liquid” ratio of 1:2.5 as for mineral soil horizons, at 1:25 - organogenic

Soils by granulometric composition	Measurement unit	Average value
Total nitrogen content		
Clayey and loamy	%	1.8
Sandy loamy		0.1
Sandy		0.1
Organogenic (peat bog)		0.3
Absorbed calcium content		
Clayey and loamy	mgEq/100 g of soil	4.4
Sandy loamy		2.2
Sandy		0.4
Organogenic (peat bog)		4.6
Absorbed magnesium content		
Clayey and loamy	mgEq/100 g of soil	4.4
Sandy loamy		2.2
Sandy		0.6
Organogenic (peat bog)		1.5
Labile phosphorus content		
Clayey and loamy	mg P_2O_5/kg	70
Sandy loamy		80
Sandy		14
Organogenic (peat bog)		119
Exchange potassium content		
Clayey and loamy	mg K_2O/kg	87
Sandy loamy		42
Sandy		33
Organogenic (peat bog)		102
Total phosphorus content		
Clayey and loamy	%	0.22
Sandy loamy		0.04
Sandy		0.01
Organogenic (peat bog)		N/a
Total potassium content		
Clayey and loamy	%	1.5
Sandy loamy		1.3
Sandy		0.5
Organogenic (peat bog)		N/a

The acid-base conditions of soil and soil-forming rocks are determined by the scarcity of lightly weathered minerals in their mineral component and the excess of decomposing organic matter. This explains the high exchangeable acidity of the soils in the License Area, characterized by the pH value of saline suspension (1M KCl) of 3.9 ÷ 5.4 (samples S1... S14, see Figure 7.5.2). For the soils at the 31st testing site, confined to the early field development areas, the actual acidity determined for aqueous suspension ranges from 4.3 to 6.1, which corresponds to an acidic or weakly acidic reaction of the medium.

The coastal soils are formed in the conditions of availability of significantly greater amounts of marine aerosols which alkalize the upper horizons. According to the survey materials for the proposed Plant and Port sites, the pH value ranges from 5.2 to 6.4 for aqueous suspension of the soils, and 4.3–4.8 – for saline suspension, which is slightly higher than the indicators of inland soils of the Gydan peninsula (which are more acidic).

Macro-salt composition of soil solutions mainly includes calcium bicarbonate with a total mineralization below or equal to 50-100 mg/l. No chlorides or sulfates were found in most of the tested soils (no more than 0.11 mmol/100 g of soil or about 40 mg/kg chloride ion, no more than 0.02% sulfate ion). The exceptions are the coastal soils of the Ob Estuary, which in some places contain up to 150 mg/kg of chlorides (TsGEI, 2017), which enter the soil via aerosols during flooding or waterlogging, and also as a result of wave splashing during storms.

The total sulfur content of the soils within the proposed Plant site varies from 0.2 to 50 mg/kg with individual samples containing 400-430 mg/kg of sulfur. In the absence of sulfates and sulfides, it can be assumed that this element is largely associated with organic matter contained in the soil.

Anaerobic decomposition of organic residues enriches the solutions with ammonium: the ammonium nitrogen reserves in the tested soils of the License Area and the site of the Plant’s onshore facilities are estimated at 5-20 mg/kg. Phosphorus is more deficient: most samples contained less than 25 mg/kg of phosphate ion, with individual samples containing 25-30 mg/kg.

The acidic reaction of the soils within the subject area in combination with the prevailing reducing conditions (excessive humidity and organic matter content, hindered soil aeration) results in a deficiency of free oxygen and development of gleying processes. Such conditions ensure the mobility of soluble organic compounds, iron and manganese, certain trace elements, but in general the rate of chemical reactions and the biochemical activity in tundra acidic and gleyic soils are extremely low. Iron in this case is a typomorphic chemical element of the soil, which combines high concentration – from 1-2 to 20-22 g/kg – with high mobility and a pronounced ability to accumulate at the oxygen barrier. At the same time, iron compounds, including hydroxides and organo-ferrous complexes, are to a large extent responsible for the coloring of the local soils, giving them a wide range of colors, from dark brown to bluish-gray.

In accordance with the laws of the Russian Federation, the object of protection is the topmost, humified, section of the soil profile, which possesses chemical, physical and biological properties favorable for plant growth – i.e. the fertile layer (GOST 17.5.1.01-83). It is diagnosed based on the criteria of GOST 17.5.1.03-86; the need for, and the extent of, its removal is determined according to GOST 17.5.3.06-85 and 17.4.3.02-85, and the possibility of using for soil transfer – according to GOST 17.5.3.05-84.

According to the engineering surveys conducted by PINRO (2012), RusGasEngineering (2014), TsGEI (2017) and Uralgeoproekt (2017), which are also supported by the environmental monitoring data reported by IEPI (2018, 2019), the material of the upper layers of all the tested soils in the License Area, including the sites of the Plant, Port and Field, does not meet the prescribed fertility criteria and is not subject to removal and preservation when performing excavation operations and other construction work. In particular, topsoil samples are characterized by excessive amounts of non-humified organic matter and high acidity – overall, the soil has unfavorable hydrophysical properties. Permafrost rocks lie close to the surface and actually represent the lower boundary of the soil profile at the depth of 20-60 cm. In such conditions, the main soil-conservation strategy should consist in preserving the soil and vegetation in undisturbed state to the greatest possible extent and preventing intensification of exogenous processes.

During the survey in the area of the Field and the Utrenniy Airport (2018-2019), PurGeoCom encountered sections where soils had fertile layer of 2-5 cm (alluvial, podburs) or 10 cm (tundra gleysols), however stripping of such soils is strictly proscribed by the surveyors, otherwise hydrothermal conditions in the soil substrate layer may be disturbed.

7.5.4 Rare and highly valuable soils

According to Article 62 of the Federal Law of January 10, 2002 No. 7-FZ "On Environmental Protection"[121] in order to register and protect rare and endangered soils, the Red Book of Soils of the Russian Federation and the Red Books of Soils of the Entities of the Russian Federation were established. In the absence of regulatory documents governing the compilation and maintenance of the Red Books of Soils, the relevant materials are compiled on the basis of common methodological approaches developed by the scientific community[122].

According to the information posted on the website of the Information System "The Red Book of Soils of the Russian Federation" at https://soil-db.ru, the Yamal-Nenets Autonomous Okrug is not among the Russian Federation entities which publish or develop Red Books of Soils. Therefore, the soils within the area under review are not subject to protection provided for by the law for Red Book soils.

No rare or unique soils have been found in the license area as a result of the environmental survey and operational environmental monitoring.

7.5.5 Chemical and radioactive contamination of soils

The program of engineering and environmental surveys conducted by PINRO (2012) in the License Area, by RusGasEngineering (2014) at the early development facilities of the Salmanovskoye (Utrenneye) OGCF, by TsGEI (2017) at the site of the Plant's onshore facilities and sanitary protection zone, by Uralgeoproekt (2017, 2018) at the site of the Port's onshore facilities and some Field facilities , by PurGeoCom (2017, 2018) for the Field facilities and the Utrenniy Airport included an assessment of the chemical and radioactive contamination levels with a standard set of indicators. The summary results of assessing the level of soil background contamination according to these surveys are shown in Figures 7.5.12-7.5.14.

---

[121] http://docs.cntd.ru/document/901808297

[122] Red Book of Soils of the Russian Federation: Red Book Objects and Cadaster of Highly Valuable Soils. / Ed. Dobrovolsky G.V., Nikitin Y.D. M.: MAKS-Press, 2009. 575 p.

7.5.5.1 Organic compounds

The total content of petroleum products (PP) and one of the polyaromatic hydrocarbons (PAH), benzo[a]pyrene (BAP), is among the mandatory criteria for assessing the quality of soil. The survey materials also contain information on the content of phenols (PHN), anionic surfactants (AS), polychlorinated biphenyls (PCB) and pesticides in the soils of the License Area.

During chemical tests, *petroleum products* are extracted from the soil with organic solvents, and therefore in this analytical group of compounds there is always a wide range of bituminous compounds of natural origin, similar in spectral and other characteristics to oil derivatives — waxes, resins, lipids, oils, humus substances. Their content can reach several grams per 1 kg of soil, and, in the belief of the Consultant, the concentrations of this group of compounds indicated in the survey materials, in the absence of visual clues or sources of pollution, should be specifically attributed to the presence of natural bitumoids, and not with the ingress of petroleum products.

Nevertheless, the concentrations of organic compounds, analytically similar to oil derivatives, represent an important background feature of the soil, which is essential for their subsequent monitoring during the proposed implementation stages. In most cases, the content of bituminous substances ranged from 30 to 400 mg/kg (Table 7.5.4): the variation is due to the natural variation of the organic profile, age difference and the state of the soil's organic matter. The highest content of natural bitumoids is found in organogenic horizons of bog soils (PurGeoCom, 2018). This finding has been verified by the environmental monitoring data reported by IEPI (2018-2019): up to 70 mg/kg of bitumoids in peaty and humic horizons where petroleum contamination is out of question, considering the location and testing results.

Benzo[a]pyrene, representing a wide group of PAHs, is one of the characteristic products of incomplete combustion of organic matter, and therefore it may enter the soils of the area under review either from natural sources, such as tundra wildfires, or from anthropogenic sources such as operation of heating systems and internal combustion engines. A certain (very small in this case) proportion of BAP is inherited by the soils from the parent substrates, but the bulk comes from the local or remote sources described above. The principal mechanism of BAP's entry into the soils is its surface precipitation with aerosols, and therefore hydrocarbon tends to concentrate in the topmost layers, which function as a barrier with respect to polyaromatic hydrocarbons, proportionally to their content of organic matter and the silt fraction of mineral fine earth.

Table 7.5.4: Current level of topsoil pollution in the Salmanovskiy (Utrenniy) License Area compared to the background soil characteristics of the Yamal-Nenets Autonomous Okrug and Tazovskiy Municipal District[123]

Soil	Concentrations of elements and compounds, mg/kg													
	Fe total	Cu	Ni	Zn	Pb	Hg	Cd	Cr^{6+}	Mn	Petroleum products	BAP	PHN	AS	As
Average concentrations for soils of different granulometric compositions (Reference Guide..., 2014)														
Sandy loamy and sandy	10040	4.7	8.3	20.5	5.4	0.012	0.32	27.9	160	13.0	<0.005	0.22	2.6	N/a
Clayey loamy	16810	12.2	27.6	41.3	7.7	0.016	0.40	51.2	336	23.5	<0.005	0.17	2.5	
Organogenic	8149	10.4	12.2	25.6	5.9	0.034	0.36	20.9	248	32.9	<0.006	0.48	2.8	
Average concentrations for various types of soil formation (Reference Guide..., 2014)														
Tundra gley (including Arctic tundra)	8354	6.9	12.3	26.6	5.1	0.012	0.30	35.7	321	N/a				
Alluvial sod	4313	2.2	5.4	30.4	2.6	0.010	0.16	8.9	74					
Peat bog arctic tundra upland	N/a	9.3	15.9	31.5	6.8	0.032	0.34	27.1	194					
The average concentrations for the soils of the Yamal, Gydan and Taz peninsulas (Reference Guide..., 2014)														
Soils in general	10982	10.9	17.8	39.6	6.8	<0.015	0.30	39.4	315	12.2	<0.005	0.30	3.7	N/a
Concentrations in soils of the Gydan Peninsula according to data found in literature[124]														
Soils in general	16392 ±6763	25.5 ±5.3	N/a	33.0 ±11.8	12.9 ±2.5	N/a	0.38 ±0.09	N/a	441 ±190	N/a				4.3 ±1.8
Concentrations in soils tested during the environmental survey of the Salmanovskiy (Utrenniy) License Area (PINRO, 2012)														
Soils in general	N/a	2÷34	2÷35	3÷ 63	0.9 ±13	0.01 ÷0.07	<0.05 ÷0.11	N/a		35 ÷255	0.0002 ÷ 0.0048	N/a		1.2÷ 4.9
Concentrations in soils tested during the environmental survey of the Salmanovskiy (Utrenniy) License Area (PINRO, 2018)														
Soils in general	N/a	11÷23	14÷32	41÷66	4.5 ÷ 16.4	0.02 ÷0.13	0.16 ÷0.21	N/a	310 ÷ 470	110 ÷ 1100	<0.005 ÷ 0.010	<0.05	<0.2	1.5 ÷ 3.1
Concentrations in soils tested during environmental survey of the early development facilities in the Salmanovskoye (Utrenneye) oil and gas condensate field (RusGasEngineering 2014)														
Soils in general	2477 ÷ 21728	<1÷22	14÷19	1÷82	<1÷ 12.8	0.006 ÷0.076	<1	3÷ 45*	80÷ 514	215÷ 386	<0.001	<0.01	N/a	<0.05
Concentrations in soils tested during the environmental survey of the Plant's onshore facilities (TsGEI, 2017)														
Soils in general	N/a	1÷14	1÷29	2÷40	<0.05 ÷6	<0.005 ÷0.013	<0.05 ÷0.06	2÷ 17*	3÷ 338	<50	<0.001	<0.05	0.34 ÷2.24	1÷ 16

PHN - phenols, N/a - concentration not defined / not specified, *total chromium content

[123] Reference Guide on the application of average regional content values for monitored components at monitoring sites when assessing the state and level of environmental pollution in the Yamal-Nenets Autonomous Okrug. - Bratsk: Sibzemproekt, 2014.

[124] Puzanov A. V., Romanov A. N., Saltykov A. V. Trace elements in the main components of landscape on the Gydan Beninsula // Altai State University Newsletter. 2016. No.12 (146). P. 60-64.

According to the survey materials, the soil layers tested in the License Area contain trace amounts of benzo[a]pyrene, measured in fractions of a microgram and, in some cases, reaching 1-8 micrograms per 1 kg of soil (Table 7.5.5, Figure 7.5.12). Apparently, these amounts reflect the aggregate contribution of local and remote sources of this compound (the latter involving long-range transport of aerosols through the atmosphere). Unlike petroleum products, diagnosis of which is hindered by natural bitumoids, the presence of benz[a]pyrene in the soils of the area under review in amounts exceeding 5-8 μg/kg suggests that the soils are almost certainly polluted with polyaromatic hydrocarbons, with the share of BAP being less than 5-10%. No benz[a]pyrene was found at most of soil sampling points within the license area as result of the surveys and environmental monitoring, i.e. its concentration did not exceed 0.001 or 0.005 mg / kg, depending on the applied method of quantitative chemical analysis of soil samples .

Phenols were not detected in any of the samples taken within the License Area and, in particular, the proposed site of the Plant's onshore facilities. Notably, peat and other organogenic soil layers always contain a certain amount of natural organic compounds that are analytically similar to phenols. According to the Reference Guide[125], their background concentration in the soils of the Gydan Peninsula is estimated at 0.3 mg/kg (Table 7.5.5).

Of the wide range of *surfactants* only the total content of anionic compounds (anionic surfactants) was measured in the soils at the proposed Plant site, which amounted to 0.34 ÷ 2.24 mg/kg. The ratio between natural and technogenic products in this group of compounds has not been determined; the reference guide cited above suggests using the concentration of 3.7 mg/kg for estimating the background presence of anionic surfactants in the topsoil of the Gydan Peninsula.

Polychlorinated biphenyls were found everywhere in amounts ranging between 0.005-0.260 mg/kg by the sum of identified compounds; in the absence of local impact sources, these values seem to reflect the contribution of long-range transport processes to the pollution of soils by stable organic compounds in the Arctic region under review.

In contrast, no *pesticides* were identified in the soil: the measured concentrations of alpha-HCH, gamma-HCH, DDD, DDT and DDE were below the detection threshold of 0.001 mg/kg.

7.5.5.2 Trace elements

The number of trace elements, the presence of which was diagnosed in the soils of the License Area, includes 7 items from the standard list of SanPiN 2.1.7.1287-03 (Hg, Cd, Pb, Cu, Ni, Zn, As) plus chromium (Cr) and manganese (Mn).

All of those elements accumulate much better in layers of loamy granulometric composition than in layers with sandy loam and, especially, sand. Notably, the concentrations of copper, lead, zinc and arsenic in some loamy soil samples from the License Area exceed the MACs and TACs prescribed for these elements by the Russian sanitary and hygienic laws (for example, PINRO sites S-2, S-11 and S-12, Uralgeoproekt site PP-04, and some other irregularly positioned locations with no ties to potential pollution sources – see Figure 7.5.12).

[125] Reference Guide on the application of average regional content values for monitored components at monitoring sites when assessing the state and level of environmental pollution in the Yamal-Nenets Autonomous Okrug. - Bratsk: Sibzemproekt, 2014.

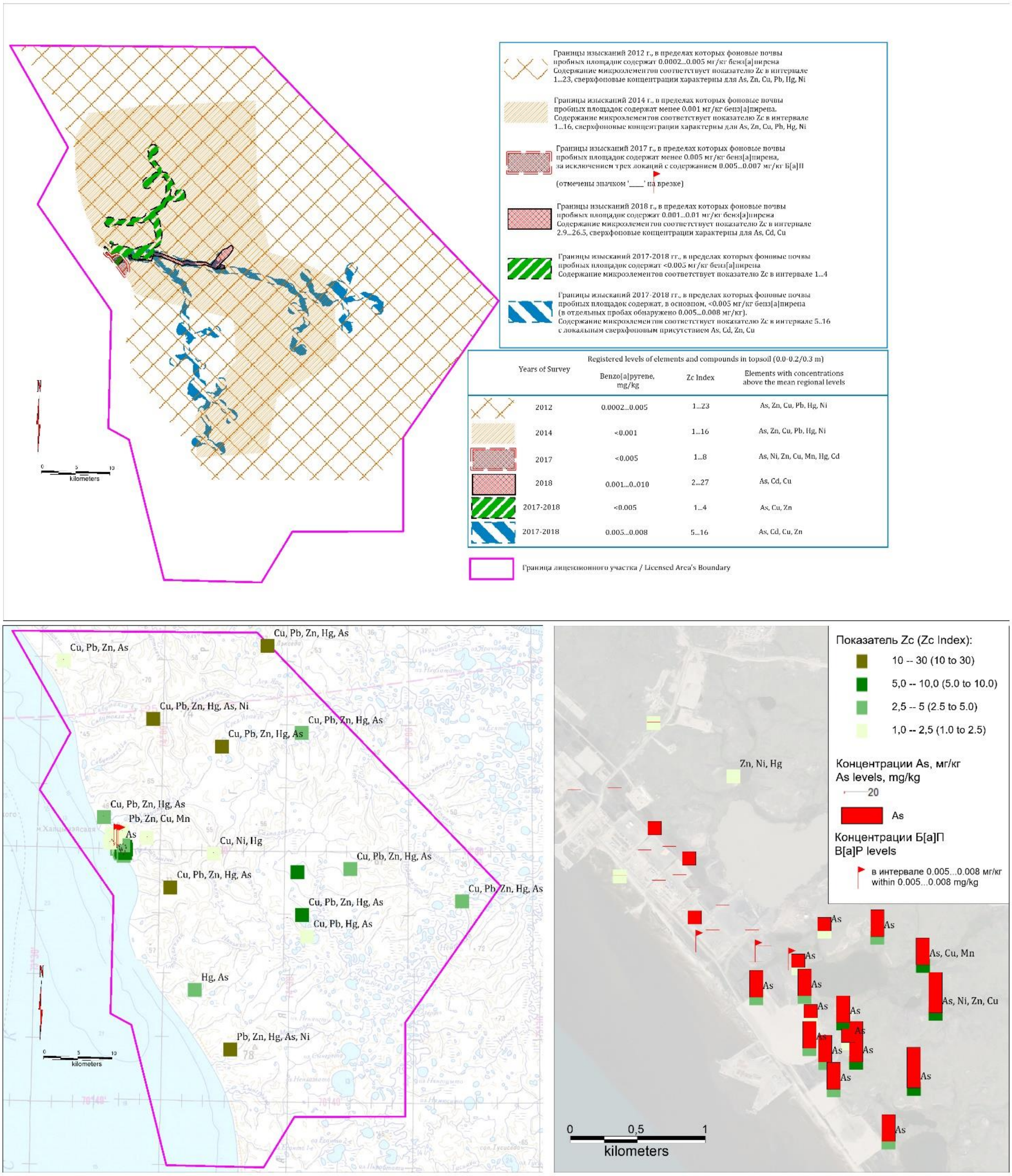


Figure 7.5.12: Background levels of benzo[a]pyrene and trace elements in soils of the Salmanovskiy Licensed Area as follows from the 2012-2018 surveys

The Consultant believes the stated concentrations of trace elements cannot in this case be interpreted as resulting from chemical pollution; they reflect the background chemical state of the soil (Figure 7.5.13): firstly, in the course of the research, undisturbed soils were tested that were distant from potential sources of heavy metals and arsenic; secondly, elevated concentrations of many trace elements, including the ones listed above, are one of the characteristic features of the soils in the Yamal-Nenets Autonomous Okrug, repeatedly noted in the scientific literature and associated with the lithogeochemistry of the area under review, i.e. a natural factor[126].

Table 7.5.4 and Figure 7.5.13 summarize all the obtained data concerning the content of trace elements in the soils of the License Area. The most dangerous of heavy metals - mercury, cadmium and lead – either remained undetected in the majority of samples or were found in trace concentrations which can be explained by their initial presence in the composition of the rocks or, to a lesser extent, their entry with aerosols. The less toxic copper, nickel, zinc, chromium and arsenic are unevenly distributed in the topsoil because of heterogeneity of the material composition of the topmost layers of the soil, as evidenced by the widely varying (Figure 7.5.13) ratio between its organic and mineral components, and by the varying proportions among the latter's particle-size fractions.

Figure 7.5.13: Variation intervals for reported concentrations of trace elements in soils of the Salmanovskiy Licensed Area

Results reported by IEPI (2018-2019) further support the conclusion from the survey about absence of pronounced chemical pollution of soils within the license area.

7.5.5.3 Integral assessment of soil toxicity

The TsGEI survey program (2017) for the site of the Plant's onshore facilities and the PurGeoCom program (2018) for the section of the Salmanovskiy (Utrenniy) subsoil license area affected by the Project also included biotesting of, respectively, 11 and 51 combined soil samples using pollution-sensitive cultures of daphnia and algae (chlorella); based on their reaction all soils were classified as non-toxic.

---

[126] Abakumov E.V., Alekseev I.I., Shamilishvili G.A. Status of soil in YANAO: diversity, morphology, chemistry and anthropogenic transformation // Scientific Bulletin of the Yamal-Nenets Autonomous Okrug. 2016. Issue 4 (93). Ecology of the Arctic Region. P. 4-7.

Aghbalyan Y.V. Study of the quality of the original habitat of the indigenous population of the Yamal-Nenets Autonomous Okrug // Scientific Bulletin of the Yamal-Nenets Autonomous Okrug. 2016. Issue 4 (93). Ecology of the Arctic Region. P. 103-107.

7.5.5.4 Integral assessment of chemical pollution of soils as a transportable or recyclable material

Due to the fact that in the event of removal and transfer of soil at the construction stage it will be subject to the Russian Federation waste management laws, the engineering survey materials contain a classification of tested soils for the Project sites in accordance with the hazard criteria applicable to solid waste.

Since the soils are not polluted and do not exhibit toxicity with respect to test cultures, their properties correspond to the least hazardous categories of wastes: hazard class V according to the Order No. 536 dated December 4, 2014 of the Ministry of Natural Resources of the Russian Federation and hazard class IV in accordance with Annex 8 to SP 2.1.7.1386-03, which implies the absence of any environmental limitations on the use or placement of soil material.

7.5.5.5 Signs of natural and technogenic radioactivity of soils

The Yamal-Nenets Autonomous Okrug is not classified among the Russian Federation entities with elevated levels of radiation exposure from natural radioactive sources.

The content of gamma-emitting isotopes in the soils affects the rate of gamma-ray ambient dose equivalent (GR ADE) recorded by instruments at the standard heights of 0.1 and 1 m above the earth's surface.

The results of point measurements of the GR ADE rate within the License Area (PINRO, 2012; PurGeoCom, 2018) range from 0.08 to 0.14 μSv/h with the average value being 0.1 μSv/h for n>500. A gamma survey of the proposed sites for the Plant's (TsGEI, 2017) and the Port's (Uralgeoproekt, 2017) onshore facilities characterizes them as generally non-anomalous with environmentally safe and naturally occurring gamma activity values in the region of 2-9 μR/h and the GR ADE rate of no more than 0.1 μSv/h. According to the data presented by the Ob-Irtysh Directorate of Hydrometeorology and Environmental Monitoring in the Yamal-Nenets District in the Uralgeoproekt survey materials (2017), the average gamma-ray ambient dose rate in the Tazovskiy District is 0.11 μSv/h, with the maximum rate being 0.18 μSv/h.

Minimum radioactivity is typical for soils of the coastal lowland plain, whereas undulating upland terrain is associated with higher average gamma activity values and the presence of local anomalies which in plan view are sized up to several meters across with recorded radioactivity levels ranging from 10 to 22 μR/h and dose rates of up to 0.15 μSv/h–.

It was established that the identified anomalies had natural causes and were confined to lenses of dark-colored sands, relatively rich in naturally occurring accessory minerals, with a high content of radioactive elements (TsGEI, 2017). The PINRO survey materials (2012) indicate that numerous radioactivity signs were previously discovered along the Yamal coast in association with dark-colored monazite sands lying close to the surface and rich in uranium and thorium, which are present throughout the entire vast territory of the Ob's paleo-delta. In contrast, no discernable traces were discovered of technogenic radionuclides deposited after the nuclear tests of the 1950s and 1960s in the Novaya Zemlya and the 1986 accident at the Chernobyl Nuclear Power Plant.

Table 7.5.5 and Figure 7.5.14 summarize all the material obtained by the surveyors with regard to the radioactivity of soils in the Salmanovskiy (Utrenniy) License Area. Mainly trace activities of technogenic cesium-139 and strontium-90 are typical, as is the relatively low activity of naturally occurring nuclides, which is integrally expressed by the level of effective specific activity ranging between 26-88 Bq/kg, with the average regional value being 77 Bq/kg.

Table 7.5.5: Indicators of the activity of natural and technogenic radionuclides (Bq/kg) in the soils at the proposed sites of the Plant and the Port compared against the indicators of soils in the Yamal-Nenets Autonomous Okrug and Salmanovskiy (Utrenniy) License Area

Technogenic radionuclides		Natural radionuclides			
^{90}Sr	^{137}Cs	^{226}Ra	^{232}Th	^{40}K	A_{eff}[127]
Average regional values of radionuclide activity in the soils of the YNAO[128]					
26.1	3.0	13.6	12.5	522.8	77

[127] Effective specific activity of natural radionuclides estimated and regulated in accordance with SanPiN 2.6.1.2523-09, 2.6.1.2800-10

[128] Reference Guide on the application of average regional content values for monitored components at monitoring sites when assessing the state and level of environmental pollution in the Yamal-Nenets Autonomous Okrug. - Bratsk: Sibzemproekt, 2014.

Technogenic radionuclides		Natural radionuclides			
^{90}Sr	^{137}Cs	^{226}Ra	^{232}Th	^{40}K	A_{eff}[127]
Radionuclide activity in the soils tested during the environmental survey in the Salmanovskiy (Utrenniy) License Area (PINRO, 2012)					
N/a	<0.4÷17	8÷25	8÷29	140÷540	36÷79
Radionuclide activity in the soils tested during the environmental survey at the early development facilities in Salmanovskoye (Utrenneye) OGCF (RusGasEngineering, 2014)					
N/a	0.8÷1.3	<6.3÷14.5	9.0÷18.2	190÷460	45÷88
Radionuclide activity in the soils tested during the environmental survey at the Salmanovskoye (Utrenneye) OGCF Facilities Setup (PurGeoCom, 2018)					
N/a	<3	10÷17	26÷35	130÷303	64÷85
Radionuclide activity in soils tested during the environmental survey at the Plant's onshore facilities (TsGEI, 2017), n = 17					
N/a	<5÷8	<12	<8÷13	127÷366	26÷74
Average activity (for n = 3) in soils tested during the environmental survey at the Port's onshore facilities (Uralgeoproekt 2017)					
0.5	0.64	5.6	0.5	407	53

Local occurrences of relatively increased (but at the same time ecologically safe) concentrations of the technogenic isotope cesium-137 are marked in the diagram of Figure 7.5.14. The highest of the fixed activities of ^{137}Cs was 17 Bq / kg.

The greatest variation in the activity levels of naturally occurring radionuclides is typical throughout License Area and is due to varying conditions of the lithogenic basis (Figure 7.5.14). Narrowing the scope of the survey to the proposed Plant and Port sites reduced the range of variation of radium-226, thorium-232 and potassium-40 activities and revealed anomalies associated with sands with specific mineralogical composition lying close to the surface.

The presence of radium in the geological environment is evidenced by the entry of radon (^{222}Rn) into the soil air with subsequent emanation into the atmosphere. The detailed (at n = 315) radon survey of the proposed site of the Plant and Port onshore facilities did not reveal any anomalies in the distribution of the corresponding gas field for the majority of the measured values of ^{222}Rn flux density (RFD) from the soil surface into the atmosphere, none of which exceeded 25 mBq/cm 2 per second; therefore, the site has been reasonably recognized as radon-safe.

RFD measurements at soil surface were also conducted within the designed sites of the gas treatment plants, temporary accommodation camps, emergency rescue center, field camp, administrative area of the Field facilities setup (PurGeoCom, 2018). The maximum measured RFD value was 5 mBq/cm^2 per second, which is by multiple times below the threshold levels applicable to industrial and residential development in Russia (250 and 80 mBq/cm^2 per second, respectively).

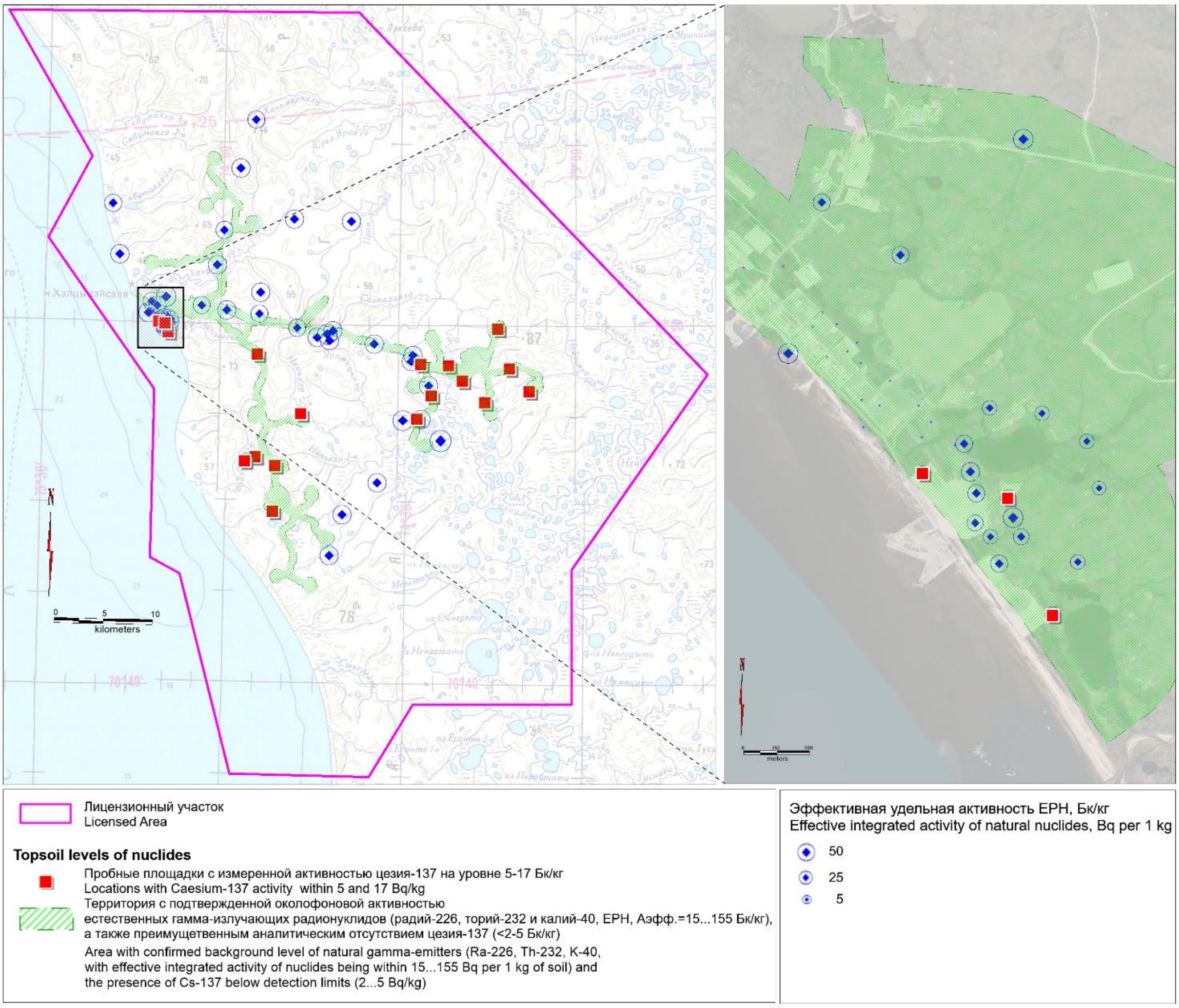


Figure 7.5.14: Lateral distribution of Caesuim-137 and naturally occurring gamma-emitters in soils of the Salmanovskiy Licensed Area

The Consultant believes the described radiation-ecological conditions of the whole area in question are generally favorable and safe for the implementation of the planned activity. Further changes in the radiation-ecological conditions of the area under review will be associated with the placement of imported soils, local degradation of permafrost, development of exogenous geological processes, including those triggered by construction work.

7.5.6 *Biological contamination of soils*

The indicators of the sanitary condition of the soils provided by SanPiN 2.1.7.1287-03 reflect the presence of E. coli bacteria, enterococci, and other pathogenic bacteria and geohelminths. The survey materials prepared by PINRO (2012), RusGasEngineering (2014), TsGEI (2017), Uralgeoproekt (2017) and PurGeoCom (2018-2019) confirm the absence of pathogenic enterobacteria, cysts of pathogenic protozoa, eggs and helminth larvae in the soil layers tested in Licensed Area, and the acceptable numbers of coliform and enterococci.

According to the Consultant, the microbiological and parasitological features of the soils of the area in question are primarily associated with nomadic pastoralism. For a large number of microorganisms and parasites, the soil plays the role of a natural reservoir, with functions changing depending on the land use and regional climate change. According to the materials of the International Symposium "Preventing the Spread of Infectious Animal Diseases in a Changing Climate"[129], the district’s pressing problem is epizootic

[129] Scientific Bulletin of the Yamal-Nenets Autonomous Okrug. Issue 1/94. Salekhard: 2017. 100 p.

outbreaks of anthrax, brucellosis and other diseases, which causative agents can persist in the soil for a long period of time.

According to the official information of the YNAO Veterinary Service (Letters No. 3401-17/1376 of 12.08.2013, No.3401-17/28 of 25.12.2017 and No.3401-17/1634 of 02.10.2018), no burial grounds – cattle mortuaries, biothermal pits – for animals that died from highly dangerous diseases, or so called "murrain fields" (i.e. areas without clearly defined boundaries where livestock mortality occurred) have been registered within the proposed sites of the Plant, Port and the Salmanovskoye (Utrenneye) OGCF Facilities Setup (nor within 1,000 m of the borders of those sites), therefore, the danger may lie in the soil foci of diseases associated with unregistered burial grounds or areas of scattered presence of the corresponding spores or bacteria. The size and exact location of the soil foci of diseases cannot be established.

However, the conditions in the Gydan Peninsula are generally favorable for the so-called self-sanitation of soil foci of disease[130]: high acidity, low content of humus and mineral nutrients, low heat supply and short warm period, high insolation, and multiple freeze-thaw cycles occurring in the topmost soil layers do not allow the pathogen to complete the full "spore-vegetative cell-spore" biological cycle and contribute to the gradual extinction of spores and the mortality of vegetative cells.

Exogenous geological processes — cryogenic, erosion-accumulative, fluvial — accompanied by the movement of soil constitute a natural factor capable of activating a soil foci of epizootic outbreaks. In particular, the permafrost degradation that has been observed in recent decades is accompanied by an increase in the thickness of the active layer and is causing those soil horizons which were previously removed from biological cycle to rejoin it; such horizons may contain dangerous spores or bacteria, and therefore this phenomenon is considered to be one of the possible causes of anthrax in the YNAO[131].

The most important anthropogenic factor of epizootic outbreaks within the area under review is pasture digression: damage to the vegetation cover in grazing and cattle-driving areas exposes the surface of the soil; soil particles containing spores and bacteria enter the bodies of hoofed mammals and other terrestrial vertebrates and subsequently move up the food chains transmitting pathogens to humans. At the same time, direct infection of a person through contact with the soil, even in places where it is highly contaminated with anthrax spores, i.e. in the very nidus of the disease, is extremely unlikely.

7.5.7 *Assessment of soil resilience to anthropogenic impacts*

The Ramboll methodology for assessing the impact of the planned activity on the soils provides for the allocation of 3 categories of soil sensitivity to design impacts.

Soils prone to physical and mechanical transformations caused by technogenic processes, which are usually realized through dangerous exogenous geological processes — erosion-accumulative, suffusion, avalanche, deflationary, and others — are of *high* sensitivity (vulnerability). Other necessary criteria for this category of soils include susceptibility to chemical pollution and being used for the performance of important economic and environmental functions, which, in turn, is possible due to high fertility and water-regulating potential. It is believed more than 10 years is required in order to restore soils with high sensitivity to impact to a state which is close to the initial state.

The soils of *medium* sensitivity differ from the ones described above by a higher potential of recovery, which requires a period not exceeding 10 years.

Soils of *low* sensitivity are characterized by such properties as resistance to physical-mechanical impacts, impermeability to pollutants, low significance for ensuring the sustainability of the ecosystem, and poorly pronounced water regulating function.

The survey materials of TsGEI (2017), Uralgeoproekt (2017), PurGeoCom (2018) suggest that most soils at the sites of the Plant, Port and Field facilities are not resistant to mechanical and chemical impacts. In particular, soils of light granulometric composition (psammozems, podburs, alluvial soils) are highly vulnerable to mechanogenesis since they are prone to eolian action and erosion and do not provide necessary conditions for rapid restoration of vegetation. In these soils, the total thickness of the organogenic horizons rarely exceeds 10 cm, and even with a single passage of heavy machinery, the damage caused to the upper horizons may lead to a rearrangement of the thermal and water regime of the

[130] Bakulov I.A., Gavrilov V.A., Seliverstov V.V. Anthrax - Vladimir: Posad, 2001. 285 p.

[131] Selyaninov Yu.O., Egorov I.Y., Listishenko A.A., Kolbasov D.V. Anthrax on Yamal: causes and problems of diagnosis // Veterinary Medicine. 2016. No. 10. P. 3-7

soil, followed by intensified cryogenic processes and waterlogging. The degradation of permafrost within sand massifs is accompanied by an outbreak of erosion and deflation, and the formation of the so-called sand arenas.

The vulnerability of waterlogged soils in poorly drained areas of a given territory to mechanical stress is due to different reasons: the danger of secondary waterlogging and the activation of cryogenic processes. It primarily concerns marshland soils with thin organogenic horizons. The soils of upland bogs, in contrast, are resistant to mechanical stress due to the thick organogenic horizons. During the construction of areal and linear facilities, these soils will be exposed to significant indirect impacts — intensified waterlogging resulting from the overall drainage slowdown. In addition, hydromorphic soils with thick organogenic horizons are generally very vulnerable to chemical pollution, since they slow down the processes of dispersion and transformation of organic substances and, in contrast, have very high sorption capacity in relation to most of those substances. The latter is ensured by organic-accumulative, gleyic and permafrost geochemical barriers.

Highly drained areas with hillocky-hummocky complexes of tundra gley peaty and peat soils, peaty and peat-gley paludal soils, and soils of barren patches have a relatively high soil and vegetation recovery potential; on the TsGEI soil map (Figure 7.5.3) they correspond to areas of peat-gleysols and cryometamorphic gleysols, on the maps of Uralgeoproekt and PurGeoCom (Figures 7.5.4, 7.5.5) – tundra gley soils.

Table 7.5.6 summarizes the information on the major factors of soil stability within the license area linking it to the sections in the above soil maps:

- the position of an area on the landscape determines the direction and intensity of migration flows, primarily mechanical and water migration contributing to the self-purification of soils from incoming pollutants;
- the presence of well-formed organogenic horizons contributes to the long-term retention of pollutants released into the soil via aerosols or spills of wastewaters or process fluids;
- the permafrost water-stagnation regime typical for most soils of the territory in question is due to the fact that permafrost rocks lie close to the surface – 0.2–0.5 to 1.5 m – coupled with the flatness of the relief and low degree of climatic evaporation; these conditions contribute to the retention of pollutants in the soils, but at the same time prevent their penetration into deeper horizons of the geological environment;
- the dominance of reductive conditions in the profiles of most soils ensures high mobility of iron and manganese compounds and decomposition products of organic residues; at the same time, the lack of oxygen, coupled with low ambient temperatures, slows down chemical reactions and biochemical processes including the destruction of organic pollutants released into the soil via aerosols or spills of wastewater or process fluids;
- soils with pronounced organogenic horizons and near-surface permafrost strata with the highest total capacity of geochemical barriers that contribute to the retention of pollutants in the soils should be a priority for monitoring chemical pollution of the soils; in other cases, monitoring activity should focus on hazardous exogenous processes that disturb the physical integrity of the soil.

When categorizing the sensitivity of soils to impacts from the planned activity (Table 7.5.6, 3rd column from the right), the following factors have been taken into consideration: resistance to physical and mechanical impacts, ability to retain pollutants, high importance for the conservation of local ecosystems and their biological diversity, duration of the recovery period.

Ramboll's universal classification is not fully applicable to the soils of the Gydan tundra which combines high ecological significance with low fertility and low water regulating function of the soil, therefore the Consultant has made some departures from it:

- the category of *low* sensitivity has been excluded in order to emphasize the high significance of the soils in the area under review as a whole;
- *highly sensitive* soils are mature soils with a well-formed profile (podburs, gleysols) with clear signs of organic matter accumulation and subsurface weathering (alfehumus process, gleying) which, at the same time, are extremely vulnerable to mechanogenesis and capable of accumulating pollutants released onto the surface;
- soils that are vulnerable, but at the same time have low value, are classified as *medium* sensitive. In particular, primitive soils of sand massifs are young formations with no fertility or pronounced water regulating function; they are easily destroyed, but at the same time they can be restored to their original state relatively quickly;

- soils of wetlands and transitional variants of gleysols and podburs possess intermediate characteristics: increased thickness of organogenic horizons makes them more resistant to mechanogenesis, but at the same time increases their water regulating significance as well as their depositing ability with respect to a wide range of pollutants. Dried-up organogenic horizons are also vulnerable to tundra wildfieres in summer. In Table 7.5.6, the sensitivity of such soils is described as "*high to medium*".

The general conclusion based on the presented analysis is the integral assessment of soils within the Salmanovskiy (Utrenniy) License Area as highly sensitive to physical, mechanical and chemical impacts. The main ecological functions of the soils within the area consist in maintaining the fragile status of local ecosystems, including lichen pastures, providing heat insulation for permafrost rocks, maintaining the stability of the relief, ensuring perennial deposition of pollutants and microorganisms, including dangerous pathogens.

Due to the high intensity of exogenous geological processes within the area of the planned activity, young primitive soils that have no ecological or economic value are widespread, and their loss will be followed by their rapid restoration – within a few years or decades – in areas free from buildings and hard surfaces. At the same time, soils with well-formed profiles (podburs, gleysols) and thick organogenic horizons (peat-gleysols, peat oligotrophic, peat cryosols) were formed over hundreds and first thousands of years, and it will be practically impossible to restore their profile after physical and mechanical destruction; therefore, taking into account the abovementioned functions of these soils, it is recommended that they be kept intact as much as possible (Table 7.5.6).

Table 7.5.6: Sensitivity of soils within the Salmanovskiy (Utrenniy) License Area to mechanical impacts and chemical pollution

Contour index in Figure 7.5.3b	Soil structures and non-soil formations	Position in the landscape	The ratio of organogenic and mineral part of the profile	Water mode	The degree of drainage and redox conditions	Resistance to physical and mechanical stress	Capacity of geochemical barriers	Soil sensitivity according to Ramboll terminology[132]
1	Beach sediments, devoid of soil	Superaqual-transaccumulative	Mineral horizons of sand composition	Frozen, seasonally floodplain with flooding and underflooding	Drainable with alternating oxidative and reducing environments	Extremely low	Extremely low	Not assessed
	Sand blowoffs on hilltops devoid of soil	Autonomous or trans-eluvial		Permafrost, plots and seasonally - limited washing	Moderately drained with alternating oxidative and reducing environments			
2	Variants of humus and typical psammozems	Trans-eluvial	Fragmentary low-power organogenic horizon, underlain by mineral horizons of sandy composition			Low	Low (biogeochemical)	Medium
3	Variations of typical and illuvial-iron water-saturated psammozems	Trans-eluvial					Low (biogeochemical, gley, oxygen)	
4	Combinations of illuvial-iron psammozems and podburs	Trans-eluvial						
5	Combinations of peat gleysols and peat oligotrophic soils	Superaqual-transaccumulative	Solid organogenic material of variable thickness, underlain by sandy and loamy mineral	Water-stagnation permafrost	Poorly drained and undrained with extremely reducing conditions.	Moderate to high	High (biogeochemical, gley, frozen)	High to medium
6	Peat cryosols	Autonomous or trans-eluvial			Poorly drained, with domination of reducing conditions	Low to moderate	Medium to high (biogeochemical, gley, permafrost)	
7	Variants of peat-podburs and peaty water-saturated podburs			Permafrost, periodic water stagnation	Poorly drained, with domination of reducing conditions			
8	Combinations of water-saturated peat-podburs, gley podburs and peaty oligotrophic soils	Trans-eluvial and superaqual-accumulative		Water-stagnation permafrost	Poorly drained and undrained with extremely reducing conditions.	Moderate to high	High (biogeochemical, gley, frozen)	
9	Underdeveloped water-saturated podburs	Trans-eluvial		Permafrost, periodic water stagnation	Poorly drained, with domination of reducing conditions	Low to moderate	Medium (biogeochemical, permafrost)	High
10	Variants of podburs and gleyic fine-peaty podburs	Trans-eluvial			Poorly drained, with domination of reducing conditions	Moderate	Medium (biogeochemical, gley, frozen)	
11	Combinations of podburs and cryometamorphic gleysols	Autonomous or trans-eluvial				Low to moderate		
12	Combinations of alluvial humus permafrost soils and water-saturated peat podburs	Superaqual-transaccumulative		Frozen, seasonally floodplain with flooding and underflooding	Drained and moderately drained with alternating oxidizing and reducing environments			High to medium

[132] As amended by the Consultant – refer to the text of this section for details

7.5.8 Summary

1. According to the Consultant, the results of engineering surveys and first two years of the local environmental monitoring adequately reflect the current state of the soils in the Salmanovskiy (Utrenniy) License Area, including the background level of their chemical pollution, primarily due to the impact of remote sources. At the same time, the interpretation of the results of quantitative chemical analysis of soil and soil samples in the survey and monitoring materials is sometimes erroneous because it is based on criteria and methods for analyzing soil quality that are not applicable to tundra-marsh landscapes, and is not supported by information on possible sources, forms and mechanisms of soil contamination.
2. For these reasons, the Consultant considers the soil in the License Area outside the boundaries of the land allotment for the planned buildings and structures as having a close to background level of pollution, mainly due to the influence of remote sources through the mechanisms of long-range transport of pollutants in the atmosphere. The following interpretation of the most probable origin of the measured concentrations of chemical elements and compounds is proposed:
   - polychlorinated biphenyls and ^{137}Cs radioisotopes found in soils are technogenic and are associated with legacy and, to a lesser extent, actual impact of distant sources, long-range transport and precipitation of aerosols containing the said components which, while maintaining the physical and mechanical integrity of the soil profile, are concentrated in its topmost centimeters; when monitoring the soils, the identification of these components should be considered as an indicator of legacy soil contamination which has a natural tendency to decrease through the biochemical degradation of PCBs and the decay of ^{137}Cs isotopes;
   - measured concentrations of trace elements (Cu, Ni, Zn, Pb, Hg, Cd, Cr, As) and the activity of natural radionuclides (^{232}Th, ^{226}Ra, ^{40}K) reflect primarily the material composition of the parent rocks and, to a much lesser extent – their ingress with aerosols; the distribution of these elements in the soils is determined by the ratio between the main soil-forming processes (accumulation and transformation of organic matter, subsurface erosion, gleying) and exogenous geological processes (cryogenic processes, waterlogging and swamping, downslope and aeolian movements of material); when monitoring the soils, the concentrations of elements prescribed by the Reference Book should be used as background values; for any elements not included in the Reference Book[133] values obtained during the engineering surveys should be used (Table 7.5.6);
   - the distribution of benzo[a]pyrene in the soils of the allocated land is uneven: the scattered background is caused by the ingress of aerosols with which PAH are associated, and does not exceed 0.001-0.005 mg/kg anywhere; local accumulation of BAP can be caused by natural or technogenic fires, various types of fuel combustion (internal combustion engines, heating systems, fires); when monitoring soils, BAP concentrations should be regarded as one of the most important indicators of chemical contamination of soil, which is sufficiently informative to reflect the impact of the proposed activity;
   - due to insufficient selectivity of Russia's standardized methods for determining the total content of petroleum products in soils, when diagnosing these groups of compounds, it is necessary to identify the source (pipeline, tank, etc.), mechanism (spillage, leakage, etc.), visual and organoleptic signs of soil contamination (discoloration, odor), in the absence of which the analytical group "petroleum products" of "phenols" should be considered as consisting of natural bituminous and phenol-like substances, the concentration of which, according to the survey data, can reach 200-700 mg/kg. due to the possibility of the presence of naturally occurring bituminous, phenol-like and surface-active compounds in the soils, when monitoring them, it is necessary to identify foci of soil contamination with organic substances (spills of process liquids, cluttering up the ground with wastes, etc.) and to subsequently verify the composition of pollutants by quantitative chromatography and, if necessary, mass spectrometry;
   - The soils studied during the engineering surveys are characterized by generally favorable sanitary and hygienic conditions, but they are confined to the territory with natural foci of anthrax or other dangerous diseases, the spread of which is associated with nomadic reindeer herding; in the absence of officially registered burials of dead animals, unrecorded (including spontaneous) animal burial grounds, murrain fields and areas of the scattered presence of spores and vegetative cells of pathogenic microorganisms may pose a threat, therefore, to ensure safe implementation of the planned activities it is necessary to minimize the risk of activating the foci of diseases associated with soil and to develop action plans for the eventuality of their detection.

[133] Reference Guide on the application of average regional content values for monitored components at monitoring sites when assessing the state and level of environmental pollution in the Yamal-Nenets Autonomous Okrug. - Bratsk: Sibzemproekt, 2014.

7.6 Biological Diversity

7.6.1 Introduction

This section describes the background state of biological diversity in the Project area and identifies the most important and vulnerable components that can be exposed to potential impacts. The initial data are taken from the materials of FEED surveys, the environmental monitoring activities within the license area territories and adjacent water areas, research publications, reports on recent off- and onshore biological, environmental and comprehensive expeditions, and the works of international conservation organizations.

This section consistently examines:

- marine biota of the Ob Estuary (p. 7.6.2); and
- terrestrial and freshwater ecosystems of the Gydan Peninsula (p. 7.6.3).

Together with the Yenisei Bay, the Ob Estuary represents the largest estuary system in the Arctic Region; up to 75% of all the fresh water flows through it into the Kara Sea. Due to the large volume of fresh water runoff from rivers, the near-surface layer has unstable salinity levels in the most part of the Kara Sea, which results in high biogenic productivity in supporting the biological diversity of fresh-water and semi-migratory fishes and, consequently, shorebirds and sea birds in this region. Moreover, the Ob Estuary is the world's largest habitat of Coregonidae (whitefish), local harvesting of which exceeds 50% of total Russian and 30% of total global production. Implementation of the Yamal LNG project in the northern section of the Ob Estuary is a source of ecosystem impacts.

The boundaries of the consideration of marine ecosystems are adopted in accordance with the schemes of natural zoning of the Ob Bay and the Kara Sea. The entire northern part of the Gulf of Ob is considered within the boundaries of the region of the same name, the thermohaline regime of which is due to the mixing of river runoff and sea waters of the Kara Sea (for more details, see Section 7.6.2.1). The boundaries of consideration are thus taken from the traverse of the Hasryo-r. Seikha in the south, up to the line of Bely Island – Cape Shokalsky (Shokalsky Island).

Terrestrial ecosystems are considered in general terms for the entire Gydan Peninsula. The boundaries of the detailed consideration are taken within the 'C' subzone according to the scheme of bioclimatic zoning of the Arctic Circumpolar Vegetation Project[134]. The southern border of this subzone runs along the Yuribey river valley and is more than 30 km south of the LA (for more details, see Section 7.6.3.1). The northern boundary of a detailed examination is taken along the boundary of the northern hypoarctic and arctic tundras in its refined version[135]. It runs approximately 20 km north of the LA borders. At the same time, in the most detail, terrestrial ecosystems are considered within the boundaries of the Salmanovsky (Utrenny) LU, based on the following provisions:

- LLC "Arctic LNG 2" is licensed to operate only within the mining allotment area including all infrastructure and gas and condensate production activities. Therefore, direct impact of the project will affect ecosystems within these boundaries;
- Location of the existing and designed Project facilities is at least 15 km off the LA boundaries. Therefore, it is expected that the main impact will not extend beyond the LA territory.

7.6.2 Biodiversity components of the Ob Estuary marine environment

7.6.2.1 Position of the surveyed water area in the systems of the hydrobiological zoning

According to the environmental zoning systems developed for the Arctic seas and coasts of the Russian Federation[136], the entire water area of the Ob Estuary belongs to the Ob-Yenisei physico-geographical province.

The conditions in the Ob Estuary aquatic ecosystems are not the same: most generally, its water area is divided into the *southern, or river area*, where the hydrology is mainly determined by the river runoff, and the *northern, or estuary area*, where the fresh water from rivers is mixed with more saline and colder sea water. Due to the pronounced seasonal and interannual variations in the hydrological and thermohaline conditions of the Ob Estuary, there is no distinct boundary between these two areas. One of the proposed

[134] Walker D.A., Raynolds M.K., Daniëls F.J., Einarsson E., Elvebakk A., Gould W.A., ... & Moskalenko N.G. The circumpolar Arctic vegetation map // Journal of Vegetation Science. 2005. Vol. 16, N 3. P. 267-282.

[135] Хитун О.В. Зональная и экотопологическая дифференциация флоры центральной части Западносибирской Арктики (Гыданский и Тазовский полуострова): Автореф. дис. ... канд. биол. наук. СПб., 2005. 28 с.

[136] V.A. Spiridonov et al. (Eds.), Atlas of Biological Diversity of the Russian Arctic Seas and Coasts. M.: WWF Russia, 2011. 64 p.

options for determining their position is based on the criterion of water salinity at the level of 0.5 per mille: according to perennial data, the salinity gradient is not actually observed to the south from corresponding isohaline (equal water salinity line) (Ilyin, 2018[137]).

In Figure 7.6.1 red dotted lines show summer and winter isohalines of 0.5 and 0.2 ‰, the position of which generally corresponds to the transition zone between the river and estuary waters of the Ob Estuary, which has a typical mosaic thermohaline structure. These data are in good agreement with the results of salinity modeling carried out in 2015 within the impact assessment for Yamal-LNG Project offshore operations[138]: according to these data, natural variations of salinity under the influence of the Kara Sea water intrusions spread southwards up to 70° N.

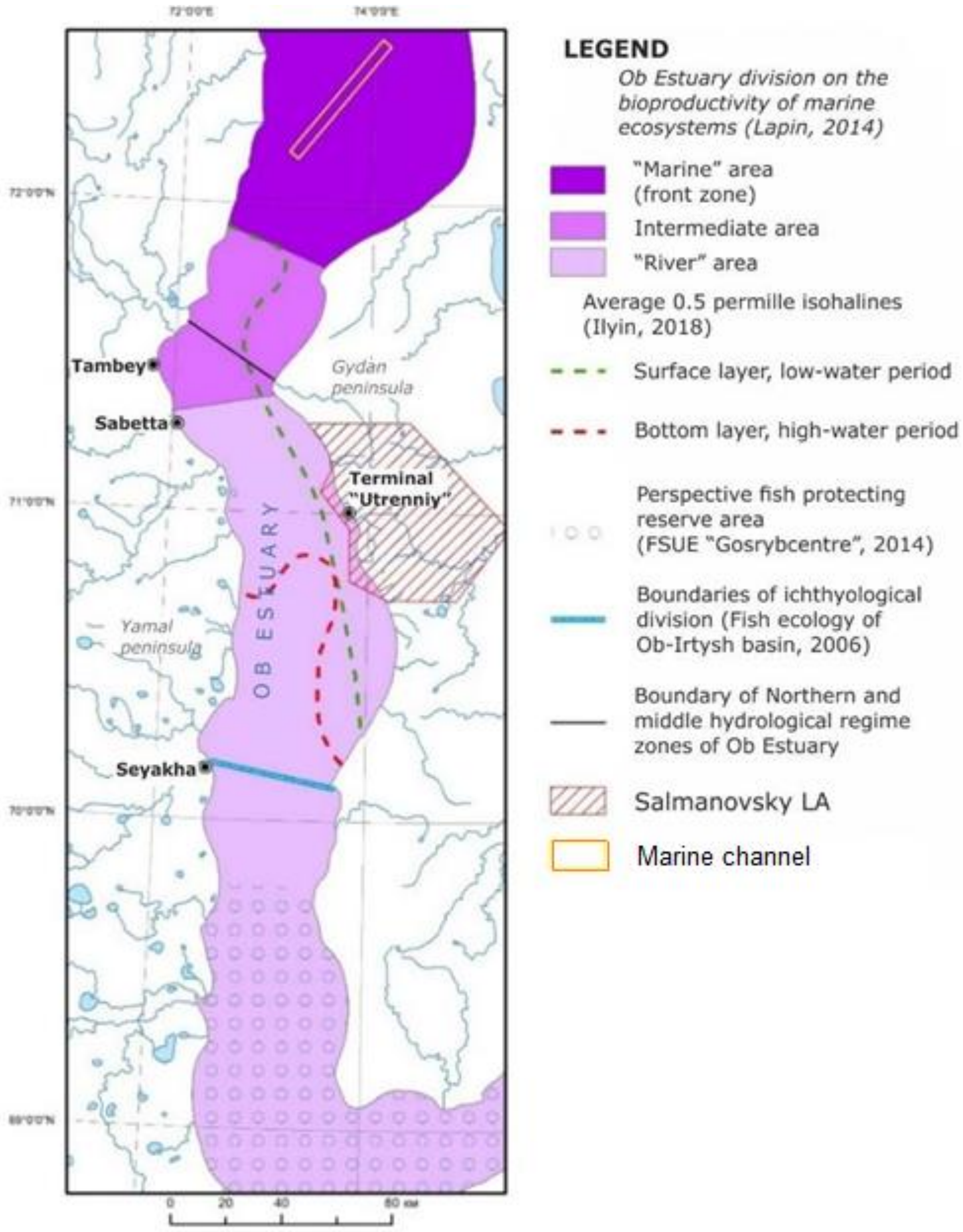


Figure 7.6.1: The Ob Estuary zoning based on hydrological, hydrochemical and hydrobiological parameters (diagram by S.A. Lapin (2014) complemented by the Consultant)

137 Ильин Г.В. Гидрологический режим Обской губы как новой области морского природопользования в Российской Арктике // Наука Юга России. 2018. Том 14. №2. С 20-32. Ilyin, G.V., Hydrological conditions of the Ob Estuary as new area of maritime wildlife management in the Russian Arctic, Nauka Yuga Rossii [Science in the South of Russia], 2018, vol. 14, no. 2, pp. 20-32.

138 Dianskii, N.A. et al., Assessing the impact of the planned approach channel to the seaport Sabetta on changes in the hydrological conditions in the Ob Estuary by numerical modeling // The Arctic: Ecology, Economy, No. 3 (19), 2015, pp. 18-29.

Position of the boundary between two ichthyologic sub-regions of the Ob-Irtysh catchment area corresponds to approximately the same value[139]: *the Northern Part of the Ob Estuary* sub-area is situated to the north from the line connecting the Seyakha River mouth and the Khasrio cape (Figure 7.6.1); it represents the zone of sea water and river runoff mixing and covers the water areas of the existing Sabetta terminal and the projected Utrenniy terminal. There, the communities of hydrobionts are classified as brackish water ones, while those in the area located to the south from the Seyakha River – Khasrio Cape line are fresh water communities[140]. It is important that the river runoff has the largest effect on the western coast of the Ob Estuary, while the eastern coast, where the onshore facilities of the Arctic LNG 2 Project are sited, is washed by waters with comparatively higher content of sea water all the year round.

More detailed zoning of this sub-region, based on the differences in the biological productivity of aquatic ecosystems, makes it possible to additionally divide it into marine, intermediate, and river areas (Figure 7.6.1). The Plant and Port, as well as the main part of their area of influence, are confined to the river segment of the estuary, where the primary production is formed almost entirely due to the winter pre-vegetation reserve of nutrients; therefore, this area is generally least productive in the Ob Estuary[141]. Its role in maintaining the number of commercial, rare and endangered fish species is minimal compared to the southward zone of the Ob and the Taz Estuaries confluence (ichthyological area referred to as *the Southern Part of the Ob-Taz Estuary with Tributaries*), which was proposed to have the status of a fishery reserve area, since there is high concentration of many fish species, including the Siberian sturgeon listed in the Red Data Book[142]. Also, this area is identified as an Arctic water area of high environmental value.[143]

The proposed location of the Plant and Port in 140 km downstream of the water area o a high environmental value virtually prevents any possibility of impacts caused by water mass transport, since the Kara Sea water intrusions upstream the Ob Estuary do not spread farther than 70° N to the south.

The following sections provide more detailed description of biological diversity components in the Ob Estuary, such as plankton, benthos, fish fauna, and marine mammals, with the special focus on their habitats in the zone affected by the Planned activities.

The area for detailed examination of the components of biodiversity covers the entire water area of the Ob Estuary, from its “river” segment near Seyakha and Tadebya-Yakha in the south to the line between the northern part of Shokalskogo island and Belyi island in the north.

7.6.2.2 Bacterioplankton

The first microbiological surveys were carried out in the Kara Sea by B.L. Isachenko who found widespread distribution of microorganisms in the water and bottom sediments of the Arctic seas[144]. The first quantitative assessment of microbial biomass in the Arctic seas, including the Kara Sea, was made by V. S. Butkevich[145] during an expedition in 1935. The author noted a low content of bacterial cells in the water of the northern part of the Kara sea on 80° N: 1.9–12.5 K cells/ml, and the biomass was 3.5–7.0 µg/l. The values of saprotrophic bacteria abundance, obtained by A.E. Kriss, were close to the earlier data[146,147]. The total number of microorganisms determined in the Kara Sea by other researchers[148] was lower than in other seas of the Arctic basin by an order of magnitude, and amounted to thousands and tens of thousands cells per one ml. Starting from 1981, the researchers from Murmansk Marine Biological Institute of the Russian Academy of Sciences (MMBI RAS) conducted separate surveys of the total bacterial count (TBC) near the

[139] Ecology of fishes in the Ob-Irtysh basin, Proc. Of Severtsov Institute of Ecology and Evolution, Moscow: Publishing House KMK, 2006. 596 p.

[140] Kara Sea Ecological Atlas. - M.: Arctic Research Center LLC, 2016. 271 p.

[141] S. A. Lapin. Specific features of formation of the high-productivity zones in the Ob inlet // Sreda obitaniya vodnykh biologicheskikh resursov [Habitat of Aquatic Biological Resources]. Proc. of VNIRO. 2014. Vol. 152. pp. 146-154.

[142] Fishery and biological ground for creating a fisheries protection zone in the Ob-Taz Estuary, Tyumen: FSBSI GosRybTsentr, 2014.

[143] Solovyev, B., Spiridonov, V., Onufrenya, I., Belikov, S., Chernova, N., Dobrynin, D., ... & Pantyulin, A. (2017). Identifying a network of priority areas for conservation in the Arctic seas: Practical lessons from Russia. Aquatic Conservation: Marine and Freshwater Ecosystems, 27. P. 30-51.

[144]Isachenko, B.L. *Mikrobiologicheskaya kharakteristika gruntov i vody Karskogo morya* (Microbiological Characteristics of Soils and Water of the Kara Sea) // Selecta. Moscow, Leningrad: Izd-vo AN SSSR, 1951. pp. 334-363.

[145]Butkevich, V.S. *Bakterial'noe naselenie arkticheskikh morei i ego raspredelenie v vode i gruntakh* (Bacterial Population of the Arctic Seas and Its Distribution in Water and Soils) // Selecta. Moscow: Izd-vo AN SSSR, 1958. Vol. II. pp. 77-134.

[146]Kriss, A.E. *Morskaya mikrobiologiya (glubokovodnaya)* (Marine Microbiology (Deep-Water)). Moscow: Izd-vo AN SSSR, 1959. 455 p.

[147]Kriss, A.E. *Mikrobiologicheskaya okeanografiya* (Microbiological Oceanography). Moscow: Nauka, 1976. 78 p.

[148]Saliot A., Cauwet G., Cahet G. Microbial activities in the Lena River delta and Laptev Sea // *Mar. Chem*. 1996. Vol. 53. Pp. 247-254.

northern boundaries of the bay on the Kara Sea side[149] and in the area of the Baydaratskaya Bay[150], where saprotrophic bacteria capable of growing on nutrient media were also counted[151]. According to N.G. Teplinskaya[152], TBC and bacterial biomass in the south-western part of the sea near Novaya Zemlya were 18–150 K cells/ml and 16–60 µl/l, respectively. The TBC values recorded in the Baydaratskaya Bay were about 400 K cells in 1 ml, which was significantly higher than in the boundary areas of the Kara Sea, where the value of this indicator was about 50 K cells in 1 ml (Teplinskaya, 1990; Baitaz, Baitaz, 1993). According to N.G. Teplinskaya (1990), the ratio between the number of saprotrophic bacteria and TBC in the Northern seas usually ranges from 10^{-3} to 10^{-5}, i.e. the share of saprotrophic bacteria here is from 0.1 to 0.001% of TBC. Even lower values of this ratio, from 10^{-6} to 10^{-4}, were found at the Kara Sea coast near Severnaya Zemlya (Golomyannyi Island), based on year-round observations[153].

In August - September 1993, the “Dmitry Mendeleev” research vessel made its 49th voyage in the Kara Sea, where the researchers from the Institute of Microbiology of the RAS collected a large array of data for the entire water area of the Kara Sea and the discharge areas of large rivers, the Yenisei and the Ob, with regard to the abundance of microorganisms and the intensity of microbial processes of the carbon and sulphur cycles in the water mass and bottom sediments[154,155]. As a result of these studies, it was found that in the marine part of the water area, the content of bacteria in water ranged from 2–3 K to 250–280 K cells in 1 ml. In addition, work was carried out to study the microbial processes of carbon and sulfur cycles in the Kara Sea. The count and species composition of methanotrophic bacteria were determined by the immuno-fluorescence method[156].

In August-September 2001, during the voyage of the Akademik Boris Petrov RV in the Kara Sea, German researchers B. Meon and R. Amon measured the TBC values and found that they did not exceed 0.5×10^6cells/ml[157]. The value of bacterial production in the Kara Sea water area was 2.4 µg C per l^{-1}. In the Ob Estuary, the maximum values of TBC and bacterial production were 1.93×10^6 cells/ml and 29.5 µg C per l^{-1}, respectively; in the Yenisei Estuary the TBC was 1.51×10^6 cells/ml and the bacterial production was 19.7 µg C per l^{-1}. Based on experiments with organic matter additives, it was concluded that fresh autochthonous organic matter is the main contributor to the production of bacterioplankton in comparison with more conservative soluble organic matter of freshwater genesis.

In the winter-spring season from 1999 to 2005, during the marine survey expeditions of the MMBI RAS[158,159,160], carried out onboard nuclear icebreakers, according to direct counting under an epifluorescence microscope with fluorescamine staining of bacterial cells (magnification x1080), the TBC ranged from 9.6 to 935 K cells/ml, and the biomass — from 7.8 to 1300 mg/m^3, with respective average values being 240 K cells/ml and 205 mg/m^3. Increased values of these indicators were observed in water mixing zones: the Ob–Yenisei near-estuary area and the marginal ice openings in the water area of the Kara Sea. The diversity and abundance of morphological forms of the winter community of bacteria allowed the authors to make a

[149]Teplinskaya, N.G. *Protsessy bakterial’noi produktsii i destruktsii organicheskogo veshchestva v severnykh moryakh* (Processes of Bacterial Production and Destruction of Organic Matter in the Northern Seas). Apatity, 1990. 105 p.

[150]Baitaz, V.A., Baitaz, O.N. Mikrobiological studies. Total Bacterioplankton and bacteriobenthos // *Gidrobiologicheskie issledovaniya Baidaratskoi guby Karskogo morya v 1990-1991 gg.* (Hydrobiological Studies in the Baydaratskaya Bay of the Kara Sea in 1990-1991). Preprint. Apatity: Izd-vo KNTs RAN, 1993. Pp. 6-13.

[151]Pesegov, V.G. Ecology of heterotrophic bacteria in the bays of the Northern seas // *Gidrobiologicheskie issledovaniya v zalivakh i bukhtakh severnykh morei Rossii* (Hydrobiological Studies in the Bays and Harbors of the Northern Seas of Russia). Apatity, 1994. pp. 31-38.

[152]Teplinskaya, N.G. *Bacterioplankton i bacteriobentos Karskogo morya* (Bacterioplankton and Bacteriobenthos of the Kara Sea). Apatity, 1989. pp. 29-37.

[153]Il’inskii, V.V. Heterotrophic bacterioplankton: Ecology and role in the processes of environment natural purification from oil contaminations. Doctor of biological sciences dissertation synopsis. Moscow: Prostator, 2000. 54 p.

[154]Mitskevich, I.N., Namsaraev, B.B. Bacterioplankton abundance and distribution in the Kara Sea in September, 1993. // *Okeanologiya*. 1994. Vol. 34. No. 5. pp. 704-708.

[155]Lein, A.Yu., Rusanov, I.I., Pimenov, N.V., Savvichev, A.S., Miller, Yu.M., Pavlova, G.A., Ivanov, M.V. Biogeochemical processes of carbon and sulphur cycles in the Kara Sea. // *Geokhimiya*, 1996, No. 11, pp. 1027–1044.

[156]Namsaraev, B.B., Rusanov, I.I., Mitskevich, I.N., Veslopolova, E.F., Bol’shakov, A.M., Egorov, A.V. Bacterial oxidization of methane in the Yenisei River and the Kara Sea. // *Okeanologiya*. 1995. Vol. 35. No. 1. pp. 88-93.

[157]Meon B., Amon R.W. Heterotrophic bacterial activity and fluxes of dissolved free amino acids and glucose in the Arctic rivers Ob, Yenisei and the adjacent Kara Sea // *Aquat. Microb. Ecol*. 2004. Vol. 37. Pp. 121-135.

[158]*Biologiya i okeanografiya Severnogo morskogo puti: Barentsevo i Karskoe morya* (Biology and Oceanography of the Northern Sea Route: the Barents and the Kara Seas)/G.G. Matishov Ed., 2nd Edition (revised and enlarged), Moscow: Nauka, 2007. 323 p.

[159]Matishov, G.G., Makarevich, P.R., Goryaev, Yu.I., Ezhov, A.V., Ishkulov, D.G., Krasnov, Yu.V., Larionov, V.V., Moiseev, D.V. *Trudnodospupnaya Arktika. 10 let biookeanologicheskikh issledovanii na atomnykh ledokolakh* (Hard-to-Reach Arctic. Ten Years of Biooceanological Research on Nuclear Icebreakers). Murmansk: Murmanskii Pechatnyi Dvor, OOO, 2005. 148 p.

[160]Matishov, G.G., Makarevich, P.R., Larionov, V.V., Bardan, S.I., Oleinik, A.A. Functioning of pelagic ecosystems of the Barents and Kara Seas in winter-spring period in ice-covered water areas // *Proceedings of the Academy of Sciences*. 2005. Vol. 404, No. 5. pp. 707-709.

conclusion that it plays an important role in zooplankton nutrition for most of the year. This is confirmed by high zooplankton biomass observed in these areas in winter under solid ice cover. Detection of increased concentrations of the pelagic ecosystem components, such as bacterio-, phyto- and zooplankton in the same areas of the basin suggests that there is an extreme degree of "spatio-temporal compression" of the processes of plankton communities development in the water areas covered with ice for most of the year.

In September 2007, comprehensive activities were organized in the Kara sea and the Ob Estuary to determine the abundance of bacterioplankton and the intensity of key microbial processes of carbon and sulfur cycling in the surface water layer, light-independent assimilation of CO_2, as well as the isotopic composition of carbon in water suspension[161].

Later, in the section from the fresh waters of the Ob River to the northern part of the Kara Sea, the maximum values of TBC and bacterial biomass were measured by A. S. Savvichev[162] in the estuary (2–3 M cells/ml and 200–570 μg/l, respectively). Relatively high values of these indicators (700–800 K cells/ml) were observed over the entire zone of sea and river waters mixing. A sharp decrease in the TBC values was observed in the northern water masses of the Kara Sea (down to 120–250 K cells/ml). In the waters of the Ob Estuary and the area of river and sea waters mixing, the TBC values were 700–3000 K cells/ml, and the biomass was 100–570 $\mu g/l^{-1}$.

During four expeditions to the Kara Sea region in 2007 and 2010, the researchers from the Institute of Oceanology of the RAS collected the material for determining a number of parameters of bacterioplankton, including its abundance and biomass[163,164,165]. Three of these expeditions covered the area of the Ob Estuary. The TBC and biomass were measured by the method of direct counting of cells stained with fluorochrome DAPI under a luminescent microscope with magnifications ×1375 and ×1000. It was found that salinity was the main factor determining the differences between the biotopes in the Ob Estuary and the adjacent shelf. In autumn (September) 2007, the section could be conventionally divided into three zones: southern river zone where the water salinity was below 6 PSU; sea shelf zone with salinity of more than 9 PSU; and estuarine frontal zone where the maximum salinity gradient was observed and a pycnocline formed. The abundance of bacteria in different water layers in the section along the Ob Estuary varied from 187 to 914 K cells/ml. In the river part, this parameter ranged from 276 to 789 K cells/ml, and in the estuarine front zone — from 197 to 867 K cells/ml. The abundance values on the shelf ranged from 187 to 914 K cells/ml. In each of the zones, the concentration of bacterioplankton in the water column decreased in the direction from South to North. The maximum spatial variability of the abundance of microorganisms was observed in the top mixed-water layer. Despite large fluctuations, the average values of the bacteria count in the water column were almost the same for all the selected zones: 423±242, 426±163, and 427±89 K cells/ml for the river zone, estuarine frontal zone, and shelf, respectively (Romanova, 2008, 2012; Sazhin et al., 2010). This fact is all the more interesting because no other component of the plankton community shows similar stability in the area of river communities replacement with marine ones[166,167]. The authors suggest that the bacterial community consumed the readily available organic matter, the source of which could be allochthonous material formed from dying-away organisms at the river-sea boundary.

In the quasi-meridional section along the Ob Estuary, completed in August 2010 (Romanova, 2012), a river zone and an estuarine frontal zone with a well-defined pycnocline were identified. The difference in the salinity of surface river water and brackish sea water penetrating along the bottom was more than 9 PSU. In summer period, the distribution of abundance in the section was uneven and probably depended on local availability of organic matter. In the river zone, the abundance of bacterioplankton in different layers varied from 320 to 2757 K cells/ml, averaging to (1441±440) K cells/ml. In the estuarine frontal zone, the average

---

[161]Savvichev, A.S., Zakharova, E.E., Veslopolova, E.F., Rusanov, I.I., Lein, A.Yu., Ivanov, M.V. Microbial processes of carbon and sulphur cycles in the Kara Sea // *Okeanologiya*. 2010. Vol. 50. No. 6. pp. 942–957.

[162]Savvichev, A.S. Microbial processes of carbon and sulphur cycles in the Russain Arctic seas. Doctor of biological sciences dissertation synopsis, Moscow, 2011. 48 p.

[163]Romanova, N.D. Current state of bacterial community in the Ob Estuary of the Kara Sea // *Proc. Russian National Conference in International Participants "Northern Territories of Russia: Challenges and Outlook for Development". Arkhangelsk, June 23–26, 2008*, IEPS, 2008. pp. 1144–1148.

[164]Romanova, N.D. Structural and functional characteristics of bakterioplankton in the Kara Sea. Candidate of boiological sciences dissertation synopsis, Moscow, 2012. 26 p.

[165]Sazhin, A.F., Romanova, N.D., Mosharov, S.A. Bacterial and primary production in the Kara Sea waters // *Okeanologiya*. 2010. Vol. 50. No. 5. pp. 801–808.

[166]Sukhanova, I.N., Flint, M.V., Mosharov, S.A., Sergeeva, V.M. Phytoplankton community structure and primary production in the Ob Estuary and on adjacent shelf // *Okeanologiya*. 2010. Vol. 50. No. 5. pp. 785–800.

[167]Flint, M.V., Semenova, T.N., Arashkevich, E.G. Zooplankton communities structure in the estuarine frontal zone of the Ob River // *Okeanologiya*. 2010. Vol. 50. No. 5. pp. 809–822.

count of bacteria was similar to that observed in the river zone and amounted to 1213±864 K cells/ml. At the same time, the concentration of microorganisms varied from 147 to 3319 K cells/ml in the water layer above the pycnocline and decreased towards the sea from 1423 to 55 K cells/ml in the layer below it. The average cell size was slightly smaller in the estuarine front zone than in the river zone (0.025 and 0.03 μm^3, respectively). The morphological composition of both parts of the section was dominated by cocci. Nevertheless, the proportion of rod-shaped forms was also significant and amounted to 15–42% (27% on average), which proved to be more than twice higher than in 2007. The biomass of bacterioplankton varied widely at different stations: from 7.15 to 58.5 mg C/m^3. Its average values for the river zone and the estuarine frontal zone were 22±11.2 and 17.5±13.6 mg C/m^3, respectively. This indicator reached the maximum values on the northern boundary of the river zone, where it was almost twice as high as at the neighboring stations.

In October 2010, in the quasi-meridional section along the Ob Estuary (Romanova, 2012), a river area (″river″ water with salinity of up to 4 PSU) and a zone of the adjacent sea shelf (″sea″ water with salinity of 6–27 PSU) were identified. However, when considering the spatial distribution of the bacterial count, the southern part of the section was clearly distinguished, since the abundance there was by an order of magnitude lower than in the adjacent river zone. The northern boundary of this area coincided with the southern boundary of the region affected by sea waters. In each of the three identified areas, the quantities of bacterioplankton were relatively stable. The average values of bacterioplankton abundance for the southern and northern parts of the river area were 126±38 K and 1423±185 K cells/ml, respectively. Seawards of this area, this parameter was slightly lower than at adjacent stations: 1002±81 K cells/ml. The bacterial abundance distribution was not found to depend on the concentration of chlorophyll "a" along the section. Like in autumn 2007, the maximum size of bacterial cells was registered at the southernmost station of the section (the value of their volume average for a water column was 0.05 μm^3). In the river and sea parts of the section did not differ much in terms of the mean size of bacterial cells; it was 0.03 μm^3 on average. The proportion of rod-shaped forms in "sea" water (more than 6 PSU) was higher than in the river zone — 35 and 24%, respectively. Changes in the distribution of bacterioplankton biomass along the section generally repeated the changes in its abundance. In the southern part of the river zone, the average biomass value was by almost an order of magnitude lower than in the northern part: 2.6±0.5 and 20.1±8.3 mg C/m^3, respectively. Its values in different water layers ranged from 1.6 to 5.5 mg C/m^3 in the south and from 4.9 to 40.3 mg C/m^3 in the north. In the sea part of the section, the biomass of bacterioplankton was slightly lower than at the neighboring "river" stations, averaging to 16.6±5.1 mg C/m^3 (from 5.6 to 56.3 mg C/m^3).

Thus, the analysis of published data on the abundance of bacterioplankton in the upper water layer of the Ob Estuary in the summer and autumn seasons (Romanova, 2008, 2012; Sazhin et al., 2010) showed that in summer the number of bacterioplankton can up to two times exceed the values of this indicator for the autumn period (1419 and 609 K cells/ml, respectively). The interannual variability of TBC is sometimes quite indistinct. Only in 1993, the abundance of bacteria in the autumn period significantly differed from the observations carried out in other years, amounting to 206 K cells/ml in the river zone and 173 K cells/ml in the shelf area (Mitskevich, Namsaraev, 1994). In subsequent years, the number of bacteria found in the river zone was 2.5 times higher on average, and 5 times higher above the shelf (Romanova, 2012). Thus, it can be concluded that in the area of the Ob Estuary, there is a well-defined seasonal and more poorly expressed interannual variability in the bacterioplankton abundance. This may be caused by the changes in both the source and composition and, consequently, the availability of allochthonous organic matter.

The results of two-year monitoring (Romanova, 2012) of the morphological and size composition of bacterioplankton in the surface layer showed that in autumn 2007, the proportion of rod-shaped forms did not exceed 10% (4% on average), whereas in 2010, it averaged 30%, both in summer and autumn periods. The author identified the following areas in the most variable top mixed-water layer in the Kara sea:

1. The area of the Ob Estuary and the adjacent shelf with the maximum indicators of bacterioplankton abundance (up to 3.3 M cells/ml) and activity (the ratio of production to average biomass, P/B, up to 0.6 day^{-1}).

2. Shelf area with a small quantity of bacterioplankton (56–290 K cells/ml), and its relatively high activity (P/B 0.36 day^{-1}).

3. Coastal area in the west of the basin, not affected by the river runoff, with bacterioplankton high abundance (up to 820 K cells/ml), but low activity (P/B 0.18 day^{-1}).

4. The southern slope of the St. Anna Trench with extremely low bacterioplankton abundance (23–43 K cells/ml) and its activity close to zero.

5. The area of the main continental Arctic slope in the north of the basin with the highest abundance of bacteria for the open sea (up to 600 K cells/ml), which is similar in the western and eastern parts of the sea. The same author showed that in summer-autumn period, the seasonal indicators of abundance of bacterioplankton in the area of the Ob Estuary and the adjacent shelf differ 2–3 times, and interannual fluctuations — up to 5 times.

Also, it was also concluded that in the area of the Ob Estuary and the adjacent sea shelf in the autumn period, only 1/3 of bacterial production is provided by the currently created primary production. The lack of new synthesized organic matter is compensated by allochthonous material formed as a result of destruction of freshwater phytoplankton in the estuarine frontal zone.

At the same time, it should be noted that most of the published data on the abundance and biomass of bacterioplankton in the Ob Estuary were collected in the autumn and late summer periods (August, September and October), which do not fully cover the period of the maximum productivity (July – early August) in the considered water area.

The characteristics of microbiological indicators in the studied water area of the Ob Bay near the Salmanovskoye (Utrenneye) oil, gas and condensate field according to the file materials is presented on the basis of the analysis of the results of research carried out in the course of surveys and environmental monitoring in 2012-2019[168][169][170][171][172][173].

The results of the study of microbiological indicators for the specified period are summarized in Table 7.6.1.

Table 7.6.1: Results of the study of microbiological indicators for the monitoring period 2012-2019

Period of work	Total bacterial count (TBC) Total microbial count (TMC)	Biomass of bacteria	Inoculation of media
September 2012	TBC: Sea part of the Ob Bay: 0.097–42 M cells/ml;* Water area of Salmanovskiy (Utrenniy) LA: 2.6–3.2 K cells/ml.*	–	Number of saprotrophic bacteria: 2.6–4.5 K cfu/ml
July – August 2013	TBC: – TMC: 2.2×103–3.6×104 cfu/ml	2.2–13 mg/dm^3	–
April 2014	TBC: – TMC: 1.2×105–6.6×105 cfu/ml	25.9–38.0 mg/dm^3	–
August 2014	–	–	–
September 2017	0.81–4.35 M cells/ml	–	–
September 2019 (IEPI JSC)	1.075 M to 5.475 M cells/ml	46.5 to 378.1 mg C/m^3, average 137,47,8 mg C/m^3	–

Note: * – the results of microbiological studies presented in the report for 2012 are ambiguous (controversial) (inconsistencies have been found in the units of measurement used; inconsistencies in the figures given in the narrative and table parts of the report, as well as in the specified methods of analyses).

According to the results of bacterioplankton studies within the comprehensive surveys of the Ob Bay, conducted by IEPI JSC in September 2019, the total bacterial count varied between the stations in the studied water area from 1.075 M to 5.475 M cells/ml. The range of average values for the water layers had a small amplitude — from 2.24 to 2.47 M cells/ml. The average TBC value for all water layers at the stations

[168] Berth structures infrastructure at Salmanovskoye (Utrenneye) oil, gas, and condensate field. Project documentation. Technical report on design survey. Environmental survey. Document cipher 603-2013-00-ИЭ.СУБ-и1. - St. Petersburg: Eco-Express-Service LLC, 2013. 389 p.

[169] Technical report on hydrometeorological and ice surveys in the Ob Bay water area for designing hydrotechnical facilities under the Project: Salmanovskoye (Utrenneye) Oil, Gas, and Condensate Field Facilities Construction. FGBU AANII – Saint Petersburg, 2012. 220 p. Berth structures infrastructure at Salmanovskoye (Utrenneye) oil, gas, and condensate field. Project documentation. Technical report on design survey. Environmental survey. Document cipher 603-2013-00-ИЭ.СУБ-и1. - St. Petersburg: Eco-Express-Service LLC, 2013, 389 p.

[170] Plant for Production, Storage and Offloading of Liquefied Natural Gas and Stabilised Gas Condensate on Gravity-based Structures. Project documentation. Section 8. List of Environmental Protection Measures. Book 4. Fishery Section. Document cipher 2017-423-M-02-OOC4, Vol. 8.4. – Moscow: SPG NOVAENGINEERING, LLC, 2019 150 p.

[171] Utrenny Terminal of Liquefied Natural Gas and Stable Gas Condensate. Project documentation. Section 8. List of Environmental Protection Measures. Book 2. Environmental Impact Assessment. Narrative, Vol. 8.2. Document cipher 2030-017-ЮР/2018(4741)-13-ООС1.СУБ-8.2/ 4010-P-LM-PDO-08.02.00.00.00-00. - St. Petersburg: LENMORNIIPROEKT, JSC, 2019. 390 p.

[172] Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas. Desk study of the field survey data. Hydrodynamic modelling. Stage 3. Book 1. 287 p.

[173] Комплексные исследования экологического состояния Обской губы в зоне потенциального воздействия Проекта «Арктик СПГ 2» и на смежной акватории. Камеральная обработка результатов полевых работ. Гидродинамическое моделирование. Этап 3. Книга 1. 287 с.

was 2.37 M cells/ml. The morphological composition of bacterioplankton was mainly represented by rods (40–63%) and vibrions (27–56%); small quantities of cocci were also detected (2–24%). The values of bacterioplankton biomass at the stations ranged from 46.5 to 378.1 mg C/m^3 with an average value of 137.47.8 mg C/m^3. The distribution of bacterial biomass values basically repeated the distribution of values of the total number of microorganisms. The average values of biomass varied slightly, from 131.1 to 146.6 mg C/m^3; however, there was a significant variation in the bacterioplankton biomass values between the stations and water layers in the studied water area. The main contribution to the formation of bacterioplankton abundance and biomass was made by small cells of various morphological forms, which indicated active processes of reproduction of microorganisms during the sampling period. The values of TBC and biomass in the water mass of the Ob Bay at the stations of the studied water area in September 2019 are in the range of published data for early autumn season during the end of phytoplankton blooming. In terms of the quantitative and production indicators of bacterioplankton, the water masses of the water area are characterized as corresponding to the mesotrophic-eutrophic water level.

7.6.2.3 Phytoplankton

Studies of phytoplankton in the Ob Bay were carried out by academic institutions during 1970s–2000s[174,175,176,177,178,179,180,181,182,183,184,185,186].

The published works cover fully enough the issues of systematics and quantitative development of microfitoplankton in the freshwater part of the Ob Bay. The work of the MMBI RAS in this region in 1989–2007 was dedicated to studying the phytoplankton community in various periods of vegetation[187,188,189,190,191].

Taxonomic composition. In the plankton of the Lower Ob and its estuary, more than 700 species, varieties and forms of microalgae from the following 8 groups have been registered: Cyanophyta, Chrysophyta, Bacillariophyta, Xanthophyta, Cryptophyta, Chlorophyta including Prasinophyta, Dinophyta, and

[174]Usachev, P.I. Phytoplankton of the Kara Sea // *Plankton Tikhogo okeana* (Plankton of the Pacific Ocean). Moscow: Nauka, 1968. pp. 6–28.

[175]Kiselev, I.A. Algae flora in the Ob Bay with some added data on the algae of the lower Ob and Irtysh // *Vodorosli i griby Zapadnoi Sibiri i Dal'nego Vostoka* (Algae and Fungi of the Western Siberia and Far East). Novosibirsk: Publisher of Siberian Branch of the USSR Academy of Sciences, 1970. Part 1 (3). Pp. 41–45.

[176]Solonevskaya, A.V. Productivity of phytoplankton in the southern part of the Ob Bay and the щи lower reaches // *Vodorosli i griby Zapadnoi Sibiri i Dal'nego Vostoka* (Algae and Fungi of the Western Siberia and Far East). Novosibirsk: Nauka, 1972. Part 2. Pp. 51–70.

[177]Naumenko, Yu.V. Phyroplankton species diversity in the Ob // *Sibirskii ecologicheskii zhurnal*. 1994. No. 6. Pp. 575–580.

[178]Naumenko, Yu.V. *Vodorosli fitoplanktona reki Obi* (Phytoplankton Algae of the Ob River). Novosibirsk, 1995. 55 p.

[179]Naumenko, Yu.V. Phytoplankton dominants in the Ob River // *Botanicheskii zhurnal*. 1998. Vol. 83, No. 10. Pp. 35–41.

[180]Naumenko, Yu.V. Environmental and geographical characteristics of the Ob phytoplankton // *Botanicheskii zhurnal*. 1997. Vol. 82, No. 7. Pp. 51–56.

[181]Semenova, L.A., Aleksyuk, V.A. Research coverage of algal flora of the northern Ob region // *Gidrobiologicheskaya kharakteristika vodoemov Urala* (Hydrobiological Characteristics of Water Bodies of the Urals). Sverdlovsk: Izd-vo UrO AN SSSR, 1989. Pp. 23-38.

[182]Semenova, L.A. Phyroplankton of the Ob Estiary area and assessment of its possible variations in case of partial withdrawal of the river runoff // *Gidrobionty Obskogo basseina v usloviyakh antropogennogo vozdeistviya* (Hydrobionts of the Ob Basin under Human-Induced Impacts). Leningrad: Izd-vo GosNIORKh, 1995. No. 327. Pp. 113–119.

[183]Semenova, L.A., Naumenko, Yu.V. New data on algal flora of the Lower Ob and Its Estuary //*Vestnik ekologii lesovedeniya i landshaftovedeniya*. 2001. No. 1. Pp. 131-137.

[184]Makarevich, P.R., Larionov, V.V., Druzhkov, N.V., Druzhkova E.I. Role of the Ob phytoplankton in forming the productivity of the Ob-Yenisei shallow waters // *Ekologiya*. 2003. No. 2. Pp. 96-100.

[185]Makarevich, P.R. Bioindication of human-induced contamination in the coastal zone of the Kara Sea // *Arkticheskie morya: Bioindikatsiya sostoyaniya sredy, biotestirovanie i tekhnologiya destruktsii zagryaznenii* (Arctic Seas: Bioindication of Environmental Condition, Biotesting, and Technology for Pollutions Destruction). Apatity: Izd. KNC RAN, 1993. Pp. 66–72.

[186]Makarevich, P.R. Phytoplankton in the south-western part of the Kara Sea: Candidate of biological sciences dissertation synopsis. Moscow, 1994. 23 p.

[187]Makarevich, P.R. Phytoplankton in the coastal area of the Kara Sea // *Sreda obitaniya i ekosystemy Novoi Zemli* (arkhipelag i shel'f (Habitats and Ecosystems of Novaya Zemlya (Archipelago and Shelf). Apatity: KNC RAN, 1996. Pp. 50-54.

[188]Makarevich, P.R. Phytoplankton of the Kara Sea // *Plankton morei Zapadnoi Arktiki* (Plankton of the Western Arctic Seas). Apatity: Izd. KNC RAN, 1997. Pp. 51-65.

[189]Makarevich, P.R. *Planktonnye al'gotsenozy estuarnykh ekosistem. Barentsevo, Karskoe i Azovskoe morya* (Plankton Algal Coenoses of Estuarine Ecosystems: the Barents, Kara, and Azov Seas). Moscow: Nauka, 2007. 221 p.

[190]Kuznetsov, V.V., Efremkin, I.M., Arzhanova, N.V., Gangnus, I.A., Klyuchareva, N.G., Luk'yanova, O.N. Modern state of the Ob Estuary ecosystem and its fishery importance. // *Voprosy promyslovoi okeanologii*, 2008. No. 2. Pp. 129-153.

[191]Semenova, L.A., Gaevskii, N.A. Structural and functional characteristics of algal coenosis of the Taz Bay // *Chelovek i Sever: Antropologiya, arkheologiya, ekologiya (Humans and the North: Antropology, Archaeology, Ecology). Proc. Russian National Conference, Tyumen', 24-26 March 2009*. Vol . 1. Pp. 281-283.

Euglenophyta (Makarevich et al., 2003; Makarevich, 2007; Semenova, Naumenko, 2001; Semenova, Gaevskii, 2009).

In the course of research in the estuarine zone of the Ob Bay, 383 species of microalgae were registered, belonging to 9 groups: Bacillariophyta, Dinophyta, Chlorophyta, Chrysophyta, Cyanophyta, Cryptophyta, Euglenophyta, Prasinophyta, and Xantophyta. Floristically, the most diverse groups are Bacillariophyta (195 taxa), Dinophyta (98 species), Chlorophyta (44 species), and Cyanophyta (29 species). The number of representatives of other groups does not exceed 10 species for each group (Makarevich, 2007).

The composition of planktonic algocenoses in the Ob Estuary varies considerably from region to region. In the Lower Ob, the southern (freshwater) part of the Ob Estuary, and the Taz Estuary, the taxonomic structure of phytoplankton is equally dominated by Bacillariophyta and Chlorophyta, which make at least 90% of the total number of species; relative share of Bacillariophyta in taxocenosis increases to 60-70% in winter and spring, and reduces to 50% in summer and autumn. In the northern part of the Ob Estuary, especially in the estuarine sea area, marine and brackish-water species of Bacillariophyta and Dinophyta are dominant[192] (Makarevich, 2007). In the environmental aspect, the taxocenosis is a complex of true plankton species making about 80%, while the share of tychopelagic (benthos and periphytic) species is about 20% of the total number.

Phytoplankton species composition as by August 2019[193] is demonstrated by the survey records from wider water area from the Khasrio cape in the south to the Drovyanoi cape in the north. Records from the observation stations located in the north of the area where the water is more saline, mention the presence of diatomic marine flora including gen. *Nitzschia, Thalassionema, Thalassiosira, Chaetoceros*, as well as dinophytes of gen. Am*phidinium, Gymnodinium, Protoperidinium, Peridiniella catenata, Scrippsiella trochoidea* and *Heterocapsa triquetra*. The dominant group in terms of numbers in the surface layer and transition layer consisted of diatoms *Asterionella formosa*, gen. *Aulacoseira, Fragilariopsis oceanica*, *Melosira jurgensii, Navicula abrupta, Navicula transitans* var. *Transitans*, with co-dominants of diatoms gen. *Tabellaria, Thalassionema, Thalassiosira*, euglena gen. *Eutreptiella* and *Heteronema klebsii*, dinophytes *Heterocapsa triquetra* and *Peridiniella catenata*. In the bottom layer, the most abundant species were diatoms gen. *Melosira, Navicula, Nitzschia*. By the biomass, the dominating complex consisted of *Aulacoseira granulata, Aulacoseira islandica, Melosira jurgensii, Gyrodinium fusiforme, Gyrodinium lachryma, Protoperidinium pallidum, Eutreptiella braarudii, Gonyaulax spinifera,* Diatoms of gen. *Aulacoseira* still dominated in the phytoplankton of the frontal zone, along with flagellate autotrophs which made a significant contribution to the total abundance. Abundance of green algae decreased towards the open sea. The number of dinoflagellates was insignificant, but their contribution to biomass increased to 45% and approached the diatoms in importance; the most significant were *Heterocapsa triquetra*, gen. *Protoperidinium, Gymnodinium*. In terms of biomass, the freshwater complex of diatoms and green algae dominated in the upper diluted layer. Below the pycnocline, marine diatoms predominated, but mutual penetration of species was observed: freshwater plankton appeared into the bottom layer (bottom accumulations of species of gen. *Aulacoseira*) and marine species were present in the surface layer.

At the stations in diluted shallow waters, the largest biomass and abundance of freshwater species of the genus *Aulacoseira* was reported. The second largest contribution to the quantitative indicators belonged to green algae gen. *Ankistrodesmus, Binuclearia, Crucigenia, Dictyosphaerium, Pediastrum, Scenedesmus, Ulothrix*. The phytocoenosis contained brackish-water centric diatoms gen. *Cyclotella and Tallasiosira*. Marine species *Chaetoceros gracilis, Navicula vanhoeffenii, Thalassionema nitzschioides, Heterocapsa triquetra, Scrippsiella trochoidea* were found in insignificant quantities; euglena species gen. *Astasia, Euglena, Eutreptiella, Heteronema, Strobomonas* developed intensively; pennate diatoms of genera *Nitzschia, Fragilaria, and Asterionella formosa* were sporadically recorded. Of the blue-greens, filamentous forms were regularly encountered - species of the genera *Oscillatoria and Aphanizomenon*.

<u>Indicators of biomass and population.</u> According to published modern data, quantitative indicators of phytoplankton are characterized as follows (Table 7.6.2). The annual cycle of phytoplankton development can be divided into active vegetation and dormant periods. The latter is characterized by the low level of production activity of microalgae, when the total biomass values lie within the annual minimum region and do not exceed 10^{-2} mg/l.

---

[192]Naumenko, Yu.V. Phytoplankton dominants in the Ob River // *Botanicheskii zhurnal*. 1998. Vol. 83, No. 10. Pp. 35–41.

[193] Comprehensive environmental monitoring programme. Ob Bay in the Yamal LNG Project area of influence. PHASE 4 REPORT - Final Report on the results of the Comprehensive environmental monitoring programme. Ob Bay in the Yamal LNG Project area of influence. Book 1. Explanatory note. FRECOM LLC, ZMI MGU LLC. Moscow, 2020. Book 1. Explanatory note. 364 p.

The succession cycle of phytoplankton in the estuarine zone of the Ob Bay is relatively autonomous; it is manifested in a stable sequence of changing stages of seasonal succession which is associated in time and space with the succession cycles of pelagic communities of phytoplankton of freshwater runoff and marine water masses that form this estuarine biotope. Its characteristic seasonal feature is that, starting from the time before the Ob Bay water area is cleared of ice in spring, and until late autumn, high levels of phytoplankton biomass are maintained in the pelagial of this basin. Even during the ice cover period (late June–early July), the biomass of pelagic microalgae in some areas may exceed 12 mg/l. Later, during the entire warm season, both in the height of summer and in the period immediately preceding the ice age, the biomass values almost never fall below 1-2 mg/l.

According to L.A. Semenova, in 1979 - 1983, from the second half of July till September, the average microalgae biomass in the central part of the Ob Estuary was 2–4 mg/l. in the southern part of the Ob Estuary, the phytoplankton biomass was 0.4–4.8 g/m^3 in 1995 and 0.2-2.1 g/m^3 in 1996. In the sea part of the estuarine zone of the Ob Bay, the main dominant in the community was the diatom *Aulacosira (Melosira) granulata*. In addition to *A. granulata*, *A. italica* and *Paralia sulcata* from the diatom complex reached significant development. Average seasonal abundance and biomass of phytoplankton in 1981-1992 varied in the Lower Ob from 1.4 to 14.6 M cells/l and from 0.5 to 6.4 mg/l (Makarevich, 2007).

According to published data, during the autumn vegetation stage in September – October 1996, Bacillariophyta (47%) and Chlorophyta (36%) predominated in phytoplankton. The other groups accounted for 17 %. Representatives of Bacillariophyta (*Asterionella formosa*, *Aulacosira (Melosira) granulata*, *M. varians)* and Chlorophyta (*Rhizoclonium sp.*, *Ulotrix sp.*) were present at almost all stations in the studied water area[194]. During the studied period, the number of phytoplankton cells ranged from 1738 K to 6582 K cells/l. (Makarevich, 2007, see Table 7.6.2).

Table 7.6.2: Values of phytoplankton biomass in the Ob Estuary according to published file data

Area	Season	Total biomass, mg/l min–max (mean)	Source
The Ob Estuary, center	Summer	0.7-12.5	(Semenova, Aleksyuk, 2009)
	Autumn	0.1–15	
The Ob Estuary, center	Summer	(3), (13)	(Kuznetsov et al., 2009)
The Ob Estuary, south–center	Summer	0.5-17	(Gaevskii, Semenova, Matkovskii, 2009)
	Autumn	2.4-5.7	
The Ob Estuary, south–center	July	3.2–5.8 (4.5) 5.0-7.7 (6.0)	
	August	4.8-8.5 (6.4) 2.8-8.2 (5.0) 2.8-12.5 (7.0) 1.8-9.9 (5.5)	
	September	1.7-8.8 (4.5) 3.0-9.0 (5.5) 9.2-14.8 (11.3) 4.2-6.7 (5.5)	
The Ob Estuary, center	June–July	0.005-13	(Makarevich, 2007)
	August	1.2-2.1	
	September–October	2.0-6.0	

Thus, in the Ob-Tazovsky district, there is only one peak of phytoplankton development; it is observed in the period of July–September, and is formed equally by Cyanophyta (representatives of the genera *Microcystis* and *Aphanizomenon*), Diatomeae (primarily representatives of the genera *Asterionella*, *Cyclotella*, *Melosira*, *Aulacoseira*) and Chlorophyta (filamentous forms of the genera *Rhizoclonium* and *Ulothrix*). The phytoplankton biomass in whole period is 1–4 mg/l, sometimes more than 10 mg/l. The period of decreasing abundance falls in October and is accompanied by mass formation of hypnospores (dormant spores) in a number of diatomic microalgae.

During the autumn vegetation stage in September–October 1996, the number of phytoplankton cells ranged from 1738 K to 6582 K cells/l. (Makarevich, 2007).

According to L.A. Semenova's data for 1979-1983 for the central part of the Ob Estuary, from the second half of July till September, the average phytoplankton biomass was 2–4 g/m^3. In the southern part of the Ob Estuary, the phytoplankton biomass was 0.4–4.8 g/m^3 in 1995 and 0.2-2.1 g/m^3 in 1996.

[194]Makarevich, P.R., Matishov, G.G. Spring prodution cycle of phytoplankton in the Kara Sea // *Proc. of RAS*. 2000. Vol. 375, No. 3. Pp. 421-423.

According to L.A. Semenova[195], 76 previously recorded phytoplankton taxa disappeared from the algocenosis of the Ob Estuary over the 10 years before the year of surveys, but the total abundance increased, which is due to an increased anthropogenic load on the water body.

Characteristics of phytoplankton indicators in the studied water area of the Ob Estuary in the area of the Salmanovskoye (Utrenneye) oil and gas condensate field according to file data for the period of 2012-2019 are given in Table 7.6.3.

Table 7.6.3: Results of the study of phytoplankton indicators for the observation period 2012-2017

Period of work	Taxonomic composition	Total abundance of phytoplankton	Total biomass of phytoplankton	Content of photosynthetic pigments of phytoplankton (chlorophyll "a")
September 2012	66 taxa, imcluding: Dinophyta - 3 taxa; Bacillariophyta - 35 taxa; Chlorophyta - 18 taxa; Euglenophyta - 1 taxon; Chrysophyta - 41 taxa; Cryptophyta - 1 taxon; Cyanophyta - 7 taxa;	Surface layer: $426.80 \cdot 10^6$ –$1388.00 \cdot 10^6$ cells/m^3. Near-bottom layer: $433.2 \cdot 10^6$ – $1240.2 \cdot 10^6$ cells/m^3	Surface layer: 1213.97 – 2384.63 mg/m^3. Near-bottom layer: 796.76 – 1968.18 mg/m^3.	Surface layer: from 3.035 –5.562 µg/l. Near-bottom layer: 1.992 – 4.258 µg/l.
July–August 2013	68 taxa belonging to 6 groups: Bacillariophyta, Chlorophyta, Cyanophyta, Cryptophyta, Dinophyta, Xanthophyta.	Surface layer: 7 – 26 M cells/l. Near-bottom layer: 8 – 12 M cells/l.	Surface layer: 11 – 61 g/m^3. Near-bottom layer: 17 – 22 g/m^3.	5 – 38 mg/m^3, average 15 mg/m^3.
April 2014	Ice period: 34 lower-rank taxa of two groups: Bacillariophyta– 28, Chlorophyta– 6	Surface layer: 8–16 K cells/l Near-bottom layer: 16–21 K cells/l Average 14.4 K cells/l	Surface layer: 11–40 mg/m^3 Near-bottom layer: 33–50 mg/m^3 Average 28.7 mg/m^3	Average 0.116±0.003 mg/m^3
August 2014	11 taxa of 2 groups: Bacillariophyta – 6; Chlorophyta – 5.	Surface layer: 0.1 M cells/l Near-bottom layer: 0.04 M cells/l	Surface layer: 0.6 g/m^3 Near-bottom layer: 0.2 g/m^3	–
September 2017	92 taxa, including: Bacillariophyta – 49; Cyanobacteria – 18; Chlorophyta – 18; Ochrophyta – 3; Cryptophyta – 2; Charophyta – 1; Dinoflagellata – 1.	Surface layer: 3502–14878 M cells/m^3, average 8282 M cells/m^3 Near-bottom layer: 4020–14957 M cells/m^3, average 7862 M cells/m^3.	Surface layer: 1.365– 9.100 g/m^3, average 4.286 g/m^3. Near-bottom layer: 1.427–8.463 g/m^3, average 4.597 g/m^3.	–
August 2019 (FRECOM LLC, ZMI MGU LLC)	171 microalgae species, of which 63 saprobity indicator species. The richest diversity is reported for gen. Aulacoseira (10 species), Chaetoceros (5 species), Melosira (5 species), Protoperidinium (5 species), in the green algae	Northern area: Surface: 177.14 (57.25 - 324.5) Intermediate: 157.85 (34.5 - 345.5) Bottom 78.06 (28 – 175) Front area: Surface: 1035.51 (106.08 – 2481) Intermediate: 593.63 (62.5-1891.00)	Northern area: Surface: 426.02 (114.32 - 716.04) Intermediate: 705.72 (262.06 - 1637.31) Bottom 349.58 (112.37 - 1043.33) Front area: Surface: 1083.981 (130.22 – 2433)	in the surface layer from 0.79 mg/m3 to 28.55 mg/m3, on average 5.78±0.48 mg/m3, trophic status - transition from oligotrophic to mesotrophic, at some station water was identified as eutrophic.

[195]Semenova, L.A. Phyroplankton of the Ob Estiary area and assessment of its possible variations in case of partial withdrawal of the river runoff // *Gidrobionty Obskogo basseina v usloviyakh antropogennogo vozdeistviya* (Hydrobionts of the Ob Basin under Human-Induced Impacts). Leningrad: Izd-vo GosNIORKh, 1995. Vol . 327. Pp. 113–119.

Period of work	Taxonomic composition	Total abundance of phytoplankton	Total biomass of phytoplankton	Content of photosynthetic pigments of phytoplankton (chlorophyll "a")
	composition - gen. Ankistrodesmus (7 species).	Bottom 263.42 (31.2 – 847) Diluted shallows: Surface layer: 573.72 (203 – 1069) Bottom 466 (103 – 940)	Intermediate: 1131.793 (142.83 - 3086.53) Bottom 1051.71 (84.26 - 3887.50) Diluted shallows: Surface layer: 857.68 (347.07 - 2235.43) Bottom: 809.9209 (221 - 2893.23)	
September 2019 (IEPI JSC)	165 species belonging to 8 systematic groups. The largest numbers of species represented the groups of Diatomeae (Bacillariophyta) (78 species or 47% of species diversity) and Chlorophyta (44 species or 27% of species diversity)	Surface layer: 237 – 9,639 On average: 4435 Intermediate: 877–11,183 On average 4,104 Near-bottom layer: 991–9,918 Average 4,504 org./m^3	Surface layer: 87.24–15,834.49 On average: 5,154.61 Intermediate: 800.2-12,871.89. Average 5,124.41 Near-bottom layer: 118.8-17,169.28 Average 5,055 mg/m	–

According to the results of expedition work in September 2019, the phytoplankton of the studied water area in the Ob Estuary was represented by 165 species belonging to 8 systematic groups. The largest numbers of species represented the groups of Diatomeae (Bacillariophyta) (78 species or 47% of the species diversity) and Chlorophyta (44 species or 27% of the species diversity). The abundance of phytoplankton varied from 118 to 11,183 M org./m^3, the biomass — from 87.2 to 17,169 mg/m^3, averaging 4,187 M org./m^3 and 5,055 mg/m^3. Phytocenosis corresponded to the autumn stage of the successional cycle of phytoplankton development in the Ob Estuary and featured high indicators of biomass and abundance of Diatomeae which formed an average of 96.8% of the total abundance and 98% of the total biomass of phytoplankton (Figure 7.6.2).

According to the data reported by FRECOM LLC, ZMI MGU LLC (2019), saprobity index of water area in the north of the Ob Estuary is within the β-mesosaprobic range (minor impact of economic activity, no organic pollution).

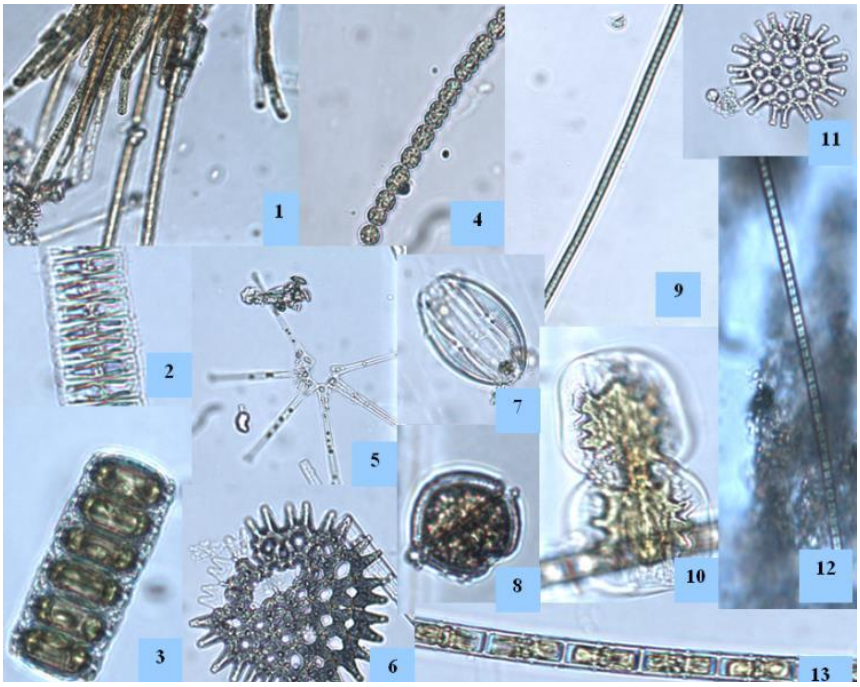


Figure 7.6.2: Species of phytoplankton registered at the stations in the studied area of the Ob Estuary in September 2019

1 – *Aphanizomenon sp.*, 2 – *Navicula septentrionalis*, 3 – *Paralia sulcata*, 4 – *Anabaena* sp., 5 – *Asterionella formosa*, 6 – *Pediastrum boryanum*, 7 – *Amphora* sp., 8 – *Gymnodinium* sp., 9 – *Planktothrix agardschii*, 10 – *Amphiprora hyperborea*, 11 – *Pediastrum duplex*, 12 – *Oscillatoria* sp., 13 – *Aulacoseira islandica*. Source: IEPI, JSC, 2019

7.6.2.4 Phytobenthos

Phytobenthos in the studied area in the Ob Estuary is represented by microalgae only. The absence of large algae (macrophytobenthos) can be explained by the predominance of soft bottom soils. In August 2017, in the Ob Estuary water area that is planned to be used for the Plant and Port facilities construction, 79 species of microalgae were found, which belonged to 4 systematic groups: *Bacillariophyta* (diatom algae); *Chlorophyta* (green algae); *Cyanophyta* (blue-green algae), and *Euglenophyta* (euglena algae). The diatoms included 94.9 % of the total number of identified species. In general, a single floral complex of 18 species can be identified for the entire working area. The main contribution to the total abundance of microphytobenthos at most stations of the planned area of work is made by Diatomeae: *Melosira granulata* (9.62% – 84.19% of the total abundance), and representatives of the genera *Navicula* and *Nitzschia*. Also, there are significant quantities of *Thalassiosira decipiens* (8.39% to 13.71%) and *Asterionella formosa* (up to 15.62%).

The number of microalgae in the entire territory of Salmanovskoye (Utrenneye) LA was from 77.84 M to 1608.65 M cells/m^2.

The biomass of microalgae in the Project area varied from 0.15 g/m^2 to 10.56 g/m^2. The average biomass of microphytes in the entire area was 2.23 g/m^2.

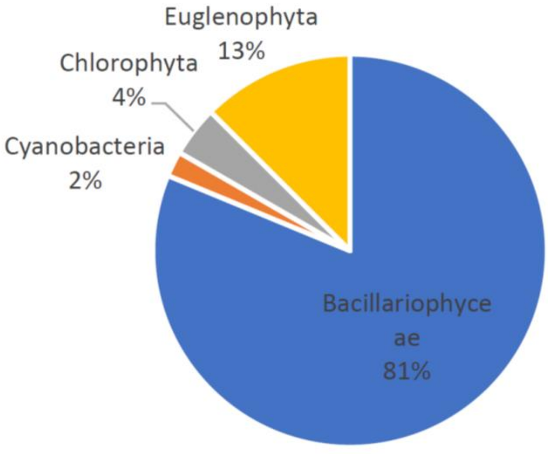
In terms of the composition of dominants, the algocenosis can be described as diatomic; however, Cyanophyta (*Oscillatoria sp.*) make a noticeable contribution in the total abundance in the surface water layer. Vertical distribution of the biomass is characterized by some reduction in the near-bottom layers. Total abundance of algocenosis is not high: according to the existing classification of trophicity, the average biomass in the Ob Estuary corresponds to oligotrophic level (<2.5 g/m^3).

Studies of fouling of the berth structures near Sabetta conducted by FRECOM LLC, ZMI MGU LLC (2019) produced some interesting results. Foul material sample taken from the berth structures near Sabetta contained 48 microalgae species of the following taxonomic groups: Ochrophyta (Bacillariophyceae) – 39 species, Cyanobacteria – 1 species, Chlorophyta – 2 species, Euglenophyta – 6 species.

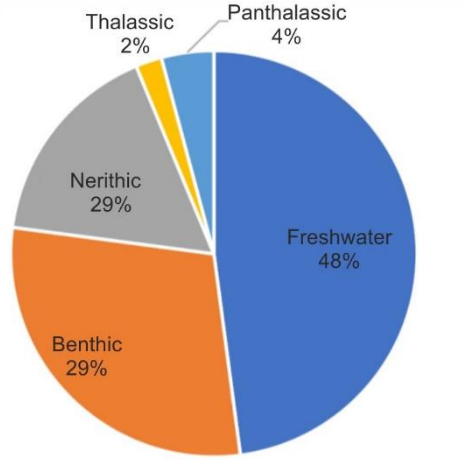
The communities consisted of purely autotrophic species. Freshwater forms accounted for 48% of the total number, benthic species – 29%, neritic – 17%, panthalassic – 4%, thalassic – 2% (Figure 7.6.3).

By phytogeographic origin, the community was dominated by boreal species (44%), cosmopolitan species accounted for 32%, arcto-boreal – 24%

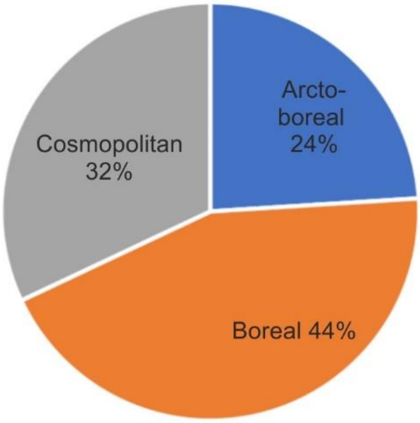
In August 2019, total abundance of microalgae in the fouling community at the Sabetta port structures was 149,721.6 thousand cells/m^2, biomass - 1,036.88 mg/m^2. Diatoms predominated in both abundance and biomass.



A.



B.



C.

Figure 7.6.3: Proportions of taxonomic (A), ecological (B) groups and geographic elements (C) in the algal flora fouling of the berth structures near Sabetta

Source: FRECOM LLC, ZMI MGU LLC, 2019

In terms of numbers and biomass, the most abundang genera in the community were *Amphora, Cocconeis, Cymbella, Halamphora, Melosira, Navicula, Pleurosigma*. All of them belong to the group of benthic diatoms characteristic of the Kara Sea basin and typical of fouling and soft soils of the Arctic seas. The fouling community on the berth structures nearSabetta is formed by diatom fouler species, nonsymbiotic diatoms of soft soils, and phytoplanktonic freshwater species. The species composition and quantitative parameters of the fouling complex correspond to the seasonal stage of development of benthic microalgae and phytoplankton of the Kara Sea. No invading alien species were found in the community.

7.6.2.5 Zooplankton

The Ob Estuary is a natural continuation of the Ob River. The composition of the zoocenoses of the Ob Estuary is highly affected by the Ob River, its hydrological and hydrochemical regimes, and plankton runoff. In the general scheme of zoogeographical zoning of brackish waters[196], it is a part of the vast Holarctic brackish water area, which is still poorly studied in terms of fauna and ecology. The estuarine frontal zone of the Ob Estuary was identified in the course of the work of researchers from the Shirshov Institute of Oceanology[197] based on the results of comprehensive research in 2007-2013. Estuarine ecosystems are classified as dynamic non-equilibrium systems with continuously changing and often unpredictable abiotic conditions. The organisms there usually experience physiological stress, which affects the species composition, abundance, and structure of existing communities. In an unstable environment, an unstable state of the community structure (quasi-structure) is formed, where the role of environmental factors in its organization increases, and the strength of interspecies interactions reduces. In summer, the studied part of the Ob Estuary is fresh-water, and it is slightly salted only in winter.

There are few works addressing the zooplankton communities in the Ob basin in general and the studied water area in particular. A small number of works are known that characterize the qualitative composition of zooplankton in the Ob Estuary. The first information about the zooplankton species composition in the Lower Ob basin was presented by N.V. Voronkov and G.Yu. Vereshchagin at the beginning of the 20th century. More detailed study of the zooplankton species composition in the Lower Ob was carried out by V.S. Yukhneva[198] based on the collections of 1964-1965, and by A.S. Leshchinskaya[199] based on the collections of 1958-1959. An extensive summary of the species composition of water fauna in the Lower Ob, dating back to the late 1970s was given by N.G. Krokhalevskaya et al.[200].

---

[196]Khlebovich, V.V. More on the biological typology of estuaries of the Soviet Union // *Gidrobiologicheskie issledovaniya estuariev* (Hydrobiological Studies of Estuaries). *Proc. Zoological Institute of the USSR Academy of Sciences*. Leningrad: ZIN, 1986. Vol. 141. Pp. 5-16.

[197]Poyarkov, S.G., Flint, M.V. Comprehensive research of the ecosystem of the Kara Sea (128th voyage of the Professor Shtokman research vessel) // *Okeanologiya*. 2015. Vol. 55. No. 4. Pp. 723-726.

[198]Yukhneva, V.S. Composition and distribution of zooplankton in the Lower Ob // Zoologicheskii zhurnal. Vol. 49. No. 5, 1970. Pp. 660-664.

[199]Leshchinskaya, A.S. Zooplankton and zoobenthos of the Ob Estuary as Fish Forage // *Proc. Salekhard Stationary of the Urals Branch of the USSR Academy of Sciences*. 1962. No. 2. Pp. 27-76.

[200]Krokhalevskaya, N.G., Aleksyuk, V.A., Semenova, L.A. Species composition of zooplankton in the Lower Ob water bodies // *Rybnoe khozyaistvo na vodoemakh Zapadnoi Sibiri* (Fisheries in Water Bodies of Western Siberia). *Proc. GosNIORKh*. No. 171, 1981. Pp. 100-105.

In the recent period, the most detailed summary was presented by L.A. Semenova et al.[201,202], taking into account the materials of previous research and data collection in 1979-2008. The summary lists the full species composition of zooplankton of the Ob Estuary; it consists of 223 taxa, including Rotifera – 103, Cladocera – 59, and Copepoda – 61. In the Ob delta, 128 taxa have been identified in zooplankton, including Rotifera – 52, Cladocera – 39, and Copepoda – 37. The quantitative indicators varied quite widely between the stations. The abundance varied from 0.04 to 113 K ind./m^3, and the biomass — from 0.8 to 1804 mg/m^3. The average seasonal abundance over the period of open water was 12–13 K ind./m^3, and the biomass — 65–130 mg/m^3. Rotifers and copepods were dominant in terms of quantities, and copepods and cladocerans — in terms of biomass (Semenova, Aleksyuk, 2010). However, despite the fact that these studies were quite detailed and long-term, they did not cover the northernmost regions of the Ob Estuary; for this reason, the list of species does not include a number of species of brackish-water Calanoida that dominate this area.

The data on mass species, the ratio of taxonomic groups, and the quantitative development of zooplankton in the Ob Estuary are also scarce. Among the key works studying the zooplankton in this region, the work of A.S. Leshchinskaya (1962) should be mentioned, which is dedicated to the study of zooplankton and zoobenthos of the Ob Estuary as the fish forage. This paper contains the information about the species composition and mass species of zooplankton, as well as its quantitative development; the author emphasizes a very high spatial non-uniformity of zooplankton indicators and their seasonal variability. According to A.S. Leshchinskaya (1962), the background species diversity of zooplankton ranged from 90 species in summer, including 12 species of rotifers, 42 species of copepods, and 36 species of Cladocera, down to a few species of zooplankton in winter. Significant variability of zooplankton indicators was noted, with the biomass ranging from units and tens of mg/m^3 to 1 g/m^3 and higher (Leshchinskaya, 1962).

Detailed data on the species composition and quantitative development of zooplankton in the Ob Estuary and the southern part of the Kara Sea, including the area of this research, were obtained during the voyage of the Dmitry Mendeleev RV in autumn 1993[203]. According to these studies, the Ob Bay was dominated by copepods *Senecella sibenca, S. calanoides, Jaschnovia tolli, Limnocalanus grimaldii, Drepanopus bungei* and the mysid *Mysis oculata*.

In the modern period, the zooplankton in the Ob Estuary was researched by V.A. Aleksyuk and G.Kh. Abdullina[204,205,206]. According to these studies, zooplankton of the Ob Estuary was represented by 82 species and subspecies. In June, the highest occurrence (19-38%) was shown by *Synchaeta kitina, Keratella quadrata quadrata* of rotifers, *Bosmina obtusirostris* of crustaceans, and by Copepoda juveniles. In August, high occurrence (65-100%) was typical of rotifers *Asplanchna herricki, Collotheca sp., Conochilus unicornis, Keratella cochlearis cochlearis, K. cochlearis macracantha, Kellicottia longispina longispina, Notholca caudata, Polyarthra luminosa, Trichocerca (s. str.) cylindrica, Trichocerca (Diurella) porcellus*; cladocerans *Bosmina longirostris, B. longispina, B. obtusirostris, Daphnia cristata, D. galeata*; and nauplial and copepodite stages of Copepods. In September, the occurrence rates varied from 50 to 100%. *Notholca acuminata acuminata* added to the above-mentioned rotifers, and *Chydorus latus, C. sphaericus*, and *Ceriodaphnia affinis* added to the cladocerans. From the Copepoda group, from June to August, the occurrence was high for juveniles and nauplii of Cyclopoidae, *Mesocyclops (s. str.) leuckarti*, and in September the proportion of Calanoida increased due to *Eudiaptomus gracilis* and *E. graciloides*. The most diverse families were Brachionidae (15 species) and Synhaetidae (9 species), and among the Cladocerans — the representatives of Daphnidae and Bosminidae families. Among the Copepods, the suborder Cyclopoida (12 species) was the most diverse. Calanoida were represented by 9 species. Among the cyclops, the largest number of species (5) represented the genus *Cyclops*.

Also, according to these studies (Abdullina, Aleksyuk, 2010; Aleksyuk, 2010), in June the number and biomass of zooplankton significantly varied from 10 to 2020 ind./m^3, and the biomass — from 0.01 to 4.67

---

[201]Semenova, L.A., Aleksyuk, V.A., Dergach, S.M., Leleko, T.I. Zooplankton species diversity in the water bodies of the Northern Ob Region // *Vestnik ekologii, lesovedeniya i landshaftovedeniya*. Tyumen: Izd-vo IPOS SO RAN, 2000. No. 1. Pp. 127-134.

[202]Semenova, L.A., Aleksyuk, V.A. Zooplankton of the Lower Ob // *Vestnik ekologii, lesovedeniya i landshaftovedeniya*. 2010. No. 10. Pp. 156-169.

[203]Vinogradov, M.E., Vinogradov, G.M., Nikolaeva, G.G., Khoroshilov, V.S. Mesozooplankton in the western part of the Kara Sea and the Baydaratskaya Bay // *Okeanologiya*, 1994. Vol. 34, No. 5. Pp. 709-715.

[204]Abdullina, G.Kh., Aleksyuk, V.A. Species diversity of zooplankton in the Taz Estuary // Environment and Management of Natural Resources. Paper abstracts for International Conference, Tyumen, 11-13 October, 2010. Tyumen: Izd. TGU, 2010. Pp. 15-16.

[205]Abdullina, G.Kh., Aleksyuk, V.A. Modern state of zooplankton in the Ob Estuary // *Modern Problems of Hydroecology: Proc. 4th International Scientific Conference in Memory of G.G. Vinberg. 11-15 October, 2010. St. Petersburg*: Russian Collection, 2010. P. 33.

[206]Aleksyuk, V.A. Modern state of zooplankton in the Lower Ob // *Problems of Ecology. Readings in Memory of Professor M.M. Kozhov: Proc. International Scientific Conference and International School for Young Scientists (Irkutsk, 20-25 September, 2010)*. Irkutsk, 2010. P. 35.

mg/m^3, on average 146 ind./m^3 and 0.47 mg/m^3. The copepods predominated in terms of abundance (82%) and biomass (71%). Mass development was reached by the nauplial stages of Cyclopoidae (74% of abundance and 52.4% of biomass). In August, the quantitative indicators of zooplankton development increased significantly; the abundance varied from 740 to 15200 ind./m^3, and the biomass — from 1.20 to 301.23 mg/m^3, on average 3964 ind./m^{3}and 41.44 mg/m^3. The abundance was mainly formed by copepods (41%) and rotifers (39%). The most common were nauplii and juveniles of Cyclopoidae, as well as the rotifer species of the genus Notholca. Copepods dominated in terms of the biomass (73%), with Calanoida accounting for 55%, primarily due to the relict crustacean *Limnocalanus macrurus* (44–98% of the total biomass). In September, the abundance of zooplankton at the stations was from 650 to 54300 ind./m^3, on average 16281 ind./m^3. The rotifers dominated: from 37 to 87% (due to the species of the genera Keratella, Polyarthra, Euchlanis, less often Asplanchna and Collotheca), and copepods — from 37 to 87% (young Cyclopoida were mass). The biomass was from 10.24 to 288.42 mg/m^3 with an average of 135.33 mg/m^3, and was formed mainly by cladocerans *Leptodora kindtii* and Bosmina, and partly by copepods; among them the most widespread species were *Acanthocyclops americanus, Senecella calanoides, Limnocalanus macrurus*, and copepodite stages of Cyclopoida (Abdullina, Aleksyuk, 2010).

According to the most recent published results of research in the northern part of the Ob Estuary[207], including the area at issue, 93 species were found in zooplankton (42 Rotifera, 19 Cladocera, 32 Copepoda). The largest number of species belonged to the northern planktic complex; there were typically Arctic species, but also relatively thermophilic species were present, as well as a large group of eurybionts. Along with freshwater zooplankton, brackish-water forms were also found. Rotifers showed the highest diversity in all areas, making 33 to 58% of the total number of species. The leading genera by the number of species are *Trichocerca, Brachionus, Polyarthra, Keratella*, and *Notholca*. The zooplankton species composition in the Ob Estuary gradually changed from south to north under the influence of physical and chemical conditions of the environment. The number of zooplankton species after the confluence of the Ob River with the Ob Estuary increased, and then decreased as it approached the estuarine zone. As a rule, the estuarine zone is characterized by low species diversity and highly spotted distribution of hydrobionts due to the high variability of many environmental factors. The abundance of zooplankton varied from 4600 to 255,120 ind./m^3, and the biomass — from 9.47 to 668.47 mg/m^3. The quantitative characteristics of zooplankton increased significantly after the confluence of the Ob River and the Ob Estuary, and then it decreased in the water mixing zone of the Ob and the Taz Estuaries. Further, the abundance and biomass of zooplankton increased downstream. Small cladocerans and a number of rotifer species fell out of the community, while the role of large Calanoida increased in the community. Thus, the growth of biomass continued even with the decline in abundance (Ermolaeva, 2017).

Characteristics of zooplankton indicators in the studied water area of the Ob Estuary in the area of Salmanovskiy (Utrenniy) LA, according to the file data for the period of 2012-2019, are shown in Table 7.6.4.

Table 7.6.4: Results of zooplankton indicators study for the period of monitoring 2012-2019

Period	Taxonomic composition	Total abundance	Total biomass
September 2012	26 taxa. Dominants: Cyclopoida, *Senecella calanoides*, *Drepanopus bungei*, *Limnocalanus macrurus*, *Diaptomus glacialis*.	205 – 1,470 ind./m^3. Average 593 ind./m^3	from 24 to 400 mg/m^3. Average 186.9 mg/m^3
July–August 2013	23 taxa, including: Rotatoria – 17 and Copepoda – 5. Dominants: *Synchaeta glacialis*, Ectinosoma (order Harpactiformes), *Limnocalanus grimaldii*. The zooplankton samples contained some nectobenthic organisms — mysids.	1050 – 14,500 ind./m^3	59.23 – 1710.55 mg/m^3
April 2014	9 taxa, including: Rotatoria – 5, Cladocera – 1, Copepoda – 3.	2190 – 4,500 ind./m^3	2.59 – 5.62 mg/m^3, average 4.02 mg/m^3

[207] Ermolaeva, N.I. Species composition and spatial distribution of zooplankton in the Ob Estuary and the Gydan Bay // In: *Water and Environmental Problems of Siberia and Central Asia: Proc. 3rd Russian National Scientific Conference with International Participation*. 4 volumes. 2017. Pp. 90-91.

Period	Taxonomic composition	Total abundance	Total biomass
August 2014	14 taxa, including: Rotatoria – 5, Cladocera – 4, Copepoda– 3, Mysidacea – 1, Amphipoda – 1.	8000 – 11,000 ind./m^3, average 9,600 ind./m^3	0.36 – 0.84 g/m^3, average 0.59 g/m^3
September 2017	14 taxa, including: Rotifera – 1, Cladocera – 5, Copepoda – 7, Mysidae – 1.	188 – 33,564 ind./m^3, average 4,743 ind./m^3	7 – 1431 mg/m^3, average 193 mg/m^3
August 2019 (FRECOM LLC, ZMI MGU LLC, 2019)	44 species. The largest role: copepods *Drepanopus bungii* dominated in numbers (on average, 30% of the total number), and *Senecella siberica* – in biomass (on average, 53% of the total biomass). Copepods genus Limnocalanus, as well as Jashnovia tolli, accounted for 5-7% of the zoomass	8-2851 ind./m^3, average 451 ind./m^3	0.3-901 ind./m^3, average 68 ind./m^3
September 2019 (IEPI JSC)	58 taxa. Dominants: *Bosmina longirostris, Bythotrephes longimanus, Daphnia galeata, Cyclops kolensis, Cyclops vicinus, Cyclops scutifer, Mesocyclops leuckarti, Eudiaptomus gracilis, Eurytemora lacustris, Heterocope appendiculata, Limnocalanus macrurus, Senecella siberica,* Gammaridae and *Mysis relicta*	410 to 17,725 ind./m^3 Average 6,273 ind./m^3	5.8 to 863.1 mg/m^3 263 mg/m^3

In August 2019 (FRECOM LLC, ZMI MGU LLC, 2019), the abundance and biomass of zooplankton organisms in the study water area were low, 452 ind./m^3 and 68 mg/m^3, and varied significantly (by 4 orders of magnitude) between the stations. The spatial distribution of zooplankton followed a mosaic pattern. Higher abundance of planktonic invertebrates was noted both in the northern and southern parts of the study water area, regardless of depth or salinity.

In September 2019 (IEPI JSC), the zooplankton in the studied water area of the Ob Estuary was represented by 58 taxa. The largest number of species belonged to copepods. *Bosmina longirostris, Bythotrephes longimanus, Daphnia galeata, Cyclops kolensis, Cyclops vicinus, Cyclops scutifer, Mesocyclops leuckarti, Eudiaptomus gracilis, Eurytemora lacustris, Heterocope appendiculata*, *Limnocalanus macrurus*, *Senecella siberica,* Gammaridae, and *Mysis relicta* dominated in the entire studied water area in terms of abundance and biomass. Among the mass and dominant species, both brackish and freshwater species were noted. The Shannon species diversity index calculated by the abundance was 2.43±0.07 bit/ind., and the Shannon index calculated by the biomass was 2.49±0.10 bit/mg. Generally, the values of the Shannon index indicate that in September 2019, the zooplankton coenosis within the studied area was characterized by a high degree of complexity. In terms of abundance and biomass, the studied water area was dominated by copepods and cladocerans; a proportion of mysids was high at some stations. The abundance of zooplankton at some individual stations in the studied area varied from 410 to 17 725 ind./m^3, and the biomass — from 5.8 to 863.1 mg/m^3. The average abundance and biomass of zooplankton in the studied area was 6273 ind./m^3 and 263 mg/m^3. By species composition, the ratio of individual taxonomic groups, as well as quantitative indicators (abundance, biomass), the state of the zooplankton community in the studied area in September 2019 corresponded to its seasonal background state.

7.6.2.6 Zoobenthos

The Ob Estuary is characterized by the presence of sea, brackish and fresh water zones. As a result, as the distance from the Kara Sea to the Ob and the Taz Estuaries confluence area increases, the qualitative composition of zoobenthos is observed to change[208,209,210]. In winter subglacial period, cold sea water is observed to flow into the bottom layers, which results in water salinization up to the Trekhbugornyi Cape[211]. Based on the variations in hydrological and hydrochemical conditions, the Ob Estuary is also traditionally divided into three parts: southern part from the Ob River delta to the line connecting the Kruglyi Cape with

[208]Ioffe, S.I. Bottom fauna of the Ob-Irtysh basin and its fishery importance // *Izvestiya VNIORKh*. Vol. XXV. No. 1. Leningrad, 1947. Pp. 113-161.

[209]Moskalenko, B.K. Biological fundamentals of exploitation and reproduction of Coregonidae in the Ob basin // *Proc. Ob-Tazovskiy Branch of VNIORKh*. Tyumen: Tyumen Book Publisher. New series. 1958, Vol. 1, p. 251.

[210]Leshchinskaya, A.S. Zooplankton and zoobenthos of the Ob Estuary as Fish Forage // *Proc. Salekhard Stationary of the Urals Branch of the USSR Academy of Sciences*. 1962. No. 2. Pp. 27-76.

[211]Kuzikova, V.B. Bottom zoocenoses of the Ob Estuary // *Collection of research works of GosNIORKh*. No. 305. 1989. Pp. 66-73.

the Kamennyi Cape; middle part from the Tambei River mouth to the Taran Cape; and northern part up to the line connecting the Drovyanoi Cape and the Tora-Sol Cape[212].

Freshwater fauna consisting of oligochaetes, chironomids, bivalves and gastropods spreads from the south up to the Kamennyi and Trekhbugornyi Capes. The oligochaete-mollusc community is noted here. The oligochaete-crestacean coenosis is observed further from the Trekhbugornyi Cape. The north of the Ob Estuary is characterized by a mollusk-polychaete community (Kuzikova, 1989).

The first studies of the bottom fauna of the Ob downstream reaches were conducted in 1936-1944 (Ioffe, 1947). In 1960s, the zoobenthos of the Lower Ob was studied in connection with the projected construction of the Nizhne-Obskaya HPP[213]. Then V.S. Yukhneva[214,215] described the bottom zoocenoses of the Ob delta, determined the degree of zoobenthos consumption by fish, and published a list of chironomid species of the downstream reaches of the Ob-Irtysh basin. Macrozoobenthos of the Lower Ob was studied by SibrybNIIproekt in connection with the planned transfer of part of the Ob runoff to Central Asia[216]. Later, the studies of macrozoobenthos were carried out within the environmental monitoring and expert reviews associated with the development of the West Siberian oil and gas complex[217,218].

---

[212]Burmakin, E.V. Hydrological and physico-gepographical assay on the Ob Estuary and the Gydan Bay // *Proc. of the Institute of Polar Agriculture, Animal Breeding and Hunting*. Leningrad: Glavsevmorput', 1940. No. 10.

[213]Ioffe, S.I., Salazkin, A.A. More on the issue of forage resource state in the projected Nizhne-Obskoye Reservoir // *Gidrostroitel'stvo i rybnoe khozyaistvo v Nizhnei Obi* (Waterworks Constructioon and Fisheries in the Lower Ob). Tyumen: Izd-vo SibNIIRKh, 1966. Pp. 92-109.

[214]Yukhneva, V.S. Benthos of the Lower Ob and its use by fishes // Biological Processes in Sea and Continental Water Bodies. Paper abstracts for the 2nd Congress of the All-Union Hydrobiological Society. Kishinev, 1970. Pp. 423-424.

[215]Yukhneva, V.S. Hydrobiological characteristics of the Taz Estuary // *Proc. of the Fishery and Ichthyology Department and Research Laboratory of Fishery Industry*. Moscow: Pishchevaya promyshlennost. 1971. Pp. 19-24.

[216]Sadyrin, V.M., Butakova, T.A., Kuzikova, V.B., Slepokurova, N.A. Modern state of benthos in the Lower Ob: predicted hydrobiological changes caused by runoff redistribution // *Ekologiya*. 1984. No. 4. Pp. 64-70.

[217]Sharapova, T.A., Kuzikova, V.B. More on the studies of zoobenthos in the Lower Ob // Water Ecosystems of the Urals, Their Protection and Sustainable Management: Information materials of the 3rd meeting of hydrobiologists of the Urals. Sverdlovsk, 1986. Pp. 158-159.

[218]Kuzikova, V.B., Butakova, T.A., Sadyrin, V.M. Modern state of bottom fauna in the Lower Ob and Its Estuary // *Gidrobiologicheskaya kharakteristika vodoemov Urala* (Hyrdobiological Characteristics of the Ural Water Bodies). Sverdlovsk: Ural Branch of the USSR Academy of Sciences, 1989. Pp. 92-102.

In general, the benthic fauna of the Ob Estuary is covered in large number of publications, which consider the communities of benthic invertebrates[219,220,221,222,223,224,225,226,227,228,229,230,231,232] (Ioffe, 1947; Kuzikova, 1989; Leshchinskaya, 1962), as well as individual groups of zoobenthos[233,234,235,236,237,238,239,240,241,242,243,244].

Although the bottom fauna of the Ob Estuary is studied quite well, at the moment there is no generalizing faunal summary covering the entire Ob Estuary from the Ob River delta up to its firth in the Kara Sea; the existing information can be found in different publications. The most well-studied southern part of the estuary is inhabited by organisms belonging to 50-130 taxa of species and supraspecific rank (Ioffe, 1947; Kuzikova, 1989; Stepanova, Stepanov, 2000, 2011), while in the northern part of the Ob Estuary the number of taxa of benthic invertebrates increases to 260[245].

The most typical representatives of the bottom fauna of the Ob Estuary are oligochaetes *Limnodrilus hoffmeisteri*, amphipods *Monoporeia affinis* (relict species), *Pontoporeia femorata, Onisimus birulai* and relict mysid *Mysis relicta*. For the Northern part of the estuary, many authors mention crustaceans *Saduria sibirica*, *Saduria entomon, Diastylis sulcata*, bivalves *Portlandia aestoriorum*, priapulid *Halicryptus spinulosus*, polychaetes *Ampharete vega* and *Marenzelleria arctia* previously identified as *Marenzelleria wireni* (Anisimova, 2000; Ioffe, 1947; Kozlovskii, 2012; Kuzikova, 1989; Stepanova, Stepanov, 2000; Frolova, 2008, 2009).

Thus, the benthic fauna in the water area of the planned waterworks construction area of the Project is not rich, which can be explained by its boundary location between the freshwater and seawater zones, as well as by unfavourable living conditions in the shallow water near the coast. Nemerteans, typical seawater representatives, are sporadic there due to low salinity, and are represented just by one species. All species,

---

[219]Kozlovskii, V.V. Macrozoobenthos on the upper shelf in the south-western part of the Kara Sea. Cand. Biol. Sci. Dissertation synopsis. Moscow, 2012. 26 p.

[220]Kuzikova, V.B., Butakova, T.A., Sadyrin, V.M. Modern state of bottom fauna in the Lower Ob and Its Estuary // *Gidrobiologicheskaya kharakteristika vodoemov Urala* (Hyrdobiological Characteristics of the Ural Water Bodies). Sverdlovsk: Ural Branch of the USSR Academy of Sciences, 1989. Pp. 92-102.

[221]Stepanova, V.B. Macrozoobenthos of the Lower Ob // *Vestnik ekologii, lesovedeniya i landshaftovedeniya*, 2009. No. 9. Pp. 155–162.

[222]Stepanova, V.B. Monitoring of macrozoobenthos in the Ob Estuary // *Humans and the North: Anthropology, Archaeology, Ecology: Proc. Russian National Conference, Tyumen, 24-26 March, 2009*. Tyumen, 2009. No. 1. Pp. 291-293.

[223]Stepanova, V.B. Zoobenthos of the Ob Estuary in the seaport construction area // *Humans and the North: Anthropology, Archaeology, Ecology: Proc. Russian National Conference, Tyumen, 6-10 April, 2015*. No. 3. Pp. 347-350.

[224]Stepanova, V.B., Stepanov, S.I. Bottom fauna of the Ob Estuary // *Prirodnaya sreda Yamala. Biotsenozy Yamala v usloviyakh promyshlennogo osvoeniya* (Environment of Yamal. Biocoenoses of Yamal in Conditions of Industrial Development). Vol. 3. Izd-vo IPOS SO RAN. 2000. Pp. 61-72.

[225]Stepanova, V.B., Stepanov, S.I., Vylezhinskii, A.V. Perennial studies of macrozoobenthos in the Ob Estuary // *Vestnik ekologii, lesovedeniya i landshaftovedeniya*. 2011. No. 11. Pp. 110-117.

[226]Sharapova, T.A. Macro invertebrates of the Taz River and water bodies within its basin // *Vestnik ekologii, lesovedeniya i landshaftovedeniya*. No. 1. 2000. Pp. 122-126.

[227]Yukhneva, V.S. Benthos of the Lower Ob and its use by fishes // Biological Processes in Sea and Continental Water Bodies. Paper abstracts for the 2nd Congress of the All-Union Hydrobiological Society. Kishinev, 1970. Pp. 423-424.

[228]Yukhneva, V.S. Hydrobiological characteristics of the Taz Estuary // Proc. of the Fishery and Ichthyology Department and Research Laboratory of Fishery Industry. Moscow: Pishchevaya promyshlennost. 1971. Pp. 19-24.

[229]Yukhneva, V.S. Bottom biocenoses of the Ob delta and regularities in their distribution // *Produktivnost' biotsenozov Subarktiki* (Subarctic Biocenoses Productivity). Sverdlovsk: Izd-vo UrO RAN. 1970. Pp. 189-191.

[230]Yukhneva, V.S. Chironomid larvae in the downstream reaches of the Ob-Irtysh basin // *Gidrobiologicheskii zhurnal*. Vol. 7. No. 1. 1971. Pp. 38–41.

[231]Denisenko N., Denisenko S., Sandler H. Zoobenthos in the Ob Bay in 1996 // Ob Bay Ecological Studies in 1996. Finnish-Russian Offshore/Tehnology Working Group. Report B15. Finland. 1997. Pp. 23-28.

[232]Poltermann H., Deubel H., Klages M., Rachor E. Benthos communites composition, diversity patterns and biomass distribution as first indicators for utilization and transformation process of organic matter // Berichte zur polar Forschung. Report on Polar Research. The Kara Sea Expedition of the Akademik Boris Petrov RV 1997/ First Results of Joint Russian-German Pilot Study. Berlin: Polarforsch. 300. 1999. Pp. 51-58.

[233]Anisimova, N.A. Crustaceans of the estuaries and bays in the southern part of the Pechora and Kara Seas // *Sovremennyi bentos Barentseva i Karskogo morei* (Modern Benthos of the Barents and Kara Seas). Apatity. 2000. Pp. 115-146.

[234]Gur'yanova, E.F. More on the Crustacea–Malacostraca fauna in the Ob-Yenisei Bay and the Ob Estuary // *Issledovaniya morei SSSR* (Research of the Seas of the USSR).No. 18. 1933. Pp. 75-90.

[235]Dolgin, V.N., Ioganzen, B.G. More on the studies of freshg-water mollusks in the lower part of the Taz River // *Gidrobiologicheskii zhurnal*. Vol. 9. No. 5. 1973. Pp. 61-63.

[236]Lyubin, P.A. Fauna and ecology of conched Gastropodae of the Kara Sea // *Fauna bespozvonichnykh Karskogo, Barentseva i Belogo morei* (Fauna of Invertebrates in the Kara, Barents and White Seas). *Informatika, ekologiya, biogeografiya*. Apatity. 2003. Pp. 130-195.

[237]Stepanova, V.B. Fauna of relic crustaceans (Malacostraca) in the Ob Estuary // *Vestnik ekologii, lesovedeniya i landshaftovedeniya*. No. 4. 2003. Pp. 97-105.

[238]Stepanova, V.B. Fauna of Chironomidae in the Ob Estuary // *Problemy vodnoi entomologii Rossii i sopredel'nykh stran* (Problems of Aquatic Entomology in Russia and Bordering Countries). *Proc. Russian National Symposium on Ambiotic and Aquatic Insects*. Voronezh. 2007. Pp. 343-346.

[239]Stepanova, V.B., Sharapova, T.A. Fauna of Chironomidae of the Western Siberia // *Vestnik ekologii, lesovedeniya i landshaftovedeniya*. No. 1. Tyumen. Izd-vo IPOS SO RAN. 2001. Pp. 117-124.

[240]Frolov, A.A., Lyubin, P.A. Fauna and quantitative distribution of bivalve mollusks of Pisidioidea superfamily in the Ob and Taz Estuaries // *Fauna bespozvonichnykh Karskogo, Barentseva i Belogo morei* (Fauna of Invertebrates in the Kara, Barents and White Seas). *Informatika, ekologiya, biogeografiya*. Apatity. 2003. Pp. 195-208.

[241]Frolova, E.A. Polychaetes in the southern part of the Kara Sea // *Fauna bespozvonichnykh Karskogo, Barentseva i Belogo morei* (Fauna of Invertebrates in the Kara, Barents and White Seas). *Informatika, ekologiya, biogeografiya*. Apatity. 2003. Pp. 92-111.

[242]Frolova, E.A. Ecology of Polychaeta in the Kara Sea. Cand. Biol. Sci. Dissertation synopsis. Murmansk, 2008. 127 p.

[243]Frolova, E.A. *Fauna i ekologiya mnogoshchetinkovykh chervei (Polychaeta) Karskogo morya* (Fauna and ecology of Polychaeta in the Kara Sea). Apatity: Izd. KNC RAN, 2009. 141 p.

[244]Korsun, S. Benthic foraminifera in the Ob and Yenisei estuaries // Berichte zur Polarforschung. Reports on Polar Research. Scientific Cruise Report of the Kara Sea Expedition of the Akademik Boris Petrov RV in 1997. Berlin: Polarforsch, 266. 1998. Pp. 29-31.

[245]Denisenko N.V, Rachor E., Denisenko S.G. Benthic fauna of the southern Kara Sea // *Siberian River Run-off in the Kara Sea. Characterisation, Quantification, Variability and Environmental Significance*. Elsevier, 2003. Pp. 213-236.

except oligochaeta, are of marine origin, but they are able to withstand water dilution and can be related to the brackish-water group of species (Figure 7.6.4).

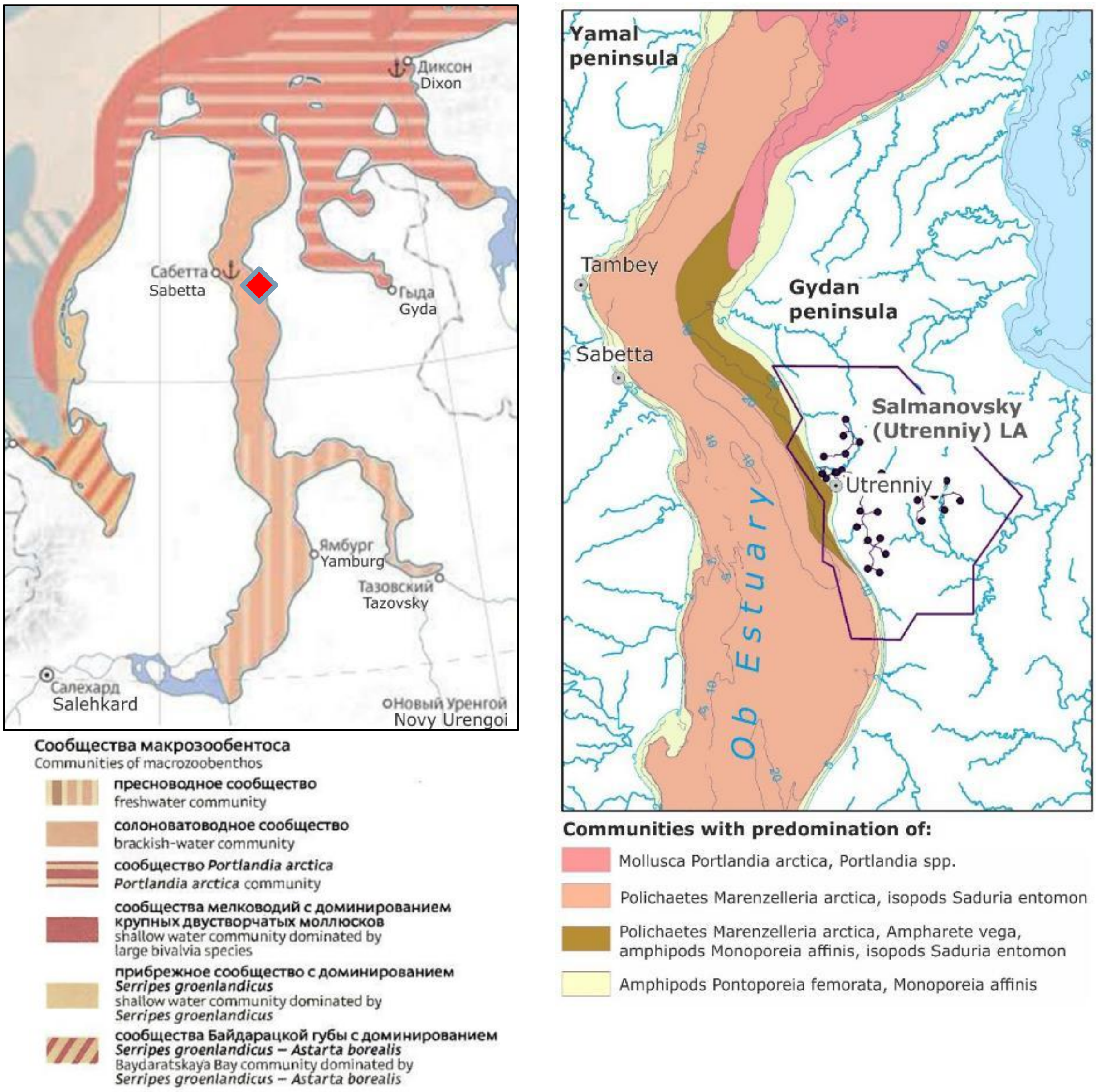


Figure 7.6.4: Distribution of macrozoobenthos communities in the entire Ob Estuary and in the Project Area

(Left. Source: The Kara Sea. Ecological Atlas. Moscow: Arctic Research Center, LLC, 2016. 271 p.), as well as in the Project area (Right. Prepared by the Consultant based on reports: Comprehensive studies of the environmental condition of the Ob Estuary in the zone potentially affected by the Arctic LNG 2 Project and in adjacent water area. IEPI, JSC. 2019; Report on the results of desktop processing of file data under the Contract for the assessment of impact of dredging works on the marine approach channels and soil dumping sites on the bottom communities of the Ob Estuary. CMI MGU, LLC. 2018)

According to literature, quantitative indicators of the zoobenthos are distributed as follows. In the south of the estuary, the abundance of invertebrates varies from 750 to 1500 ind./m^2, and the biomass — from 2.5 to 3.3 g/m^2 (on silts) and up to 9 g/m^2 on silty sands. In the middle part of the estuary, the abundance of organisms reduces to 710–1200 ind./m^2, and the biomass, on the contrary, increases up to 6–12.4 g/m^2. In the area opening to the Kara Sea, the zoobenthos abundance parameters reach 1700 ind./m^2 and 20-26 g/m^2, respectively (Kuzikova, 1989; Denisenko et al., 2003).

Characteristics of macrozoobenthos indicators in the studied water area of the Ob Estuary in the area of the Arctic LNG 2 Project, based on file data for the period 2012-2019, are shown in Table 7.6.5.

Table 7.6.5: Results of the study of macrozoobenthos indicators for the monitoring period 2012-2019

Period	Taxonomic composition	Total abundance	Total biomass
September 2012	4 taxa: Oligochaeta, Polychaeta, Amphipoda, Isopoda	17 – 230 ind./m^2, average 86 ind./m^2	0.11 – 42.25 g/m^2, average 6.45 g/m^2
July–August 2013	5 taxa: Amphipoda – 3 (*Monoporeia affinis, Gammaracanthus lacustris, Pseudalibrotus birulai*), Isopoda – 1 (*Saduria entomon*), Mysidacea – 1 (*Mysis relicta*). Dominants at all stations: scuds *P. birulai* (74–94 % of total abundance)	1400 – 28240 ind./m²	9.98 – 65.88 g/m²
April 2014	4 taxa: Polychaeta – 1, Amphipoda – 2 (*Monoporeia affinis*), Isopoda – 1 (*Saduria entomon*), Mysidacea – 1 (*Mysis relicta*).	80 – 360 ind./m²	0.44 – 1.60 g/m²
August 2014	8 taxa: Enopla – 1 (Nemertinig. sp.), Oligochaeta – 2 (*Potamothrix grimmi, Limnodrilus hoffmeisteri*), Polychaeta – 1 (*Marenzelleria arctia*), Amphipoda – 2 (*Monoporeia affinis, Onisimus birulai*), Isopoda – 1 (*Saduria sibirica*), Mysidacea – 1 (*Mysis relicta*).	120 – 4400 ind./m^2, average 1070 ind./m^2	0.5 – 145.5 g/m^2, Average 25 g/m^2
September 2017	9 taxa: Polychaeta – 2, Amphipoda – 4, Isopoda – 2, Nemertea – 1.	23 – 497 ind./m^2, average 140 ind./m^2	0.15 – 11.8 g/m^2, average 3.3 g/m^2
August 2019 (FRECOM LLC, ZMI MGU LLC)	84 taxa The most characteristic species are Marenzelleria wireni, Ampharete vega, Oligahaeta, Pontoporeia femorata and cumaceans Diastylis sulcata	17 to 5,413 ind./m^2 average 737 ind./m^2	0.19 to 192 g/m^2 26 g/m^2
September 2019 (IEPI JSC)	11 taxa. The dominant species were *Marenzelleria arctia* (in 83% of samples and at 91.1% of stations), *Limnodrilus hoffmeisteri* (in 51.9% of samples and at 71.7% stations), *Ampharete vega* (in 27.4% of samples and at 31.1% of stations).	0 to 610 ind./m^2 186 ind./m^2	0 to 44.69 g/m^2 7.85 g/m^2

According to the results of the field studies by FRECOM LLC, ZMI MGU LLC (2019), 84 taxa of invertebrates were registered in the entire water area of the northern part of the Ob Estuary. Of the individual taxonomic groups, polychaetes were the most common (registered at almost all stations).

The average species variety of zoobenthos was 8.2 species per station, varying in the range from 2 to 33. The maximum species diversity was recorded at station 14 opposite the Khalyango island, the minimum at station 10 near Shokalskogo island and station 58 on the southern border of the study area. Analysis of the distribution of biodiversity showed that higher diversity was reported in the northern parts of the study area, near the mouth of the Ob Estuary. Diversity was lower in the south of the study area and near Sabetta. At some stations, the main component of zoobenthos species diversity were polychaetes. The number of taxa of this group varied from 0 (station 12 at the on the Khalyango island - cape Turysalya section) to 17 (station 4 on the northern border of the study area).

Below is a schematic map of benthic communities generated by statistical methods (based on cluster analysis of data on species' significance in the community) (Figure 7.6.5).

The average total number of zoobenthos according to the results of the field studies by FRECOM LLC, ZMI MGU LLC (2019) was 737 ind./m^2, varying in the range from 17 to 5,413 ind./m^2. The maximum abundance of zoobenthos (mainly due to the high abundance of polychaetes *Ampharete vega*) was recorded at station 38 north of Tambey, minimum - at station 10 near Shokalskogo island. An increased abundance of benthos was typical for the area near Sabetta and the central part of the study area between Tambey and Khalyango island. Low abundance of benthos was observed both at the southern section and at the northernmost stations at the outlet of estuary.

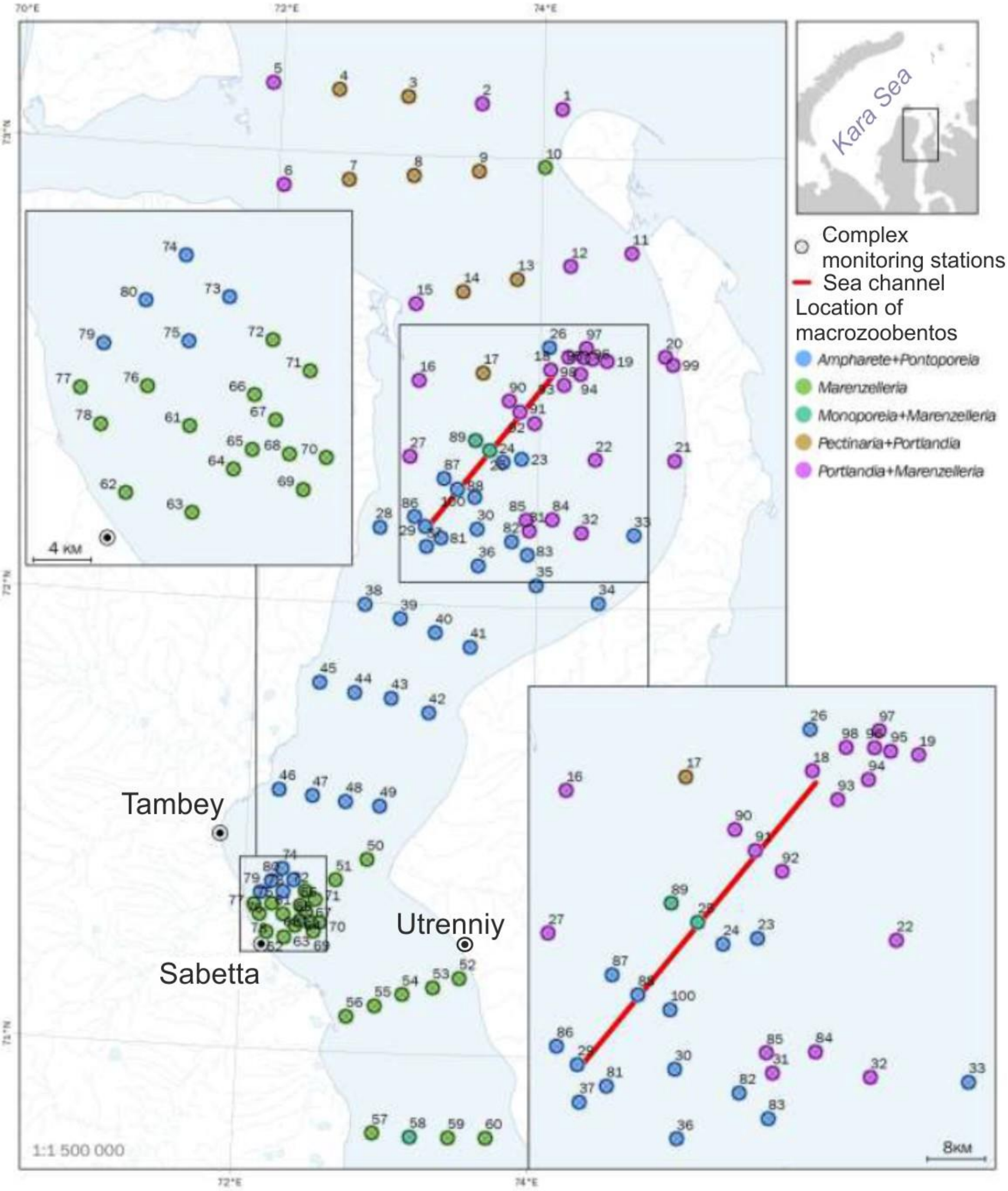


Figure 7.6.5: Distribution of macrozoobenthos communities in the Ob Estuary, based on the results of field studies within the area of influence of the Yamal LNG Project. Source: FRECOM LLC, ZMI MGU LLC, 2020

In general, the distribution of the total benthos abundance in the study area was mosaic, without any pronounced trends. The total number of zoobenthos was mainly determined by the abundance of polychaetes. Average size of this group was 392 ind./m^2 (53% of the total) number, varying in the range from 0 to 3567 ind./m^2. Higher abundance of polychaetes was more often observed in the southern half of the surveyed water area and near Sabetta, minimal – in the northern half. Bivalves and scuds were also found in significant quantities. The average abundance of bivalves was 121 ind./m^2 (16% of the total number), varying from 0 (at 49 out of 100 survey stations) to 1 217 ind./m^2 (station 20 on the right shore opposing the village of Drovyanoy). Increased abundance of bivalves is reported almost exclusively in the northern part of the surveyed water area, abeam of the Khalyango island.

Average total biomass of zoobenthos in the study area was 26 g/m^2, varying in the range of 0.19 to 192 g/m^2. The maximum biomass of zoobenthos (mainly due to the high biomass of bivalve mollusks *Portlandia arctica*) was recorded at the station near Drovyanoy, minimal - near the Shokalskogo island. The distribution of biomass, as well as the abundance of benthos, was mosaic, without pronounced trends. Higher abundance of benthos was more often noted in the area of Drovyanoy village and the Khalyango island, and was associated with the maximum development of either bivalves, or polychaetes, or isopods. Lower biomass values were observed both in the southern section< and in the area of Sabetta and at the northernmost stations at the outlet of estuary. The distribution of macrozoobenthos biomass in the northern part of the Ob Estuary, according to the results of field studies by FRECOM LLC, ZMI MGU LLC in 2019 in the area of influence of the Yamal LNG Project is shown below (Figure 7.6.6).

Field studies by FRECOM LLC, ZMI MGU LLC in 2019 show that the distribution of benthic communities in the northern part of the Ob Estuary largely correlates with the salinity of the bottom waters, which determines the presence of freshwater, brackish-water, or typical marine species. Soils in the concerned area of the Ob Estuary are rather uniform and are not a decisive factor in the distribution of macrozoobenthos. In general, macrozoobenthos abundance is higher at the outlet of the Ob Estuary, in the sea water conditions.

Comparison with the data from the previous studies indicates fluctuations of benthos in the northern part of the Ob Estuary, due to the unstable hydrological conditions. The highest biomass values are observed at the outlet estuary. Here, according to the results of monitoring in 2019, fluctuations were observed within the boundaries of the distribution of the brackish-water community of bivalve mollusk *Portlandia arctica*.

According to the results of the expedition work of IEPI, JSC, in September 2019, macrozoobenthos in the studied water area of the Ob Estuary was characterized by low taxonomic diversity: 11 taxa of bottom invertebrates were found, 8 of which were identified to the species level. Species diversity ranged from complete absence of species in a sample to 1–6 species per sample, and from the absence of macrozoobenthos representatives to 1–7 species (3 species on average) per station. In terms of occurrence frequency in the sampled material, 3 invertebrate species dominated: polychaete *Marenzelleria arctia* (in 83% of samples and 91.1% of stations), oligochaete *Limnodrilus hoffmeisteri* (in 51.9% of samples and 71.7% of stations), and polychaete *Ampharete vega* (in 27.4% of samples and 31.1% of stations). Glacial relict crustaceans were also quite common: isopoda *Saduria entomon* (or sea louse) — in 19.3% of samples and at 42.2.6% of stations, amphipoda *Pontoporeia femorata* — in 17.8% of samples and 33.3% of stations, and amphipoda — in 8.9% of samples and 13.3% of stations. The rarest species in the samples were the representatives of sipunculids (Sipuncula gen. sp.), ribbon worms (Nemertea gen. sp.), priapulids *Halicryptus spinulosus*, larvae of Chironomidae, and bivalve mollusc *Musculium transversum*. All the detected species are typical of the studied part of the Ob Estuary; no alien species were found. The values of the total abundance of macrozoobenthos at the stations varied from 0 to 610 ind./m^2, and the values of the total biomass — from 0 to 44.69 g/m^2. The average values of macrozoobenthos abundance and biomass for 45 stations were 186 ind./m^2 and 7.85 g/m^2. The main contribution to the formation of total abundance and biomass values of macrozoobenthos at most stations was made by polychaete *Marenzelleria arctia* (on average 66% of the total abundance and 52.5% of the total biomass), polychaete *Ampharete vega arctia* (on average 13% of the total abundance and 16.6% of the total biomass).At some individual stations, a significant contribution to the total abundance and biomass was made by isopod *Saduria entomon*, oligochaete *Limnodrilus hoffmeisteri*, and amphipods *Pontoporeia femorata* and *Monoporeia affinis*. Generally, according to the number of identified taxa and the ranges of total abundance and biomass (including their average values), the values of macrozoobenthos indicators obtained in September 2019 lie within the ranges of values known for the water area from the results of studies performed for the needs of the Project at issue in 2012-2017, and from the published data.

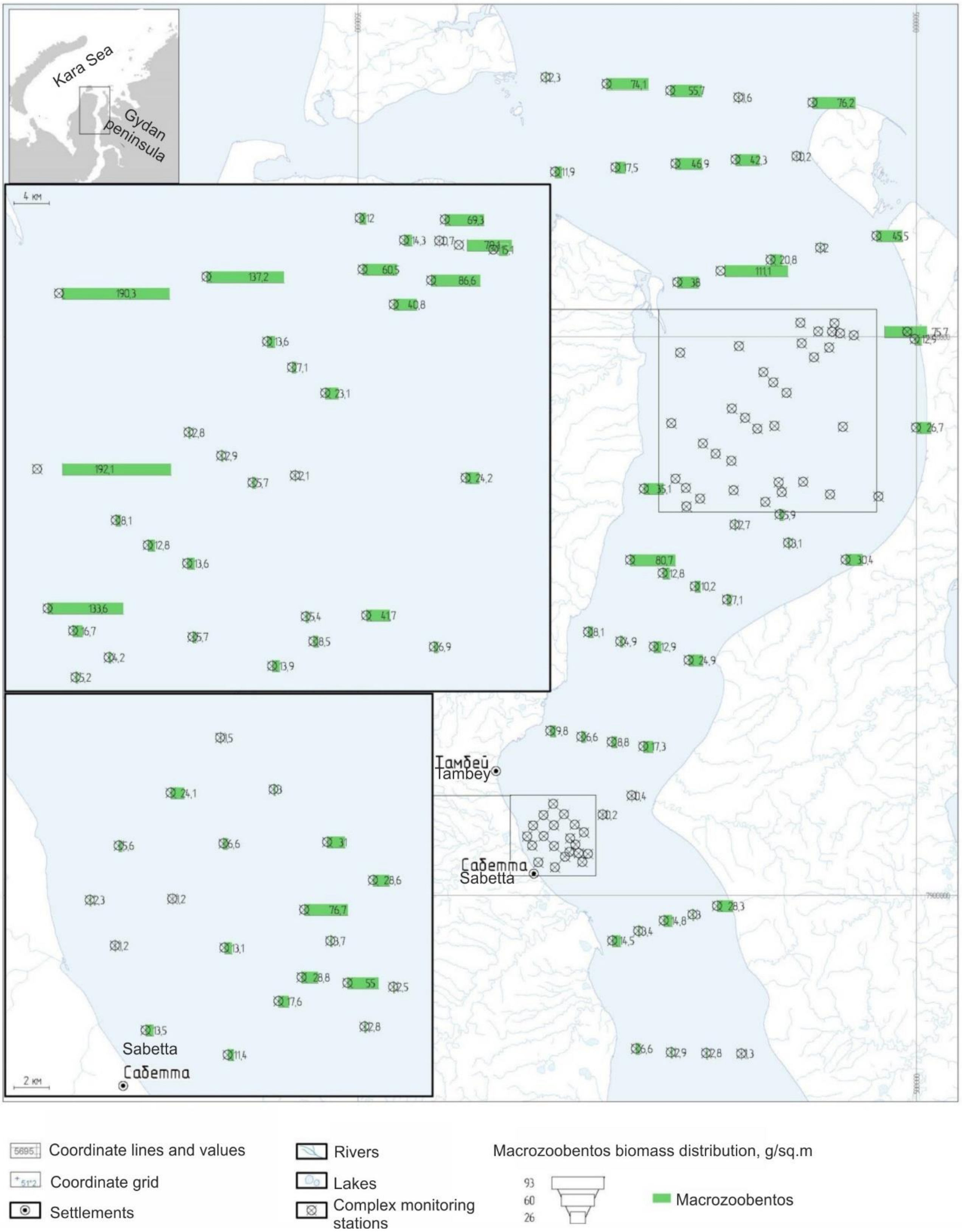


Figure 7.6.6: Macrozoobenthos distributiom in the nort of the Ob Estuary, based on the field studies within the the Yamal LNG project area of influence

Source: FRECOM LLC, ZMI MGU LLC, 2020

The composition of macrozoobenthos is dominated by eurybiont species. The index of stenobiont and eurybiont species ratio in the macrozoobenthos is 0.3±0.06 on average for the surveyed stations (based on the results of the analysis of scooping samples in 2019 season). The Shannon index calculated by the number of benthic invertebrates and reflecting the assessment of species diversity and the degree of dominance, averaged 1.1±0.09, with the range of variations being 0.0-1.92. The index of recovery (regeneration) of zoobenthos fauna[246] at the stations averaged 2.4±0.201, i.e. the benthic communities are dominated by widespread species that have a pelagic juvenile stage in their life cycle. Thus, despite the relative taxonomic and functional scarcity, the ichthyic and benthic coenoses of the Ob Estuary are potentially resistant to the expected anthropogenic impact during the Project implementation.

Isopod *Saduria entomon*

Polychaete *Marenzelleria arctia*

Polychaete *Ampharete vega* (without tube), magnification 10x

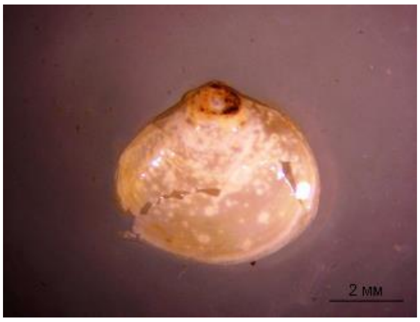
A fragment of tubes of *Ampharete vega* "encrusted" with transparent grains of sand (usually, the tubes of polychaetes are of uniform composition), magnification 10x

Oligochaetes *Limnodrilus hoffmeisteri, sample* O10(b), magnification 10x

Amphipods *Pontoporeia femorata,* sample O13(a), magnification 10x. Adults of this species have reduced eyes.

Priapulid *Halicryptus spinulosus*, sample O10(c), magnification 10x

Sipunculid *Sipuncula gen. sp.,* sample O36(c), magnification 10x



Bivalve mollusk *Musculium transversum*, sample O35(c), magnification 10x

Figure 7.6.7: Background macrozoobenthos representatives in the Project water area

(IEPI, JSC, 2019)

The analysis of the spatial distribution of macrozoobenthos indicators at the stations showed that benthic communities in the zone of existing dredging and dumping (stations O1-O9, O13) are impoverished in terms of species composition, and are characterized by low abundance and biomass. The median values of the number of benthic species in and out of the dredging and dumping areas are 1.6 and 3.1, respectively. The median values of biomass in the samples are 0.22 g/m^2 and 7.23 g/m^2 in the dredging and dumping areas and in the areas outside the direct impact, respectively. The median values of benthos abundance were 13.3 and 186.7 individuals at disturbed and undisturbed stations, respectively. Thus, the results of

[246] Drozdov, V.V. Environmental safety provision in developing the resources of shelf seas, and nature use management based on the assessment of marine ecosystems immunity to human-induced impacts // *Arktika: ekologiya i ekonomika*. 2018. No. 4. Pp. 55-69.

the expedition works confirm the degradation of benthic communities in the area of works and indicate the zone of actual impact of the Project.

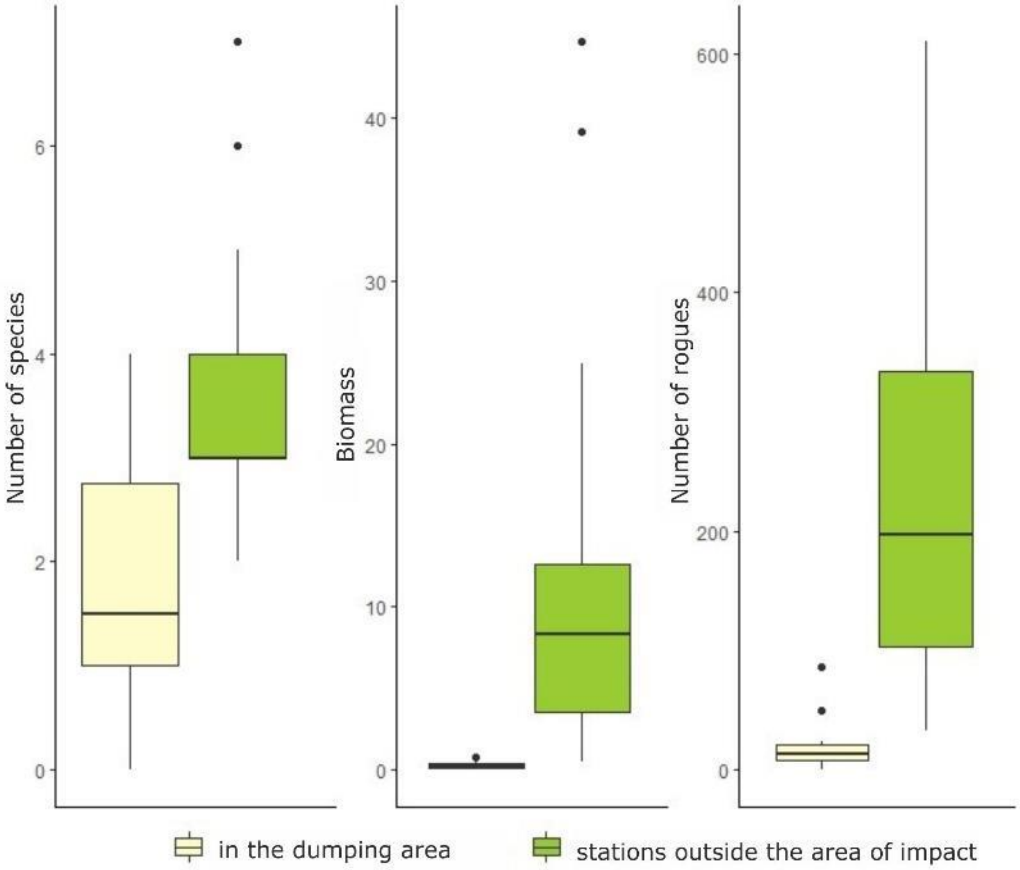


Figure 7.6.8: Differences in the number of species, biomass (g/m²) and abundance (ind./m²) of zoobenthos in the dredging (stations O1-O9) and soil dumping (station O13) areas, and at background stations outside the zone of direct impact

The horizontal line is the median; the upper and lower lines of the rectangle are the lower and upper quartile; the vertical line is the minimum and the maximum; and the points show outliers. (Source: IEPI, JSC, 2019)

Figure 7.6.9 below shows a map of the current state of macrozoobenthos indicators in the water area of the Arctic LNG 2 Project, based on the results of expedition work in 2019. The zone where low values of benthic abundance and biomass were observed in bottom-scooping samples is confined to the water area of the approach channel and the existing dumping site. The zone of benthic communities degradation, therefore, is approximately 1 km from the boundaries of the approach channel and the construction site of other water facilities.

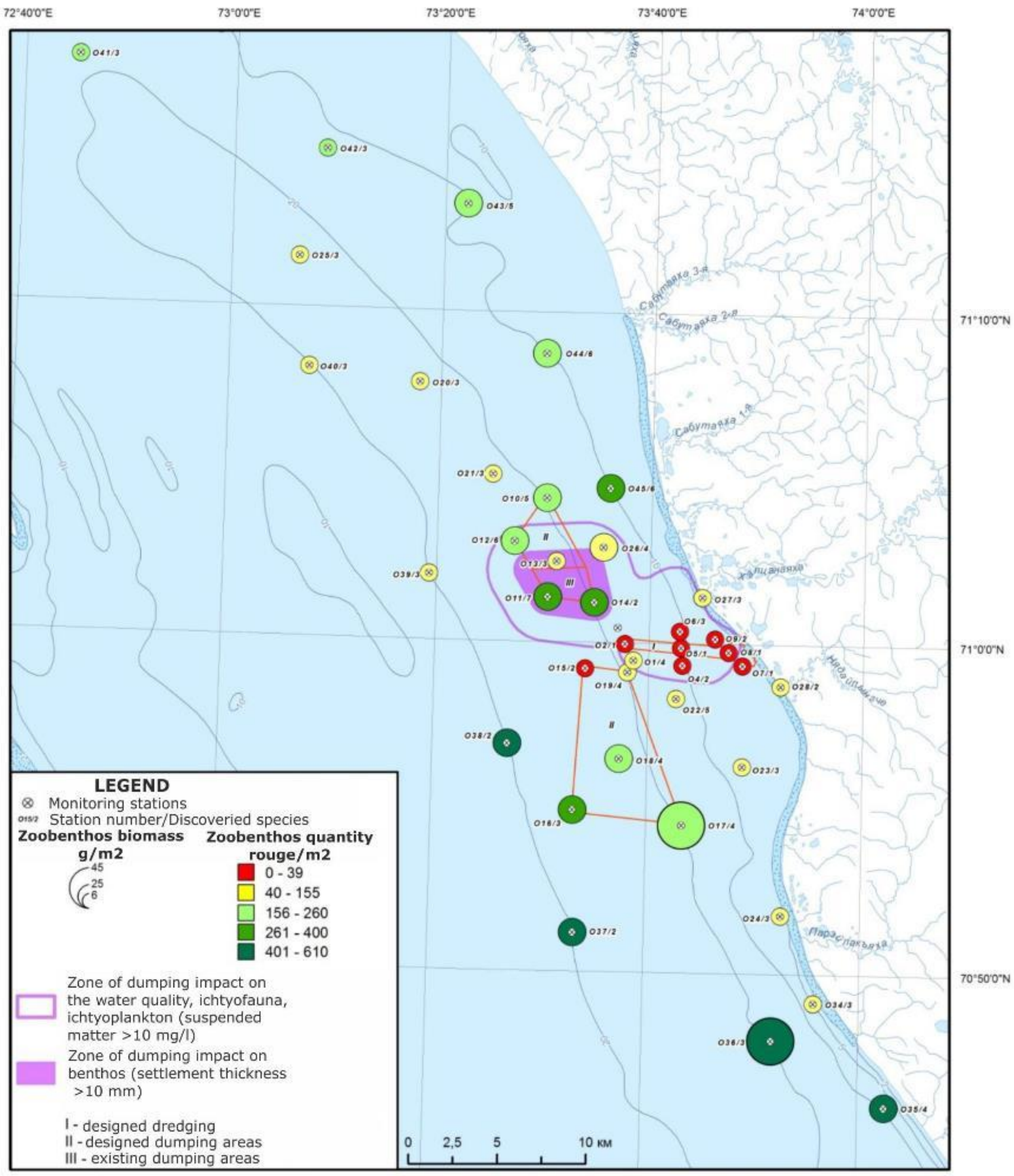


Figure 7.6.9: Macrozoobenthos indicators in the Project water area, based on the results of environmental monitoring

(Source: IEPI, JSC, 2019)

According to the data provided in the report of IEPI, JSC, the benthic communities have a natural potential to recover after disturbances, thanks to the active lithodynamic processes at the bottom of the Ob Estuary and the predominance of widespread species. As soon as the technogenic load has been removed, the recovery of zoobenthos communities will take from one to several seasons. The recovery of the longest-forming and most permanent communities of polychaetes *Marenzelleria arctia* and *Ampharete vega arctia* in their habitat areas may take several seasons, taking into account the active lithodynamic processes.

7.6.2.7 Ichthyofauna

<u>General assessment of fish fauna diversity</u>

According to zoo-geographical zoning of the Western Siberia Region by fish fauna, the territory and waters in the place of the planned location of the Project facilities belong to the *Primorsko-Obskiy District, a sub-district of the northern part of the Ob Estuary*. The Ob Estuary is classified as the water body of top fishery value.

Fishery characteristics of the Ob Estuary are taken from the library and archive materials of FSBSI GosRybTsentr, FSUE PINRO, Eco-Express-Service LLC, and from open literature. The ichthyofauna of the Ob Estuary can be conventionally divided into five groups (Table 7.6.6).

Fifteen fish species are of high commercial value. Most of the commercial fish species are associated with diluted zone. In the marine area with high salinity, mainly non-commercial species can be met.

The ichthyofauna of the Ob Estuary is relatively diverse. It generally includes the representatives of the Arctic freshwater faunal complex and the boreal flatland one. Fishes of the Arctic freshwater complex, such as Coregonidae, burbot, Arctic char, rainbow smelt and nine-spined stickleback, form the basis of the ichthyofauna.

Representatives of the Coregonidae family dominate in terms of both the number of species and the abundance of populations. Relatively thermophilic fishes of the boreal flatland faunal complex in the Ob and Taz Estuaries are represented by Cyprinidae (10 species), pike, common ruff and river perch.

Table 7.6.6: Ichthyofauna species composition in the Ob Estuary

Fish groups	Fish species
1. Fish living in freshwater zone	**1. Broad whitefish *Coregonus nasus**** **2. Siberian whitefish *Coregonus lavaretus pidschian**** **3. Peled *Coregonus peled**** 4. Siberian sterlet *Acipenser ruthenus marsiglii* 5. Bream *Abramis brama* **6. Common roach *Rutilus rutilus rutilus**** **7. Siberian dace *Leuciscus leuciscus baicalensis**** **8. Nerfling *Leuciscus idus**** 9. Crucian carp *Carassius carassius* 10. Golden carp *Carassius auratus gibelio* 11. Common minnow *Phoxinus phoxinus* 12. Lake minnow *Phoxinus perenurus* **13. Burbot *Lota lota**** 14. Arctic grayling *Thymallus arcticus* **15. Common pike *Esox Lucius**** **16. Common ruff *Gymnocephalus cernuus**** **17. River perch *Perca fluviatilis**** 18. Common pike perch *Stizostedion lucioperca* 19. Siberian bearded stone loach *Barbatula toni*
2. Fish living in freshwater and brackish-water zones	20. Siberian sturgeon *Acipenser baerii Brandt* 21. Arctic char *Salvelinus alpinus* 22. Humpback salmon *Oncorhynchus gorbuscha* **23.Siberian white salmon *Stenodus leucichthys nelma**** **24. Muksun *Coregonus muksun**** **25. Siberian cisco *Coregonus sardinella**** **26. Rainbow smelt *Osmerus mordax dentex**** **27. Arctic cisco *Coregonus autumnalis autumnalis**** 28. Nine-spined stickleback *Pungitius pungitius*
3. Fish living in brackish-water zone	29. Fourhorn sculpin *Triglopsis quadricornis* 30. Christmas flounder *Liopsetta glacialis*
4. Fish living in brackish-water and seawater zones	31. Navaga *Eleginus navaga* 32. Polar cod *Boreogadus saida*
5. Fish living in seawater zone	33. White Sea herring *Clupea pallasi* 34. Atlantic herring *Clupea harengus pallasi* 35. Polar eelpout *Lycodes polaris* 36. Ribbed sculpin *Triglops pingeli* 37. Arctic staghorn sculpin *Gymnacanthu stricuspis* 38. Shorthorn scorpion *Myoxocephalus scorpius* 39. Rough hamecon *Artediellus scaber* 40. Lumpfish *Cyclopterus lumpus* 41. Striped sea snail *Liparis liparis* 42. Two-horned sculpin *Icelus bicornis* 43. Spatulate sculpin *Icelus spatula* 44. Arctic alligatorfish *Ulcina olriki* 45. Slender eelblenny *Lumpenus fabricii* 46. Stout eelblenny *Lumpenus medius*

**** - commercial fish species***

Most of fish species (66 %) are non-migratory; their lifecycle passes in freshwater conditions. They inhabit the southern part of the Ob Estuary and the Taz Estuary, and in spring they go for long feeding and spawning migrations in the rivers and their floodplain system.

Anadromous species include the Arctic char, humpback salmon and rainbow smelt. Only the latter reproduces in the rivers around the Ob-Taz estuary region where it stays for the whole life cycle. The Arctic char can be infrequently found in the northern part of the Ob Estuary. Humpback salmon comes from the Kola Peninsula coast in odd-numbered years and is caught in the southern part of the Ob Estuary and in the Taz River.

Semi-anadromous species migrating from fresh to salt water are represented by 9 species: Siberian sturgeon, sterlet, Siberian white salmon, broad whitefish, muksun, peled, Siberian whitefish, Siberian cisco and Arctic cisco. Local populations of typical freshwater fishes such as burbot and bream feed and winter in brackish water environment.

Marine fish species inhabit the northern part of the Ob Estuary and are related to the boreal and Arctic zoo-geographical complexes. Quantitative proportions and the boundaries of species occurrence vary from year to year and are associated with climate changes in the region. Most of the marine fishes in the Ob Estuary are few in numbers and live at the bottom or in near-bottom water of littoral zone. Polar cod and navaga are exceptions; in some years, they form remunerative concentrations during feeding and spawning migrations. Fourhorn sculpin is a rather abundant species of the Ob Estuary; it is a euryhaline species which penetrates the brackish-water zone of hydrological frontier and enters river mouths.

In terms of spawning time, the fish species can be divided into three groups: spring-spawning species (sturgeons, Asian smelt, grayling, pike, Cyprinidae, Percidae and nine-spined stickleback); autumn-spawning species (Coregonidae), and winter-spawning burbot.

Masses of spring-spawning species enter the rivers for spawning after the water bodies have become free of ice and the spawning substrate has been filled with water. Spawning usually takes place in May and June. The Coregonidae finish their summer feeding and migrate to river spawning grounds in late July or early August. Siberian cisco reproduces directly in the Ob Estuary (in the Novyi Port Bay and near the Kamennyi Cape), and so do the Siberian whitefish (near the Kamennyi cape) and, probably, the broad whitefish. In August and September, underyearlings of the Siberian whitefish, Siberian cisco and Asian smelt were caught in minnow seine in the littoral zone in the eastern part of the Ob Estuary. Burbot migrates for spawning in November and December, after freeze-up.

<u>Ichthyofauna in the area of the Project's offshore facilities</u>

The species composition of the ichthyofauna in the Ob Estuary in the Project water area was studied in the course of research in 2011 (September), 2012 (September), 2014 (August), 2017 (August), 2018 (September), and 2019 (September).

The Arctic cisco *Coregonus autumnalis* is of the highest commercial importance (in terms of catch volume) in the middle and northern parts of the Ob Estuary, which includes the Project area.

Cisco is a dominant component of ichthyic coenosis in the area of the Project offshore facilities construction. This species uses the large water area of the Estuary as a feeding ground. Upon reaching puberty, it migrates to the Yenisei Bay. In summer and autumn, the Arctic cisco is quite often observed near the Shokalskogo Island, in the Malygina Straight, near the Drovyanoi Cape, in the estuaries of the Khabei-Yakha, Tambei and Vendibei-Yakha Rivers. In these areas, cisco stays in the narrow littoral zone where it feeds actively. Its main prey is mysids that are concentrated in shallow water. The Arctic cisco's habitats in the littoral zone are limited to the depth of 10 m. The age structure of the Arctic cisco population includes up to 11-12 age groups. The largest age group is eight-year-old fishes, while mass puberty is reached at the age of five to six years.

All in all, there are 14 fish species in the area of salt water dilution in the Ob Estuary; however, only Siberian cisco and especially the Arctic cisco form remunerative concentrations in some seasons.

Thus, in August 2019, in the water area of the North-Obskiy LA, one fish species - navaga *Eleginus nawag*a (Koelreuter 1770) was caught, which is a near-bottom pelagic Arctic species, an object of commercial and coastal fishing. A total of 14 fish were caught, the total catch was 1.661 kg.

Further to the south, in the area of Sabetta port (South Tambey GCF), the dominant species in catches in September 2011 were omul, navaga, and fourhorn sculpin. Omul was the most common species; in total, 8 age groups from 2+ to 9+ were identified. The male to female ratio was close to 1/1. Omul forage was poor and mainly consisted of crustaceans. The entire catch of navaga caught in nets in the area adjacent to the designed port structures at cape Sabetta consisted of individuals aged 2+ (100%). Males accounted for 36%, females - 64%. All fish were at maturity stage III. Navaga was actively foraging (stomach filling index 1.5).

In a later period (October 3, 2013), again, navaga accounted for most part of catches near the water area of Sabetta port - 856 individuals (99.3%), In addition, 3 fourhorn sculpins were caught, 1 omul, 1 ruff and 1 Siberian cisco. The estimated catch ranged from 18.5 kg to 95.6 kg / order / day of fishing. Like other fish, navaga is mainly concentrated along the coastal strip. Navaga concentration along the coast ranged from 145 to 420 kg/ha. Such a large number of navaga is explained by the beginning of spawning migration.

At the beginning of August 2013, 7 fish species were present in catches in the area of Salmanovskoye OGCF. The largest part of the catch was Siberian cisco - 308 units, smelt - 130 units, and fourhorn sculpin - 107 units. Besides them, 54 units of navaga were caught, 30 omuls, 19 ruffs and 1 lamprey. The catch in nets set at the depths of 1.5–3 m was almost three times higher than at the depths of 7–9 m. In addition, omul was present in the nets in the coastal zone, while not a single unit of omul was caught at depth. The bulk of Siberian cisco and smelt was present in the tidal zone, where the main food resources are concentrated. With distance from the coast, the biomass of Siberian cisco decreased rather rapidly: at the depth of 1–3 m its biomass was 60–100 kg/ha, at 7–9 m - only 20–40 kg/ha. In the areas with maximum concentration, the biomass of smelt reached 30–35 kg/ha. The highest concentration of fourhorn sculpin was 25–28 kg/ha. Of all whitefishes, omul occupies the most northern regions, survives salinity of 20–22 ‰, sometimes enters even more saline waters; during the summer feeding period, it sometimes occurs in the open part of the Kara Sea. All omul caught in early August 2013 were encountered in the coastal zone, where it fed. The catches included omul specimens from 21 to 41 cm long and 2+ to 9+ years old. The entire catch of navaga consisted of juveniles. Like other fish, navaga is mainly concentrated along the coastal strip. Navaga biomass along the coast ranged from 6 to 12 kg/ha, its biomass decreasing with increasing depth.

Smelt, sterlet (single specimen), Siberian cisco, and omul were present in the catches in the fixed combined nets (ice fishing) in the area of the Salmanovskoye OGCF in April 2014. The main components were omul and smelt (49.1% and 41.4%, respectively). The catch of omul consisted of fish ranging in length from 13 to 42 cm (average 33.9 cm). The weight of fish varied from 27 to 1,190 g (average 596.9 g). The age of omul in the catches was 1–9 years old, with a predominance of individuals aged 6+. The sex composition of omul from the catches in the combined nets was characterized by the predominance of females (52.7%). Smelt individuals from 11 to 18 cm long (on average 14.9 cm) were noted in the catches with fixed combined nets. The weight of fish in the catches varied from 12 to 57 g with an average value of 32 g. Both omul and smelt were intensively foraging during the survey period in April 2014.

During test fishing in the area of the Project facilities (Plant and Port) in August 2014, seven fish species were registered: fourhorn sculpin, Siberian white salmon, burbot, Atlantic navaga, broad whitefish, Siberian whitefish, and Arctic cisco; the latter made up to 57% in the catches (Figure 7.6.10).

Figure 7.6.10: Ichthyofauna of the projected Plant and Port facilities water area

Top to bottom: broad whitefish (1), Siberian whitefish (2), Siberian white salmon (3), navaga (4), Arctic cisco (5). Photo materials of NPF DIEM, LLC (2014)

In August 2017, 10 species belonging to the boreal Arctic and Arctic faunal complexes were found in the catches within the environmental technical surveys of InzhGeo company. Siberian cisco was the dominant species and accounted for about 70% of the total catch (Figure 7.6.11).

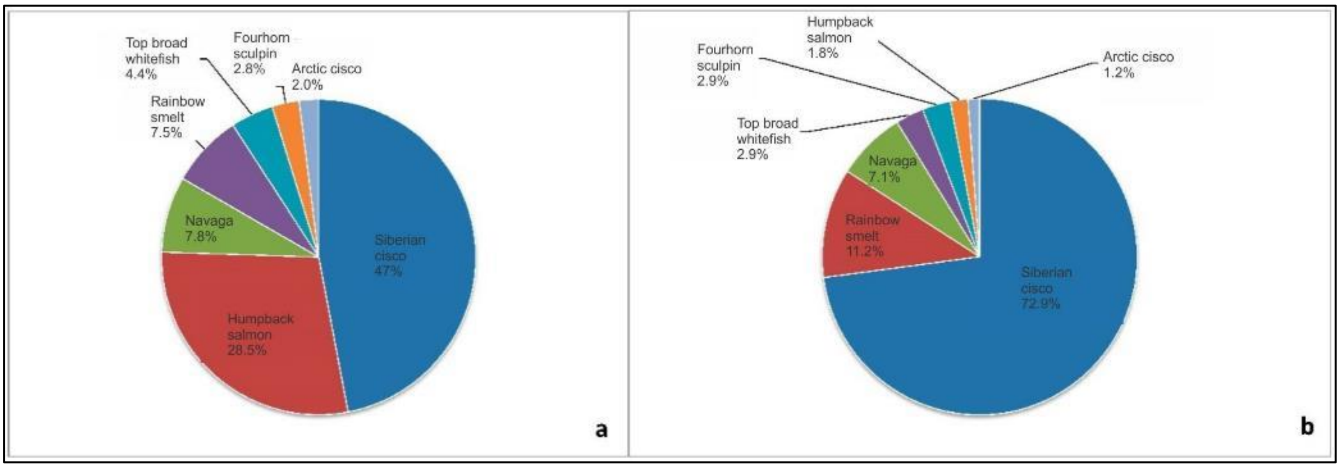


Figure 7.6.11: Proportion of species in net catches from the water area of Salmanovskiy (Utrenniy) License Area in August 2017, %

a – by weight, b – by the number of individuals

The dominant species in all nets installed by FSUE PINRO in September 2012 was the Arctic cisco. Smelt made up to 20% of catches by weight in some nets (Figure 7.6.12).

Comprehensive research of IEPI, JSC, in the water area adjacent to the Project's offshore facilities in 2019 revealed the presence of 7 fish species in the water area. According to the results of field studies, an uneven distribution of ichthyofauna in the water area was observed, with quantitative predominance of Siberian cisco *Coregonus sardinella* (32%) – 132 ind./day and rainbow smelt *Osmerus dentex* (22%) – 88 ind./day. However, the biomass of these fish species is insignificant – 9.1 kg/day and 5 kg/day, respectively. The species dominant by biomass are Arctic cisco *Coregonus autumnalis* (29%) – 14.6 kg/day and sea whitefish *Coregonus pidschian* (26%) - 12.7 kg/day. Less common are navaga, fourhorn sculpin, and ruff; these species do not form dense clusters (Figure 7.6.13).

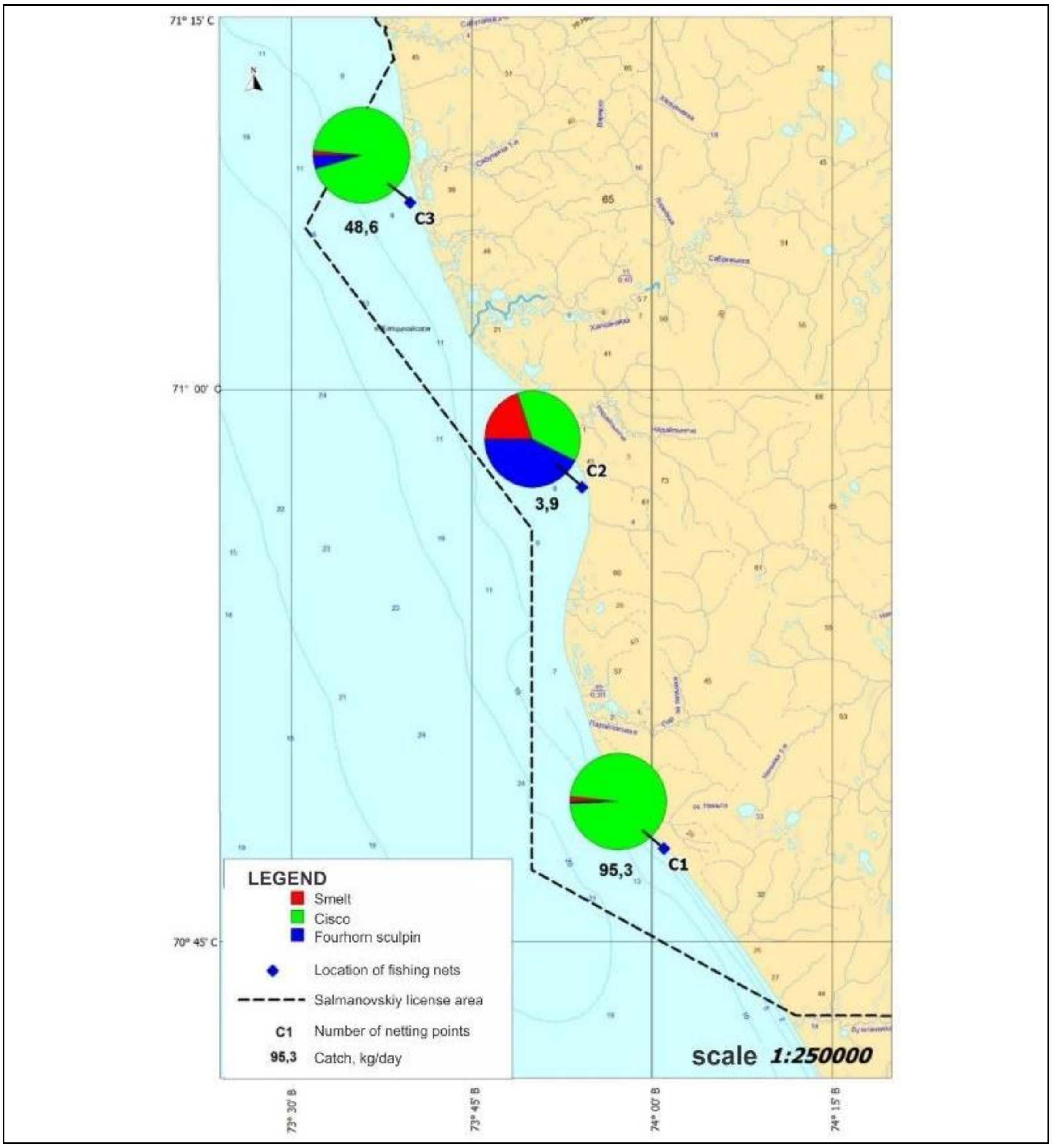
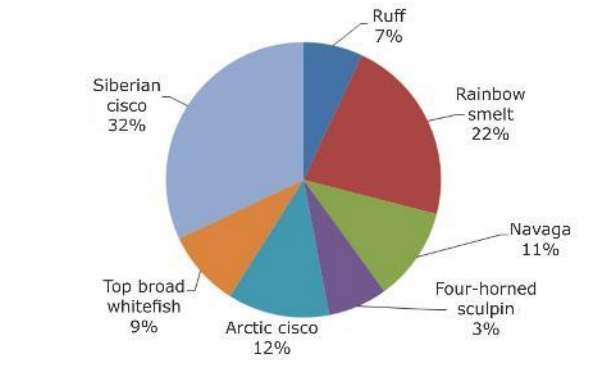


Figure 7.6.12: Proportion of species in the net catches (by weight) in September 2012

Source: FSUE PINRO



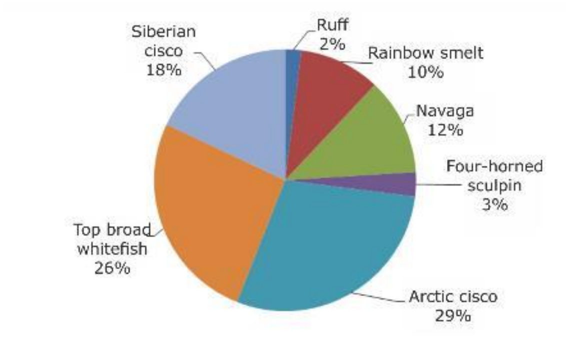


Figure 7.6.13: Proportion of species in the net catches (left – by weight, right – by biomass) in September 2019 (IEPI, JSC, 2019)

Development, migrations and specific features of seasonal distribution of **fish**

Of all the fish inhabiting the Ob Estuary, the absolute majority of species reproduce outside this estuary, migrating for spawning upstream of the rivers and brooks flowing into the estuary. Early stages of development of these fish, in particular, eggs brooding, larvae hatching, and start of active feeding, take place in rivers; in most cases, further maturation up to juvenile and underyearling also develops there. These species usually get into the estuary at the juvenile stage and use actively this water area for intensive feeding. This is especially relevant for the most valuable commercial fish of this region, namely Coregonidae, such as muksun and peled. A part of the Ob population of Siberian whitefish and Siberian cisco spawn directly in the Estuary.

This is especially relevant for the most valuable commercial fishes of this region, namely Coregonidae, such as muksun and peled, etc. [247][248][249]. Among them, a part of the Ob population of Siberian whitefish and Siberian cisco spawn directly in the Estuary. According to V.V. Kuznetsov, at the end of September 2006, mature individuals of these species with IV stage gonads were found in the estuary, and underyearlings in the catch near the coast with the sue of minnow seine, which, on the authors' opinion, indicates local spawning[250]. Also, spawning of broad whitefish is possible in this area.

Spawning of Siberian cisco in the Ob Estuary takes place from the first ten days of October to mid-November in the Novy Port Bay, tributaries of the Lower Ob and Taz Estuary. Within the Estuary, spawning is confined to the discharge areas of tundra rivers[251][252]. Eggs are cast onto sandy soil at the depth of 2-3 m. The incubation period is as long as 220-240 days. Larvae hatch from late May to early June. Hatching is dependent on ice drift - it occurs either during or immediately after the ice drift period. The larval stage takes about 20 days. In summer, Siberian cisco fry feed mainly in the southern area of the Estuary and, in small numbers, along the coast in its middle part, mainly in the eastern section. In winter, it keeps to the central area of the Estuary. Fertility ranges from 5 to 12 thousand eggs. Unlike other whitefishes, Siberian cisco spends most of its life in the Ob Estuary.

Siberian whitefish mainly spawns in the Ural tributaries of the Ob river in September-early October, but some individuals spawn in the coastal zone of the Ob Estuary, along its western coast from Cape Kamenny to Cape Lebediny, at the depth of 2-3 m, most often in October-November, under ice. Eggs are cast on pebble soil. The incubation period is long, about seven months. Most larvae hatch from late April to early June. Their length at hatching is 8.3-11.3 mm. The migration of larvae from spawning grounds occurs, according to various sources, either before the ice breaks down, or during ice drift. Mortality at this stage on thespawning grounds is about 10%, and may increase up to 50% if hatching occurs in open water. Juveniles keep in near-shore shallow waters of rivers, mainly in the southern half of the Estuary. Absolute fecundity of Siberian whitefish varies varies within a wide range: from 3.4 to 57.8 thousand eggs.

Broad whitefish is a freshwater species. According to some reports, it can spawn in the south of the Ob Estuary. Juveniles (1+, 2+) of this species feed here in summer in near-shore shallow waters, in gulfs and bays (Popov, 2012). Spawning takes place in rivers from October to November at temperatures close to 0°C during the freeze-up period. Fecundity is from 36 to 124 thousand eggs.

In rivers, whitefish larvae hatch in early spring and, before the ice drift, migrate down to the lower reaches of the rivers, where they feed until late autumn. They prefer to stay in the floodplain waterbodies of their native rivers, without going out at the early stages to the Ob Estuary and estuarine areas with unstable temperature and salinity conditions. Grown juveniles migrate to these areas later in autumn. They keep within near-shore shallow waters, and enter estuarine sections, lower reaches of rivers and small streams for feeding. The main concentrations are confined to the southern and middle parts of the Ob Estuary. The distribution depends on the season and the location of the dead zone in each particular year. Muksun and

---

[247] V. D. Bogdanov. Spatial distribution of whitefish larvae in the Lower Ob area // Whitefish biology. Collection of research papers of Severtsov Institute of Ecology and Evolution, USSR Academy of Sciences. M.: Nauka, 1988. pp. 178-191

[248] V. D. Bogdanov, A. I. Tselischev. Distribution, migration and growth of juvenile Asian smelt in the basin of the Mordy-Yakha river // Aquatic life ecology studies in the Eastern Urals // Collection of research papers of the Ural Branch of the USSR Academy of Sciences. Sverdlovsk, 1992. pp. 86-93

[249] V. D. Bogdanov, S. M. Melnichenko, I. P. Melnichenko. Migration of whitefish larvae at the spawning grounds of Manya river (Lower Ob basin) // Ichthyology. 1991. Vol. 31, issue 5. pp. 776-782.

[250] V. V. Kuznetsov, I. M. Efremkin, N. V. Arzhanova et al. Modern state of the Ob Estuary ecosystem and its fishery importance // Industrial oceanology. 2008. #2. pp. 129-153.

[251] I. N. Brusynina. Siberian cisco biology and production in the Ob and Taz estuaries // Proc. of the Salekhard Section of the Ural Branch of the USSR Academy of Sciences. Sverdlovsk, 1963. Issue 3. pp. 18-30.

[252] P. A. Popov. Adaptation of aquatic organisms to living conditions in Subarctic waterbodies - on the example of the ecology of fish in Subarctic waterbodies of Western Siberia. Novosibirsk: NSU Publishers, 2012. 255 p.

Siberian cisco keep further to the north of other species, at the boundary of fresh and brackish waters. In the water mixing zone, Siberian cisco develops relatively high concentrations in some seasons. Here, as well as in the northern part of the Estuary, immature omul individuals feed. This area of the Ob Estuary, under the significant influence of the Kara Sea, is inhabited by typical marine species: Arctic cod, navaga, Christmas flounder, chosa herring, sculpin - mainly four-horned, Arctic staghorn sculpin, as well as snailfish, snakefish, lumpfish and several other species[253] [254]. Saltwater fish are usually scarce in these areas, with the exception of Arctic cod, navaga and fourhorn sculpin, which are more common. Juveniles of navaga and fourhorn sculpin can spread far to the south, to the middle part of the Estuary, depending on the conditions in particular year: the level of continental runoff, the course of temperatures, the strength and direction of winds that determine the spread of sea waters in the Ob Estuary, primarily in its central area.

Spawning grounds for navaga are usually located in areas with diluted waters at river mouths, zones of tidal currents. Eggs are cast in winter on pebble or sandy-pebble soils at a depth of 5 to 15 m. The incubation period is 2.5 to 3 months. Larvae with a length of 4.7-5.4 mm appear most often by mid-late April, however, the time of incubation and hatching may vary depending on the area, water warming conditions in spring and some other factors. Juveniles of navaga are very typical for the northern and middle parts of the Ob Estuary.

Juveniles of fourhorn sculpin are also common in these areas. Fourhorn sculpin is an Arctic circumpolar species. It inhabits coastal areas of the northern seas, enters bays and lower reaches of rivers, lives in sea, brackish and fresh waters. It seldom occurs at depths below 20 m. Mass spawning takes place in December-January, sometimes until March, at subzero water temperatures, at shallow depths, under ice. Eggs are is dark, cast on stones, usually among algae, and rather large in size - more than 2 mm in diameter. The male protect eggs during the long incubation period. Hatching takes place in May-June, when larvae length is about 8.0 mm. By August, they grow to 20-22 mm[255]. The timing of hatching and the rate of larvae growth may differ depending on specific habitat. Juvenile fourhorn sculpin play an important role in the diet of omul, which actively feeds in the northern and middle parts of the Ob Estuary.

Arctic cod juveniles are common in the southwestern part of the Kara Sea, where they are the most abundant ichthyoplankton species[256]. No information is available about its reproduction in the areas located on the eastern side of the Yamal Peninsula.

Information on the early stages of the Christmas flounder inhabiting the northern part of the Ob Estuary is also scarce. Like navaga, this species spawns in winter.

Besides the species mentioned above, ichthyoplankton of the Ob Estuary may also include some species, the early stages of which enter here from the reproduction grounds in rivers and tributaries. Those include, in particular, smelt and, to a lesser extent, ruff and some cyprinoids.

Smelt spawning grounds in the Ob Estuary are located in rivers, both along its western and eastern coasts. The spawning period is short - usually 1-2 weeks, including the ascent to the spawning grounds and downstream migration after casting eggs (Bogdanov, Tselischev, 1992). At the beginning of spawning, water is warmed, depending on the area, to 3.6 - 12 ° C. Hatching of larvae occurs on the 8-12 day of incubation. After hatching, larvae concentrate in the mouths and estuaries of rivers, and in the shallow areas of the Ob Estuary.

Ruff spawns in rivers, bays and shallow areas. Spawning has multiple stages, starting after the ice breaks down when water warms up to 4.5°C, and continues until mid-July. Eggs are cast at a depth of 0.5-3 m on various substrates, most often sandy and pebble. The period of embryonic development is relatively short, depending on temperature, from 5 to 12 days. Larvae switch to independent feeding after 11-14 days. Ruff larvae can be found in conditions of low salinity, as is observed in the Pechora Estuary[257] (Kashkina, 1962).

Cyprinoids spawn mainly in the southern part of the Estuary, but some of their populations also breed in the northern tributaries.

[253] A. P. Andriyashev. Fish of the northern seas of the USSR. Moscow, Leningrad: USSR Acadamy of Sciences, 1954. 556 p.

[254] V. K. Yesipov. Fish of the Kara Sea - Leningrad: USSR Acadamy of Sciences, 1952. – 145 p.

[255] Atlas of freshwater fish of Russia: 2 volumes. Vol. 1 / Ed. Y. S. Reshetnikov. M.: Nauka, 2002. 379 p.: il.

[256] I. V. Borkin. Ichthyoplankton // Ecosystem of the Kara Sea. Murmansk: PINRO Publishers, 2008. pp. 124-129.

[257] A. A. Kashkina. Ichthyoplankton of the south-east of the Barents Sea // MMBI Proceedings. 1962. Issue 4(8). Pp. 97-133.

Summary of the ichthyoplankton studies over the period 2012-2019 is provided in the table below (Table 7.6.7).

Table 7.6.7: Ichthyoplankton data collected over the observation period 2012-2017

Period	Number of species	Abundance	Biomass	Note
September 2012	Ichthyoplankton was absent in the catches of the ichthyoplankton net	–	–	
July–August 2013	–	–	–	
April 2014	–	–	–	–
August 2014	–	–	–	–
September 2017	In the catches of the ichthyoplankton net, only juveniles of Asian smelt *Osmerus mordax* were found	1 ind./m^2	0.19 g/m^2	Recorded at only one station
August 2019 (FRECOM LLC, ZMI MGU LLC[258])	fourhorn sculpin *Myoxocephalus quadricornis* (Linnaeus, 1758), Arctic cod *Boreogadus saida* (Lepechin, 1774), snakefish *Lumpenus* sp., Arctic snailfish *Gymnocanthus tricuspis*	0.0044 ind./m^3 excluding empty stations and 0.0013 ind./m^3 taking into account empty stations	0.275 mg/m^3 excluding empty stations and 0.08 mg/m^3 including empty stations	–
September 2019 (IEPI JSC)	–	–	–	–

Analysis of the results of previous surveys (2012-2019) indicates that in those seasons when ichthyoplankton studies were conducted in the concerned water area (September 2012 and 2017), no ichthyoplankton organisms (eggs and larvae of fish) were found in ichthyoplankton net, which corresponds to the natural seasonal conditions. In late summer and autumn periods, ichthyoplankton is hardly present in the water area, due to the reproduction patterns of fish inhabiting it.

Fish juveniles (only marine species) were noted in the northern part of the Ob Estuary during the integrated studies by FRECOM LLC, ZMI MGU LLC in the area of influence of the Yamal LNG Project. Larvae and juveniles of four marine and circumpolar fish species were found: fourhorn sculpin, Arctic snailfish, Arctic cod and snakefish. No fish eggs were found in the samples from the area of influence of the Yamal LNG project, since the monitoring was carried out in a season when the earliest stages of development of most fish species have already passed (August).

Presence of significant quantities of ichthyoplankton is expected in ichthyoplankton net catches if sampling is carried out during the open water period at the beginning of the biological summer (June-July and the first half of August).

In spring, when the suffocation zone outbursts, masses of fish migrate mainly to the south, to spawning and fattening grounds. In the Estuary water area, the fish start spring movements under the ice. In the downstream reaches of the Ob River, there is a well-developed floodplain system where the fish can find a lot of food. Fattening in the floodplain system lasts for two to four months. In wet years, fattening of immature individuals lasts till autumn. In low-water years, the fish leave shallow bays in the middle of summer.

Due to the migration of fish to the southern part of the Estuary, the density and species ratio of fish population change. For instance, mainly Siberian cisco remains of all the Coregonidae in the middle of the Ob Estuary; moreover, the Arctic smelt and ruff migrate to these water areas for fattening after spawning. Burbot follows the ruff, since the latter is its main prey. The Arctic smelt migrates mainly along the western (Yamal) coast of the Ob Estuary.

The lowest concentrations of fish are observed to form in the northern part of the Ob Estuary (see Figure 7.6.13) where the main commercial species is the Arctic cisco. Beside this species, during the ice-free season the fish population of this area generally consists of the representatives of the Arctic Basin.

By early August, most of mature Coregonidae finish the period of summer intensive feeding and start the spawning migration. From this moment, the fish distribution manifests significant changes again, because

[258] In the area of influence of the Yamal LNG project, to the north of the Project water area

younglings take part in the migrations together with mature fishes. In particular, clusters of Siberian cisco migrate from south to north, while in the deltas of rivers and creeks the concentration of fish increases as it migrates there from floodplain water bodies. Unlike the spawning shoals, all these fishes continue feeding actively.

Having spawned, the whitefish migrate to the bay again and, together with immature individuals, start moving to wintering areas. Wintering migration of fish in the Ob-Taz estuary area starts after freeze-up (usually in November). Migration of fish takes place under the effect of decreasing oxygen dissolved in water. By that moment, most of the whitefish migrating after spawning have already reached the estuaries. Since the patterns of suffocative water spreading in the Taz and the Ob Estuaries are different, the time and prevailing directions of fish migration are different, too. In the Taz Bay, wintering migration starts earlier and is observed mainly along the eastern coast, while in the Ob Estuary it passes mainly along the western (Yamal) coast.

Wintering migration caused by unfavourable oxygen conditions in the waters of the Ob and Taz Estuaries and associated rivers is highly time-stretched. Large fishes are the first to migrate, since they are very demanding to oxygen content in water. Whitefish juveniles migrate when suffocation starts. The distribution pattern of different species also reflects their sensitivity to water salinity. Of Coregonidae, broad whitefish, peled and Siberian whitefish try to avoid salt water. During the subglacial period, the abundance of these species naturally reduces from the Novyi Port—Yamburg line towards the Kamennyi Cape—Trekhbugornyi Cape line. The broad whitefish, Siberian whitefish, and peled spend winter in the southernmost areas of non-suffocative zone. In contrast to them, muksun, preferring fresh water, is distributed in higher latitudes, so its abundance increases northwards and reaches the maximum in the Yaptik-Sale settlement area.

Whitefish representatives even more resistant to salinity are the Arctic cisco, Siberian cisco and Siberian white salmon. It is interesting that it is quite typical of the Arctic cisco to live in brackish water environment, while the presence of the Siberian cisco and Siberian white salmon in the northern part of the bay is temporary, and is associated mainly with their feeding migration, because both these species prefer to spend winter in fresh-water zone. The Arctic smelt and ruff do not migrate far to the north and spend winter mainly near the Kamennyi and Trekhbugornyi Capes, i.e. feeding and wintering grounds of these fish species overlap to a significant extent. The wintering zone area is known to vary from year to year, depending on the river runoff volume. Its average area is 10,000 km².

With the approach of spring and the beginning of processes of water saturation with oxygen, most of populations migrate to the south as the suffocation frontier shifts. This migration is especially pronounced for the Arctic smelt, Siberian cisco and ruff, who start migrating as early as in May, i.e. long before the suffocation zone outburst.

Key wintering, feeding and spawning grounds of fish in the Project area

There are no significant clusters of fish in the northern and middle parts of the Ob Estuary. Variations of ichthyomass by season is shown below (see Figure 7.6.14). Feeding and fattening of fishes generally take place in the period of open water, when the biomasses of forage plankton and benthic organisms reach the maximum level. In August and September, the biomass of benthos in the tidal area near the coast can reach 30–50 g/m². During this period, shoals of Siberian cisco, Arctic smelt and Arctic cisco migrate along the coast line over the entire water area in the north of the Ob Estuary. The density of shoals reaches 100–150 kg/ha, which is much lower compared to the southern area of the Ob Estuary. Their prey is scuds whose density is the highest in the tidal zone. All fattening fishes (both Siberian cisco and Arctic smelt) are either immature juveniles, or the individuals not spawning in the given year.

Besides the Siberian cisco, Arctic smelt and Arctic cisco, whose numbers vary in a very wide range, navaga is always present in the region under study. This species can form significant aggregations both in spawning and fattening periods. In autumn (September-October), the density of navaga can reach 300-500 kg/ha in some areas.

The main migration routes of the fish are littoral zones diluted to a certain extent by river and land runoff; and different bays are the places of their concentration. The projected Plant and Port location area has an even coastal line, and flat and monotonous bottom relief; therefore, for natural reasons, it does not provide favourable conditions for fish living, so the latter do not form any large clusters in this area.

Rare and protected fish species

Siberian sturgeon (*Acipenser baerii Brandt*) living in the catchments of the Ob and Irtysh rivers is listed in the Red Books of the Russian Federation and YNAO as an endangered species (category I). It is also included in the IUCN List (2010) under the category EN (endangered species). Catching this species is absolutely prohibited. In terms of ecological features, the sturgeon is a semi-anadromous fish whose spawning grounds are located in the middle reaches of the Ob and Irtysh Rivers, and its wintering grounds — in the middle part of the Ob Estuary and in the Taz Estuary (Figure 7.6.15). The northern border of Siberian sturgeon range in the Ob Estuary is reported at 72°N [259][260], which corresponds to the border of the sea-water area. The fish occurs sporadically in the middle and northern parts of the Estuary. Sturgeon is known to call rivers of the Yamal peninsula[261]. In particular, sturgeon was recorded in Venuimuyeyakha River[262]. In July 2018, two juvenile sturgeons were caught in the middle and lower reaches of Venuimuyeyakha River during the biodiversity monitoring activities in the South Tambey LA[263]. The length of the individuals was 421 mm and 428 mm, the weight was 284 g and 381 g, respectively.

---

[259] Ruban G. I. Species structure, contemporary distribution and status of the Siberian surgeon Acipenser baerii //Environmental Biology of Fishes. 1997. V. 48. N. 1-4. P. 221-230.

[260] Ruban G. I. Geographical Distribution, Ecological and Biological Characteristics //The Siberian Sturgeon (Acipenser baerii, Brandt, 1869) Volume 1-Biology. 2018. P. 1.

[261] V. D. Bogdanov, E. N. Bogdanova, O. A. Goskova, I. P. Melnichenko. Retrospective review of ichthyological and hydrobiological studies on the Yamal Peninsula. Yekaterinburg Publishers, 2000. 88 p.

[262] V. K. Ryabitsev, A. V. Ryabitsev, V. V. Tarasov. Look back review of fish of Venuimuyeyakha river (north-east Yamal, Yamal-Nenets Autonomous Okrug) //Fauna of the Urals and Siberia. 2016. No. 1. pp. 134–138.

[263] Comprehensive Biodiversity Monitoring in the South Tambey License Area (YNAO). Final Report on studies in 2018. FRECOM LLC Moscow, 2018. 276 p.

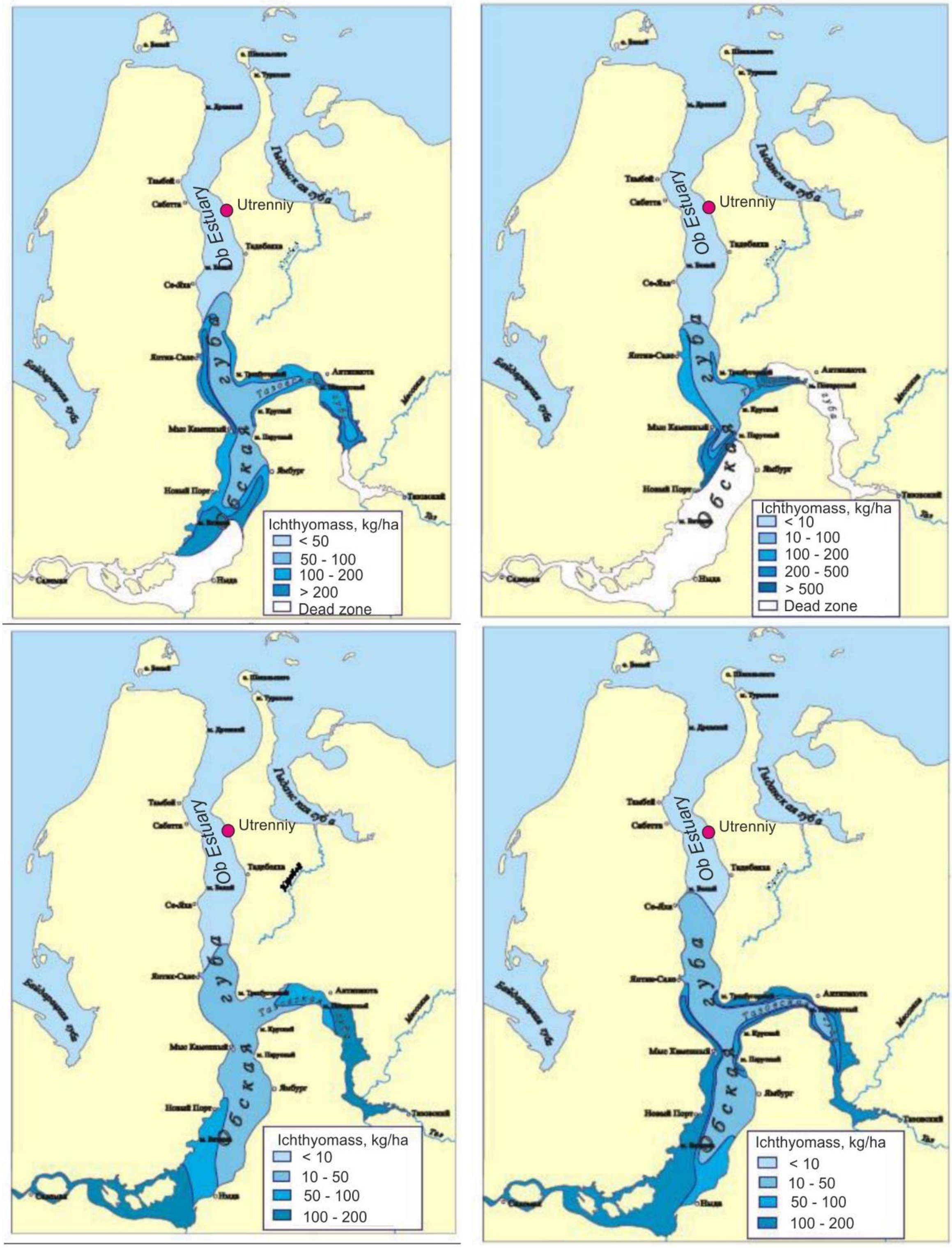


Figure 7.6.14: Distribution of ichthyomass in the Ob Estuary by seasons: from left to right, top to bottom: January-March; late May-early June; July August; September-November.

(Eco-Express-Service LLC, 2019)

Anadromous fish not going to spawn this year, as well as immature and spawned in spring, migrate back to the Ob Bay at the end of summer. The diet of the Ob population of sturgeon is based on benthic invertebrates: larvae of caddis flies, mayflies, midges, chironomids, molluscs, oligochaetes and amphipods. In the water area of the Ob Estuary, sea louse *Saduria entomon* is the main component of the diet. Due to the variable salinity and suffocation conditions in the Ob Estuary in winter, most of its the water area is unsuitable for the permanent habitation of this species (Red Data Book of YNAO, 2010).

Sturgeon spawns in large rivers and lakes with strong currents with a stone or gravel bottom (Red Data Book of YNAO 2010); sturgeon spawning grounds are located in the Irtysh River. The natural reproduction of the Ob population of sturgeon has significantly decreased due to the construction of dams and deterioration of water quality; at present, the most important measure to support the population is its reproduction at fish breeding plants.

For 9 years of regular scientific net and non-water fishing in the northern part of the Ob Bay and in its tributaries, one capture of 2 individuals is known on the Yamal Peninsula. No sturgeon has been found in the rivers of the Gydan Peninsula affected by the Project, and this species has not been found in the water area of the Ob Bay during scientific fishing. The appearance of representatives of this species in the zone of influence of the planned activity should be considered extremely unlikely.

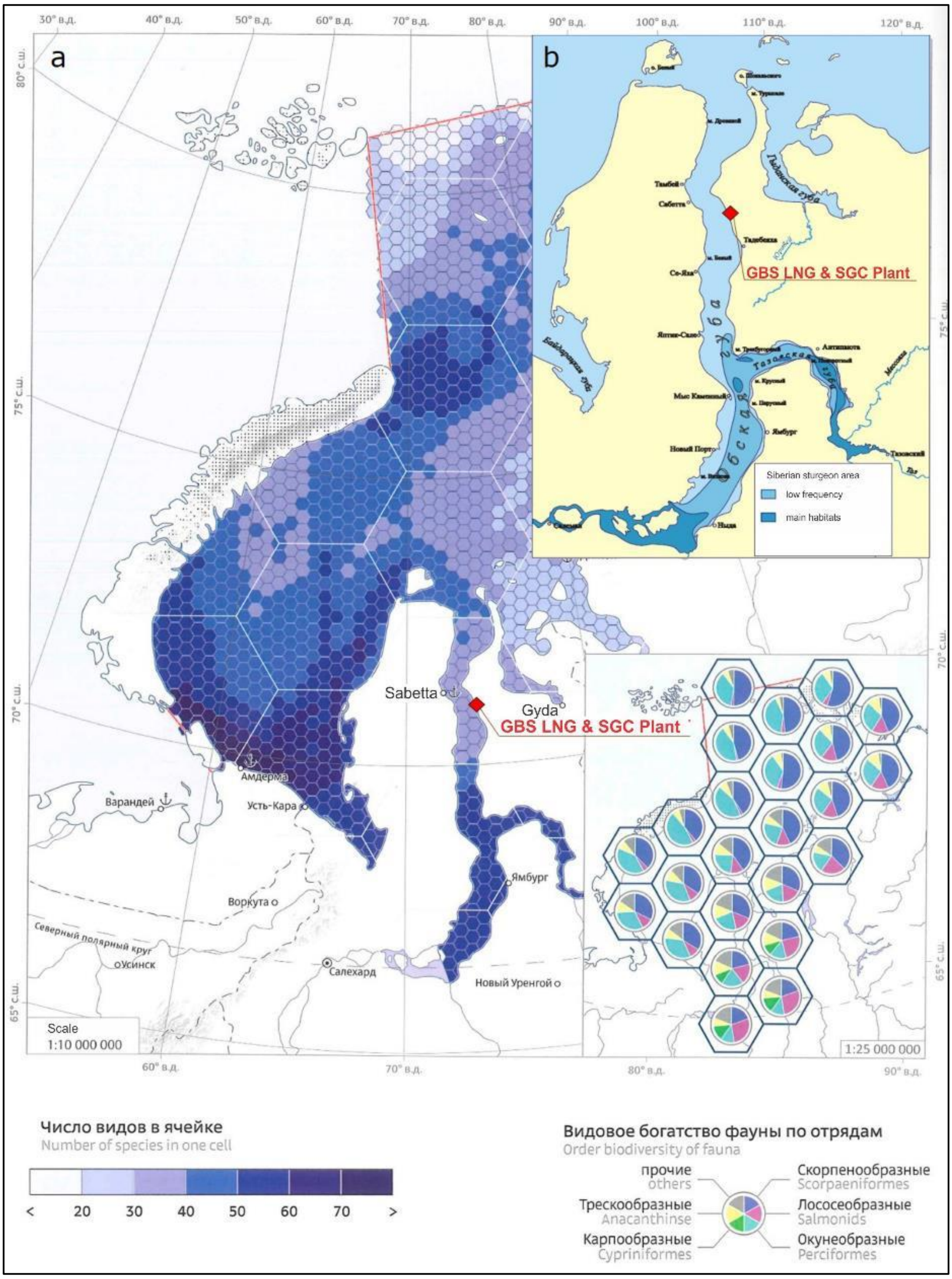


Figure 7.6.15: Ichthyofauna diversity in the Kara Sea (a) and the range of Siberian sturgeon in the Ob Estuary (b)

(Sources: I – The Kara Sea. Ecological Atlas. Moscow: Arctic Research Center, LLC, 2016; II - Fish-cultural and Biological Reasons for Creating a Fishery Conservation Zone)

Muksun. The Red Book of YNAO lists the population of muksun (*Coregonus muksun*) that inhabits the Mordyyakha River catchment on the Yamal Peninsula (flows to the Baydaratskaya Bay). At the same time, since 2014 catching the muksun has been absolutely prohibited in all water bodies of YNAO[264] due to the fact that this valuable species was recorded to deplete. Being a typical semi-anadromous species, muksun forms local stocks confined to large rivers. In winter, its main prey is planktonic small crustaceans, and in summer — near-bottom crustaceans, mollusks, chironomid larvae, and oligochaeta.

The main habitat of the Ob population of muksun is the southern, diluted part of the estuary. The largest number of this species was registered close to Yaptik-Sale settlement, which corresponds to the northern part of the projected fish conservation area (see Figure 7.6.1) in 150-170 km upstream of the Plant and Port[265]. There was no muksun in the trawl and seine catches during the FEED surveys in 2011-2019.

Arctic char (*Salvelinus alpinus*) is represented by a widespread association of lake/river and semi-anadromous populations, some of which are listed in the Red Books of the RF constituent entities. The Ob and Taz population of the Arctic char is considered to experience extremely high fishing pressure; therefore, FSBSI GosRybTsentr (2014) proposed to classify it as rare and protected species of Category V (species whose biology is underinvestigated, and there are concerns about their number and condition, but they cannot be related to any other category due to the lack of information).

<u>Invasive species</u>

Since 1970s, representatives of ichthyofauna from the southern waterbodies, such as bream (*Abramis brama*), pike perch (*Sander lucioperca*), and carp (*Cyprinus carpio*) have been observed in the Ob Estuary. Originally, these fish got to the Ob River from the Novosibirsk water reservoir where they were naturalized, and then migrated to the Ob Estuary under the effect of suffocative water. Bream became common in the Mid-Ob Region where it reproduces successfully; however, no facts of its reproduction in the Ob Estuary have been registered. Bream comes to the estuary from the Ob River as suffocative water forces it out in winter period. The number of breams in the Ob Estuary can be quite significant, but living conditions there are not favourable for this species due to cold water, and the population has to continuously recruit new individuals. In 2018, two specimens of bream were caught in Venuimuyeyakha River in the course of biodiversity monitoring of the South Tambey LA (Comprehensive biodiversity monitoring ..., 2018).

During the same studies, one specimen of river perch *Perca fluviatilis* (Linneaeus, 1758) was caught in the miccle reaches of Venuimuyeyakha River. This was the first capture of this species in the Yamal peninsula waterbodies located north of Cape Kamenny. Perch is a typical representative of the ichthyofauna of the Ob river. However, until recently, perch was hardly found in the central and northern parts of the Ob Estuary and rivers discharging to them. In recent years, an increase in the number of perch has been observed both in the southern and central parts of the Ob Estuary. Moreover, perch is becoming so abundant that it is included in the list of species recommended for commercial fishing. Based on its biology and ecology, perch can be considered as an aggressive invader capable of causing serious damage to native fish species.

Bream and perch were not recorded in the waterbodies of the Salmanovskiy (Utrenniy) LA.

Also, since the 70s of the XX century, pink salmon (Oncorhynchus gorbuscha) has been found in the Gulf of Ob, which fell into the Kara Sea after its introduction in the White Sea. This species is regularly found in small quantities in the Ob Bay and the mouths of rivers flowing into it during the open water period. In particular, in 2017, pink salmon in the water area of the Gulf of Ob was noted during engineering and environmental surveys (Fertoing LLC, 2017). It is noted that the specimens caught in the Ob Bay most likely belong to self-reproducing groups of Norway and the Kola Peninsula, and the naturalization of pink salmon in the Project area is unlikely due to the duration of the subglacial period of more than 240 days, the freezing of rivers suitable for spawning this species to the bottom and the formation of local fish kills, which prevents the development of caviar and larvae. This conclusion is confirmed by the absence of facts of registration of alevins and grilses in feeding areas. Competitive relations with native fish species are not manifested due to the small number of producers.

[264] Except for fishing for research and monitoring purposes, as well as fishing for the purposes of aquiculture and fish farming

[265] Popov, P.A. Migrations of freshwater fishes of the Ob-Taz Estuary region // *Vestnik SVFU*. 2017. No. 4 (60). Pp. 22-33.

7.6.2.8 Seabirds and marine mammals

The avifauna of the Kara Sea is characterized by a distinct seasonal distribution (Figure 7.6.17). In winter, the highest abundance and diversity of birds are usually observed within a relatively narrow strip of water south-eastwards of Novaya Zemlya; in summer, on the contrary, birds are distributed more evenly, although the Ob Estuary still remains one of the least preferred areas even during the warm season.

Figure 7.6.16: Birds reported by surveyors in the Project area.

From left to right, top to bottom: Heuglin's gull (*Larus heuglini*), Arctic skua (*Stercorarius parasiticus*); herring gull (*Larus argentatus*) and orn glaucous gull (*Larus hyperboreus*); long-tailed duck (*Clangula hyemalis*); curlew sandpiper (*Calidris ferruginea*). Photo materials of FSUE PINRO (2012), NPF DIEM (2014), FERTOING (2017), InjGeo (2017)

Nesting of colonial alcidine birds is limited due to the lack of rock cliffs and low submerged coasts. Therefore, the most widespread along the coastline of the Ob Estuary are gulls (Heuglin's gull and glaucous gull) and loons (black-throated and red-throated), which are almost evenly distributed on laidas (Table 7.6.8). Brant goose colonies are distributed mainly on the low islands adjacent to the northern end of the Gydan Peninsula, which is quite far from the study area. They are observed in the field territory only during migrations.

In spring and autumn, during the migration period, the avifauna composition in the Ob Estuary water area is most diverse. In the absence of ice, colonial seabirds can enter here. Presence of most species is limited due to the long period of ice cover. In autumn, significant masses of ducks, geese, gulls and waders of the West Siberian (Gydan and Taimyr) populations migrate over the water area.

Table 7.6.8: Species composition, status of presence, relative abundance of seabird fauna in the area of the Arctic LNG 2 Project hydraulic structures. Source: IEPI JSC, 2019-2020

No.	Species	Status	Relative abundance	Conservation status	2019	2020
	Gaviiformes					
1	Red-throated loon *Gavia stellata*	nest	com		+	–
2	Black-throated loon *Gavia arctica*	nest	com		+	+
	Anseriformes					
3	Brant goose *Branta bernicla*	nest	r		+	–
4	Bewick's swan *Cygnus bewickii*	nest	r	RDB YNAO	+	+
5	Greater scaup *Aythya marila*	nest	r		+	+
6	Long-tailed duck *Clangula hyemalis*	nest	ab		+	+
7	King eider *Somateria spectabilis*	nest	com		+	–
8	Steller's eider *Polysticta stelleri*	nest?	occ	RDB RF	–	–
9	Velvet scoter *Melanitta fusca*	vag	occ	RDB YNAO	–	–
	Charadriiformes					
10	Heuglin's gull *Larus heuglini*	nest	com		+	+
11	Glaucous gull *Larus hyperboreus*	nest	com		+	+
12	Arctic tern *Sterna paradisaea*	nest	com		+	–
Designations: P – permanent; S – seazonal; vag – vagrant; ? – likely; *occ* – occasional; *r* – rare; *com* – common; *ab* – abundant; + - presence is known; – - presence is not known RDB RF - species is listed in the Red Data Book of the Russian Federation (2020), RDB YNAO - species is listed in the Red Data Book of YNAO (2014)						

According to the results of the field studies by FRECOM LLC, ZMI MGU LLC in August 2019 (during active migrations), migratory flocks of Anseriformes, flocks and single individuals of waders (little stint, curlew sandpiper, red-necked phalarope, dunlin and turnstone), as well as typical marine species of black-legged kittywake, glaucous gulls, skuas were encountered in the northern part of the Ob Estuary.

Diversity and abundance of birds were maximal in the north of the Ob Estuary and gradually declined in the southward direction. However, this was due to the greater length of the survey routes in the north, which resulted in better coverage of the composition of the avifauna in this part of the water area; in addition, birds of the marine ecological group were recorded here. Heuglin’s gull, the background species of the region's gulls, was the predominant species throughout the study area. In the north of the Ob Estuary, Arctic skua and red-necked phalarope were also regularly encountered. In the northern and middle parts of the study area, long-tailed duck, short-tailed and long-tailed skuas, black-throated and red-throated loons, common and Steller’s eiders, turnstone, dunlin (near coast), Arctic tern and glaucous gull were recorded. Rare and protected species of seabirds - black-legged kittiwake (IUCN: VU), Steller’s (IUCN: VU) and common eiders (IUCN: NT) were recorded only in the frontal area of the Ob Estuary.

The schematic map (Figure 7.6.18) shows the distribution of rare and protected bird species in the Ob Estuary based on the results of observations from vessels in August 2019 (FRECOM LLC, ZMI MGU LLC, 2020).

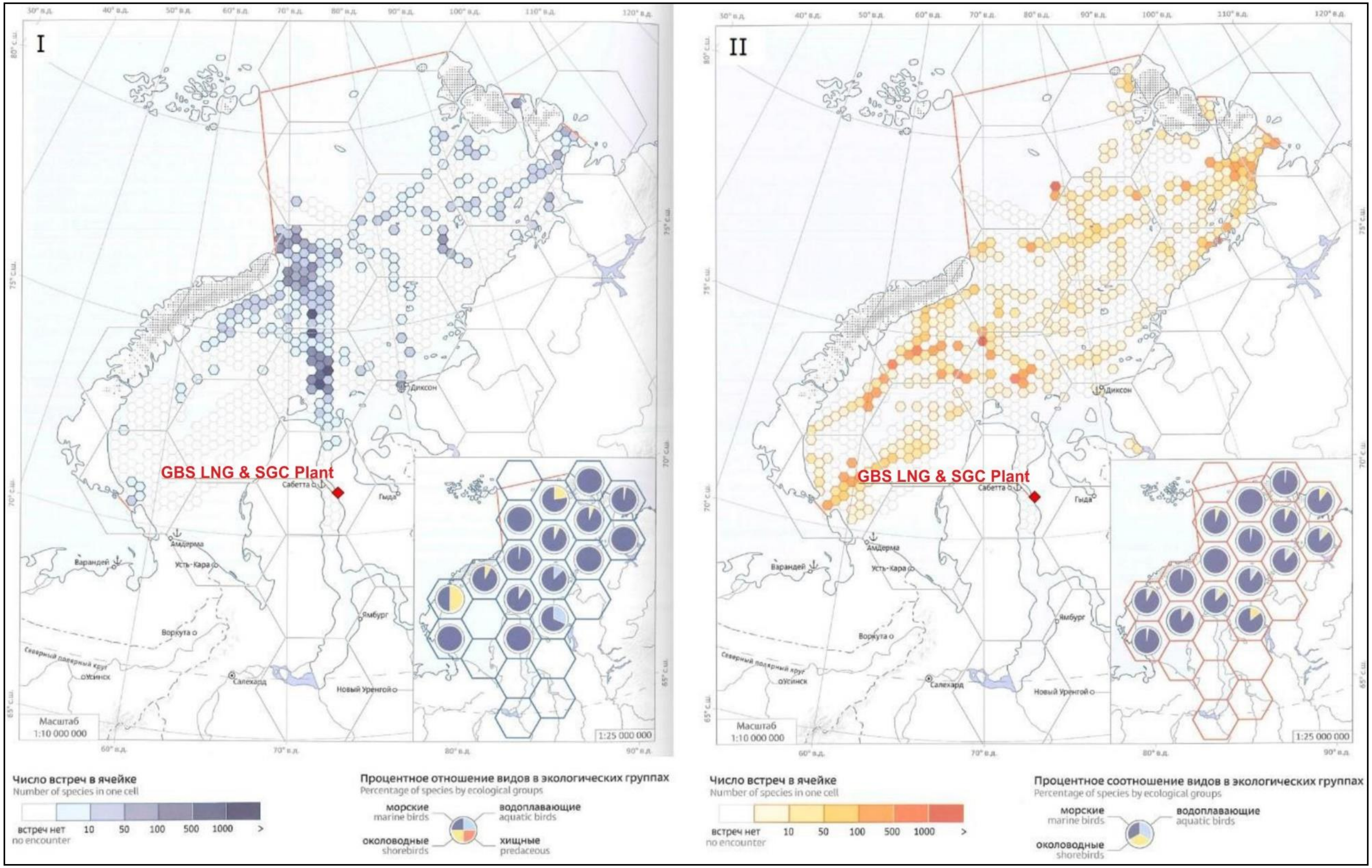


Figure 7.6.17: Summary of bird fauna biodiversity monitoring in the Kara Sea during the field studies by Rosneft Oil Company

I – winter periods 2014-2016; II – summer periods 2013-2015 (Sources: The Kara Sea. Ecological Atlas. Moscow: Arctic Research Center, LLC, 2016)

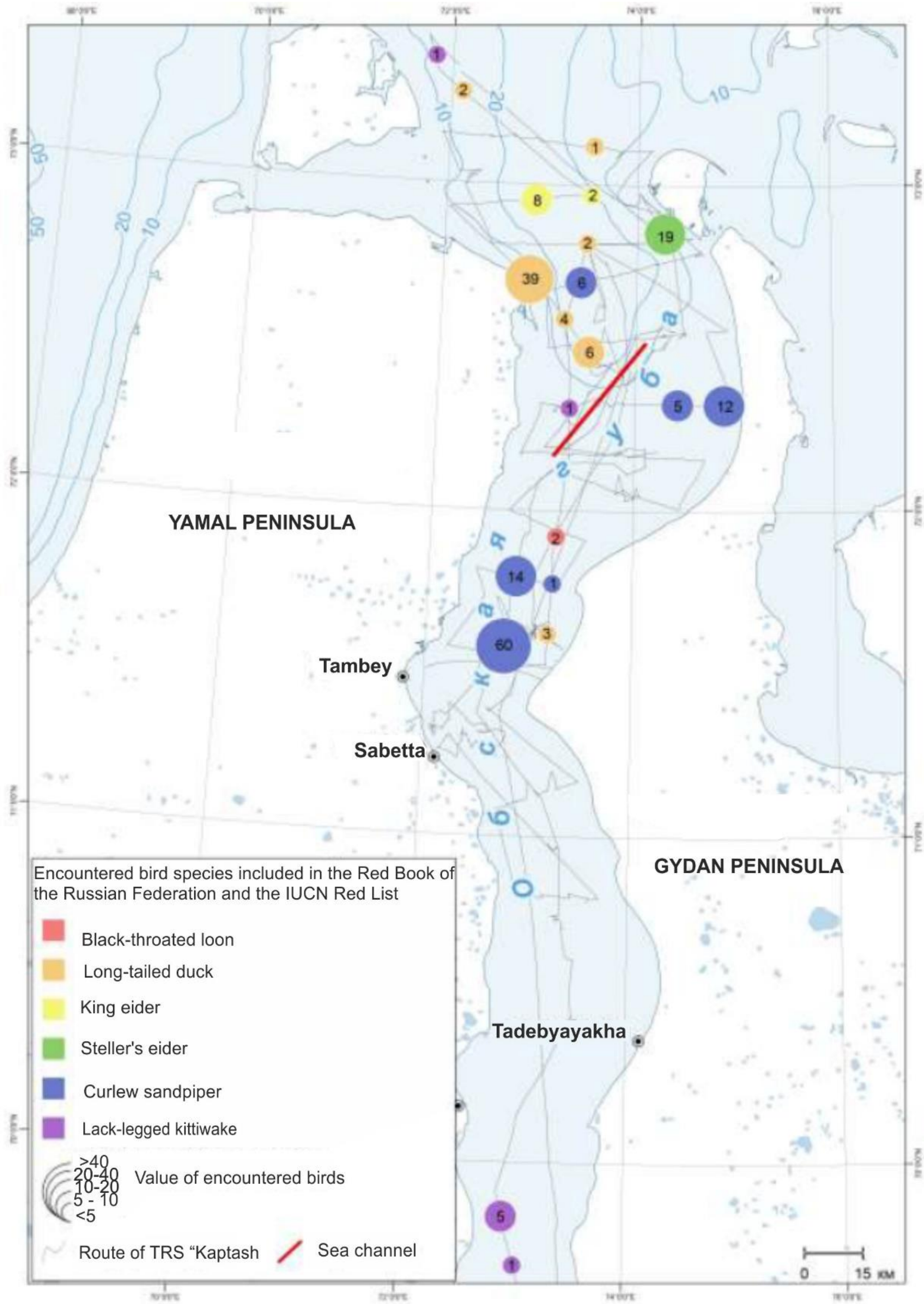


Figure 7.6.18: Encounters of rare and protected bird species during the field studies in August 2019

(Source: FRECOM LLC, ZMI MGU LLC, 2020)

Marine mammals are represented in the Kara Sea by 11 species of 2 orders: cetaceans (Cetacea): bow-headed whale (*Balaena mysticetus*), fin whale (*Balaenoptera physalus*), white whale (*Delphinapterus leucas*), narwhale (*Monodon monoceros*), killer whale (*Orcinus orca*), harbour porpoise (*Phocoena phocoena*); carnivores (Carnivora): harp seal (*Histrophoca groenlandica*), ringed seal (*Phoca hispida*), bearded seal (ugrug) (*Erignathus barbatus*), walrus (*Odobenus rosmarus*), polar bear (*Ursus maritimus*).

The Ob Estuary does not belong to water areas with high diversity and abundance of marine mammals (Figure 7.6.19).

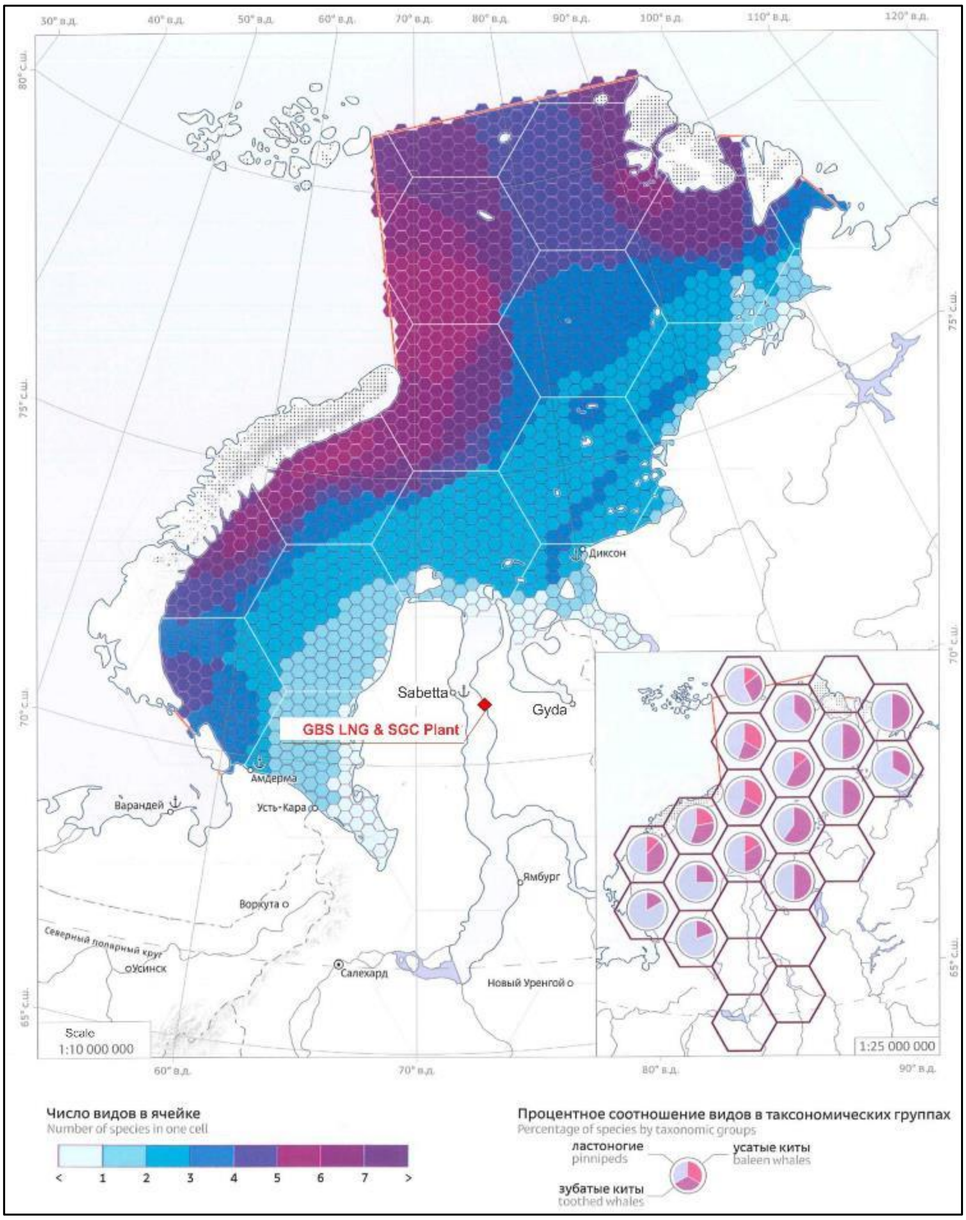


Figure 7.6.19: Diversity of mammal fauna in the Kara Sea

(Source: Kara Sea. Ecological Atlas. M.: Arctic Research Center, 2016)

Marine mammals pecies most common in the Ob Estuary are bearded seal *Erignathus barbatus*, ringed seal *Phoca hispida* and white whale *Delphinapterus Leucas*[266,267,268,269,270,271,272] (Figure 7.6.20).

---

[266] V. G. Geptner, K. K. Tchapskiy, V. A. Arsenjev, V. E. Sokolov, 1976. Mammals of the Sorivet Union. Vol. 2 Paft 3. Pinnipeds and toothed whales. M.: High School. 718 p.

[267] K. K. Tchapskiy. White whale migrations and production in the northern sector of the Ob Estuary // Proc. of Arc. Inst. 1937. Vol. 71.

[268] V. N. Boltunov, S. Ye. Belikov, N. G. Tchelintsev. Aerial counting of ringed seal and bearded seal in the Yamal-Nenets Autonomous Okrug in 1996 // Marine Mammals of Holarctic Region. International conference. Arkhangelsk. - 2000. pp. 21-23.

[269] G. G. Matishov, G. N. Ognetov. White whale of the Russian Arctic seas: biology, ecology, conservation and resource use // Apatity: Kola Scientific Centre of RAS. - 2006.

[270] Geophysial offshore works programme in the Ob Estuary of the Kara Sea 2012 (Vostochno-Tambeyskiy, Salmanovskiy, Geofizicheskiy license areas). Volume 2 - Environmental Protection. Environmental Impact Assessment. Environmental Protection Measures. SPNG Center CJSC, NefteGasStroy Center LLC. 2012. 222 c. http://smngc.ru/assets/Anons/TOM-2-programma-rabot.pdf

[271] A. I. Boltnev, A. I. Grachev. K. A. Zharikov V. B. Zabavnikov, S. I. Kornev, V. V. Kuznetsov, ... I. N. Shafikov. Marine mammals resources and their production in 2013 // Proc. of VNIRO. 2016. Vol. 160. pp. 230-249.

[272] A. R. Semenov, S. S. Yevfratova. Encounters of marine mammals in the nearshore zone of the eastern section of the Kara Sea // Marine Mammals of Holarctic Region. Collection of research papers. Moscow, Marine Mammal Council. Issue 2019. 2019. Vol. 1. pp. 297-303

Figure 7.6.20: Marine mammals in the water areas within the Salmanovsky (Utrenniy) LA, near the Plant and Port.

Left to right: ringed seal (Phoca hispida) and bearded seal (Erignathus barbatus). Photo materials of Eco-Express-Service (2013) and NPF DIEM (2014)

Ringed seal is the most massive marine mammals species in the Ob and Taz estuaries. It lives in all parts of the Ob Estuary up to its apex, and in most areas of the Taz Estuary (Geptner et al., 1976). Information on the seal numbers in the sourth of the Kara Sea is fragmentary, only expert assessments are available. After the disappearance of drifting ice in the Kara Sea, the seal concentrate on fast ice in the southern sections of the sea[273,274], with a density up to 0.5 units per 1 km^2.

As for the ice-free season, the most detailed information on the population numbers is also available for the southern - Ob-Yenisei - sector of the sea (approximately 50,000 km^2), where about 60,000 ringed seals live (density about 1 unit per km^2)[275]. Similar results are reported by the transect counts in the south-western sector of the sea - outfall of the Baydaratskiy estuary - about 1.85 units per 1 km^2.[276] (Murmansk Marine Biology Institute (MMBI) Archive: quoted in the Programme of Marine Geophysical..., 2012). At the level of Kara Sea in general, G. N. Ognetov (2002) refers to the species density of 0.1-0.16 units per 1 km^2. Based on the results of aerial counting in the pinnipeds' ice-based hauling grounds in 1996[277], the seal distribution density in the northern part of the Ob Estuary varied from 0.1 to 2.3 units (average 0.4 units) per 1 sq. km. Considering the decline trend in the animal numbers closer to the upstream areas of the Ob Estuary, it can be suggested that seal density is also low in the rest of the concerned area (not covered during the counting in 1996). At present, estimated number of seals in the Kara Sea is within the range of 90-150 thousand units (Ognetov, 2002).

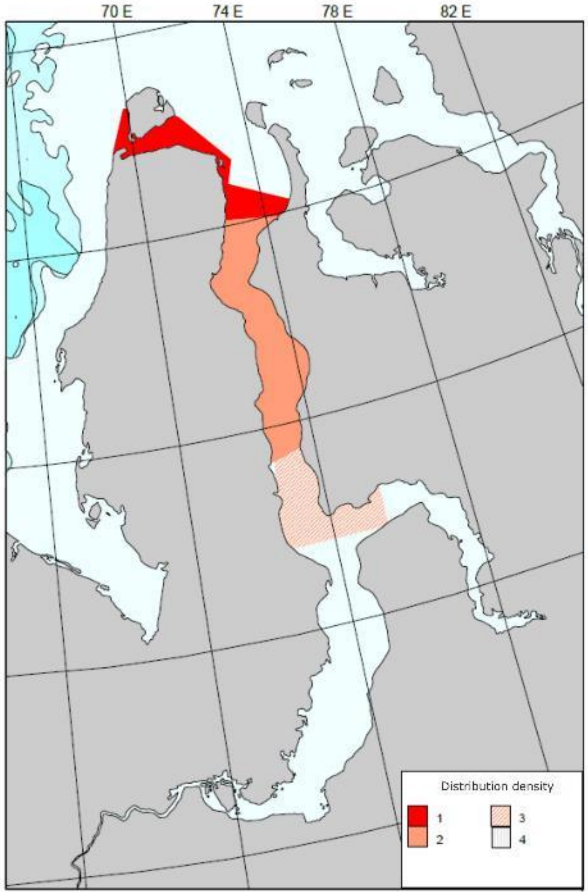
[273] G. N. Ognetov 2002. Quantitative assessment of resources of ringed seal (Phoca hispida) in the White, Barents and Kara seas // Marine Mammals of Holarctic Region. 2nd intern. conf.: Abstract of presentation. (Baikal, 10-15 September 2002). pp. 209-210.

[274] G. N. Ognetov, G. G. Matishov, A. V. Vorontsov. Ringed seal of the Russian Arctic seas. Murmansk, MIP 99. 38 p.

[275] G. M. Tchmarkova, N. D. Daydenok, Ye. G. Martyniuk, S. M. Repyakh, Yu. D. Alashkevish. Assessment of the total reserve of ringed seal in the Ob-Yenisei sector of the Kara Sea. Marine Mammals of Holarctic Region. 2002. pp. 284-286.

[276] A. A. Kondakov. Observations of ringed seal in the Baydaratskiy Estuary of the Kara Sea during ice-free season // Present-day and prospective status of ecosystem research in the Barents, Kara and Laptev seas: Abstr. of present. at internat. conf. Murmansk, 1995. P. 45.

[277] V. N. Boltunov, S. Ye. Belikov, N. G. Tchelintsev. Aerial counting of ringed seal and bearded seal in the Yamal-Nenets Autonomous Okrug in 1996 // Marine Mammals of Holarctic Region. International conference. Arkhangelsk. - 2000. pp. 21-23.



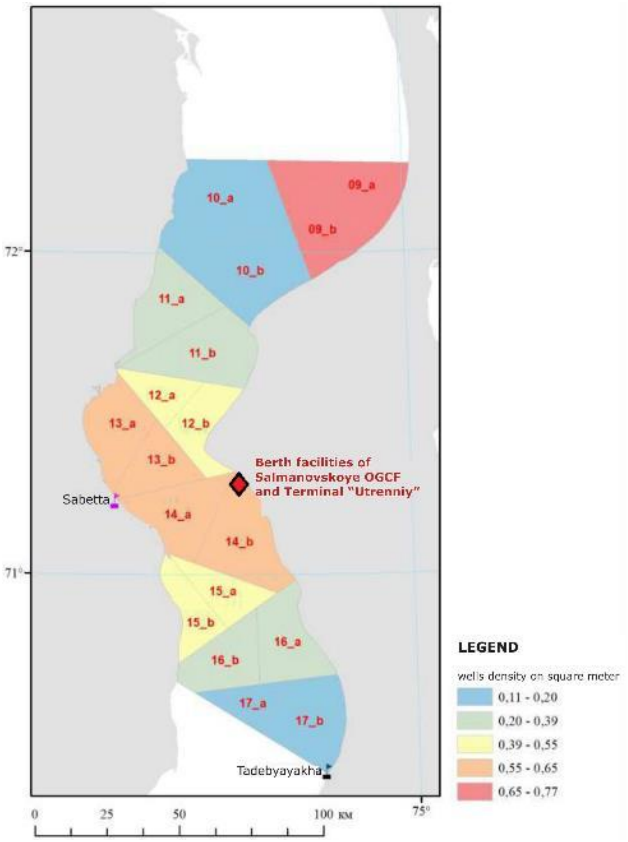


Figure 7.6.21: Ringed seal population density and distribution in the Ob Estuary in June-July 1996

(1 - more than 1 unit/km2; 2 - 0.1-1 units/km2; 3 - less than 0.1 unit/km2; 4 no animals found during the counting survey). Source: Boltunov et al., 2000

Figure 7.6.22: Density of holes in the Ob Estuary ice in May 2018, based on aerial counting results

Source: NEZ "Morskiye Mlekopitajushchiye", 2018

As for the ice-free season, the most detailed information on the population numbers is also available for the southern - Ob-Yenisei - sector of the sea (approximately 50,000 km^2), where about 60000 ringed seals live (density about 1 unit per km^2) (Tchmarkova et al., 2002). Similar results are reported by the transect counts in the south-western sector of the sea - outfall of the Baydaratskiy estuary - about 1.85 units per 1 km^2. (Kondakov, 1995; Murmansk Marine Biology Institute (MMBI) Archive: quoted in the Programme of Marine Geophysical..., 2012). At the level of Kara Sea in general, G. N. Ognetov (2002) refers to the species density of 0.1-0.16 units per 1 km^2. Based on the results of aerial counting of the pinnipeds' ice-based hauling grounds in 1996 (Boltunov et al., 2000), the seal distribution density in the northern part of the Ob Estuary varied from 0.1 to 2.3 units (average 0.4 units) per 1 sq. km. Considering the decline trend in the animal numbers closer to the upstream areas of the Ob Estuary, it can be suggested that seal density is also low in the rest of the concerned area (not covered during the counting in 1996). At present, estimated number of seals in the Kara Sea is within the range of 90-150 thousand units (Ognetov, 2002).

Up-to date information on distribution of seal in the Ob Estuary is provided in the report of NEZ "Morskiye Mlekopitajushchiye" on aerial counting of the animals on ice in May 2018. 510 holes in ice and 391 animals were found. By interpolating the instrumental counting data, it is concluded that 4479 units of seal are present in the survey area (90% confidence range of 3639-5433), and the density varies significantly - from 0.2 to 0.77 units per km^2. In 2018, most encounters with seal were recorded to the south of 71.2° N. Significant variations in the ringed seal numbers are reported in the Ob Estuary. Comparison of counting results in 2018 and 2017 shows a major decline in the animal number - by more than 4 times (from 21491 to 4479 units). Scientists attribute this decline to the difference in ice conditions. 2/3 of al seals were met in 2017 on young and nilas ice, which was not present in the area in 2018.

Bearded Seal lives in the northern half of the Ob Estuary[278,279] (Geptner et al., 1976). The bearded seal reserves in specific areas of the Kara Sea have not been subject to scientific surveys, with the exception of counting in few local areas, or counting to produce relative numbers. Population in the Kara Sea is not known, however, based on the proportion of 1:4[280,281] (Ognetov, 2002) of encounters with this species and with ringed seal that uses similar biotopes, the number of bearded seal in the Kara Sea can be tentatively estimated at 30-50 thousand units (Figure 7.6.23).

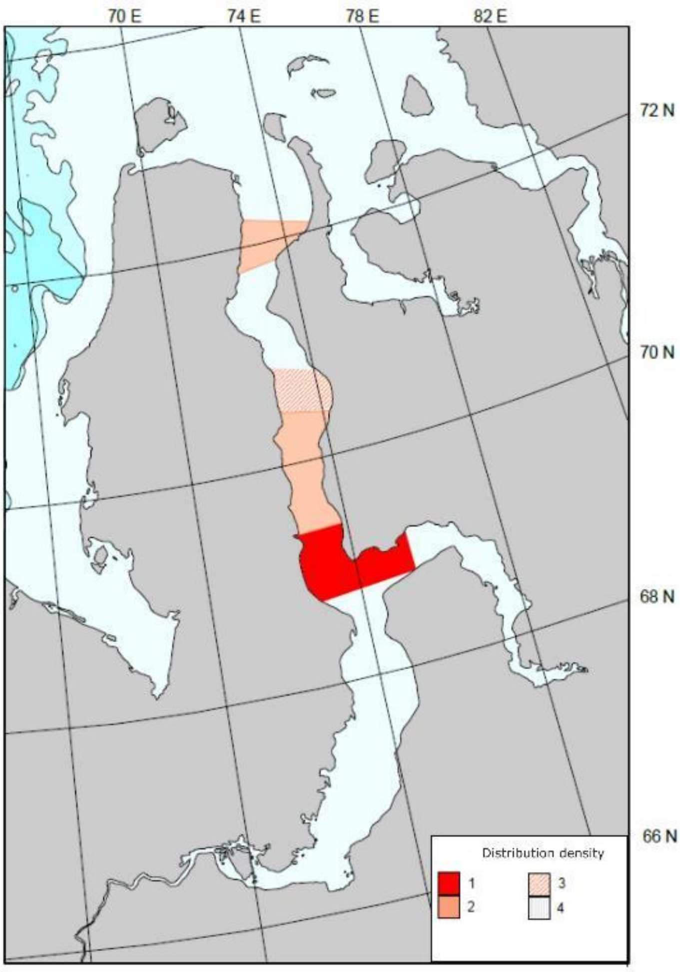


Figure 7.6.23: Bearded seal population density and distribution in the Ob Estuary in June-July 1996

(1 - more than 0.03 unit/km^2; 2 - 0.01-0.03 units/km^2; 3 - less than 0.01 unit/km^2; 4 no animals found during the counting survey). Source: Boltunov et al., 2000

However, the estuariane sections with diluted sea water (including the survey area) are not preferred habitats of seals, therefore their density in such areas is lower than on open foreshores. Based on the results of aerial counting of the pinnipeds' ice-based hauling grounds in the northern sector of the Ob Estuary in 1996 (Boltunov et al., 2000), the bearded seal distribution density varies from 0.01 to 0.03 units (average 0.016 units) per 01 km^2. In 2017, bearded seal was registered in the area of the Arctic LNG 2 Project (Semenov, Yevfratova, 2019).

[278]Decker, M. B., Gavrilo, M., Mehlum, F., & Bakken, V. Distribution and abundance of birds and marine mammals in the eastern Barents Sea and the Kara Sea, late summer, 1995. Oslo, 1998. 85 p.

[279]Brude OW, Moe KA, Bakken V, Hansson R, Larsen LH, Lovas SM, Thomassen J, Wiig O Northern Sea route dynamic environmental Atlas. INSROP Working Paper No. 99 1998.

[280] G. G. Matishov, P. R. Makarevich, Yu. I. Goryayev, A. V. Yezhov, D. G. Ishkulov, Yu. V. Krasnov, V. V. Larionov, D. V. Moiseyev. Hard-to-reach Arctic. 10 years of bio-oceanological studies from nuclear-powered icebreakers. Murmansk: Murmanskiy Pechatny Dvor LLC, 2005. 148 p.

[281] O. N. Svetocheva, V. N. Svetochev, Yu. I. Goryayev. Ringed seal and bearded seal of the Kara Sea: biology, ecology and production // Eurasian Scientific Association. 2016. Vol. 2. No. 4. pp. 92-102.

Both species of pinnipeds prefer shallow areas; in the surveyed area, encounters of ringed seal and bearded seal can be expected near shore. Both species were recorded in the area of the berth structures during the FEED survey and the operational environmental monitoring.

White Whale. Red Data Book of YNAO, 2010. Status. Category 4. Little-studied species with indefinite status. Some studies report[282] that white whale appears in the Estuary for breeding and reproduction during the ice-free season. White whale stay in the Estuary for a short period of up to two months, and, according to Tchapsky[283], the highest concentration of the animal in the Estuary is reached by second decade of June - early August. However, the timing of first calls depends on the ice conditions. The whales appear in their summer grounds on the day when ice breaks up (end of June - first decade of July), and completely leave the area when solid or fast ice cover establishes on water (last decade of October)[284]. K.K. Tchapskiy reports that white whale use the Ob Estuary as a forage ground. Reportedly, the whale move along the shore of the Gydan Peninsula and seldom appear near the shore of the Yamal. At the end of breeding and foraging, white whale leave the Ob Estuary and move to the Barents Sea for wintering.

In the beginning of 1930-s, white whale was an object of massive production in the Ob Estuary, with annual yield of 717 units. Subsequently, production enhances, and white whale population diminished dramatically. No white whale was found on 1 August 1986 during the survey of the Ob Estuary area between the New Pot and Shokalskogo island, including the Gydan Estuary, 15 days after disappearance of the ice cover. During the repeated survey on 4 August, only 12 white whales were found in the northern sector, in the Malygina Strait. However, according to V. K. Ryabitseva et al.[285], in 1976 a herd of few hundred white whales came to the Ob from the Ob Estuary. In August 1995, a vessel-based counting study was conducted along a 825 km route[286], however, no white whales were encountered at that time. Reportedly, in the first decade of 21st century, in summer white whale called only northern sector of the estuary, and the animal quantity was small - just few dozens[287]. In 2017 (Semenov, Yevfratova, 2019) groups of 2-11 white whales were registered at the Ob Estuary coast, in the area of the Khonorasalya Cape (about 40 km N of the Port and Utrenniy Terminal). Reportedly (Programme of Marine Geophysical..., 2012), the whales tend to call the Ob Estuary mouth in early July. Moving upstream, the animals keep close to the right shore, as north-eastern winds prevailing at this time push the ice towards the left shore. On the way back, the whales keep in the middle sector of the estuary or closer to the left shore. In the center of the Ob, Taz and Gydan estuaries, the animals are occasionally encountered all the time till ice cover is established (till the start of November). The main components of forage for white whale are bottom and pelagic fish, the second important component are crustaceans.

White whales were recorded not far from Sabetta during aerial counting in May 2016[288], and also summer 2018 (observed twice in the Port area)[289]. The local environmental monitoring reports (IEPI JSC, 2019) mention two finds of dead white whale driven ashore 1.5 km north of the outlet of the Khaltsyney-Yakha River and at the mouth of the Paralekyakha River.

Walrus. *Odobenus rosmarus.* According to the IUCN classification, this species belongs to "vulnerable" category (VU), while its status in the Red Data Book of the Russian Federation is "reducing in number" (Category II). In the Red Data Book of YNAO, walrus is related to Category I ("endangered").

Walrus distribution in the Kara and Barents Sea regions is studied by air photo survey and route observations from sea vessels, according to which its range covers the western coast and the northern end of the Yamal Peninsula (Figure 7.6.24). Most part of the Ob Estuary water area, including the Plant Project's area of influence, is not a part of this species range. Single adult individuals of *Odobenus rosmarus* were sporadically seen on the eastern coast of Yamal up to the Seyakha settlement and the Kamennyi Cape.

[282] M. F. Zaikov. Production of white whale (Delphinapterus leucas Pall.) in the Ob Estuary in summer 1933 // Studies at the Ob and Taz Fishery Research Station of VNIRO. Tobolsk. 1934. Vol. 2. No. 1. pp. 17-44.

[283] K. K. Tchapskiy. White whale migrations and production in the northern sector of the Ob Estuary // Proc. of Arc. Inst. 1937. Vol. 71.

[284] Red Data Book of the Yamal-Nenets Autonomous Okrug: animals, plants, mushrooms. 80 years of the Yamal-Nenets Autonomous Okrug / Ed.-in-chief S. N. Ectova, D. O. Zamyatin. Yekaterinburg: Basco, 2010. 307 p.

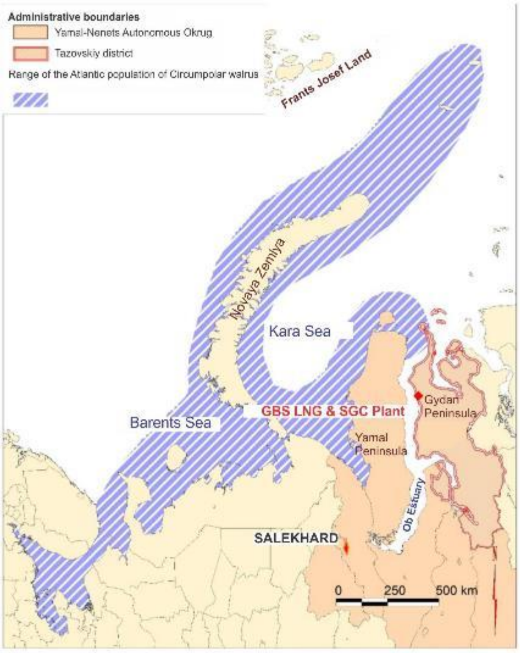
[285] V. K. Ryabitsev, A. V. Ryabitsev, V. V. Tarasov. Mammal fauna of the middle and north of Yamal. Fauna of the Urals and Siberia. 2015. No. 1. pp. 156-166

[286] Decker, M. B., Gavrilo, M., Mehlum, F., & Bakken, V. Distribution and abundance of birds and marine mammals in the eastern Barents Sea and the Kara Sea, late summer, 1995. Oslo, 1998. 85 p.

[287] G. G. Matishov, G. N. Ognetov. White whale of the Russian Arctic seas: biology, ecology, conservation and resource use // Apatity: Kola Scientific Centre of RAS. - 2006.

[288] Biodiversity Conservation Programme of OJSC "Yamal LNG", Report 2017. Yamal LNG. 2018, 23 p.

[289] Mammals of Russia portal at: http://rusmam.ru/ . Accessed on 15.07.2020



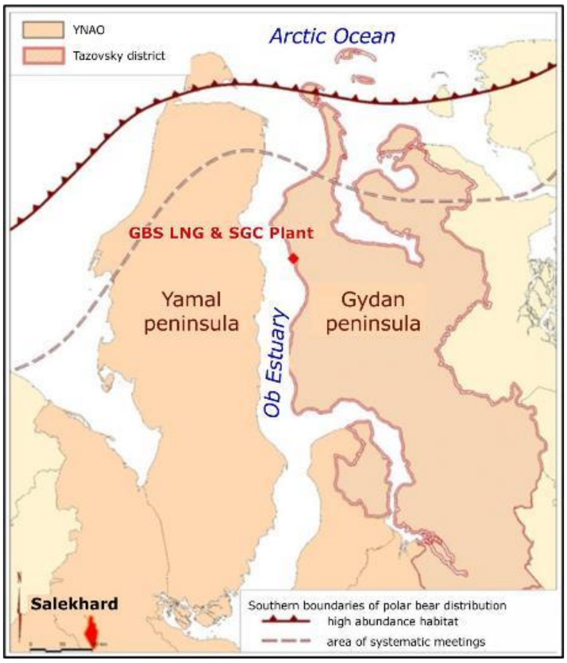


Figure 7.6.24: Range of the Atlantic population of walrus according to the data of WWF Arctic Programme

(Source: State of Circumpolar walrus populations Odobenus rosmarus. WWF Arctic Programme Report. May 2018)

Figure 7.6.25: Southern boundaries of the polar bear range near the Ob Estuary of the Kara Sea according to S.M. Uspenskiy (1977) and the Ecological Atlas of the Kara Sea (2017)

Polar bear *Ursus maritimus*. Since 1976, the polar bear has been under the international protection. In the IUCN Red List, this species is classified as vulnerable (VU). In the Red Data Book of Russia, the status of the Karsk-Barents population is not specified (Category 4). In the Red Data Book of YNAO, the polar bear has the status of rare species (Category 3).

The Kara Sea bear belongs to the Kara-Barents-Sea population (Ecological Atlas... , 2016). In the Kara Sea region, in summer and winter, the polar bears can be mainly met in the south-western part of the sea and along the eastern coast of Novaya Zemlya. Some individuals can be relatively rarely observed on fast ice along the north-western coast of the Taimyr Peninsula. In the Russian Arctic, the polar bears spend most part of the year at sea, although they can also be found on the coast depending on food availability or on unusual ice conditions. During summer, the sea ice drifts off the Russian coast. At this time, polar bears either migrate with the pack ice or (less often) go inland, half-starving until the ice restores. In the Kara Sea, the bear adheres to areas with openings, fractures and cracks in the shelf area[290][291][292], one of such areas being the outer part of the Ob-Yenisei estuary system with the islands of Shokalskogo, Vilkitsky, Neupokoeva, Oleniy, Sibiryakova. It is identified by WWF as a priority area for protection in the Arctic[293]. On the Gydan Peninsula, presence of bear was recorded in the vicinity of Vilkitsky, Neupokoeva, Shokalskogo islands[294], however, on the Yamal Peninsula polar bear was encountered in 2019 at least two times in the area of the accommodation camp[295], and also during the aerial observations of seals in 2016 (Report on.. , 2018).

[290] Northern Sea Route biology and oceanography: Barents and Kara seas. 25th edition, revised. and updated. Murmansk, Moscow, Murmansk Marine Biology Institute of the RAS KSC, Nauka, 2007.

[291] A. V. Vorontsov. Current distribution and variations of abundance of polar bear (*Ursus maritimus*) and its main food resource - ringed seal нерпы (*Phoca hispida*) in the Kara Sea in winter and spring period. Proc. 2nd Int. Conf. Marine Mammals of Holarctic Region. Baikal. 10-15 September 2002. Moscow, 2002.

[292] Y. I. Goryayev, A. V. Vorontsov, D. V. Yanina, A. V. Yezhov. Observations of polar bear (Ursus maritimus) and pinnipeds from vessels in the southern area of the Kara Sea in February-May 1997-2003. Collection of research papers. Proc. 3rd Int. Conf. Marine Mammals of Holarctic Region. Koktebel, 11-17 October. Moscow, 2004, p. 168-172.

[293] V. A. Spiridonov, B. A. Solovjev, I. A. Onufrenya. Spatial planning of biodiversity conservation in the Russian Arctic seas - M. WWF Russia, 2020. – 376 p.

[294] S. B. Rosenfeld, G. V. Kirtayev, N. V. Rogova, M. Yu. Soloviev, A. A. Gortchakovsky, M. S. Bizin, S. S. Demyanets. 2018. Assessment of population status and habitat conditions for anseriformes in the Gydanskiy state nature reserve (Russia) and adjacent territories, with the use of ultralight aviation. Nature Conservation Research. Conservation Science, 3 (Appendix 2).

[295] Russian Mammal Portal. rusmam.ru

The license area is located at a significant distance from the nearest habitats of this species (Figure 7.6.25), therefore, the planned activities cannot affect the condition of its populations.

Therefore, it can be concluded that marine mammals fauna in the work areas within the Ob Estuary is relatively scarce and represented by the Arctic pinnipeds typical of the Kara Sea. Bearded seal and ringed seal are common and small in number. White whale sporadically calls the Ob Estuary. Walrus and polar bear are present occasionally.

7.6.3 Components of terrestrial ecosystems of the Gydan Peninsula

7.6.3.1 Vegetation

Botanical studies in the Yamal-Gydan region and the LA territory

Until recently, vegetation of the Gydan Peninsula was poorly studied. Floristic and geobotanical data on the coastal areas were published by A. I. Tolmachev (Tolmachev, 1926[296]). The data on the Gyda River vegetation and soils was first collected by B. N. Gorodkov (Gorodkov, 1928, 1932). As the author's field surveys were conducted in winter, his geobotanical relevés lack details of herbaceous plants. Since late 1980s, floristic studies on the peninsula have been conducted by the Komarov Institute of Botany of the RAS - O. V. Rebristaya and O. V. Khitun Rebristaya, Khitun, 1994[297]; Khitun, 1998, 2002, 2003, 2005[298]). The observation covered areas in the west of the peninsula. The same authors compiled the original data on vegetation of the Gydan tundra (Khitun, Rebristaya, 1998; Khitun, 2002, 2005) which still represent the spatially closest published survey for the Project area.

Few publications are available with information on mosses and lichens that play a major role in the Arctic plant communities, including on the Gydan Peninsula (Andreyev, 1994; Tchernyadjeva, 1994[299]). The above sources examine the lower reaches of Tchugoryakha River (south-west of the Gydan Peninsula).

In 1970-1980s, tundra vegetation studies in the Western Siberia were conducted by L. I. Meltzer (Meltzer, 1977, 1984[300]). Her findings are reflected in in the legend of the West Siberian Plain Vegetation Map (Ilyina etc., 1985[301]) with vegetation analysis from the perspective of V. B. Sochava fratrie formations. The most recent researchers of the Gydan Peninsula are K. A. Ermokhina (IPEE RAS) and M. Yu. Telatnikov (TsBS SO RAS). Results of their studies, particularly in the LA territory, are included in the scope of the Circumpolar Arctic Vegetation Classification project (Walker et al. 2018[302]), and are partially published (Teliatnikov et al., 2019 a[303]).

Vegetation in the Yamal Peninsula is similar to that of Gydan, and is much better studied. The key research publications on this area are mentioned below. Results of long-term studies conducted in the region by

[296] A. I. Tolmachev. Preliminary report on the visit to the lower reaches of the Yenisei River and coastal areas of the Gydan Tundra in summer 1926 // USSR Academy of Science Newsletter, 1926. Ser. 6. No. 18. pp. 1655-1680

[297] O. V. Rebristaya, O. V. Khitun. Vascular plants flora in the lower reaches of the Tchugoryakha River (south-west of the Gydan Peninsula, West-Siberian Arctic) // Botany Journal. 1994. Vol. 79, No.8. pp. 68-77

[298] O. V. Khitun. Intra-landscape flora structure in the lower reaches of the Tinikyakhya River (Northern hypo-Arctic tundras, Gudan Peninsula // Botany Journal, 2002. Vol. 87, No.8. pp. 1-24).

O. V. Khitun. Analysis of intra-landscape flora structure in the middle reaches of the Khalmeryakha River (Gydan Peninsula) // Botany Journal, 2003. Vol. 88, No.10. P. 9–30.

O. V. Khitun, O. V. Rebristaya. Vegetation and eco-topological structure of flora in the Khonorasale Cape area (Arctic tundras of the Gydan Peninsula) // Botany Journal, 1998. Vol. 83, No.12. pp. 21-37

O. V. Khitun. Zonal and eco-topological differentiation of flora in the central part of West-Siberian Arctic (Gydan and Taz peninsulas): Author's abstract of Ph.D. thesis in Biology. StPb, 2005. 28 p.

[299] M. P. Andreyev. Lichens flora in the lower reaches of the Tchugoryakha River (south-west of the Gydan Peninsula, West-Siberian Arctic) // Botany Journal. 1994. Vol. 79. No. 8. pp. 39-50.

I. V. Tchernyadjeva. Leafy mosses in the lower reaches of the Tchugoryakha River (south-west of the Gydan Peninsula, West-Siberian Arctic) // Botany Journal. 1994. Vol. 79. No. 8. pp. 57-67.

[300] L. I. Meltzer. Classification and mapping of vegetation of West-Siberian tundras // Regional bio-geographic studies in Siberia. Irkutsk, 1977. pp. 40-59

L. I. Meltzer. Zonal distribution of vegetation in West-Siberian plain tundras // Vegetation of Western Siberia and its mapping. Novosibirsk, 1984. pp. 7-19.

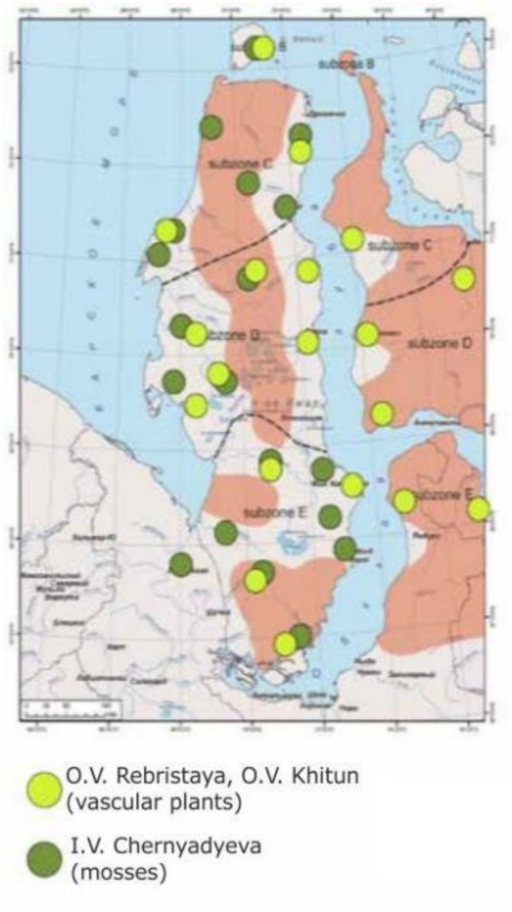
[301] I. S. Ilyina, Ye. I. Lapshyna, N. N. Lavrenko, L. I. Meltzer, Ye. A. Romanova, B. A. Bogoyavlenskiy, V. D. Makhno. Vegetation cover of West-Siberian plain. Novosibirsk: Nauka, 1985. 251 p.

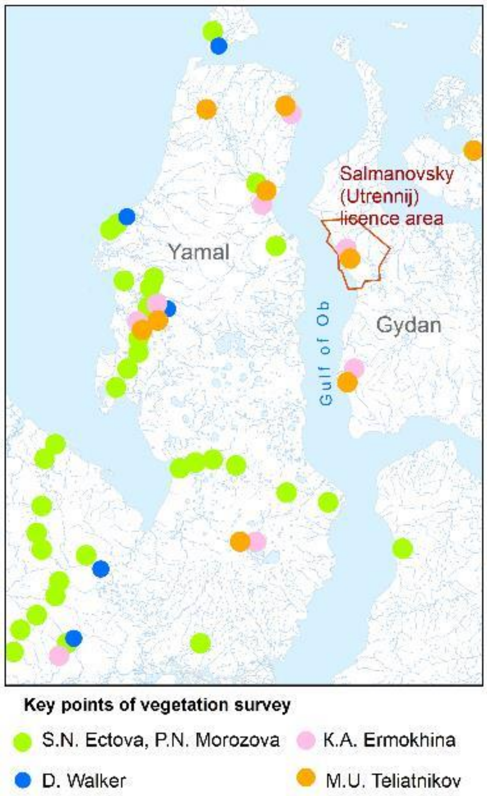
[302] Walker D.A., Daniëls F.J., Matveyeva N.V., Šibík J., Walker M.D., Breen A.L., ... & Buchhorn M. Circumpolar Arctic vegetation classification. // Phytocoenologia. 2018. N 48 Vol 2. P. 181-201.

[303] M. Yu. Taliatnikov, Ye. I. Troyeva, K. A. Ermokhina, S. A. Pristyazhniuk. Vegetation of two areas in the north of Gydan Peninsula (typical tundra subzone) // Turczaninowia. 2019a. N 22 Vol 4. P. 128-144.

expert of the Botany Institute of RAS O. V. Rebristaya have been published (Rebristaya, 2013[304]). Integrated results of long-term studies on the Yamal Peninsula are published in monographies (Morozova, Magomedova, 2004; Yamal Peninsula…, 2006[305]). At present, expert of the Central-Siberian Botanic Garden M. Y. Taliatnikov is actively publishing results of research of tundra vegetation of the peninsula and surrounding territories (Taliatnikov, 2003; Taliatnikov, Pristyazhniuk, 2012a, Taliatnikov, Pristyazhniuk, 20126; Taliatnikov et al., 2019 b[306]).

The areas of floristic and vegetation studies areas in the Yamal and Gydan territories are shown on the schematic map in Figure 7.6.26. Geobotanical studies areas refer to the article of K. A. Ermokhina[307].





I II

Figure 7.6.26: Studies of the flora and vegetation in the Yamal and Gydan Peninsulas
I - key floristic studies areas; II - key areas of geo-botanical studies (1990-2018) (based on Ermokhina, 2013 supplemented with Teliatnikov et al., 2019 a, b)

Information on vegetation cover in the Salmanovskiy (Utrenniy) LA is adopted from engineering surveys and operational environmental monitoring reports. The main sources with descriptions of vegetation and flora are listed in Table 7.6.9. Analysis in this Section refers to these data and sources mentioned above. It should be noted that no detailed studies of vegetation cover in the whole license area have been conducted by present.

---

304 O. V. Rebristaya Flora of Yamal Peninsula. Current status and development history. StPb, 2013. 312 p.

305 L. M. Morozova, L. A. Magomedova. Structure of vegetation cover and vegetation resources of Yamal Peninsula. Yekaterinburg, 2004. 63 p.

Yamal Peninsula vegetation cover. Tyumen: City-Press, 2006. 360 p.

306 M. Yu. Taliatnikov. Typical tundra vegetation of Yamal Peninsula. - Nauka, 2003.

M. Yu. Talyatnikov, S. A. Pristyazhnyuk. Intrazonal grass communities of Yamal Peninsula and eastern foorhills of Polar Urals // Flora of Asian Russia, 2012 a, No. 1(9), pp. 96–105.

M. Yu. Talyatnikov, S. A. Pristyazhnyuk. Classification of subshrub and moss tundras of Yamal Peninsula and adjacent territories // Newsletter of Novosibirsk State University. Series: Biology, clinical medicine. 2012 b. Vol. 10, issue 2. pp. 56-64

M. Yu. Taliatnikov, Ye. I. Troyeva, K. A. Ermokhina, S. A. Pristyazhnyuk. Vegetation of the milddle reaches of Yady'yakha River (southern section of Arctic tundras of Yamal Peninsula). // Turczaninowia. 2019b Vol. 22 No.2. pp. 58-78.

307 K. A. Ermokhina. Yamal and Gydan vegetation datasets // Arctic Vegetation Archive (AVA) Workshop. 2013. P. 40-44.

Table 7.6.9: Main archive sources referenced for preparation of the section on vegetation cover

Issuing organisation	Survey year	Title (names of publications, design documents)	Number of study sites
FSUE PINRO, Northern Filial / FRECOM LLC	2012	Assessment of Background (Baseline) Status of Environmental Components of Onshore and Offshore Areas of the Salmanovskiy (Utrenniy) License Area (Yamal-Nenets Autonomous Okrug) Based on Results of the Environmental Survey	14 full relevés (in the main report)
GK RusGazEngineering CJSC	2014	Early development facilities at the Salmanovskoye (Utrenneye) OGCF Technical report on environmental survey.	Not specified
Uralgeoproject LLC	2017	Salmanovskoye (Utrenneye) OGCF Facilities Setup. Gas supply for the power supply facilities to support construction, hydraulic filling and drilling operations (PIR-1) Technical report on environmental survey.	Not specified
LLC "PurGeoCom"	2018	Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Phase PIR-5. Technical report on environmental survey.	7 full relevés (in the main report) 147 brief relevés (listing predominating species)
LLC "PurGeoCom"	2018	Utrenniy Airport. Technical report on results of environmental survey.	79 brief relevés (listing predominating species)
FSU R&D E "AeroGeologia". "Ecozont" Centre	2017	Ecological monitoring of the natural environment in the onshore and offshore areas of the Salmanovskoye (Utrenneye) oil, gas and condensate field	16 (in the form of verbal description)
IEPI JSC	2018	Environmental Monitoring at the Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup 2018	16 full relevés
IEPI JSC	2019	Phase 3.1. Final Report on the environmental monitoring of the Salmanovskoye (Utrenneye) oil, gas and condensate field 2019	27 full relevés
IEPI JSC	2020	Report on the local environmental monitoring of the Salmanovskoye (Utrenneye) oil, gas and condensate field 2020	73 full relevés

Vegetation cover of the Salmanovskiy (Utrenniy) LA in the phytogeographical zoning schemes

In accordance with the map of vegetation zones and zonality types[308] and zoning scheme by V.D. Aleksandrova[309], the LA territory is located in the subzone of arctic tundras. In the same way, the area vegetation is also reflected on the general vegetation maps[310]. In accordance with the bio-climatic zoning system adopted in the Arctic Circumpolar Vegetation Projec (Walker et al., 2005)t[311], the concerned area belongs to Sub-zone C which corresponds to the southern variant of Arctic tundras. However, considering the updated information by O. V. Khitun (2005), northern boundaries of the sub-zones on the Gydan Peninsula is located significantly further to the north, compared to the position indicated by the earlier studies. The examined area, therefore, falls within sub-zone of the northern Hypo-Arctic tundras[312] (Figure 7.6.27).

---

308 Map "Zones and zonality types of Russia and adjacent territories / Ed.-in-chief M 1:8 000 000. M., 1999. 2 sheets

309 Aleksandrova, V.D., Geobotanicheskoe raionirovanie Arktiki i Antarktiki [Geobotanical Zoning of the Arctic and Antarctic], USSR Academy of Sciences, Komarov Institute of Botany, Leningrad: Nauka, 1977. 187 p.

310 T. V. Popova, L. N. Vdoviuk. Vegetation / Atlas of YNAO, 2004, P. 190-191

311 Walker D.A., Raynolds M.K., Daniëls F.J., Einarsson E., Elvebakk A., Gould W.A., ... & Moskalenko N.G. The circumpolar Arctic vegetation map // Journal of Vegetation Science. 2005. Vol. 16, N 3. P. 267-282.

312 B. A. Yurtsev, A. I. Tolmachev, O. V. Rebristaya. Floristic delineation and division of the Arctic // Arctic floristic region. L., 1978. pp. 9-104.

According to the floristic zoning scheme of the Arctic region adopted by the Panarctic Flora Initiative[313][314], the examined area belongs to Yamal-Gydan flora province of the Euro-Siberian flora region.

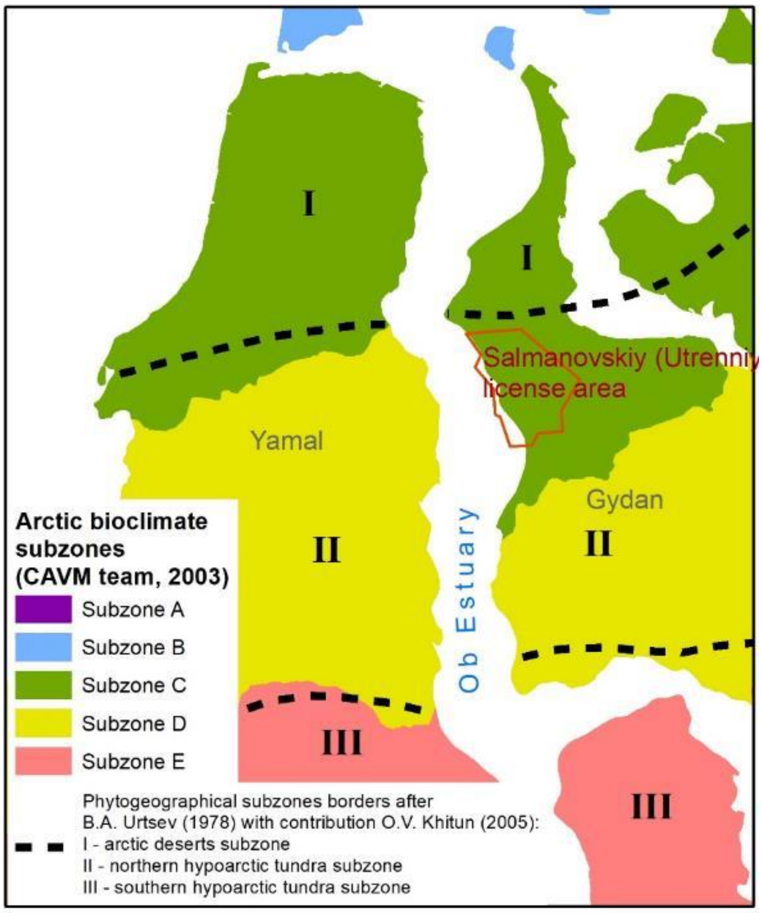


Figure 7.6.27: Location of the Salmanovskiy (Utrenniy) LA in the botanical-geographic zoning system of the Yamal-Gydan flora province

In the sub-zone of northern Hypo-Arctic tundras on the Gydan peninsula, Arctic species of plants play an important role in phytocoenoses, however, Hypo-Arctic species are still among the main dominants. Shrubs (Betula nana, Salix glauca, S. lanata) become low and adopt the form of hem-prostrate subshrubs. The zonal type of vegetation is hillicky shrubby-lichen-mossy tundras with dwarf birch and willow (Ilyina et al., 1985).

Flora of the Salmanovskiy (Utrenniy) LA

The Yamal-Gydan province is relatively poor in terms of floristic abundance (Yurtsev, 1994). As a result of field studies on the Gydan and Taz peninsulas (2005), O. V. Khitun reported the total of 332 taxons of plants at the level of species and sub-species, and estimated the total floristic diversity at more than 360 species.

The taxonomic diversity analysis of the area is based on the floristic list in the report of IEPI on the local environmental monitoring which includes 124 species of 75 genera and 28 families (refer to Annex 18).

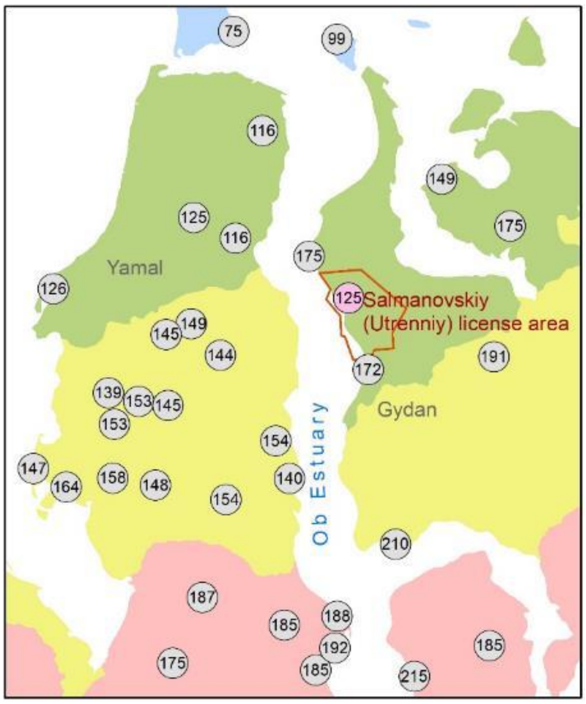
The leading families by the number of species are *Poaceae, Cyperaceae, Asteraceae, Caryophyllaceae, Salicaceae* и *Ranunculaceae,* which also include multiple common species and community dominants.

Comparing the published information on the diversity of local flora of the Yamal and Gydan peninsulas (Khitun, 2005; Rebristaya, 2013), it can be concluded that overall floristic diversity in the study area would be approximately 180-200 species. Therefore, flora is identified in the LA by 60-70% (Figure 7.6.28).

---

[313] Elvebakk, A. 1999. Bioclimatic delimitation and subdivision of the Arctic. Pages 81-112 in I. Nordal and V. Y. Razzhivin (eds.). The Species Concept in the High North - A Panarctic Flora Initiative. The Norwegian Academy of Science andLetters, Oslo, Norway.

[314] Yurtsev B.A. Floristic division of the Arctic // J. Vegetation sci. 1994. Vol. 5. P. 765-774.



Legend

Local flora in the Gydan and Taz Peninsulas (Khityn, 2005): Layakha (L), Poylovayakha (P), Chugoryakha (Ch), Tinikyakha (T), Nganangsio (N), Khalmeryakha (Kha), Khonorosale (Kho), Matyujsale (M), Shokalskogo island (Sh)

Local flora of the Yamal Paninsula (Rebristaya, 2006, 2013):

Syunajsale (Sy), Khadyta (Kh), Kharangyneto (Khr), Yeryakha (Ye), Laptayakha (La), Khevese (Khe), Yuribei (Yu), Khuty'yakha (Khu), Sebayakha (Se), Lyakkatose (Ly), Yuribeitoyakha (Yt), Marresale (Mr), Khakhayayakha (KhKh), Saletayakha (Sa), Neromayakha (Ne), Ngaranato (Ng), Bovanenkovo (Bo), Tomboitoyakha (Tm), Mantyto (Mn), Venujeyo (Ve), Matiuyakha (Ma), Tiutei (Ti), Verkhniy Tambey (VT), Tirvayakha (Tr), Kharasavey (Khs), Khabeyakha (Khb), Bely (B)

Figure 7.6.28: Taxonomic diversity of local floras of the Yamal-Gydan region and position of flora of the Salmanovskiy (Utrenniy) LA

Source: IEPI JSC, 2019; Rebristaya, 2013; Khitun, 2005. Analysed by the Consultant

Flora analysis in the Salmanovskiy (Utrenniy) LA showed the presence of latitude elements of all types[315]: Arctic (29 species of vascular plants), Arctalpine (30), Arctic-boreal (14), boreal (3), Hypo-Arctic (15), Hypo-Arctalpine (22) and Meta-Arctic (8). Arctic and Arctalpine species play the most important role (48%) in the structure of flora, while the contribution of boreal species is the smallest.

Figure 7.6.29: Plant species in drained tundras in the study area

a. - Eightpetal mountain avens (*Dryas octopetala* subsp. *subincisa*); b. – perennial low polster - Arctic sandwort (*Minuartia arctica*); c. – species growing on the Gydan Peninsula, at the western edge of its range - Tiselius Saussurea (*Saussurea tilesii*). Source: IEPI JSC, 2019

[315] The elements are quoted from the work of O. V. Khivtun (2005)

Examination of flora in certain habitats (Figure 7.6.30) shows that they have no boreal elements at all.

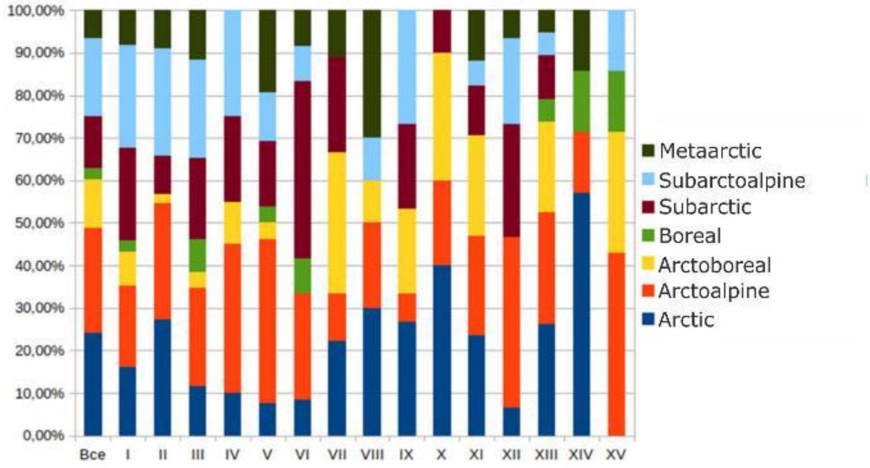


Figure 7.6.30: Geographic latitude elements in vascular plants flora of the Salmanovskiy (Utrenniy) LA

"All" - referes to flora as a whole, I sub-horizontal watershed surfaces with subshrub-cottongrass-moss tundras, II - subshrub tundras on ridge top surfaces with thin snow cover, III - slopes of river valleys, runoff valleys with subshrub willow tundras, IV - heave mounds top surfaces, V - steep and medium-steep slopes of ravines and depressions with late snow-melting, VI - bottoms of ravines and gulches, runoff valleys with sedge bogs and meadows, VII - waterlogged lowland bogs, sedge tundras in floodplains, VIII - sands in river floodplains, IX - lake shores with moss tundras, X - shallows in waterbodies, foreshore areas, XI - sandy slopes and deflated areas on sea coast, XII - seaside lichen and subshrub-lichen tundras, XIII - sedge and cottongrass bogs on laidas, XIV - filled sand, banks of sites, XV - exposed peat, tracks of all-terrain vehicles in tundras. Source: IEPI JSC, 2019, updated by the Consultant

No Meta-Arctic elements are present on the heave mounds top surfaces, lake shores and shallows in waterbodies, exposed peat. The largest species diversity of these elements is found in subshrub-cottongrass-moss tundras on sub-horizontal watershed surfaces.

Figure 7.6.31: Mass species of waterlogged habitats: common cottongrass (*Eriophorum polystachion*) – left; Scheichzer's cottongrass (*Eriophorum scheichzerii*) – right

Source: IEPI JSC, 2019

Hypo-Arctic elements are not present on sands in river floodplains, filled sand a banks of sites, and on all-terrain vehicles' tracks in tundras. On the exposed peat and all-terrain vehicle tracks, no Arctic species are present, and only 7 species of vascular plants are on this partial flora list (XV). In general, the following pattern is observed: High-Arctic species mainly occur in the ridge-top habitats (I, II) and on slopes of depressions and ravines with late snow-melting (V).

The following conclusions yield from the analysis of position of flora of the Salmanovskiy (Utrenniy) LA in the published range of local flora variants of the Yamal and Gydan Peninsulas (Rebristaya, 2013; Khitun, 2005):

- based on the Ward's cluster analysis, the LA flora is combined with floras of typical tundras on Yamal peninsula, apparently, due to the lack of research data;

- detrended correspondence analysis consistently indicates similarity of the LA flora with other floras in the Gydan Peninsula;
- the largest share of common species in the LA flora is observed in relation to other floras of northern Hypo-Arctic tundras of the Gydan Peninsula (Figure 7.6.32).

Importation of adventitious plants is reported in the Yamal-Gydan region, due to human activity. 190 stranger species are identified on the Yamal Peninsula[316]. Most of them are ephemerophytes which presence in the region depends on the introduction of diaspores from elsewhere[317]. 21 plant species (mainly meadow type) grow in the vicinity of accommodation camps Sabetta and Bovanenkovo where bioclimatic conditions are similar to those in the LA territory, namely[318]:*Achillea asiatica* Serg., *Arctium tomentosum* Mill., *Erigeron acris* L., *Tanacetum vulgare* L., *Tripleurospermum inodorum* (L.) Sch. Bip., *Cerastium holosteoides* Fries, *Melandrium album* (Mill.) Garcke, *Chenopodium album* L., *Plantago major* L., *Polygonum aviculare* L. s.l., *Rumex longifolius* DC., *Rumex pseudonatranatus* Borb., *Potentilla heidenreichii* Zimm., *Potentilla intermedia* L., *Galium spurium* L., *Urtica dioica* L., *Artemisia vulgaris* L., *Barbarea arcuata* (Opiz ex J. et C. Presl) Reichenb., *Dactylis glomerata* L., *Elytrigia repens* (L.) Nevski, *Poa compressa* L. Finds of all of these species are, as a rule, confined to anthropogenic habitats: dumps, soil heaps, roadsides, etc., however, none of these species can be attributed to naturalized invasive species.

The following alien species were identified during survey of reclamation areas in 2020: rapeseed (*Brassica napus* L.), oat (*Avena sativa* L.), medicinal sweetcorn (*Melilotus* sp.), scentless false mayweed (*Tripleurospermum inodorum* (L.) Sch. Bip.), goosefoot (*Chenopodium album* L.), field pennycress (*Thlaspi arvense* L.), wheat (*Triticum* sp.), reed fescue (*Festuca arundinacea* Schreb.), white campion (*Melandrium album* (Mill.) Garcke), red clover (*Trifolium pratense* L.), dock (*Rumex* sp.). All these species are introduced with grass mixtures. These species are most likely ephemerophytes: such plants are found in places of introduction for 1-2 years, but do not reproduce, and then disappear, since they do not develop sustainable populations, and depend on re-introduction. No facts of introduction of species into natural communities have been found.

[316] Ye. V. Pismarkina, V. V. Byalt, A. A. Yegorov, O. V. Khitun, A. V. Scherbakov, A. G. Bystrushkin. Materials of vascular plants flora studies in the Yamal-Nenets Autonomous Okrug (Russia) // Botany Nowadays. Proceeds of the XIV Congress of the Russian Botanic Society and Conference "Botany Nowadays". Vol. 1. Makhachkala: Alef, 2018. pp. 178-180

[317] S. R. Mayorov, V. D. Bochkin, Yu. A. Nasimovich, A. V. Scherbakov. Adventive flora of Moscow and Moscow Region. M.: Publishing House KMK, 2012. 412+120 (col.)

[318] V. V. Byalt, A. A. Yegorov. New alien species of vasular plants on the Yamal Peninsula // Botanical Journal. Vol. 104. No.7. 2019. pp. 1154-1164. N. I. Andreyashkina. Composition of plant communities on natural and technogenically disturbed ecotopes in watershed areas of the Yamal Peninsula: floristic diversity // Ecology. No. 1. 2012. pp. 22-26.

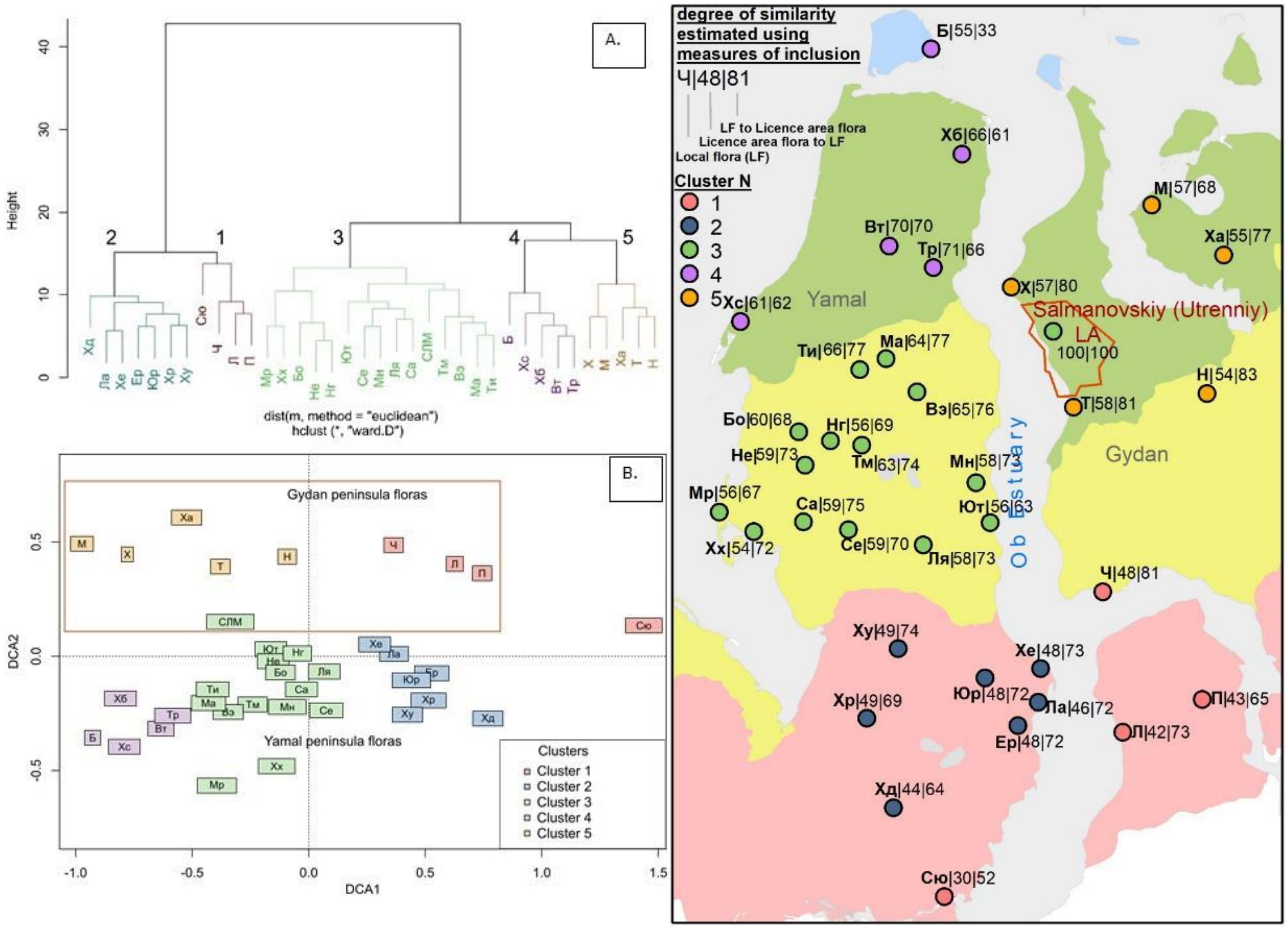


Figure 7.6.32: Position of vascular plants flora of the Salmanovskiy (Utrenniy) LA in the range of local floras of the Yamal and Gydan Peninsulas

A. - Dendrogram of local floras' similarity by Ward's method, B. - Ordination diagram in the axes of detrended correspondence analysis (DCA) reflecting flora clusters, C. - local flora clusters on the map. Mutual inclusion measures of floras are shown. Source: IEPI JSC, 2019; Rebristaya, 2013; Khitun, 2005. Analysed by the Consultant

Vegetation of the Salmanovskiy (Utrenniy) LA

Vegetation in the study area is a product of complex interaction of multiple ecological factors which are defined by the terrain genesis and morphology, geological substrata, and cryogenic processes. The driving factors of development of the structure of vegetation cover are:

- Cold and wet climate, high air humidity;

- Dissected terrain with absolute elevations up to 87 m and relative elevation of watersheds above valley bottoms of 15-30 m;

- Differences in duration of presence of snow blanket and its thickness;

- Different mechanical composition of soils (shell deposits, sands, clayey loams);

- Active exogenic geological processes: cryogenic (seasonal and perennial frost heaving, frost cracking, thermokarst), post-cryogenic (solifluction, thermal erosion and thermal abrasion), wind-induced (deflation), etc.

The international team compiled a map of the whole Arctic region in scale 1:7 500 000 using pseudo-colour thermal images (pixel resolution 1 km x 1 km)[319]. Vegetation types are categorized into five physiognomic groups, which are in turn divided into 15 vegetative mapping units.

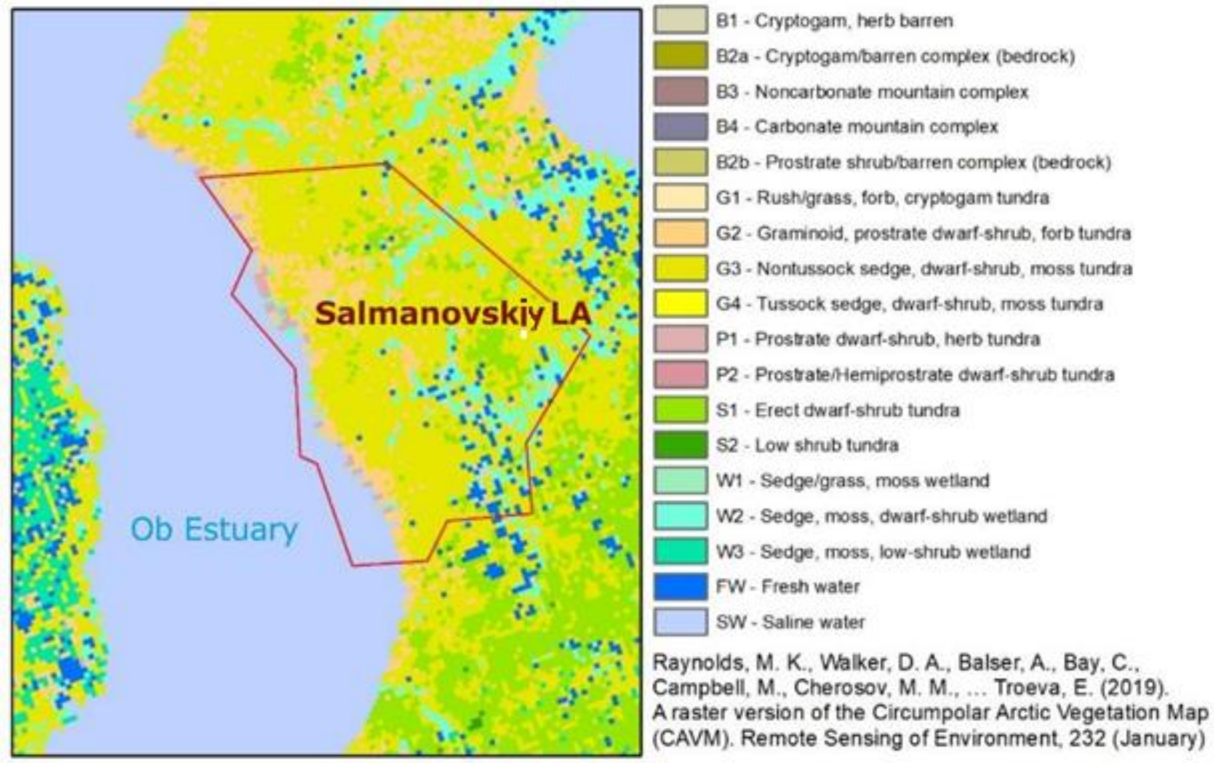


Figure 7.6.33: Salmanovskiy (Utrenniy) LA on the Arctic vegetation map

Source: CAVM team, 2019

Vegetation within the LA belongs to the following categories (Figure 7.6.33):

G2 – Graminoid, prostrate dwarf-shrub, forb tundra: major part of the Ob Estuary catchment basin;
W2 – Sedge, moss, dwarf-shrub wetland: mainly in the river valleys in the Gydan Estuary catchment basin;
S1 – Erect dwarf-shrub tundra: river valleys;
P2 – Prostrate/Hemiprostrate dwarf-shrub tundra: ridges near the Ob Estuary coast;
B1 – Cryptogram herb barren: along the shoreline;
G3 – Nontussock sedge, dwarf-shrub, moss tundra: most of the territory.

[319] CAVM Team. 2003. Circumpolar Arctic Vegetation Map. (1:7,500,000 scale), Conservation of Arctic Flora and Fauna (CAFF) Map No. 1. U.S. Fish and Wildlife Service, Anchorage, Alaska. ISBN: 0-9767525-0-6, ISBN-13: 978-0-9767525-0-9.

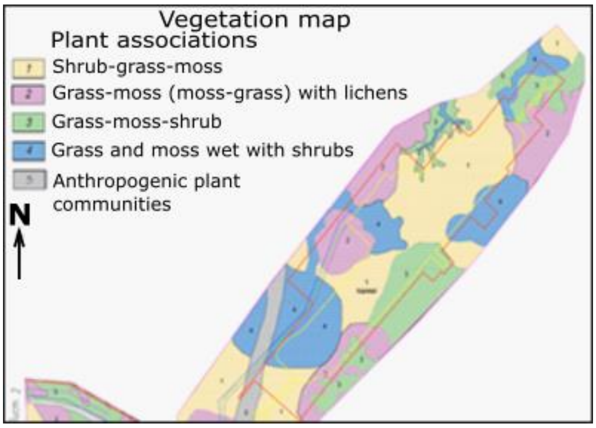
Raynolds M.K., Walker D.A., Balser A., Bay C., Campbell M., Cherosov M.M., ... & Jedrzejek, B. A raster version of the Circumpolar Arctic Vegetation Map (CAVM). // Remote Sensing of Environment. 2019. 232, 111297.

Under the influence of these factors, vegetation in the Salmanovskiy (Utrenniy) LA features a complex nature at both micro and meso level of development of various combinations and complexes. Based on the information extracted from the environmental survey and environmental monitoring records, and geo-botanical publications on the region, we produced a map of the LA vegetation in scale 1:100 000.

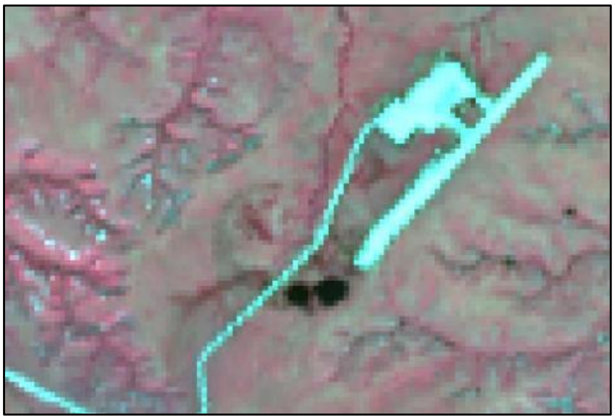
The vegetation map uses a Landsat 8 multispectral satellite image with 30 m resolution as a background (the image is dated 24.06.2019, i.e. at the height of vegetation season) and employs the automated classification tool with the support vector machine. Figure 7.6.34 shows comparison of the classification results using the example of satellite image and vegetation map prepared at the engineering survey stage.

Table 7.6.10 provides characteristic of the legend elements, as well as their alignment with the Circumpolar Arctic Vegetation Map and the region’s ecological-floristic classification syntaxons.

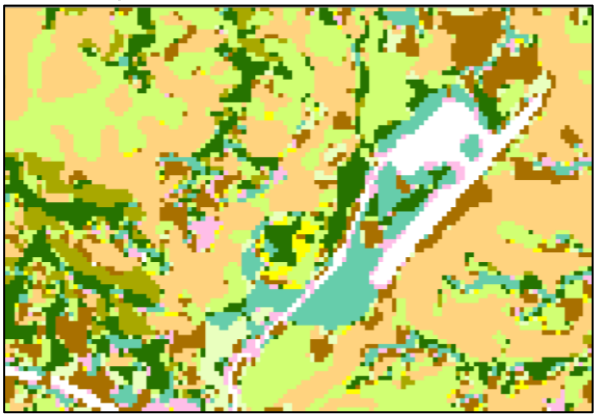
Area in satellite image Spot 5 (natural colours)



Fragment of vegetation map (Source: PurGeoCom LLC, 2019)



Area in satellite image Landsat 8 (synthesis with the near and far infrared channels)



Final output of automated interpretation

Figure 7.6.34: Comparison of the resulting vegetation map with the input satellite images and vegetation map prepared at the stage of engineering surveys

Table 7.6.10: Vegetation of Salmanovskiy (Utrenniy) licence area

Vegetation units at 1:100 000-scale	Vegetation	Circumpolar Arctic Vegetation Map Units (CAVM team, 2005)	Representative syntaxa (The Braun-Blanquet approach)	Dominant / constant species	Edaphic conditions	
					Topographic information	Soils (WRB-2015)
1. Polygonal and patterned ground dwarf-shrub and lichen tundra	Forb-dwarf-shrub moss tundra; dwarf-shrub moss lichen tundra, pioneer communities on bare grounds	P2 – Prostrate/hemiprostrate dwarf-shrub tundra[320]	Luzulo tundricolae–Hylocomietum spendentis Teliatnikov et al. 2019; Hierochloo alpinae–Hylocomietum splendentis Teliatnikov et al. 2019	Dryas octopetala, Salix polaris, Oxytropis sordida, Cassiope ericoides, Festuca braphyphylla, Minuartia arctica, Astragalus subarcticus, Luzula tundricola, Rhytidium rugosum, Hylocomium splendens, Hedysarum arcticum	Ridges / hilltops / canyon edges / upper slopes	**Codominants:** Histic Reductaquic Turbic Cryosols (Dystric, Arenic). **Associated:** Dystric Cryic Histosols (Turbic), Protic Arenosols (Aeolic), Dystric Arenosols, Turbic Leptic Cryosols
2. Forb- prostrate dwarf-shrub -moss tundra	Willow- dwarf-shrub -non tussock sedge (Cares aquatilis subsp. stans, C. arctisibirica) moss (Hylocomium splendens) tundra	G2 – Graminoid, prostrate dwarf-shrub, forb tundra	Carici concoloris–Hylocomietum splendentis Taliatnikov et al. 2013	Carex aquatilis subsp. stans, Dryas octopetala, Lagotis glauca subsp. minor, Salix lanata, Pyrola rotundifolia, Stereocaulon alpinum	Subhorizontal surfaces and gentle slopes on watersheds	**Codominants:** Histic Reductaquic Turbic Cryosols (Dystric, Arenic), Dystric Cryic Histosols (Fluvic, Turbic), Dystric Histic Reductic Gleysols (Turbic). **Associated:** Histic Turbic Cryosols (Dystric)
3. Willow sedge and cottongrass wet tundra	Low shrub-cottongrass-moss with cloudberry wet tundra, moss-tussock sedge wet tundra	G3 – Nontussock sedge, dwarf-shrub, moss tundra	Classification of these vegetation communities was not developed	Calamagrostis holmii, Salix lanata, Valeriana capitata, Arctagrostis latifolia, Cerastium regelii, Eriophorum polystachyon, Eriophorum scheuchzeri, Sphagnum squarrosum	Depressions, collecting funnels, sa ddles, upland drainages, headwaters	Codominants: Dystric Histic Reductic Gleysols (Turbic), Dystric Cryic Histosols (Turbic). Associated: Histic Reductaquic Turbic Cryosols (Dystric, Arenic)
4. Dwarf-shrub and forb late-lying snowbed[321] communities	Forb -sedge (Carex lachenalia) and forb-prostrate willow (Salix polaris) moss lichen tundra, forb-moss communities	B1 – Cryptogam, herb barren	Deschampsio–Cerastietum regelii Matveyeva 1994 Community Carex lachenalii–Luzula confusa (Telyatnikov et al., 2019 b)	Lagotis minor, Chrysosplenium alternifolium subsp. sibiricum, Polemonium acutiflorum, Cetraria islandica, Ranunculus propiquus, Poa alpigena, Oxyria digyna, Saxifraga cernua, Pachypleurum alpinum, Luzula confusa	Nothern concave slopes, deep narrow canyons with late-lying snowbed	**Codominants:** Dystric Fluvic Gleyic Arenosols (Turbic), Spodic Cryosols (Dystric, Arenic). **Associated:** Protic Arenosols (Aeolic), Dystric Arenosols

[320] Prostrate dwarf shrub: Lying flat on the ground

[321] Communities in habitats with late snow-melting

Vegetation units at 1:100 000-scale	Vegetation	Circumpolar Arctic Vegetation Map Units (CAVM team, 2005)	Representative syntaxa (The Braun-Blanquet approach)	Dominant / constant species	Edaphic conditions	
					Topographic information	Soils (WRB-2015)
5. Low-shrub willow tundra	Low-shrub (willow and birch) communities	S2 – Low-shrub tundra	Classification of these vegetation communities was not developed	Salix glauca, S. lanata, Betula nana	Gentle and steep slopes of valleys	**Codominants:** Spodic Histic Reductaquic Cryosols (Dystric), Dystric Fluvic Spodic Histic Gleysols. **Associated:** Spodic Histic Turbic Cryosols (Arenic)
6. Vegetation complexes of small valleys; meadows, subshrub tundras, sedge bogs	Low-shrub willow communities, sedge, sedge-graminoid meadows, sedge and cottongrass wetlands	Not represented	Pediculari verticillatae–Astragaletum arctici Zanokha 1993, Arctophilo–Hippuridetum lanceolatae Pestrjakov et Gogoleva 1989	Carex aquatilis subsp. stans, Alopecurus alpinus, Salix lanata, Pedicularis verticilla, Astragalus subarctica, Polemonium acutifolium, Petasites frigidus, Poa alpigena, Arctophila fulva	Small valleys	**Codominants:** Spodic Histic Reductaquic Cryosols (Dystric), Dystric Fluvic Spodic Histic Gleysols. **Associated**: Dystric Cryic Histosols
7. Dwarf-shrub lichen tundra	Dwarf-shrub lichen, graminoid dwarf-shrub lichen tundra	G2 – Graminoid, prostrate dwarf-shrub, forb tundra	Classification of these vegetation communities was not developed	Salix nummularia, Arctous alpina, Flavocetrria nivalis, F. cucculata, Astragalus subpolaris	Drained terraces in river valleys	**Dominant:** Dystric Gleyic Histic Fluvisols (Turbic). **Associated:** Subaquic Fluvisols (Arenic), Spodic Histic Reductaquic Turbic Cryosols (Dystric, Arenic, Fluvic), Haplic Arenosols, Dystric Arenosols
8. Sedge and cottongrass wetlands	Wet grass-cottongrads-sedge-moss tundra, graminoid (Arctophila fulva) sedge moss (Limprichtia revolvens) communities	W2 – Sedge, moss, dwarf-shrub wetland	Caricion stantis Matveyeva1994; Arctophilo–Hippuridetum lanceolatae Pestrjakov et Gogoleva 1989	Carex aquatilis subsp. stans, Dupontia fisheri, Comarum palustre, Eriophorum angustifolium, Limprichtia revolvens	Bottoms of wet valleys of of seasonal (intermittent) streams; lows of river floodplains and terraces	**Codominants:** Dystric Histic Reductic Gleysols (Turbic), Dystric Cryic Histosols (Turbic). **Associated:** Histic Reductaquic Turbic Cryosols (Dystric, Arenic), Dystric Cryic Histosols (Fluvic)
9. Sphagnum and sedge-sphagnum bogs	Cloudberry-moss and willow-sedge-cottongrass communities	W2 – Sedge, moss, dwarf-shrub wetland	Classification of these vegetation communities was not developed	Sphagnum teres, S. squarrosum, Rubus chamaemorus, Salix lanata	Peat swelling hummocks in river valleys, wetland complexes, costal terraces	**Dominant:** Histic Gleysols (Dystric). **Associated:** Eutric Cryic Histosols, Eutric Gleysols

Vegetation units at 1:100 000-scale	Vegetation	Circumpolar Arctic Vegetation Map Units (CAVM team, 2005)	Representative syntaxa (The Braun-Blanquet approach)	Dominant / constant species	Edaphic conditions	
					Topographic information	Soils (WRB-2015)
10. Sands on foreshores, deflated areas, fills	Sparce psammophytic graminoid communities of river sands	Not represented		Poa alpigena subsp. colpoidea, Festuca richardsonii, Deshampsia glauca, Koeleria asiatica, Cerastium arvense	River shores	**Codominants:** Subaquic Protic Arenosols, Protic Arenosols. **Associated:** Haplic Arenosols, Dystric Fluvic Gleyic Arenosols (Turbic)
	Sparce psammophytic costal meadows			Festuca richardsonii, Poa alpigena subsp. colpoidea, Deshampsia glauca, Rumex graminifolius, Cerastium arvense, Honkenya peploides	Beaches of the Ob Estuary shore	**Codominants:** Subaquic Protic Arenosols, Tidalic Protic Arenosols. **Associated:** Haplic Arenosols, Dystric Arenosols
	Sparce psammophytic forb-graminoid communities		Antennario lanatae–Arctoetum alpinae Telyatnikov et Prystyazhnyuk 2012	Koeleria asiatica, Eremogone polaris, Polemonium boreale, Oxytropis sordida	Sandy cliffs	**Codominants:** Haplic Arenosols, Dystric Arenosols. **Associated:** Protic Arenosols (Aeolic), Spodic Cryosols (Dystric, Arenic)
	Sparce anthropogenic meadow graminoid communities		Matricario-Poetea artcicae A. Ishbirdin in Sumina 2012	Deshampsia glauca, Tripleurospermum hookerii, Tephroseris palustris, Equisetum arvense	Technogenic topography with light material fills (sand) and re-deposition products (debris cones, scouring, drift fills, etc.)	**Codominants:** Leptic Technosols (Arenic, Relocatic, Transportic), Protic Arenosols (Aeolic)

Polygonal and patterned ground dwarf-shrub and lichen tundras of the Salmanovskiy (Utrenniy) LA develop on ridges exposed to wind impacts in the valleys and sea coast areas. Those include moss-dwarf-shrub-willow (*Salix polaris*) tundra; crazyweed-dwarf-shrub tundra; dwarf-shrub-sedge-hylocomium tundra in combination with pioneer communities on bare grounds. Polygones' surfaces are covered with dwarf shrubs *(Arctous alpina*, *Dryas octopetala*, *Salix nummularia),* much smaller quantity of graminoids (*Arctogrostis latifolia, Carex arctisibirica)* and a thick moss-lichen layer *(Cladina rangiferina*, *Cl. mitis*, *Cetraria islandica, Sphaerophorus globosus*, *Racomitrium lanuginosum*). Depressions have an incoherent mat of *Dicranum elongatum*, *Racomitrium lanuginosum*, *Polytrichum juniperinum*, *Drepanocladus uncinatus, Carex arctisibirica, Luzula confusa*, *Arctagrostis latifolia*. The most distinct convexes are exposed to erosion under the action of constantly blowing winds, therefore, deflation plots barren of vegetation are developed on their surfaces. Here, isolated small patches of vegetation survive under the protection of micro-terrain features, often with single specimen of *Dryas octopetala*, *Arctous alpina*, *Minuartia arctica*, *Polytrichum alpestre, Racomitrium lanuginosum, Cetraria cucullata, Dactylina arctica,* etc. Polygons on ridge slopes feature abundant perennial grasses (*Oxytropis sordida, Astragalus subarcticus, Lagotis minor, Minuartia arctica, Saussurea tilesii, Pedicularis albolabiata*), refer to Figure 7.6.35. Woodrush *Luzula confusa* и L. *tundricol*a is common. Moss stratum is mostly well developed, with a coverage of 30-60% in drained tundras. Dominant species are *Polytrichum strictum, P. piliferum, Racomitrium lanuginosum, Abietinella abietina, Hylocomium splendens*.

Figure 7.6.35: Polygonal tundras. Left - Picture of ridge top surface, Right - crazyweed-willow-dwarf-shrub-moss tundra

Photos by Federal State Unitary R&D Enterprise "AeroGeologia", 2017; IEPI JSC, 2019

Figure 7.6.36: Willow-sedge moss tundra on watershed in the area of Power Supply Complex No.2

Photos by IEPI JSC, 2019

Figure 7.6.37: Willow-cloudberry-sedge moss tundra on watershed in the area of well 297

Photos by IEPI JSC, 2019

Sub-horizontal and gently sloping watershed surfaces are occupied by forb-dwarf-shrub-moss and dawrf-shrub-lichen-hylocomium tundras. These coenoses are common in the Gydan Peninsula (Khitun, 2005), and are dominated by mosses *Hylocomium splendens, Aulacomnium turgidum, Dicranum elongatum*. A smaller share belongs to hemi-prostrate shrubs (*Salix glauca, S. lanata, S. pulchra*), prostrate subshrubs (*Dryas punctata*), hygrophytic and mesophytic grasses (*Carex aquatilis* subsp. stans, *C. bigelowii* subsp. *arctisibirica, Saxifraga hirculus, Luzula confusa*).

Depressings, collecting funnels, saddles are occupied by willow-cottongrass-moss-cloudberry tundras, moss-cottongrass tussock tundras (Figure 7.6.37). The layer of *Salix lanata* normally reaches the height of 34-40 cm. The well developed grass cover consists of sedge and cottongrass species (*Carex arctisibirica, Carex concolor Eriophorum polystachyon, Eriophorum russeolum, Eriophorum angustifolium)* with some *Luzula wahlenbergii.* Often present are *Calamagrostis holmii, Valeriana capitata, Arctagrostis latifolia, Cerastium regeli.* Ground vegetation dominants are mosses *(Aulacomnium turgidum, Dicranum angustum*, *Sphagnum aquarrosum).*

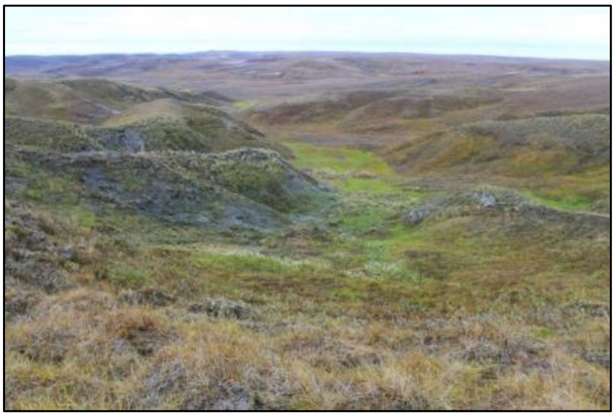


Figure 7.6.38: Late-lying snowbed chyonophyte communities develop on ravine tributaries

Photos by IEPI JSC, 2019

Figure 7.6.39: Dwarf-shrub tundra (*Salix lanata*) on a lake shore

Photos by Federal State Unitary R&D Enterprise "AeroGeologia", 2017

Figure 7.6.40: Cottongrass bot with scorpidium moss on a lake shore, in depression between ridges

Photos by IEPI JSC, 2018

Figure 7.6.41: Sparse meadow on the Ob Estuary coast *Deshampsia glauca, Cerastium arvense, Honkenia peploides*

Photos by IEPI JSC, 2019

Northern concave slopes of valleys and ridges, where snow disappears as late as early July, host various chionophilous communities — Forb-sedge (Carex lachenalli) and forb-willow (*Salix polaris*) moss-lichen tundras, nival tundra meadows, nival moss tundras (Figure 7.6.38). In such conditions, common species are *Lagotis minor, Chrysosplenium alternifolium subsp. sibiricum, Polemonium acutiflorum, Cetraria islandica, Ranunculus propiquus, Poa alpigena, Oxyria digyna, Saxifraga cernua, Pachypleurum alpinum, Luzula confusa.*

Gentle valley slopes and lake shores are occupied by dwarf-shrub tundras with *Salix glauca, S. lanata*, and less frequently – *Betula nana*. These communities feature a height of 40-50 cm. In the ground cover, most abundant are green mosses, with smaller quantity of sedge (*Carex aquatilis* subsp. *stans*) and grass (*Ranunculus borealis, Lagotis minor*).

Wet bottoms of valleys of intermittent streams, river terrace depressions are occupied by sedge-cottongrass-moss and sedge-hypnum bogs. Predominants species in vegetation cover are hydrophilous *Carex aquatilis* subsp. *stans*, cottongrass *Eriophorum polystachion*, in the ground cover - green and hypnum mosses: *Aulacomnium turgidum, Limprichtia revolvens.* The vegetation communities of brook valleys are dominated by arctophila *Arctophila fulva,* bog strawberry *Comarum palustre*, marsh marigold *Caltha palustris,* mare's-tail *Hippuris vulgaris*.

Frequent are cloudberry-moss and willow-sedge-cottongrass communities on peat swelling hummocks in river valleys, wetland tundra complexes and lake shores. Of vascular plants, dominant is cloudberry *Rubus chamaemorus,* grasses are also present, such as *Saxifraga cernua, Saxifraga hieracifolia*. Predominant species are *Sphagnum teres, S. squarrosum*.

Vegetation communities on sandy soils are wide spread. River beaches are occupied by *Poa alpigena* subsp*. colpoidea, Festuca richardsonii, Deshampsia glauca, Koeleria asiatica, Cerastium arvense.* On sandy slopes of the Ob Estuary, sparse psammophylic forb-graminoid coastal communities of *Koeleria asiatica, Eremogone polaris, Polemonium boreale, Oxytropis sordida* are present. Technogenic disturbances result in development of fragmentary anthropogenic sparse communities dominated by *Deshampsia glauca, Tripleurospermum hookerii, Tephroseris palustris, Equisetum arvense.*

Figure 7.6.42: Vegetation map of the Salmanovskiy (Utrenniy) LA (compiled by the Consultant)

Proportions of areas occupied by the main types of plant communities are shown in Table 7.6.11.

Table 7.6.11: Vegetation in the territory of the Salmanovskiy (Utrenniy) LA (refer to the map compiled to the Consultant)

Vegetation type	Terrain conditions	Area, ha	Share of the license area
1. Polygonal and patterned ground dwarf-shrub and lichen tundra	Ridges / hilltops / canyon edges / upper slopes	37938.1	13.0
2. Forb- prostrate dwarf-shrub - moss tundra	Flat and gently sloping watersheds	75310.4	25.8
3. Willow sedge and cottongrass wet tundra	Depressings, collecting funnels, saddles	62708.8	21.5
4. Hillocky tundras and chionophilous communities	Nothern concave slopes, deep narrow canyons with late-lying snowbed	5598.2	1.9
5. Low-shrub willow tundra	Gentle and steep slopes of valleys and ridges	18874.3	6.5
6. Vegetation complexes of small valleys; meadows, subshrub tundras, sedge bogs	Small valleys	35050.7	12.0
7. Dwarf-shrub lichen tundra	River terraces, sandy substrates	6243.4	2.1
8. Sedge and cottongrass wetlands	Wet bottoms of valleys of intermittent streams, river terrace depressions	35857.1	12.3
9. Sphagnum, sedge-sphagnum bogs with willows	Peat swelling hummocks in river valleys, wetland tundra complexes, lake shores, laidas	9977.0	3.4
10. Sands on foreshores, deflated areas, fills	Sandy beaches on shores of medium-sized rivers		
	Beaches of the Ob Estuary shore		
	Sandy cliffs on the Ob Estuary shore, ridge tops		
	Industrial facilities' sites and roads. Vegetation develops on slopes, washout surfaces	4598.7	1.6
Total:		292156.5	100

Phytomass stock in typical tundra areas of the Gydan Peninsula varies in a wide range from 87 g/m^2 in horsetail (*Equisetum arvense*) communities to 3080 g/m^2 in willow (*Salix glauca, S. lanata*) tundras[322].

Plant communities are among the main receptors of anthropogenic impact. Construction and operation of the gas production facilities and transport infrastructure results in technogenic disturbance of tundra plant communities, due to mechanical damage of vegetation, burial of communities under drifting fine earth, development of exogenic geological processes induced by industrial activity. The Arctic plant communities are known to be slow to restore. Reportedly, restoration of the original tundra vegetaion takes more than 30 years[323][324]. After 10-20 years, Arctic communities restore by 40-60%. The overgrowth process is the slowest on sandy substrates: sand-drifts, sand fills and quarries. The fastest to restore are wet biotopes (grass-moss waterlogged tundras in watershed areas, subshrub-moss tundras on terraces above floodplains, runoff valley communities with grass and hypnum communities)[325]. Fruticose lichens are one of the species that need the longest time to restore their position in phytocoenoses: after complete

[322] D. A. Sorochinskaya, N. B. Leonova. Structure and distribution of the aboveground phytomass of tundra communities in Western Siberia // Ecosystems: ecology and dynamics. 2020. Vol. 4. No. 3. pp. 5-33

[323] Lawson D.E., Brown J., Everett K.R., Johnson A.W., Komarkova V., Murray B.M., Murray D.F., Webber P.J. Tundra disturbances and recovery following the 1949 exploratory drilling, Fish Creek, northern Alaska // CRRREL report 78-28. 1978. P. 4-29.

[324] Yamal Peninsula: vegetation. Tyumen: City-Press. 2006. 360 p.

[325] D. V. Moskovchenko. Long-term dynamics of vegetation in the Bovanenkovskoye field (Yama Peninsula) // Tyumen State University Newsletter. 2013. No. 12. pp. 57-67

destruction, it can take as long as 100 years before their original projective cover in tundra plant communities is fully restored[326].

Restoratiion of vegetation in the disturbed areas within the Salmanovsky (Utrenniy) LA is monitored through a network of fixed testing sites at the berth structures (FSU R&D E "AeroGeologia", 2017; IEPI JSC, 2018, 2019) since 2013. Most sites were established in 2016 and marked with wooden pegs. Observations were conducted annually during 2016-2019.

Reportedly, areas disturbed by machinery traffic, drifting fine earth from filled banks, barren sites are overgrowing with local species. Vegetation on coastal ecotopes contains vascular plants and mosses that feature a ruderal strategy which are the first to appear on disturbed surfaces. The most distinguished of them are gramineous species. Dominants on disturbed substrates, both dry and wet, are tufted hairgrass (*Deshampsia glauca*), and often rhizomatous grasses, such as bluegrass *Poa alpigena* var. *vivipara*, dupontia *Dupontia psilocantha*. On disturbed sands, pioneering species are Huron tansy and wooly pussytoes (*Antennaria lanata*). Disturbed waterlogged sites are overgrown with cottongrass – *Eriophorum polystachion* and *E. schechzerii*. Exposed peat surfaces are often occupied by rushes *Juncus castaneus, J. biglumis*. Pioneer species in early stages of successions are *Pohlia filum, Psilopilum cavifolium, Sanionia uncinata, Bryum* spp.

The results of observations confirm the conclusion about slow restoration of Arctic phytocoenoses. Only slight changes in vegetation have been observed over the three-years' period. Projective cover in barren laida sections increases by 10% per year, maximum, and species composition hardly changes on heavily disturbed surfaces. Restoration is faster in wet areas with remaining surface soil horizons.

Rare species and rare plant communities

Rare Plant Species. Rare plant species are relatively abundant on the Gydan Peninsula. The list of taxa (species and subspecies) of plants and fungi listed in the Red Data Book of YNAO, republished in 2010, has been approved by the YNAO Governor Resolution No. 254-PG dated 20 December, 2010.

Within the Salmanovskiy (Utrenniy) LA, there may be over 20 plant species listed in the main pages of the Red Data Book of YNAO with the "rare species" status, rarity category 3: *Bromopsis vogulica, Eriophorum callitrix, Luzula tundricola* (on the western boundary of the habitat); *Lychnis samoiedorum, Thymus reverdattoanus, Ranunculus samoiedorum, Saxifraga cespitosa, Castilleja arctica* and some others.

The environmental survey materials and records of the operational environmental monitoring do not mention presence of any rare or protected species in the monitored area. However, the local environmental monitoring reports of IEPI 2019 mention four species of vascular plants which are listed in the Red Data Book of YNAO[327] as status III rare species.

The same report mentions the presence of four species listed in the appendix of the Red Data Book of YNAO as "requiring special attention". Also, one species with this status - papaver yugor (*Papaver jugoricum*) is mentioned in the report of FSUE PINRO on the assessment of existing (background) status of the LA (2012).

Based on the results of the focussed search for rare species in September 2020, 29 locations of valerium (*Polemonium boreale)* were identified (of which 25 are new), 9 localities of Vogul brome *Bromopsisvogulica*, 10 of tundra woodrush (*Luzula undricola), 2* of tufted saxifrage (*Saxifraga cespitosa , 2 of Thymus reverdattoanus*. All these species are listed in the Red Data Book of YNAO under Category 3 - "rare species". In addition, previously known populations and new populations were examined of species included in the Appendix to the Red Data Book (2010) as "requiring special attention" (Table 7.6.12, Figure 7.6.43).

Table 7.6.12: Locations of finding rare and protected species in the territory of the Salmanovskiy (Utrenniy) LA

Species	No.	Coordinates		Population details
		latitude	longitude	
Category 3 rare species				
	1.1	70.95713	74.53881	Mass species, about 10 individuals per 100

[326] Jandt R.R., Meyers C.R. Recovery of lichen in tussock tundra following fire in Northwester Alaska. BLM-Alaska Open File Report 82. September 2000.

[327] Red Data Book of the Yamal-Nenets Autonomous Okrug: animals, plants, mushrooms / Ed.-in-chief A. N. Ectova, D. O. Zamyatin Yekaterinburg: Basco, 2010. 308 p.

Species	No.	Coordinates		Population details
		latitude	longitude	
1. Valerium *Polemonium boreale*				m^2, ecotope about 1 ha
	1.2	70.99602	73.84562	Single units
	1.3	70.96649	74.56725	Single units
	1.4	70.95319	74.64497	Mass species, about 20 individuals per 100 m^2
	1.5	70.95844	74.52585	50 units, ecotope of 300 m^2
	1.6	70.96303	74.51946	Single units
	1.7	70.85011	73.92139	Single units
	1.8	70.95016	73.91462	Single units
	1.9	70.90572	74.67806	Single units
	1.10	70.93881	73.91927	Single units
	1.11	70.95959	74.50865	Single units
	1.12	70.97103	74.47659	Single units
	1.13	70.95235	74.62432	Single units
	1.14	70.95622	74.55115	Single units
	1.15	70.99418	73.84977	Single units
	1.16	71.00503	73.81172	Single units
	1.17	71.02145	73.75949	Mass species, about 100 individuals in a narrow strip 300 m long
	1.18	71.00771	73.88009	Single units
	1.19	71.0361	73.80042	Common species, about 5 individuals per 100m^2
	1.20	70.97958	73.87416	Single units
	1.21	70.97905	73.87782	Single units
	1.22	70.99043	73.94237	Single units
	1.23	70.9889	73.9552	Common species, about 5 individuals per 100m^2
	1.24	70.98387	73.96046	Common species, about 5 individuals per 100m^2
	1.25	70.98766	73.96731	Single units
	1.26	70.9886	73.96727	Single units
	1.27	70.98908	73.96446	Single units
	1.28	70.98961	73.96265	Single units
	1.29	70.9962	73.95066	Single units
2. Vogul brome *Bromopsis vogulica*	2.1	71.03588	73.86385	5 units, ecotope of 25 m^2
	2.2	71.01949	73.79384	10 units, ecotope of 25 m^2
	2.3	71.00729	73.87968	Mass species in an area of about 75 m^2
	2.4	70.97904	73.8779	Single units
	2.5	70.98881	73.92975	Single units
	2.6	70.98804	73.96657	Single units

Species	No.	Coordinates		Population details
		latitude	longitude	
	2.7	70.98867	73.96519	Common species in an area of about 20 m^2
	2.8	70.9896	73.96281	Mass species in an area of about 30 m2
	2.9	70.99134	73.96143	Single units
3. Tundra woodrush *Luzula tundricola*	3.1	70.98834	73.927	Single units
	3.2	70.98982	74.6109	10 units, ecotope of 50 m2
	3.3	71.01118	73.89251	Single units
	3.4	70.99808	73.90077	20 units, ecotope of 100 m2
	3.5	71.01543	73.88284	20 units, ecotope of 100 m^2
	3.6	70.85814	73.95717	20 units, ecotope of 100 m^2
	3.7	71.01861	73.79661	20 units, ecotope of 100 m^2
	3.8	71.00333	73.89429	Single units
	3.9	71.01233	73.95911	Single units
	3.10	70.98980	74.61052	Single units
4. Tufted saxifrage *Saxifraga cespitosa*	4.1	70.98699	73.96674	Single units
	4.2	70.85011	73.92139	5 units, ecotope of appr. 5 m^2
5. Thumus reverdattoanus	5.1	70.99601	73.84531	Single units
	5.2	70.98909	73.96453	Single units
Appendix. Requiring special attention				
6. Snowcup *Ranunculus nivalis*	6.1	71.03276	73.87629	Not found in 2020
7. Naked-stem wallflower *Parrya nudicaulis*	7.1	71.01861	73.79661	Not found on the site, possibly already faded
	7.2	71.035857	73.86381	Single units
8. Papaver yugor *Papaver jugoricum*	8.1	70.98666	73.91745	Single units
	8.2	70.91377	74.57888	Single units
9. Polar eremogone *Eremogone polaris*	9.1	70.99594	73.84601	Single units
	9.2	70.99413	73.84956	Mass species, about 20 individuals per 100 m^2
	9.3	70.98731	73.96717	Mass species, about 650 individuals on a biotope of some 3 hectares
	9.4	70.98902	73.96424	Mass species, about 150 individuals on a biotope of about 500 m^2

Species	No.	Coordinates		Population details
		latitude	longitude	
	9.5	70.98948	73.96293	Mass species, about 50 individuals on a biotope of about 500 m^2
	9.6	70.99178	73.96144	Mass species, about 50 individuals on a biotope of about 500 m^2
	9.7	70.99464	73.95653	Single units
	9.8	70.99639	73.94723	Single units
	9.9	70.85011	73.92139	Mass species in sea coast dunes, about 50 units per 100 m^2

Source: IEPI JSC, 2019-2020

Vogul brome *Bromopsis vogulica* (Socz.) Holub (*B. pumpelliana* (Scribn.) Holub subsp. *vogulica* (Socz.) Tzvel.)

Poaceae (Gramineae).

Status. Category 3. Rare species. The plant grows in Middle (occasional single units along the Yenisei River) and Western Siberia (Yamal, Gydan Peninsulas), and in Urals (Red Data Book, 2010). On the Gydan Peninsula, its presence is known in the lower reaches of the Tinikyakha River, upper reaches of the Ngarka-Ngynyangsyo and Ngarka-Khorty-Yakha Rivers (Khonorasale Cape) (Khityn, 2005). In all known locations, its abundance is low - single units and small groups have been observed (Red Data Book, 2010). Within the Salmanovskiy (Utrenniy) LA, the plant has been registered in nine locations: at the top of heave mound in the middle reaches of the Khaltsyney-Yakha River, on a dry sea-coast slope near the helipads, on a deflated sandy patch near the burrows of polar fox at the Power Supply Complex No.1, on the dry slopes of the Nyadaj-Pyngchyo River valley.

Table 7.6.13: Assessment of the status of rare and protected species of plants by IUCN criteria, and their ecological attribution

Species	Category in the Red Data Book of YNAO	IUCN assessment at the regional level[328]	Range	Ecological attribution	
				Within the LA	On the Gydan Peninsula
Vogul brome *Bromopsis vogulica*	3 rare species	LC (least concern)	Polar and Sub-Polar Urals, West Siberia (Yamal, Gydan, Taimyr Peninsulas)	Top of heave mound in the middle reaches of the Khaltsyney-Yakha River	Subshrub-gramineous-forb meadows on steep slopes; sparce psammophytic forb-graminoid communities on exposed sandy soils on marine terrace ridges
Tundra woodrush *Luzula tundricola*	3 rare species	LC (least concern)	From the Polar Urals to the coast of Chukotka.	Moderately drained ridge tops with subshrub-moss tundras	Forb-willow-moss tundras on watershed ridge tops; hillocky broken tundras on ridges' edges; forb-subshrub-moss, forb-willow-moss tundras on foots of ridge slopes, sparse forb-graminoid pioneer communities on loamy landslides and scoured beadrock coast of the Ob Estuary
Tufted saxifrage *Saxifraga cespitosa*	3 rare species	LC (least concern)	Circumpolar Arctic species	Heave mound tops	Forb-sedge-willow-moss tundras on ridge foots; forb-willow-moss communities on drained river terraces; graminoid-forb-willow-moss tundra on elevated sections of river floodplain
Valerium *Polemonium boreale*	3 rare species	LC (least concern)	Circumpolar species; besides the Arctic regions, is also common in mountains of the East Siberia, Altai, and on the Kamchatka Peninsula	Sandy substrates on the sea coast and in river valleys	Forb-graminoid communities on sandy cliffs and upper slopes; sparse forb-graminoid communities on sand beaches and shore screes
Thumus reverdattoanus	3 rare species	LC (least concern)	Siberian hypo-Arctic species: recorded in Western and Central Siberia, Yakutia	Sandy substrates on the sea coast	Occurs on the southern slopes of sandy hills and terraces, on drift sands, pebble surfaces, occasionally grows in forb and forb-shrub communities, in moss-lichen tundra
Snowcup *Ranunculus nivalis*	3 rare species	LC (least concern)	Circumpolar Arctic species	Ridge slope on valley wall	Forb-graminoid-subshrub, blueberry-fescue communities on steep slopes of low ridges, forb-sedge and forb-willow-moss and lichen tundras at slope foots and depressions
Papaver yugor *Papaver jugoricum*	Requiring special attention	LC (least concern)	Polar Urals, lower Yenisei, Bolshaya Zemlya tundra, coast of the Ob Estuary	Lake shore ridge top	Vegetation on eroded sands at ridge tops and sandy beaches; hillocky broken tundras on ridges' edges; forb-subshrub-sedge-moss tussock willow-cottongrass moss tundras on gentle slopes of ridges

[328] Assessed by the Consultant in accordance with the Guidelines for application of IUCN Red list criteria at regional and national levels: version 4.0. IUCN. 2012.

Species	Category in the Red Data Book of YNAO	IUCN assessment at the regional level[328]	Range	Ecological attribution	
				Within the LA	On the Gydan Peninsula
Naked-stem wallflower *Parrya nudicaulis*	Requiring special attention	LC (least concern)	Siberian Arctomontane species. Transpolar territories east of the Kanin Peninsula to Chukotka; in the mountains of Siberia and Far East	Ridge tops	Forb-willow-moss tundras on tops of watershed ridges; forb-graminoid-subshrub-polytrich-lichen communities on ridge tongues in saddles; waterlogged sedge-cottongrass-moss willow-shrubs in depressions; sparse forb-graminoid pioneer communities on loamy landslides and scoured beadrock coast of the Ob Estuary
Polar eremogone *Eremogone polaris*	Requiring special attention	LC (least concern)	Polar Urals, Yamal, Gydan, Tazovsky Peninsulas, lower reaches of the Lena and Yenisei Rivers	Exposed sand on sea slopes and seashore dunes	Sparce psammophytic forb-graminoid communities on marine terrace ridges

Tundra woodrush *Luzula tundricola* Gorodk. ex V. Vassil. Juncaceae. Status. Category 3. Rare species. Western edge of the range.

In Russia, the species' range is from the Polar Urals to the coast of Chukotka[329]. On the Gydan Peninsula (in the neighbourhood of Chugor Cape, 15 km north of Tadybeyakha vil., 30 km east of the Vento Lake), on the Mammonth Island (lower reaches of the Khalmeryakha River, near the Matyujsale Cape) (Rebristaya, Khitun, 1994; Khitun, 2005).

Seven locations are reported within the territory of the Salmanovskiy (Utrenniy) LA (samples are stored in the MW Herbarium) on flat moderately-drained ridge tops with subshrub-moss tundras. In all reported habitats, abundance of tundra woodrush is low (projective cover < 1%), i.e. few dozens of plants per 100 m^2. The reports suggest that this species has a wider spread of occurrence, but may be ignored by geobotanical surveys.

Valerium *Polemonium boreale* Adams (*P. nudipedum* Klok.)

Polemoniaceae.

Status. Category 3. Rare species. Circumpolar Arctic species with a range in the Northern Europe, Urals, Siberia and North America. On the Gydan Peninsula, is known to be present not unfrequently in the lower reaches of the Chugoryakha and Tinikyakha Rivers, 30 km from the Vento Lake, Khanorasale and Matyujsale Capes (Khitun, 2005). Grows ainly on sandy soil on tundra hills and riverine terraces. Small-numbered species that does not develop large populations.

In the territory of the Salmanovskiy (Utrenniy) LA is found on sandy substrates on the sea coast and in river valleys. Single units are registered in all reported locations. Further survey is required to clarify the range and abundance.

The species is quite common in the study area; in 2020, 24 new growth locations were identified in addition to the 4 already known.

[329] Arctic flora of the USSR. Vol. 4. L.: Nauka. 1987

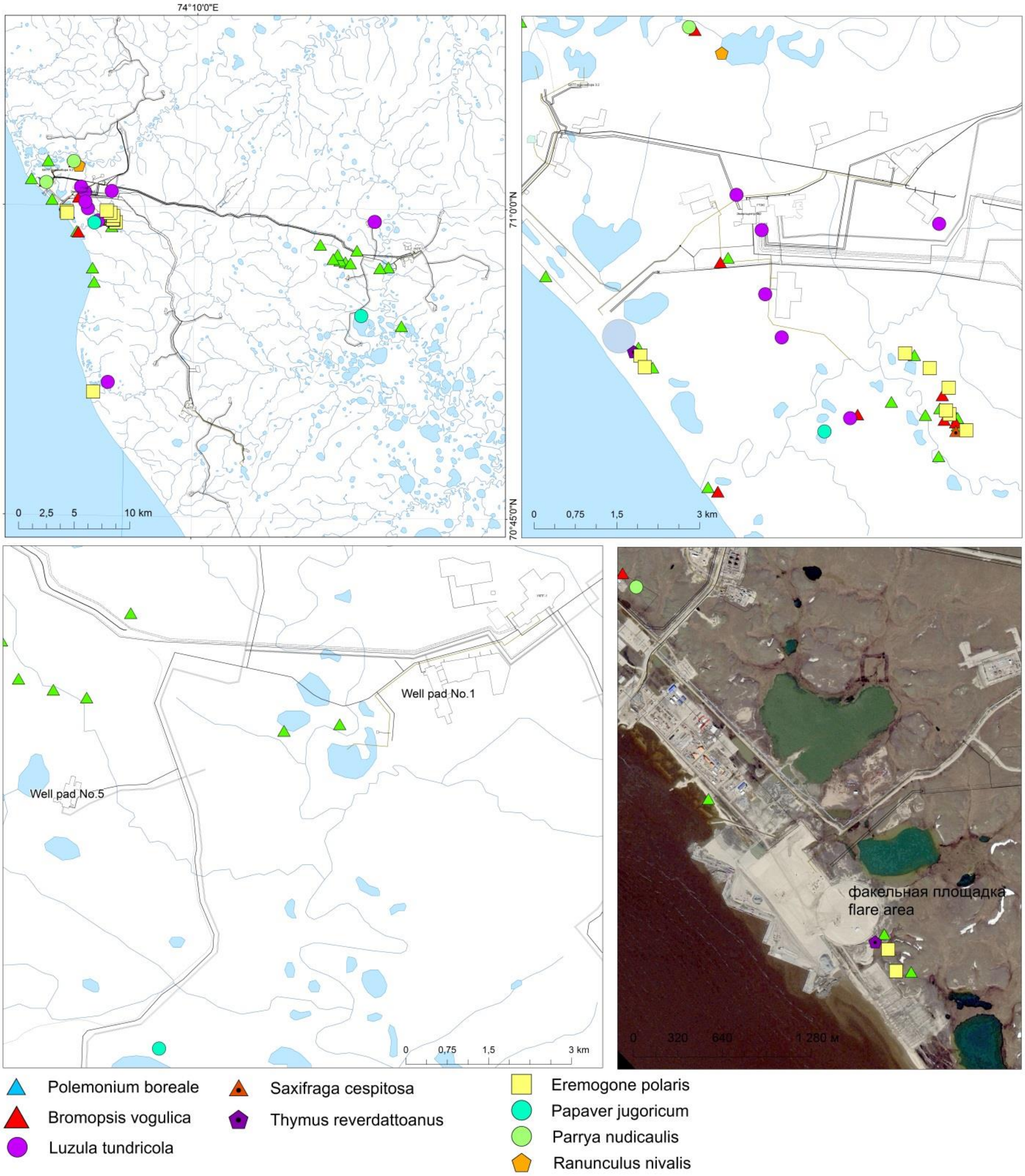


Figure 7.6.43: Locations of finding rare and protected species in the territory of the Salmanovskiy (Utrenniy) LA

Source: IEPI JSC, 2019-2020

Figure 7.6.44: Rare Arctic herb Vogul brome *Bromopsis vogulica* – listed in the Red Data Book of YNAO, category 3

Photos by IEPI JSC, 2019-2020

Figure 7.6.45: Polar eremogone *Eremogone polaris* – listed in the appendix of the Red Data Book of YNAO. Sands on the coast of Ob Estuary

Photos by IEPI JSC, 2019

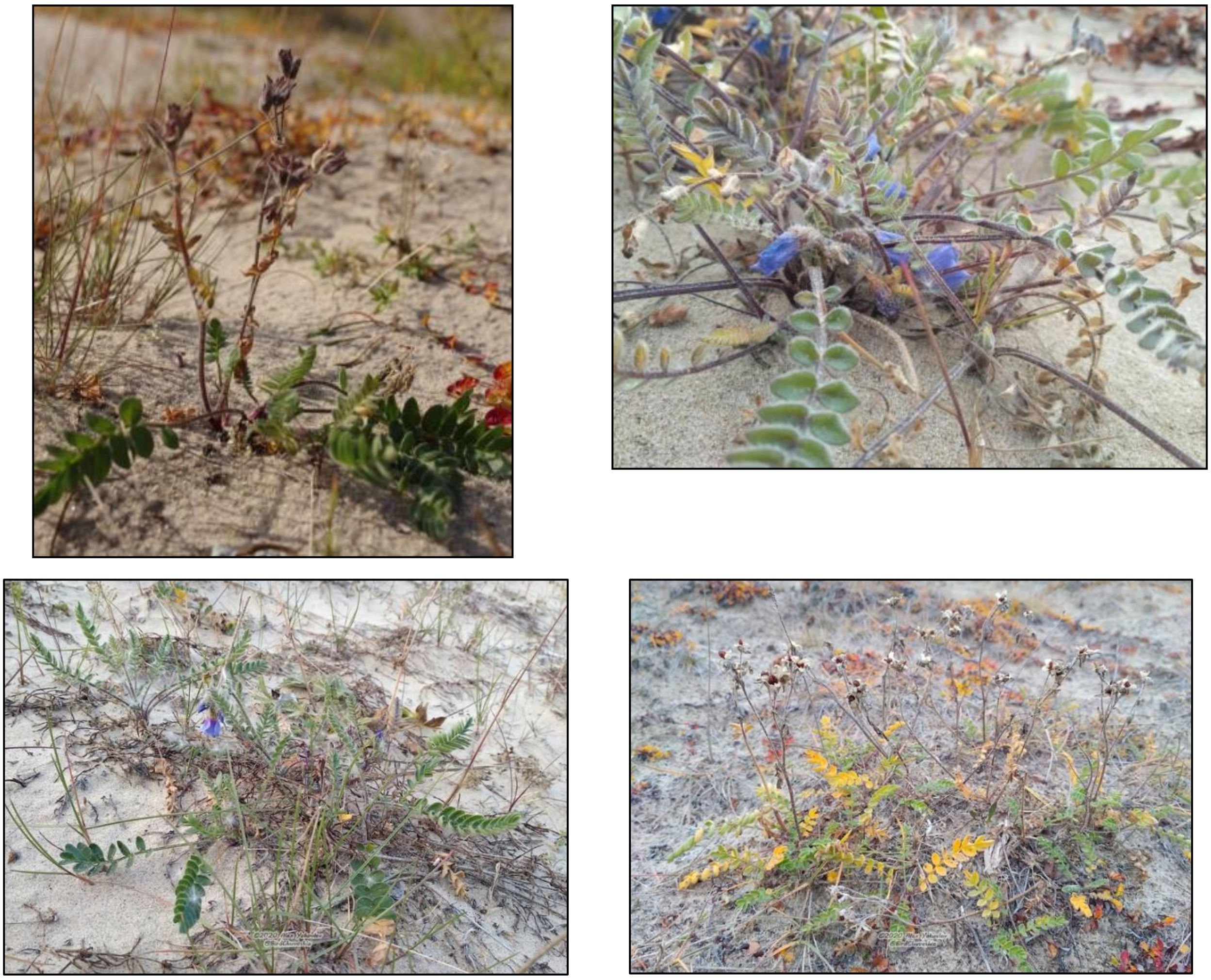


Figure 7.6.46: Valerium *Polemonium boreale* – listed in the Red Data Book of YNAO, category 3

Photos by IEPI JSC, 2019

Tufted saxifrage *Saxifraga cespitosa* L. Saxifragaceae.

Status. Category 3. Rare species. Listed in the Red Data Book of the Khanty-Mansi Autonomous Okrug (2003) as a category 3 species.

Range: North of European Russia, mountains in the northe of Middle and East Siberia, Far East, North America. Presence on the Gydan Peninsula is known in several locations: 15 km north of Tadybeyakha vil., 30 km east of the Vento Lake, the Khanarasalya Cape, near the Matyujsale Cape (Khitun, 2005). Always as single units. In the territory of the Salmanovskiy (Utrenniy) LA is registered as single units on the top of heave mound on the coast of the Ob Estuary.

Figure 7.6.47: *Thumus reverdattoanus* – Species listed in the Red Data Book of YNAO, Category 3: biotope 5.1 (sandy slope of marine terrace in the construction area of the LNG Plant)

Photos by IEPI JSC, 2020

Figure 7.6.48: *Saxifraga cespitosa* – Species listed in the Red Data Book of YNAO, Category 3: biotope 4.1 (dry slope of the Nyadaj-Pyngchyo River valley)

Photos by IEPI JSC, 2020

Thumus reverdattoanus Serg. Lamiaceae family.

Category 3. Rare species.

Siberian hypo-Arctic species: recorded in Western and Central Siberia, Yakutia. On the Gydan Peninsula, its presence is known on Cape Sapozhnikov, in the lower reaches of the Chugoryakha River, in the upper reaches of the Ngarka-Ngynyangsyo River. Occurs on the southern slopes of sandy hills and terraces, on drift sands, pebble surfaces, occasionally grows in forb and forb-shrub communities, in moss-lichen tundra; singly and in small groups developing patches up to 30 cm in diameter.

Within the Salmanovskiy (Utrenniy) LA, the plant has been registered in two locations: on the dry slope of the valley of the Nyadaj-Pyngchyo, and on the sandy slope of the marine terrace near the LNG plant.

Snowcup *Ranunculus nivalis* L. Ranunculaceae.

Red Data Book of YNAO (2010), status "requiring special attention".

Arctic circumpolar species. On the Gydan Peninsula, presence is known along the Chugoryakha, Tinikyakha, Ngarka-Ngynyangsyo, Khalmeryakha Rivers, in the neighbourhood of the Khonorasale, Matyujsale, Trekhgubniy Capes, on the southern shore of the Gydan Estuary (Khitun, 2005). Small sparse populations in subniveal habitats. In the territory of the Salmanovskiy (Utrenniy) LA, one plant was registered on a ridge slope on the left-side wall of the Khaltsyney-Yakha River valley. Not registered in 2020 due to inappropriate phenological phase.

Papaver yugor *Papaver lapponicum* (Tolm.) Nordh. subsp. *jugoricum* (Tolm.) Tolm. Papaveraceae .

Red Data Book of YNAO (2010), status "requiring special attention".

Arctic Siberian species. On the Gydan Peninsula: 15 km north of Tadybeyakha vil., Mammonth Peninsula (lower reaches of the Khalmeryakha River), south-west of Mammonth Peninsula (near the Matyujsale Cape), the Khanarasalya Cape (lower reaches of the Ngarka-Khorty-Yakha River) (Khitun, 2005).

Grows on shore slopes, pebble beds of rivers and lakes, sea coast areas. In tundra - on drained sites, banks enriched with fine earth, stony highland tundras, on sandy ridges. In the territory of the Salmanovskiy (Utrenniy) LA, one population (5 plants) is registered on a ridge top on the northern shore of the Yabtarmato Lake.

Figure 7.6.49: Papaver yugor *Papaver lapponicum* subsp. *jugoricum* – listed in the appendix of the Red Data Book of YNAO

Photo by IEPI JSC, 2019

Figure 7.6.50: Snowcup *Ranunculus nivalis* – listed in the appendix of the Red Data Book of YNAO

Photo by IEPI JSC, 2019

Naked-stem wallflower *Parrya nudicaulis* (L.) Regel (*Achoriphragma nudicaule* (L.) Sojak.) Brassicaceae (Cruciferae)

Red Data Book of YNAO (2010), status "requiring special attention".

Siberian Arctomontane species. On the Gydan Peninsula, presence is known in several locations (lower reaches of the Churgoryakha River, 15 north of Tadybeyakha vil., upper reaches of the Ngarka-Ngynyangsyo River (30 km east of the Vento Lake), the Khonorasale Cape, the Mammonth Peninsula, lower reaches of the Khalmeryakha River near the Matyujsale Cape) (Khitun, 2005). Erosiphilic species with a wide ecological range, grows on solifluctional slopes, pebble and clayey river banks, in patterned tundras.

In the territory of the Salmanovskiy LA was found on bare ridge top in the area of the berth structures (sample is in MW). In 2020, the species was not found on the biotope, it probably stopped growing by the time of the survey, there is no reason to suggest that the population has been destroyed. Another biotope was found at the top of the heave mound in the middle reaches of the Khaltsyney-Yakha River.

Polar eremogone *Eremogone polaris* (Schischk.) Ikonn. Caryophyllaceae.

Sub-endemic species of the Malaya Zemlya and Bolshaya Zemlya tundras, Polar Urals, Arctic Siberia. On the Gydan Peninsula, is found along the Messoyakha River, in the lower reaches of Chugoryakha and Tinikyakha Rivers, upper reaches of the Ngarka-Ngynyangsyo River.

Within the Salmanovskiy LA, it was found on sandy swells on exposed sandy soils on sea slopes and as small groups in the dunes; massively occurs on dry slopes of the Nyadaj-Pyngchyo River valley. A total of 9 ecotopes have been identified.

To clarify potential impact on the populations of the two rare and protected species, valerium and tundra woodrush, which are evidenced by the maximum number of finds during the vegetation monitoring activity in 2020, the Consultant built habitat suitability models using the method of maximum entropy[330][331][332] which is widely applied in bio-geographic studies, with MaxEnt 3.4.1 software. Morphometric indices calculated

[330] Phillips S.J., Dudík M., Schapire R.E. 2004. A maximum entropy approach to species distribution modeling // Proceedings of the twenty-first international conference on Machine learning. P. 83.

[331] Phillips S.J., Dudík M., Schapire R.E. 2019. Maxent software for modeling species niches and distributions (Version 3.4.1).

[332] Phillips S.J., Anderson R.P., Schapire R.E. 2006. Maximum entropy modeling of species geographic distributions // Ecological Modelling. Vol. 190. No. 3–4. P. 231-259.

using digital model of the terrain[333] were used as predictors of habitat suitability: slope steepness and exposition, slope curvature metric, topographic wetness index (TWI), calculated on the basis of RSD - scene of the Landsat 8 multispectral satellite image for July 2020: metrics of humidity, greenness, brightness[334] and enhanced vegetation index (EVI). Metric of habitat heterogeneity was also used - spectral index Rao's Q[335] All data was prepared using the SAGA GIS[336] geographic information system.

The built models are characterized by high prediction quality (AUC[337] > 0.9). The most important predictors of habitat suitability evaluated by the "Permutation importance" tundra woodrush are the terrain metrics: topographic wetness index (TWI) 74.7, relative slope position 17.1, exposition 8.1. The suitability of valerium habitats is explained by both topographic data and metrics calculated on the basis of RSD. The leading factors are: hegerogeneity index Rao's Q (39.5), wetness (15.5), topographic wetness index (13.4), relative slope position (16.1), slope exposition (6.8).

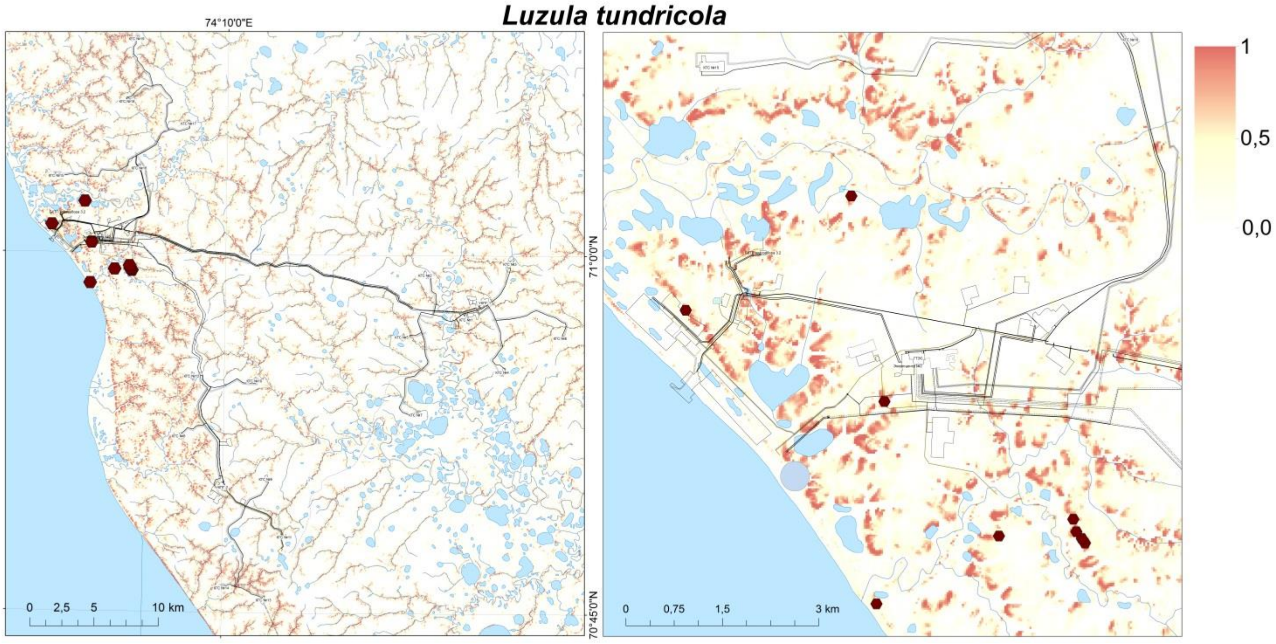


Figure 7.6.51: Distribution of tundra woodrush (*Luzula tundicola*) in the territory of the Salmanovskiy (Utrenniy) LA. Potential suitability of habitats calculated using the maximum entropy (MaxEnt) method is shown

The output data facilitated obtaining new information on the distribution of these species. Tundra woodrush is confined to the eluvial parts of the ridge slopes with mineral soils (Figure 7.6.51); this species is more common in areas with highly fragmented erosional relief between the Ob and Gydan estuaries. The most suitable habitats for tundra woodrush aare located in river valleys and on sandy slopes on the coast (Figure 7.6.52).

[333] Porter C., Morin P., Howat I., Noh M.J., Bates B., Peterman K., Keesey S., Schlenk M., Gardiner J., Tomko K. 2018. ArcticDEM. Harvard Dataverse.

[334] Liu, Q., Liu, G., Huang, C., Liu, S., & Zhao, J. (2014, July). A tasseled cap transformation for Landsat 8 OLI TOA reflectance images. In 2014 IEEE Geoscience and Remote Sensing Symposium (pp. 541-544). IEEE.

[335] Rocchini, D., Bacaro, G., Chirici, G., Da Re, D., Feilhauer, H., Foody, G. M., Galluzzi, M., Garzon-Lopez, C. X., Gillespie, T. W., He, K. S., Lenoir, J., Marcantonio, M., Nagendra, H., Ricotta, C., Rommel, E., Schmidtlein, S., Skidmore, A. K., Van De Kerchove, R., Wegmann, M., & Rugani, B. (2018). Remotely sensed spatial heterogeneity as an exploratory tool for taxonomic and functional diversity study. Ecological Indicators, 85, 983–990. https://doi.org/10.1016/j.ecolind.2017.09.055

[336] Conrad O., Bechtel B., Bock M., Dietrich H., Fischer E., Gerlitz L., Wehberg J., Wichmann V., Böhner J. 2015. System for Automated Geoscientific Analyses (SAGA) v. 2.1.4 // Geoscientific Model Development. V. 8. No. 7. P. 1991-2007.

[337] Araujo M.B., Pearson R.G., Thuiller W., Erhard M. 2005. Validation of species-climate impact models under climate change // Global Change Biology. Vol. 11. No. 9. P. 1504–1513

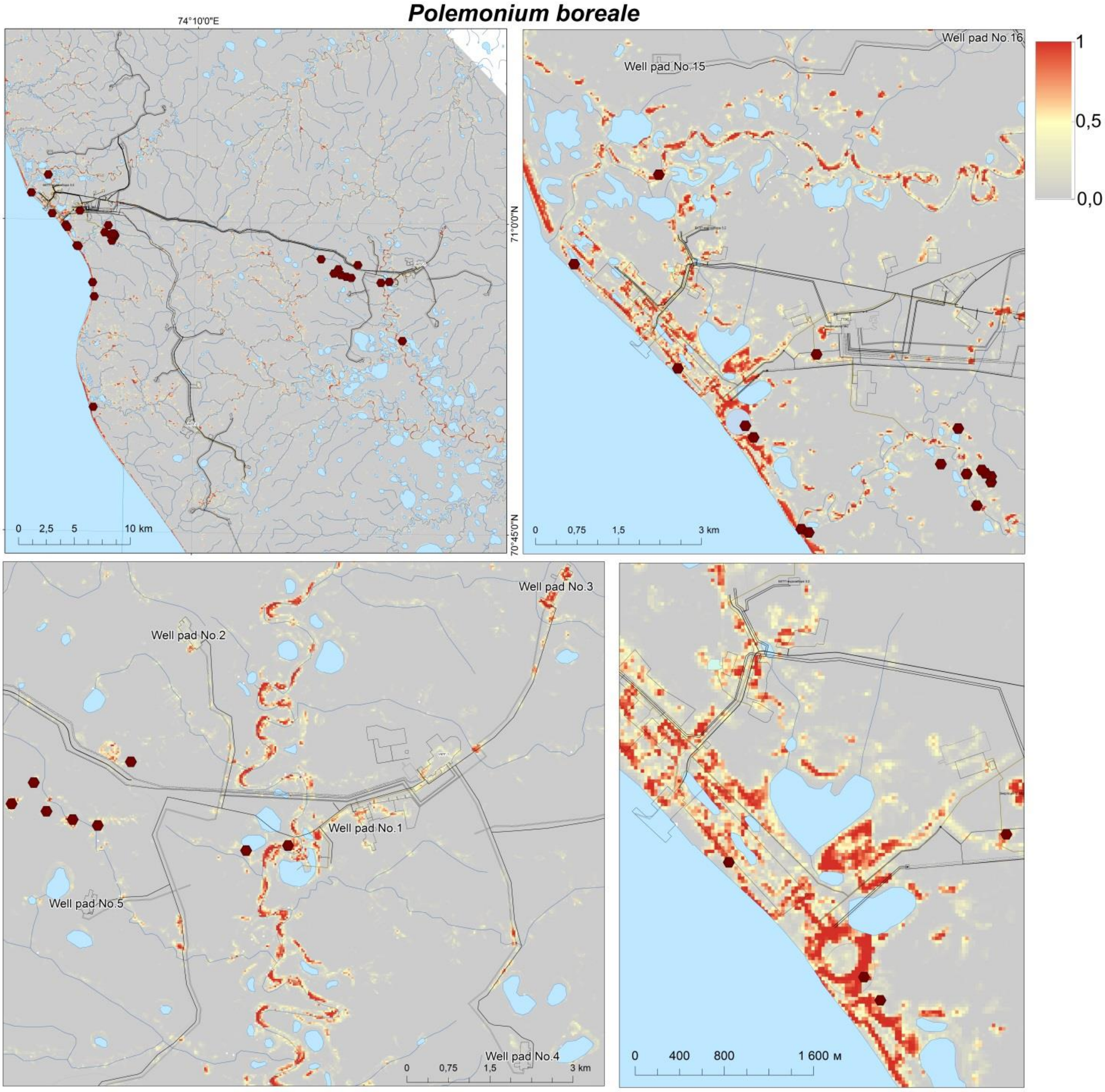


Figure 7.6.52: Distribution of valerium (*Polemonium boreale*) in the territory of the Salmanovskiy (Utrenniy) LA. Potential suitability of habitats calculated using the maximum entropy (MaxEnt) method is shown

Based on the results of monitoring by IEPI JSC in 2020, it was concluded that most of the identified populations do not experience a negative impact from construction at this stage.

Rare Plant Communities

There exist multiple criteria of rare plant communities[338]. This term denotes phitocoenoses with one or several of the following attributes: limited range due to natural or anthropogenic reasons; special floristic or functional structure features; presence of relict plants as dominant or co-dominant species; confinedness in the range of respective type of vegetation, or in isolated location apart of the main range, etc.

Within the studied area, rare communities with limited range, relying on specific rare environmental conditions, are subshrub-moss tundra on perennial frost heave mounds, as well as sparse forb/grass meadows on the sandy seashore cliffs.

On the heave mounds' tops, as part of the subshrub (*Dryas punctata, Salix nummularia*)-moss (*Rhytidium rugosum, Abietinella abietina*) tundras, species listed in the Red Data Book of YNAO *Bromopsis vogulica и*

338 Reference is made to the review of the notion of "rare plant communities" in publication: P. V. Krestov, V. P. Verkholat. Rare plant communities of Primorye and Amur River region. Vladivostok: DVO RAS, 2003. 200 p.

Saxifraga cespitosa are reportedly present. Besides the above species, also *Saxifraga bronchialis, Draba glabella, Sagina intermedia, Cerastium maximum* have been registered only in these conditions. These communities occupy territories of few square meters.

Figure 7.6.53: Perennial heave mounds - potential habitats of rare species

Photos by IEPI JSC, 2019

Sparse forb-graminous meadows on slopes towards the Ob Estuary are composed of *Dryas punctata*, *Saussurea tilesii*, *Oxytropis sordida*, *Artemisia borealis, Antennaria lanata, Tanacetum bipinnatum, Koeleria asiatica*. Velarium (*Polemonium boreale*) - species listed in the Red Data Book of YNAO, and Polar eremogone (*Eremogone polaris*) - species recommended for monitoring are reportedly present in these conditions. Only in these conditions, *Erigeron silenifolius*, *Dianthus repens*, *Aconogon ochreatum* have been registered in the territory of the Salmanovskiy (Utrenniy) LA. These communities feature a high aesthetic value due to abundance of species with bright blossom (Figure 7.6.54).

Figure 7.6.54: Colourful tundra meadows on steep shores of the Ob Estuary

Photo by IEPI JSC, 2019

O. V. Khitun (2002, 2005) identified sand screes on cliffs with species composition similar to that in the Salmanovskiy (Utrenniy) LA as a rare biotope. The same author registered such communities at the mouth of the Tinikyakha River. Within the LA, these communities occupy territories ranging from few square meters to few dozens square meters. Figure 7.6.55 illustrates potential range of these communities.

Given the very special environmental conditions, the concerned rare plant communities are potentially vulnerable to disturbance. The temporal instability of habitats occupied by these communities should also be noted.

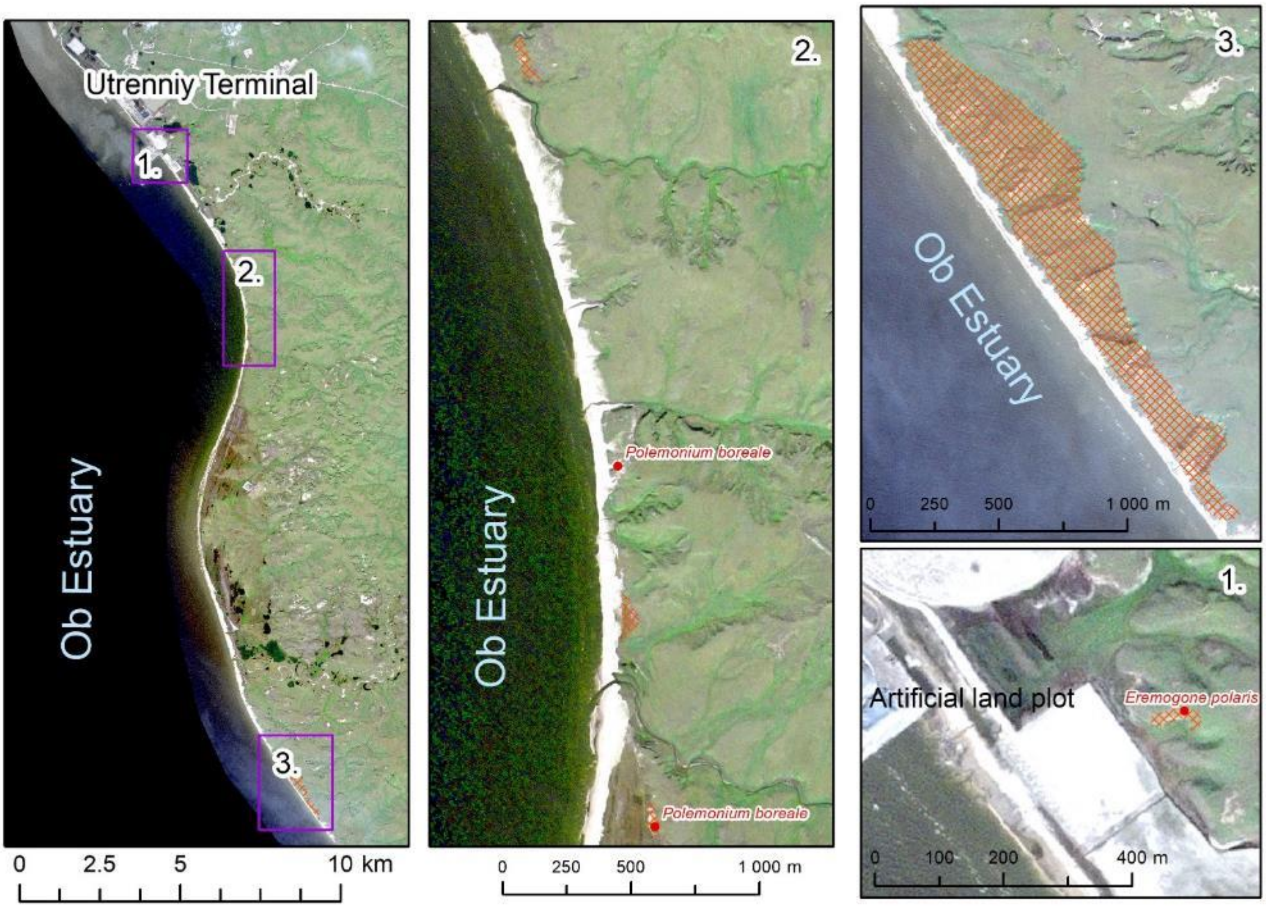


Figure 7.6.55: Probable range of tundra meadows on sandy sea slopes

It is reliably known that these communities are present at the locations where Polar eremegone *Eremogone polaris* and valerium *Polemonium boreale* are registered. Prepared by the Consultant with reference to the local environmental monitoring materials by IEPI JSC, 2019

7.6.3.2 Invertebrates

Invertebrate animals of tundra play the key role in the primary production of zoocenoses and make up to 95% of total biomass. Their function in the northern biocenoses is varied and quite important. A specific feature of the Arctic ecosystems is a low rate of organic substance destruction processes; saprotrophic bacteria and fungi are much less active there than in other regions, and therefore, especially important are the invertebrates that decompose dead organic substance: protozoa, worms, soil mites and some other insects both in larval and imago stages.

Many aquatic insects, crustaceans, worms and mollusks are the prey of fish, as well as waterfowl and wetland birds. Invertebrates are known to take part in substance and energy exchange between terrestrial and aquatic ecosystems.

Together with soil and above-soil invertebrates, the insects developing in aquatic environment, during their terrestrial stage, form the food base for insectivorous birds, mainly waders and passerines.

Within the survey area, the composition of invertebrates differs from more southern latitudes only in lower diversity of species. There are no specific types of invertebrates here. The number and biomass of invertebrates increases from watershed tundras towards bogs. The richest and most diverse population of invertebrates is observed in the willow shrubs.

Nematodes living in the soil are the largest group of soil organisms. The main representatives of annelids are earthworms, enchytraeids and leeches. Earthworms can be found in a variety of sufficiently drained soils, most of them can be found in floodplains. Enchytraeids related to the earthworms in origin and the way of life, are also abundant in drained soils (up to several thousand per 1 m^2 of soil).

Arthropods are distinguished among the invertebrates by the number of species and abundance. Crustaceans (fairy shrimps, tadpole shrimps, daphnids and cyclops) are found almost exclusively in water, and most of insects, arachnids and all millepedes prefer terrestrial habitats; they are mainly concentrated in the moss turf and thin warmed topsoil layer. In terms of abundance, saprotrophic small species of springtails (*Collembola*) and even smaller (less than 1 mm long) soil oribatida mites (*Oribatei*).

Most of the invertebrates are insects (*Insecta*), spiders (*Aranei*), millepedes (*Myriapoda*), and earthworms (*Oligochaeta Lumbricidae*). These larger animals form the macrofauna; the species diversity is estimated at 2—2.5 thousand species. Insects and spiders are the most diverse and numerous animals of the tundra. There are more than 100 species of spiders. Generally, they are small species.

Insects are one of the most numerous groups, which includes springtails, primitive wingless small insects living in the soil, mosses and lichens. Of the Orthoptera order, there are dusky cockroach, three species of locust — Melanoplus friaidus, Tetrix, and Podismopsis poppiusi; and one species of grasshopper — wart-biter bush cricket. Some insects (dragonflies, mayflies and stoneflies) have adapted well to water bodies inhabited by their imago individuals or larvae. Bugs belong to Hemipterans. Small bugs live on grass, trees and shrubs. Predatory shore bugs are common near water bodies, while the backswimmer, pond-skater, boatman, water scorpion, and water creeper inhabit the water bodies.

There are more than 1000 species of Coleoptera in the north of Siberia. The most common of them are water tigers, predatory beetles such as ground beetles, ladybirds, leaf beetles (Chrysolina cerealis and Chrysolina arctica), weevils (Lepyrus arcticus), elaterids etc. Bipterans, i.e. mosquitoes and flies, are also quite numerous. Long-horned flies include buzzers, chironomids whose larvae live in water; midges whose larvae live in plant tissues; fungus gnats etc. Of all the mosquitoes, females of only three or four species attack humans. Minges are numerous, there are more than 20 species. There are also a lot of biting midges, but they are not abundant. Up to 14 species of blood-sucking mosquitoes are registered. None of them are carriers of infections such as malaria. There are also hymenoptera, wasps and bumblebees, known for their social life. Typical species for the northern region are Norwegian wasp living in spherical nests, and common bumblebees.

There are about 600 species of butterflies (*Lepidoptera*). Many of them are active only at dusk: owl moths, geometrid moths, tiger moths and hawk moths. Satyr butterflies and erebias are common for moss bogs. There are also bright-coloured butterflies, such as yellow and tiger moth.

7.6.3.3 Reptiles and amphibians

There are no reptiles and amphibians in the LA territory.

7.6.3.4 Bird fauna

In ornithological terms, the described area belongs to the Gydan-Tazovskiy ornitho-geographical section of the West Siberian Plain. Population is of tundra type[339]. In terms of fauna types, the species composition of the Arctic tundra birds is mainly represented by the Arctic (61.6%), widespread (19.2%) and Siberian (14.1%) species with some European (3.8%) and Holarctic (1.3%) species.

The avifauna of YNAO consists of 221 bird species belonging to 15 orders, including 155 species nesting or settling in at least one of the two natural subzones (Arctic and Hypo-Arctic tundra). At the same time, 64 bird species are exclusively visitant, or their possible stay in the survey territory and water area is doubtful. The diversity of bird species naturally increases from the Kara Sea towards the forest-tundra.

[339] E. S. Ravkin, Y. S. Ravkin. Birds of the North-Eurasian plains: Population, range, spatial organization of communities. Novosibirsk: Nauka, 2005. 304 p.

Information about avifauna in the Project area (both the continental part within the Salmanovskiy (Utrenniy) LA and the northern part of the Ob Estuary) was obtained on the basis of analysis of published data, as well as records of environmental surveys and monitoring. Ornithological studies were carried out in different seasons, and covered both nesting and migration periods (Table 7.6.14).

Table 7.6.14: List and timing of ornithological studies in the territory of the Salmanovskiy (Utrenniy) LA

Organisation	Title (names of publications, design documents)	Period of ornithological studies
FSUE PINRO, Northern Filial / FRECOM LLC	Assessment of Background (Baseline) Status of Environmental Components of Onshore and Offshore Areas of the Salmanovskiy (Utrenniy) License Area (Yamal-Nenets Autonomous Okrug) Based on Results of the Environmental Survey	July 19 to August 7, 2012. Route surveys and aerial observations
PurGeoCom LLC	Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Phase PIR-5. Technical report on environmental survey.	07-19 July 2018
PurGeoCom LLC	Utrenniy Airport. Technical report on results of environmental survey.	July 2018
FSU R&D E "AeroGeologia". "Ecozont" Centre	Ecological monitoring of the natural environment in the onshore and offshore areas of the Salmanovskoye (Utrenneye) oil, gas and condensate field	August 30 to September 2, 2017
IEPI JSC	Environmental Monitoring at the Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup 2018	17-30 August, 23-30 September 2018
IEPI JSC	Phase 3.1. Final Report on the environmental monitoring of the Salmanovskoye (Utrenneye) oil, gas and condensate field 2019	June 30-July 05, September 11-20, 2020
IEPI JSC	Report on the local environmental monitoring of the Salmanovskoye (Utrenneye) oil, gas and condensate field 2020	August 30 - September 20, 2020, September 30 - October 3, 2020

Representatives of about 90 bird species can be met in the territory of Salmanovskiy (Utrenniy) license area; 38% of them are passerines, 25 % are charadriiformes, and about 16 % are anseriformes (only 21% of birds belong to all other orders). Almost all of the birds present in this region are classified as breeding and migratory ones, and only a few species are resident (these are mainly the snowy owl and the white grouse) (Table 7.6.15).

Species composition, living status, relative abundance and biotopical distribution of the avifauna in the LA (areographically expected species) are summarized in Table 7.6.15.

Table 7.6.15: Species composition, living status, relative abundance and biotopical distribution of avifauna in the territory of Salmanovskiy (Utrenniy) LA (areographically expected species)

No.	Species	Status	Relative abundance	Ecological group
Gaviiformes				
1	Red-throated loon *Gavia stellata*	nest	c	1
2	Black-throated loon *Gavia arctica*	nest	c	1
Pelecaniformes				
3	Northern gannet *Morus bassanus*	vag	occ	1
Anseriformes				
4	Brant goose *Branta bernicla*	nest	r	1
5	Red-breasted goose *Branta ruficollis*	pass	occ	1
6	Lesser white-fronted goose *Anser erythropus*	pass, nest?	occ	1
7	Greater white-fronted goose *Anser albifrons*	nest	c	1
8	Bean goose *Anser fabalis*	nest	r	1
9	Snow goose *Anser caerulescens*	pass	occ	1
10	Whooping swan *Cygnus cygnus*	vag	occ	1
11	Bewick's swan *Cygnus bewickii*	nest	r	1
12	Common teal *Anas crecca*	nest?	occ	1
13	Wigeon *Anas penelope*	vag	occ	1
14	Northern pintail *Anas acuta*	nest	r	1
15	Northern shoveler *Anas clypeata*	vag	occ	1
16	Greater scaup *Aythya marila*	nest	r	1
17	Bullhead *Bucephala clangula*	vag	occ	1
18	Long-tailed duck *Clangula hyemalis*	nest	ab	1
19	King eider *Somateria spectabilis*	nest	c	1

No.	Species	Status	Relative abundance	Ecological group
20	Steller's eider *Polysticta stelleri*	nest?	r	1
21	Velvet scoter *Melanitta fusca*	pass	r	1
22	Black scoter *Melanitta nigra*	vag	r	1
23	Smew, or pied diver *Mergel lusalbellus*	vag	r	1
24	Red-breasted merganser *Mergus serrator*	vag	occ	1
25	Common merganser *Mergus merganser*	vag	occ	1
Falconiformes				
26	Rough-legged buzzard *Buteo lagopus*	nest	c	2
27	White-tailed eagle *Haliaeetus albicilla*	vag	r	1, 2, 4
28	Gyrfalcon *Falco rusticolus*	vag	occ	2
29	Peregrine falcon *Falco peregrinus*	nest	r	2
30	Pigeon hawk *Falco columbarius*	vag	occ	2
Galliformes				
31	White grouse *Lagopus lagopus*	nest	ab	2
32	Willow ptarmigan *Lagopus mutus*	nest?	r	2
Charadriiformes				
33	Grey plover *Pluvialis squatarola*	nest	c	2
34	Lesser golden plover *Pluvialis fulva*	nest	r	2
35	Greater golden plover *Pluvialis apricaria*	nest	r	2
36	Ringed plover *Charadrius hiaticula*	nest	c	1.2
37	Common dotterel *Eudromias morinellus*	nest?	occ	2
38	Ruddy turnstone *Arenaria interpres*	nest	r	1
39	Wood sandpiper *Tringa glareola*	nest	r	1.2
40	Spotted redshank *Tringa erythropus*	pass	r	1
41	Terek sandpiper *Xenus cinereus*	vag	occ	1
42	Grey phalarope *Phalaropus fulicarius*	nest	r	1.2
43	Red-necked phalarope *Phalaropus lobatus*	nest	ab	1.2
44	Ruff *Philomachus pugnax*	nest	c	1.2
45	Little stint *Calidris minuta*	nest	ab	1.2
46	Temmnick's stint *Calidris temminckii*	nest	ab	1.2
47	Curlew sandpiper *Calidris ferruginea*	nest	ab	1.2
48	Dunlin *Calidris alpina*	nest	ab	1.2
49	Purple sandpiper *Calidris maritima*	pass	occ	1
50	Pectoral sandpiper *Calidris melanotos*	nest	occ	1.2
51	Robin sandpiper *Calidris canutus*	pass	occ	1
52	Sanderling *Calidris alba*	pass	occ	1
53	Bar-tailed godwit *Limosa lapponica*	vag	occ	1
54	Jack snipe *Lymnocryptes minimus*	nest?	occ	1.2
55	Common snipe *Gallinago gallinago*	nest	occ	1.2
56	Pin-tailed snipe *Gallinago stenura*	nest?	occ	1.2
57	Double snipe *Gallinago media*	nest?	occ	1.2
58	Pomarine skua *Stercorarius pomarinus*	nest	c	1.2
59	Arctic skua *Stercorarius parasiticus*	nest	c	1.2
60	Long-tailed skua *Stercorarius longicaudus*	nest	c	1.2
61	Heuglin's gull *Larus heuglini*	nest	c	1.2
62	Glaucous gull *Larus hyperboreus*	nest	r	1
63	Black-legged kittywake *Rissa tridactyla*	vag	occ	1
64	Ivory gull *Pagophila eburnea*	vag	occ	1
65	Arctic tern *Sterna paradisaea*	nest	c	1
66	Tystle *Cepphus grylle*	vag	occ	1
Strigiformes				
67	Snowy owl *Nyctea scandiaca*	nest	c	2
68	Short-eared owl *Asio flammeus*	nest	occ	2
Passeriformes				
69	Common sand martin *Riparia riparia*	vag	occ	1.2
70	Horned lark *Eremophila alpestris*	nest	ab	2
71	Red-throated pipit *Anthus cervinus*	nest	ab	2.3
72	Meadow pipit *Anthus pratensis*	nest?	r	2.3
73	Western yellow wagtail *Motacilla flava*	nest?	occ	1
74	Citrine wagtail *Motacilla citreola*	nest?	occ	1.5
75	White wagtail *Motacilla alba*	nest	c	1.5
76	Willow warbler *Phylloscopus trochilus*	nest	occ	3
77	Common chiffchaff *Phylloscopus collybita*	vag	occ	3
78	Northern wheatear *Oenanthe oenanthe*	nest	c	2.5
79	Bluethroat *Luscinia svecica*	nest	c	1,2,3
80	Redwing *Turdus iliacus*	nest	occ	3.5
81	Fieldfare *Turdus pilaris*	vag	occ	3.5
82	Common redpoll *Acanthis flammea*	nest	r	3

No.	Species	Status	Relative abundance	Ecological group
83	Hooded crow *Corvus cornix*	vag	occ	5
84	Common raven *Corvus corax*	vag	occ	5
85	White-winged crossbill *Loxia leucoptera*	vag	occ	4
86	Little bunting *Ocyris pusillus*	nest?	occ	3
87	Lapland longspur *Calcarius lapponicus*	nest	ab	2
88	Snow bunting *Plectrophenax nivalis*	nest	c	1.5

Designations: *nest* – nesting; *pass* – bird of passage; *vag* – vagrant; ? – probably; *occ* – occasionally; *r* – rare; *c* – common; *ab* – abundant; 1 – semi-aquatic birds; 2 – open space birds; 3 – shrub birds; 4 – forest birds; 5 – synanthropes.

* - colour-highlighted species are listed in the Red Data Books of Russia (red), and YNAO (blue).

Figure 7.6.56: Near-water species of birds recorded in the territory of the Salmanovskiy (Utrenniy) LA. From left to right, top to bottom: Black-throated loon *Gavia arctica*, Common teal *Anas crecca*, Northern pintail *Anas acuta*, Greater white-fronted goose *Anser albifrons*

Source: IEPI, LLC, 2019-2020

Ornithocoenosis structure is determined by subarctic species which find here optimal conditions for existence. These include: little stint *Calidris minuta*, dunlin *Calidris alpina*, Lapland longspur *Calcarius lapponicus*, Temminck's stint *Calidris temminckii*, long-tailed duck *Clangula hyemalis*, horned lark *Eremophila alpestris*, willow ptarmigan *Lagopus lagopus*, red-throated pipit *Anthus cervinus*, red-necked phalarope *Phalaropus lobatus*, ruff *Philomachus pugnax*, black-bellied plover *Pluvialis squatarola*, and king eider *Somateria spectabilis*. These species distinctly prevail in numbers over all other inhabitants of the area. In addition to these, the nesting population of the concerned area includes other species with a very wide or cosmopolitan distribution , demonstrating high ecological plasticity, which have also established in subarctic conditions. Of these species some are relatively common, such as white wagtail *Motacilla alba*, common wheatear *Oenanthe oenanthe* and blue-throated robin *Luscinia svecica*.

Figure 7.6.57: Carnivores and waders recorded in the territory of the Salmanovskiy (Utrenniy) LA. From left to right, top to bottom: Pigeon hawk *Falcocolumbarius*, rough-legged buzzard *Buteolagopus*, black-bellied plover *Pluvialis squatarola*, lesser golden plover *Pluvialis fulva*, little stint *Calidris minuta*, dunlin *Calidris alpina*

Source: IEPI JSC, 2019-2020

The birds are distributed across the tundra unevenly. The richest in species and most densely populated are river floodplains, seaside meadows - laidas. In the Arctic tundra, with its abundance of lakes and bogs, aquatic and near-water complex are best represented. Besides the aforementioned long-tailed duck and king eider those include loons (red-throated *Gavia stellata* and black-throated *G. arctica*), greater white-fronted goose (*Anser albifrons*), three species of skuas (pomarine skua *Stercorarius pomarinus*, Arctic skua *St. parasiticus* and long-tailed skua *St. longicaudus*), seagulls (Heuglin's gull *Larus heuglini* and glaucous gull *L. hyperboreus*), Arctic tern *Sterna paradisaea*. Less common are Bewick's swan *Cygnus bewickii*, geese – brant goose *Branta bernicla* and bean goose *Anser fabalis*, ducks – northern pintail *Anas acuta*, greater scaup duck *Aythya marila* and Steller's eider *Polysticta stelleri*, waders – lesser and greater golden plover (*Pluvialis fulva* and *P. apricaria*).

The abundance and diversity are low in the dry watershed areas of tundra. They are inhabited by red-throated pipit *Anthus cervinus*, Lapland bunting *Calcarius lapponicus*, and white grouse *Lagopus lagopus*. Less common are horned lark *Eremophila alpestris*, black-bellied plover *Pluvialis squatarola,* lesser golden plover *Pluvialis fulva*.

Figure 7.6.58: Passerines recorded in the territory of the Salmanovskiy (Utrenniy) LA. From left to right, top to bottom: red-throated pipit *Anthus cervinus*, common wheatear *Oenanthe oenanthe*, redwing *Turdus iliacus*, white wagtail *Motacilla alba*, snow bunting *Plectrophenax nivalis*, common redpoll *Acanthis flammea*

Source: IEPI JSC, 2019-2020

Of the meat-eating predators, relatively common species are rough-legged buzzard *Buteo lagopus* and snowy owl *Nyctea scandiaca*, but their population is entirely dependent on the abundance of lemmings and voles. Peregrine falcon *Falco peregrinus* occasionally nests on cliffs.

The distinct synanthropic species are snow bunting *Plectrophenax nivalis* and, to some extent, ringed plover *Charadrius hiaticula,* Temminck's stint *Calidris temminckii* and white wagtail *Motacilla alba.*

Through the willow grows in the river valleys and mounds, tree-shrub species migrate to the Arctic tundra, such as willow warbler *Phylloscopus trochilus*, redwing *Turdus iliacus*, common redpoll *Acanthis flammea*, little bunting *Ocyris pusilla*.

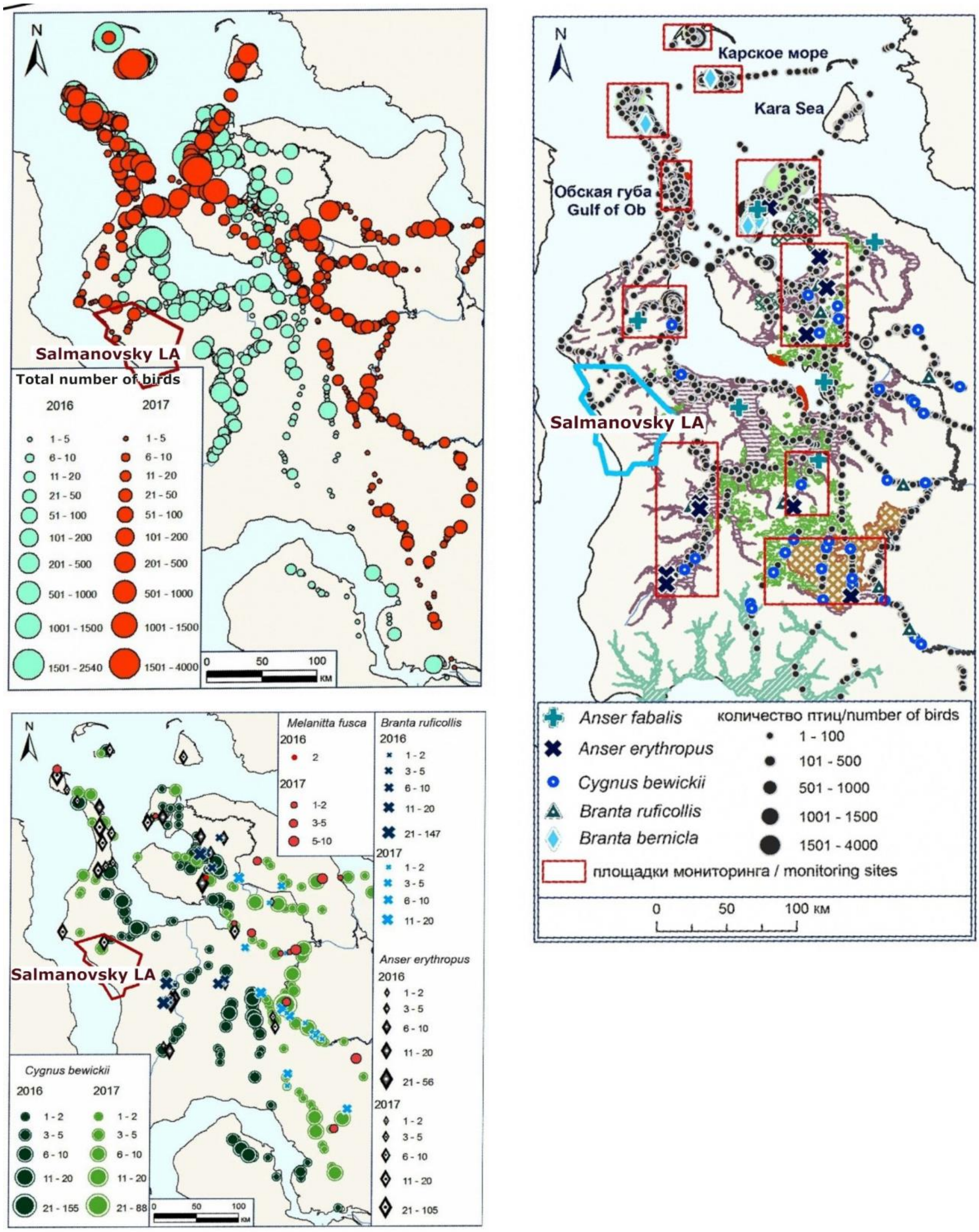


Figure 7.6.59: Gydan Peninsula anseriformes data based on aerial counting, 2016-2017

Source: (Rosenfeld et al. 2018)

Around the license area, two species of *gaviiformes* are quite common: the Arctic and red-throated loons. The former is common everywhere and is distributed evenly enough over the territory. The red-throated loon is noted more often in the valleys of rivers and large lakes, in the Ob Estuary coastal zone. All loon come to the region late, when the rivers break up, and open water appears at the edges of lakes (late May – early June). Departure in autumn depends on the time of freeze-up (late September – early October).

Of the 11 breeding species of *anseriformes*, the long-tailed duck and king eider are dominant. A rare breeding species is the Bewick's swan. Its breeding grounds are different types of tundra with lakes, mainly in broad river floodplains and on laidas.

Also, in the license area up to 5 species of geese breed: Brandt goose, red-breasted goose, greater white-fronted goose, lesser white-fronted goose and bean goose. They distribute over the territory without any particular places of concentration. Their arrival depends on the conditions in spring period and is usually observed in the 3rd decade of May; mass passage of these birds is more often observed in late May and early June.

In the territory of the license area, two species of *day birds of prey* can breed, the number of which depends on the abundance of rodents. One of them is the rough– legged buzzard that often inhabits the bogs, lowlands and floodplains. The other bird of prey is peregrine Falcon – usually choosing the river floodplains. In addition, young white– tailed eagles and gyrfalcons can be found here during their migrations. In course of the environmental surveys and the local environmental monitoring, none of these birds was noted, but deeper in the mainland, within the license area close to its eastern boundary, the breeding ground of the rarest bird of prey – the peregrine falcon – has been documented (this species is listed in the Red Data Book of Russia as a small species, protection category II).

Aerial counting with the use of ultralight aircraft is a valuable source of information on fauna and population of anseriformes on the Gydan Peninsula[340] (Figure 7.6.59). This data suggests that the main nesting gatherings of anseriformes including rare and protected species are located outside the Salmanovskiy (Utrenniy) LA.

Bird migrations

The Project area lies on the way of migration of birds from breeding areas on Gydan and Taimyr to European and West Asian wintering grounds. Taking into account rather low general diversity of bird species nesting in the high latitudes of Western and Eastern Siberia and wintering in Europe, Western Asia and partly in Africa, significant species diversity of migrants can hardly be expected. Various anseriformes and waders call the Project area on their migration passage from high-latitude regions.

In spring, the birds are usually on transit passage in the northern and eastern directions with short stops. These stops become longer in case of longer springs with dramatic temperature drops, and sometimes the birds can even migrate back. Spring passage of geese in the LA ends in late June.

In autumn, the species composition of waterfowl is the same as in spring. River duck males start the migration after molting in the middle of August. Migration flows in autumn are less intensive than in spring, ending by mid-October. Lesser white-fronted goose, wigeon, northern pintail, greater scaup, greater white-fronted goose are observed on passage.

The main bird migration routes have been examined based on published satellite telemetry information[341][342] (Figure 7.6.60).

---

[340] S. B. Rosenfeld, G. V. Kirtayev, N. V. Rogova, M. Yu. Solovjev, A. A. Gorchakovskiy, M. S. Bizin, S. S. Demjyanets. Assessment of population status and habitat conditions for anseriformes in the Gydanskiy state nature reserve (Russia) and adjacent territories, with the use of ultralight aviation. Nature Conservation Research. Conservation Science. 2018

[341] Simeonov P., Nagendran M., Michels E., Possardt E., Vangeluwe D. Red-breasted Goose: satellite tracking, ecology and conservation // Dutch Birding. 2014. Vol. 36. P. 73-86

[342] Kruckenberg H. et al. White-fronted goose flyway population status //Angew. Feldbiol. 2008. Vol. 2. N. 1. P. 77.

Martini I.P. et al. Northern Polar Coastal Wetlands: Development, Structure, and Land Use //Coastal Wetlands. Elsevier, 2019. P. 153-186.

Koelzsch A. et al. Flyway connectivity and exchange primarily driven by moult migration in geese //Movement ecology. 2019. Vol. 7. N. 1. P. 3.

Sokolov A., Sokolov V., Dixon A. Return to the wild: migratory peregrine falcons breeding in Arctic Eurasia following their use in Arabic falconry //Journal of Raptor Research. 2016. Vol. 50. N. 1. P. 103-108.

Marchant J. H., Musgrove A. J. Review of European flyways of the Lesser White-fronted Goose Anser erythropus //BTO Research Report. 2011. Vol. 595. P. 2.

Drent R. H., Fox A. D., Stahl J. Travelling to breed //Journal of Ornithology. 2006. Vol. 147. N. 2. P. 122-134

Aarvak T., Øien I., Shimmings P. A critical review of Lesser White-fronted Goose release projects //Norsk ornitologisk forening. 2016. P. 1-6.

ölzsch A. et al. A periodic Markov model to formalize animal migration on a network //Royal Society open science. 2018. Vol. 5. N. 6. P. 180438.

https://savebranta.org/en/birds-tracker

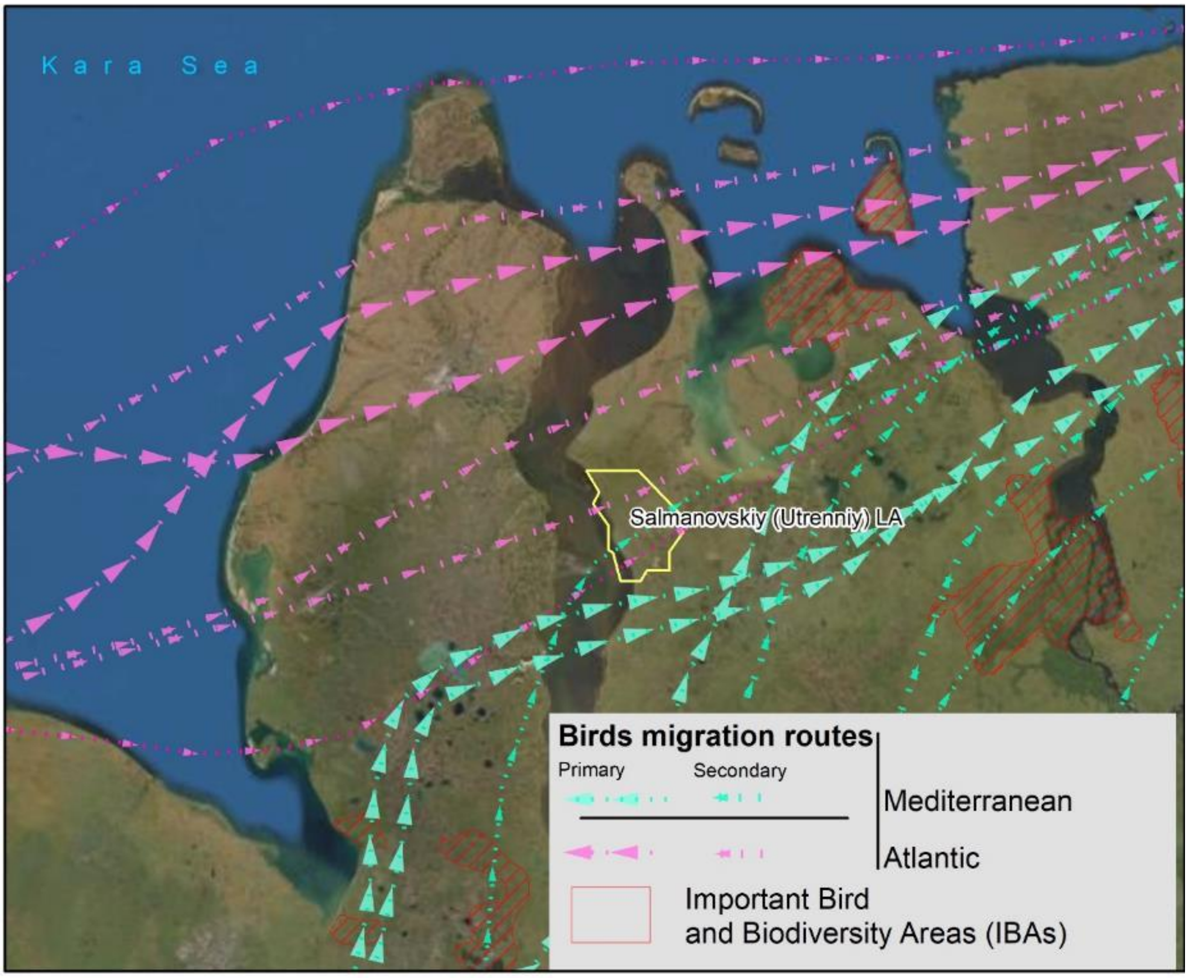


Figure 7.6.60: Main migration routes of birds in the Project area, based on satellite telemetry materials

Prepared by the Consultant

The total number of ducks in the Ob estuary and in the adjacent water area of the Ob Estuary after breeding and molting ranges from 0.7 to 1.5 million individuals. The first to migrate in autumn are the duck males after molting. Autumn migration is less intense than in spring and ends in late September-early October.

The sites of seasonal gatherings, most valuable for birds, including the nearest key ornithological areas (Upper and Middle Yuribei) and the wetlands of international importance (islands in the Ob Estuary of the Kara Sea), are situated at a considerable distance from the survey area. Monitoring activities in September 2019 (IEPI JSC, 2019) included registration of local nesting anseriformes with advancer youngs, gatherings on foraging stations, and transit birds passing the field area without stopping.

According to the monitoring records, autumn migration at the Salmanovskiy (Utrenniy) LA is characterized by the following features:

- Transit flights of most species of birds (charadriiformes, passerines) over the concerned territory is completed by September, therefore, overall observed migration intensity is low;
- Most of the birds fly in a wide front, without connection to natural landscape features and without concentration; this is why overall birds density is reportedly low;
- Small concentrations of waterfowl (ducks, loons) are recorded at floodplain reservoirs in river valleys and coastal laidas;
- The bulk of gulls (Heuglin's gull, glaucous gull) form clusters in the coastal zone of the Ob Estuary, and keep close by operational objects - moving vessels, facilities under construction and operation (Berth and Plant, quarries and MSW disposal site).

According to observations in 2019, migration gatherings of geese are confined in valleys at the mouths of Khaltsyney-Yakha and Syabuta-Yakha 1st Rivers (Figure 7.6.61). Transit flocks were also noted mainly along the sea coast. The results of observations in 2020 show similar patterns: groups of Anseriformes are mainly found in river valleys (Figure 7.6.62).

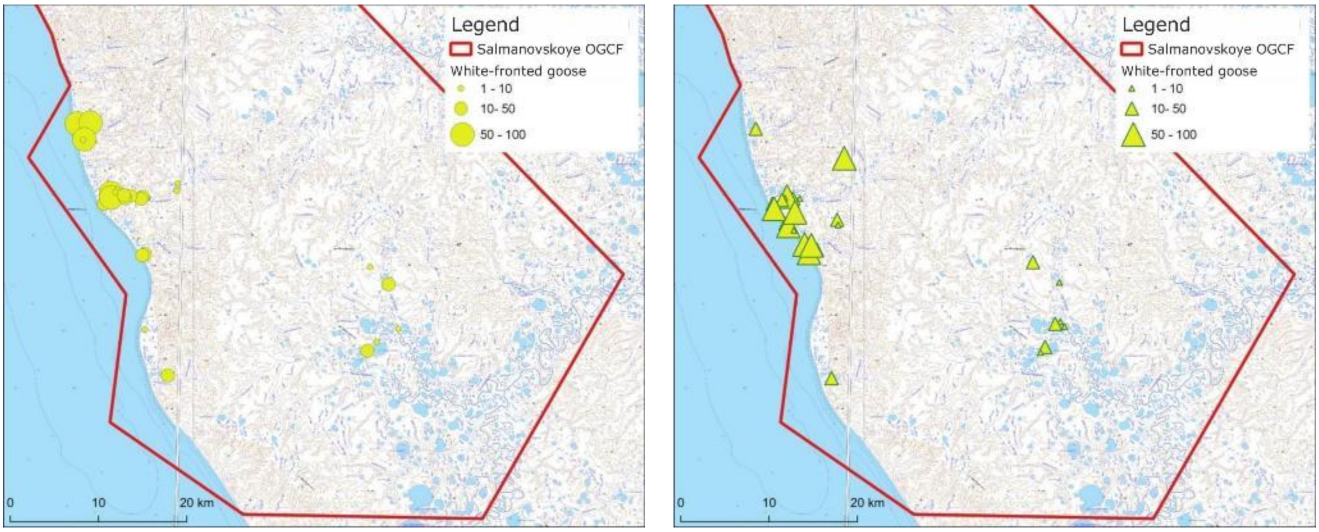


Figure 7.6.61: Abundance of greater white-fronted goose

Right: migration gatherings (stops). Left: on passage (transit flocks). Source: IEPI JSC, 2019

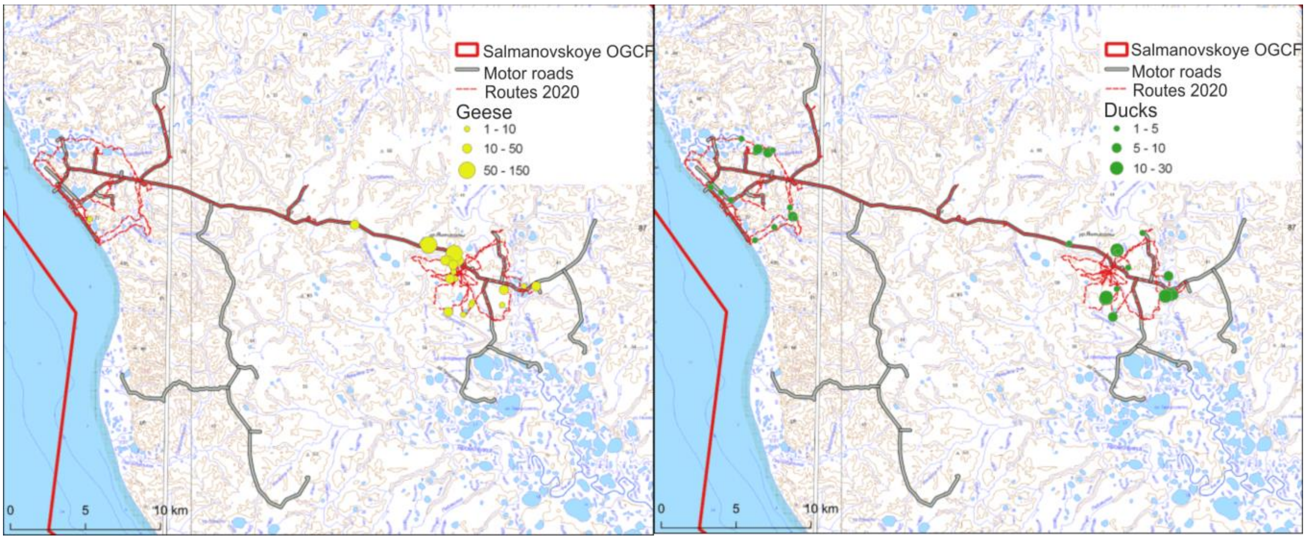


Figure 7.6.62: Abundance of geese (left) and ducks (right) in September 2020

Source: IEPI JSC, 2019

Avifauna of the Salmanovskiy (Utrenniy) LA is thus typical for the Gydan Peninsula. The prevailing drained watershed areas of tundra where the main Project facilities are located are not attractive to birds. The richest in species and more densely populated are river floodplains and laidas. The same areas are most preferred by birds at migratory stops. The fauna and population of birds in the area of the Utrenny airport are similar to those in the entire LA.

7.6.3.5 Rare and protected bird species

15 species of rare and protected terrestrial birds can be encountered in the territory of the Salmanovskiy (Utrenniy) LA. These are the species listed in the Red Data Books of the Russian Federation, Yamal-Nenets Autonomous Okrug, and IUCN Red List of Threatened Species (under the NT, VU, EN categories). It should be noted that in 2020 a new list of rare and protected animal species was approved for the Red Data Book of the Russian Federation, which introduces new categorisation of rarity (Table 7.6.16).

Table 7.6.16: Protected bird species

Species	RDB RF* ** ***	RDB YNAO****	UICN*****
White-billed loon *Gavia adamsii*	**3-VU-III**	3	**NT**
Red-breasted goose *Branta ruficollis*	**3-VU-II**	3	**VU**

Species	RDB RF* ** ***	RDB YNAO****	UICN*****
Lesser white-fronted goose *Anser erythropus*	**2-EN-II**	2	**VU**
Bewick's swan *Cygnus bewickii*		5	LC
Long-tailed duck *Clangula hyemalis*			**VU**
Velvet scoter *Melanitta fusca*		4	**VU**
Steller's eider *Polysticta stelleri*	**2-VU-III**		**VU**
White-tailed eagle *Haliaeetus albicilla*	**5-LC-III**	5	LC
Gyrfalcon *Falco rusticolus*	**2-EN-I**	1	LC
Peregrine falcon *Falco peregrinus*	**3-VU-III**	3	LC
Common dotterel *Eudromias morinellus*	**4-DD-III**		LC
Curlew sandpiper *Calidris ferruginea*			**NT**
Bar-tailed godwit *Limosa lapponica*			**NT**
Double snipe *Gallinago media*		3	**NT**
Snowy owl *Nyctea scandiaca*		2	**VU**
Notes:			
Red Data Book of the Russian Federation (2020) * Categories of the rarity status of objects of fauna: 0 – Probably extinct, 1 – Critically endangered, 2 – Threatened (declining in number and/or range), 3 – Rare, 4 – Unidentified status, 5 – Recoverable and recovering.			
	** Categories of the status of the threat of extinction of objects of fauna which characterize their state in their natural habitat: RE – Regionally Extinct (in the RF); CR – Critically Endangered; EN - Endangered; VU - Vulnerable; NT –Near Threatened; LC – Least Concern. DD – Data Deficient		
*** Categories of the degree and priority of environmental measures taken and to be taken (nature conservation status): Priority I - urgent integrated measures are needed, including development and implementation of a conservation strategy and/or program for restoration (reintroduction) of the object of wildlife, as well as appropriate action plans;Priority II - one or more special measures are needed to preserve the wildlife object; Priority III - general measures provided for by the legal acts of the Russian Federation in the field of environmental protection, management, protection and use of designated nature conservation areas, and protection and use of wildlife and its habitat, provide sufficient conservation of the objects and flora and fauna listed in the Red Data Book of the Russian Federation			
**** Red Data Book of the Yamal-Nenets Autonomous Okrug (2010) category 2 - threatened species; category 3 - rare species; category 4 - but lack of population data; category 5 - species with restoring number			
	***** The IUCN Red List of Threatened Species. Version 2019-2. https://www.iucnredlist.org - LC – least concern; NT – near threatened; VU – vulnerable; EN – endangered		

Five species from this list were registered on the territory of the Salmanovskiy (Utrenniy) LA during the period 2012-2020 (Table 7.6.17).

White-billed loon *Gavia adamsii*. Listed in the Red Data Book of the Russian Federation (2020) as a rare vulnerable species, Priority III (conservation status). In the Red Data Book of YNAO - Category 3. Rare bird of passage. Occasionally occurs within YNAO during migration periods and less often during nesting period; no information on nesting is available. On the territory of the field, can be encountered during migrations. Not registered.

Red-breasted goose *Branta ruficollis* Listed in the Red Data Book of the Russian Federation (2020) as a rare vulnerable species of Priority II (conservation status) requiring special conservation measures. In the Red Data Book of YNAO – Category 3. Rare nesting, small-range species. Russian endemic. The territory of the field is located close to the northern border of the species range[343]. Nesting habitats are peculiar - they occupy river bank cliffs and steep valley walls near the nests of peregrine falcon (less often rough-legged buzzard, snowy owl, gulls or terns), for protection against predators.

Lesser white-fronted goose *Anser erythropus*. Listed in the Red Data Book of the Russian Federation (2020) as an endangered species of Priority II (conservation status) declining in number and/or range, which requires special conservation measures. In the Red Data Book of YNAO - Category 2. Rare species inhabiting a limited territory, with progressively declining number. The territory of the Salmanovskiy LA lies outside the nesting range of the species, however, nomadic and molting individuals are observed here in summer (Rosenfeld et al., 2018).

Bewick's swan *Cygnus bewickii*. Previously listed in the Red Data Book of the Russian Federation; Siberian populations have been removed from the latest edition (2020). InRed Data Book of YNAO - Category 5. Recovering species, but its number has not reached the former value. In YNAO, the bird is nesting in tundras of the Yamal and Gydan Peninsulas up to the border of the Arctic tundra zone. West-Siberian population of the species is assessed at 4.7-10 thousand. Appears at the nesting grounds late, in late May - early June. Departure in September is triggered by frost, snowfalls and storms. The main nesting habitats are in river floodplains, seaside meadows, moss-sedge bogs and tundra lake shores.

In autumn 2019, were recorded in river valleys in the study area. Five couples were recorded at the floodplain lakes of the Salpadayakha River, near quarries Nos.5 and 37 and well pad No.34. In 2020, territorial birds were also recorded in the valley of the Salpada-Yakha River (Figure 7.6.65). A brood of birds with 4 grown-up chicks was encountered in the Nyadaj-Pyngchyo River valley.

Long-tailed duck *Clangula hyemalis*. The species is included in the IUCN Red List under category VU vulnerable[344]. On the territory of the field, it is a common and background nesting species of tundra lakes and laidas, the most massive duck in the field territory. The birds were registered at waterbodies during the migration in September 2019 and 2020.

Velvet scoter *Melanitta fusca*. In the Red Data Book of YNAO - Category 4, rare species, but lack of population data. The territory of the field is located outside the nesting range of the species, occasional encounters of migratory and vagrant birds are possible.

Steller's eider *Polysticta stelleri*. Listed in the Red Data Book of the Russian Federation (2020) as an endangered species of Priority III (conservation status) declining in number and/or range. Within the YNAO, it is more often observed during migrations; occasionally, individual couples nest on laidas. No reliable records of the species' presence within the field territory are available; occasional encounters in the coastal strip are possible.

White-tailed eagle *Haliaeetus albicilla*. Listed in the Red Data Book of the Russian Federation (2020) as a recoverable and recovering species of least concern, Priority , III (conservation status). In the Red Book of YNAO - Category 5, a small species with recovering abundance. The territory of the Salmanovskiy LA is not included in the nesting range ofthe species, however, nomadic birds can be observed throughout the area. During the survey period in 2014, 2 individuals were registered. In 2019, according to the interview data, one young bird was encountered in tundra; no encounters reported in 2020.

Gyrfalcon *Falco rusticolus*. Listed in the Red Data Book of the Russian Federation (2020) as an endangered species of Priority I (conservation status) declining in number and/or range, which requires urgent integrated measures are needed, including development and implementation of a conservation strategy and/or program for restoration (reintroduction) of the object of wildlife, as well as appropriate action plans. In the Red Book of YNAO - Category 1, threatened species with rapidly declining number. The territory of the Salmanovskoye field lies outside the nesting range of the species, however, nomadic individuals can be observed here.

Peregrine falcon *Falco peregrinus*. Listed in the Red Data Book of the Russian Federation (2020) as a rare vulnerable species, Priority III (conservation status). In the Red Data Book of YNAO - Category 3, rare vulnerable species. A tundra sub-species lives in the YNAO. The total size of YNAO population in 2000-2009

---

[343] N. N. Melnichenko, D. S. Nizovtsev, A. E. Dmitriev. (2012). Eiders in the north of the Gydan Peninsula. Goose: Bulletin of the Working Group for Anseriformes of the Northern Eurasia, 15(1), 71-83.

[344] The IUCN Red List of Threatened Species. Version 2019-2; https://www.iucnredlist.org

can be assessed at 600-800 couples, during the nesting season. Within the study area, the species lives mainly at river floodplains and lake basins, makes nests on solo mounds, bank cliffs, slopes of ravines. The bird leaves to wintering grounds in late August - September.

In the study area, 4 migratory birds were encountered in September 2019, and 2 birds in September 2020. The availability of suitable biotopes and records of the previous studies suggest potential nesting of few couples in the field territory (Neita-Yakha and other rivers).

Table 7.6.17: Register of encounters of rare and protected terrestrial vertebrates in the Salmanovskiy (Utrenniy) LA Source: IEPI JSC, 2019-2020.

Date of encounter	Species	N	E	Number
13.09.2019	Bewick's swan *Cygnus bewickii*	73.7168	71.1118	2
14.09.2019		74.5975	70.9105	2
14.09.2019		74.5492	70.8683	4
14.09.2019		74.6486	70.9254	2
14.09.2019		74.6999	70.8980	2
15.09.2019		73.7737	71.0421	1
16.09.2019		74.6740	70.9823	3
19.09.2019		73.8453	71.0461	2
01.09.2020		70.9349	74.6514	2
04.09.2020		70.9461	74.5263	2
09.09.2020		70.9950	74.6509	3
09.09.2020		70.9862	74.6653	2
12.09.2020		70.9908	73.945	6
16.09.2020		70.9869	73.9019	6
14.09.2019	Peregrine falcon *Falco peregrines*	74.6118	70.8928	1
14.09.2019		74.6256	70.9152	1
14.09.2019		74.6332	70.9161	1
15.09.2019		73.9955	71.0456	1
16.09.2019		74.5406	70.9756	1
08.09.2020		70.9671	74.5409	2
24.08.2019	Snowy owl *Nyctea scandiaca*	74.0268	70.8071	1
30.08.2019		73.9914	71.0306	1
14.09.2019		74.5821	70.8948	1
15.09.2019		73.8144	71.0543	1
18.09.2019		73.9828	70.9995	1
18.09.2019		73.9602	70.9848	1
18.09.2019		73.9099	70.9974	1
19.09.2019		73.7810	71.0272	1
19.09.2019		73.7496	71.0268	1
19.09.2019		73.7942	71.0203	1
30.08.2020	Long-tailed duck *Clangula hyemalis*	70.9372	74.5412	8
30.08.2020		70.9482	74.5276	16
30.08.2020		70.9540	74.5481	2
01.09.2020		70.9771	74.5481	13
01.09.2020		70.9619	74.6426	6
04.09.2020		70.9489	74.5289	22
07.09.2020		70.9809	74.4600	2
07.09.2020		71.0040	73.8373	1

Date of encounter	Species	N	E	Number
10.09.2020		71.0328	73.8816	1
12.09.2020		71.0002	73.9461	1
14.09.2020		71.0347	73.8851	8
14.09.2020		71.0342	73.9128	1
16.09.2020		70.9803	73.8829	1
16.09.2020		70.9883	73.9179	2
16.09.2020		70.9939	73.9553	1

Source: IEPI, LLC, 2019-2020

Common dotterel *Eudromias morinellus*. Listed in the Red Data Book of the Russian Federation (2020) as a species of unidentified status and lack of data, Priority III (conservation status). Inhabits dry lichen tundra, mounds with low and sparse grass cover. The species range covers the whole territory of the Gydan Peninsula; however, it is distributed locally. Special studies are needed to understand biology and distribution of the species within the LA.

Curlew sandpiper *Calidris ferruginea*. The species is included in the IUCN Red List under Category NT – Near Threatened. Small nesting and common migratory species. Breeds in moss-lichen hummocky tundras. The nesting population can vary greatly from year to year, from massive to zero presence. Adult birds are weakly attached to the nesting sites.

No presence was registered in 2020.

Figure 7.6.63: Rare and protected bird species registered within the LA

From left to right, top to bottom: Bewick's swan (*Cygnus bewickii*), peregrine (*Falco peregrinus*), and snowy owl (*Nyctea scandiaca*). Photo by IEPI JSC, 2019

Bar-tailed godwit *Limosa lapponica*. The species is included in the IUCN Red List under Category NT – Near Threatened. The Salmanovskiy LA is located to the north of the nesting range ofthe species; nomadic and vagrant individuals can be encountered in the concerned area. Not found within the LA territory.

Double snipe *Gallinago media*. In the Red Book of YNAO - Category 3, a rare species on the edge of range. The species is included in the IUCN Red List under Category NT – Near Threatened. The Salmanovskiy LA is located to the north of the nesting range ofthe species; vagrant individuals can be encountered in the concerned area.

Snowy owl *Nyctea scandiaca*. In the Red Book of YNAO - Category 2, threatened species. The whole area of the Gydan Peninsula is a part of the species' nesting range. Nesting density varies substantially depending on abundance of lemmings. In recent years, due to the overgrazing of domestic reindeer in Yamal, the peaks of the lemming population have become localized, their amplitude has decreased significantly, and the abundance of owls has sharply decreased. Reproduction has practically stopped (no cases of reproduction have been recorded). All birds encountered are nomadic individuals. On the Gydan peninsula, the situation is not clear, but is probably similar (Red Data Book, 2010). In September 2019, nomadic birds were observed 8 times in different places throughout the field territory. According to information provided verbally by personnel, the owls were observed at the road crossing in the Khaltsyney-Yakha River valley throughout the summer period.

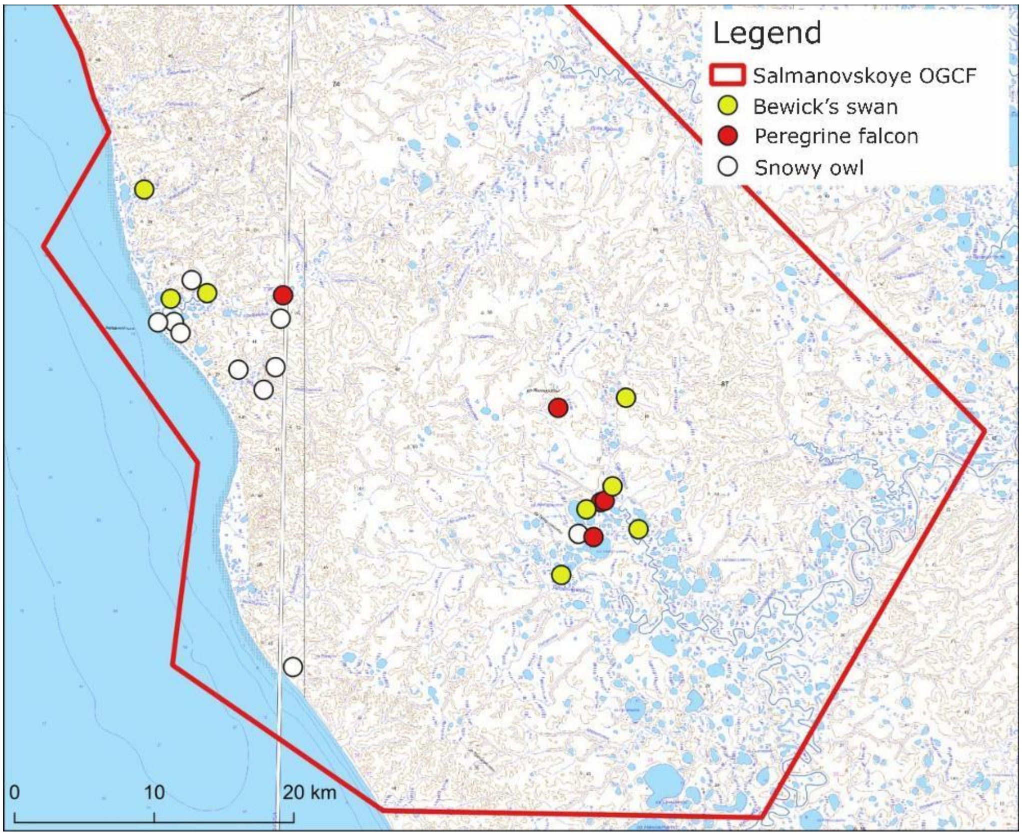


Figure 7.6.64: Encounters of rare and protected bird species in September 2019

Source: IEPI JSC, 2019

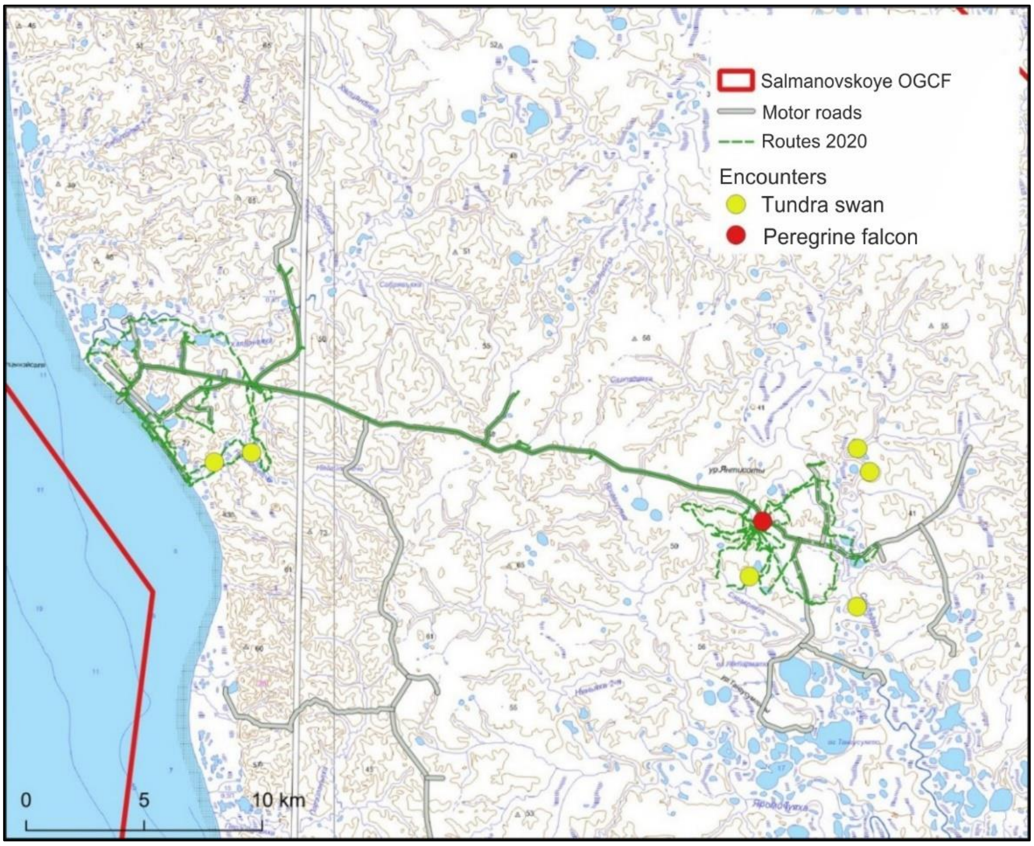


Figure 7.6.65: Encounters of rare and protected bird species in September 2020

Source: IEPI JSC, 2020

In addition to migratory birds and rare and protected species, the Working Group of the Arctic Council on Arctic Flora and Fauna Conservation has approved a list of priority species for conservation activities under the Arctic Migratory Birds Initiative (Table 7.6.18).

Table 7.6.18: Priority bird species for conservation activities under the Arctic Migratory Birds Initiative (CAFF, 2013)

Flyway	Species	UICN	CMS	AEWA Action Plan
East Asian-Australasian	Bar-tailed godwit (*Limosa lapponica baueri and mensbeiri*)	LC	Annex II	N/A
	Dunlin (*Calidris alphina arcicola*)	LC	Annex II	
	Eastern knot (*Calidris tenuirostris*)	VU	Annex I	
	Red knot (*Calidris canutus rogersi and piersmal*)	LC	Annex II	
	Spoon-billed sandpiper (*Eurynorhynchus pygmeus*)	CR	Annex I	
	Lesser white-fronted goose (*Anser erythtopus*)	VU	Annex I	A 1a 1b 1c, 2
Americas (Pacific, along the Mississippi, Central and Atlantic flyways)	Buff-breasted sandpiper (*Calidris subruficollis*)	NT	Annex I	N/A
	Robin sandpiper (*Calidris canutus rufa*)	LC	Annex I	
	Robin sandpiper (*Calidris canutus roselaari*)	LC	Annex II	
	Semipalmated sandpiper (*Calidris pusilla*)	NT	Annex I	
	Hudsonian godwit (*Limosa haemastica*)	LC	Annex II	
Central Pacific	Bristle-thighed curlew (*Numenius tahitiensis*)	VU	Annex I	
	Black-tailed godwit (*Limosa limosa islandica*)	NT	Annex II	A 4

Flyway	Species	UICN	CMS	AEWA Action Plan
(East Atlantic, Mediterranean-Black Sea flyways)	Bar-tailed godwit (*Limosa lapponica taymeyrensis*)	LC	Annex II	B 2a 2c
	Broad-billed sandpiper (*Limicola falcinellus*)	LC	Annex II	A 3c
	Dunlin (*Calidris alpina arctica and schinzii*)	LC	Annex II	A 1c, 2, 3a
	Robin sandpiper (*Calidris canutus canutus and islandica*)	LC	Annex II	B 2a 2c
	Ruff (*Philomachus pugnax*)	LC	Annex II	B 2c
	Lesser white-fronted goose (*Anser erythropus*)	VU	Annex I	A 1a 1b 1c, 2
Circumpolar (migration from east to west in Circumpolar Arctic)	Ivory gull (*Pagophila eburnea*)	NT		N/A
	Kittlitz's murrelet (*Brachyramphus brevirostris*)	NT		
	Thick-billed murre (*Uria lomvia*)	LC		B 2c
	Velvet scoter (*Melanitta fusca*)	EN	Annex II	B 2a 2c
	Black scoter (*Melanitta nigra*)	NT	Annex II	B 2a 2c
	Steller's eider (*Polysticta stelleri*)	EN	Annex I	A 1a 1b 2
	Common eider (*Somateria mollissima*)	LC	Annex II	B 1 2d
	Long-tailed duck (*Clangula hyemalis*)	VU	Annex II	B 2c
	White (yellow)-billed diver (*Gavia Adamsii*) (except Iceland and Greenland)	NT	Annex II	A 1c
	Snowy owl (*Nyctea scandiaca*)	LC		N/A

7.6.3.6 Terrestrial mammals

The mammal fauna in the survey area is characterized by scarce species composition and is represented by 24 mammal species belonging to six groups: insectivores, leporines, rodents, cetaceans, carnivores and artiodactyls. Rodents and carnivores are the leaders in the number of species. Common mammal species are tundra shrew (*Sorex tundrensis*), varying hare (*Lepus timidus*), Siberian lemming (*Lemmus sibiricus*), wolf (*Canis lupus*), Arctic fox (*Alopex lagopus*), ermine (*Mustela erminea*), and weasel (*Mustela nivalis*).

The table shows the species composition, residence status, and relative abundance of terrestrial mammals identified during monitoring studies in 2018-2020 (Table 7.6.19).

Table 7.6.19: Species composition, status of presence, relative abundance of mammals in the territory of the Salmanovskiy LA (including areographically expected species)

No.	Species	Status	Relative abundance	Conservation status	2019	2020
	Eulipotyphla					
1	Tundra shrew *Sorex tundrensis*	P	com		+	–
	Artiodactyla					
2	Reindeer *Rangifer tarandus*	vag?	occ	RDB YNAO	–	–
	Carnivora					
3	Wolf *Canis lupus*	P?	occ		–	–
4	Polar fos *Vulpes lagopus*	P	com		+	+
5	Polar bear *Ursus maritimus*	vag	occ	RDB RF	–	–
	Lagomorpha					
6	Varying hare *Lepus timidus*	P	P		+	+

No.	Species	Status	Relative abundance	Conservation status	2019	2020
	Rodentia					
7	House mouse *Mus musculus*	P?	occ		–	–
8	Siberian lemming *Lemmus lemmus*	P	com		+	–
9	Collared lemming *Dicrostonyx torquatus*	P	R		–	+
10	Tundra vole *Alexandromys oeconomus*	P?	R		–	+
11	Middendorf's vole *Alexandromys middendorffii*	P?	R		–	–
12	Narrow-skulled vole *Lasiopodomys gregalis*	P	Ab		+	+

Designations: P – permanent; S – seazonal; vag – vagrant; ? – likely; *occ* – occasional; *r* – rare; *com* – common; *ab* – abundant; 1 – phytophage; 2 – carivore; 3 – marine species; 4 – omnivore; + - presence is known; – - presence is not known

RDB RF - species is listed in the Red Data Book of the Russian Federation (2020), RDB YNAO - species is listed in the Red Data Book of YNAO (2014)

Source: IEPI JSC, 2019-2020

Insectivores are represented by *tundra shrew*. In the tundra zone, its range spreads up to the Arctic tundra, but distribution is sporadic. Rare species, captured once in 2019, the relative abundance is estimated at 0.71 ind/100 trap-days.

Rodents are кepresented by Siberian and collared lemmings, narrow-skulled and tundra voles.

The main habitats of *Siberian lemming* are different types of moss tundra. In summer, they occupy most willingly the humid tundra lowlands with abundant sedge. In summer they live in burrows, which can be used by several generations of lemmings. In winter, they live in places with the thickest snow cover, in the lowlands, where many of them build snow-covered nests of cottongrass and sedge. Their basic forage is sedge and cottongrass, less commonly — gramineous plants and herbs.

Collared lemming avoids waterlogged areas. In disturbed landscapes where the lichen cover is replaced by cottongrass and sedges, the number of lemmings is expected to be higher. Lemmings are the main prey for a number of carnivores, primarily the Arctic Fox, as well as ermine, weasels, owls, buzzard, skuas, and even wolf. In the years of mass reproduction, the population of lemmings exceeds the abundance of all other rodents.

Figure 7.6.66: Varying hare

Photo by IEPI JSC, 2020

Figure 7.6.67: Collared lemming

Photo by IEPI JSC, 2020

Narrow-skulled vole is an element of the polyzonal faunal complex and belongs to the tundra-meadow ecological group. It can live both in natural biotopes and developed territories where some vegetation remains. Common, possibly abundant species. Observed and captured in various types of tundra (IEPI JSC, 2019-2020).

Tundra vole was first identified within the Salmanovskiy (Utrenniy) LA in 2020 (IEPI JSC); previously the species was recorded only in the south of the Gydan Peninsula[345]. When placing traps and checking them, burrows and droppings of the animal were noted; a vole was observed one time.

Varying hare is common, especially in floodplains and ravines. Its abundance hardly depends on human-induced impact on the terrain; the hare is regularly encountered in the area of construction activity.

The number of *Arctic foxes* strongly depends on the abundance of lemmings, their main prey in the years when the lemmings are highly abundant. In the years of lemmings depression, the Arctic foxes become omnivorous. Fertility of the Arctic foxes also depends on the food conditions; the number of cubs varies from 3-6 to 12-14. The percentage of reproducing females varies from year to year from 30 to 80%. The abundance fluctuates with a periodicity of about 3-4 years, and also with a long-term periodicity of 20 years. Favourite place for burrows is sandy-hilly tundra. More Arctic foxes are also observed on the seashores. In typical tundra, the density of burrows reaches the maximum values, up to 3.0-3.5 burrows per 10 km^2; in the license area this density is much lower. Sedentary life of the Arctic fox lasts only from spring till winter, and in winter it migrates over large areas. It is common and abundant on the LA territory, the burrows of the Arctic fox are located mainly in the river valleys. During the monitoring studies of 2019-2020, 12 active burrows of Arctic were identified (IEPI JSC, 2019-2020).

In 2020, the staff of the Arctic Research Station IERiZh UB RAS at the LA noted the presence of a rare specimen of a melanistic Arctic fox, they are observing the movement of Arctic foxes using satellite telemetry.

Wolf can be met in all types of habitats, but it also prefers ravines, river and brook valleys. Except the reproduction period, wolves wander around. Seasonal migrations coincide with the routes of reindeer herds, since the latter are the main prey of wolves in winter period. During the offspring breeding, the life of wolves is sedentary and hidden: they choose the places for lairs far from human residential areas. In winter, the wolves gather in packs of 5 to 10 individuals. According to the interview data, it was encountered at the field in the winter period 2019-2020.

The Arctic tundra can be visited by foxes, ermines, weasels and wolverines. The ermine and weasel can be observed up to the Arctic coast. However, the distribution of these small meat-eating predators in the tundra fully depends on the distribution of rodents, that is why they are most frequent along the banks of water bodies. In the peak years of lemmings' abundance, number of meat-eating predators increases significantly, too. The *ermine and weasel* can be found in all habitats, but they prefer floodplains and shrubs. The *wolverine* is not a constant inhabitant; in winter, it wanders widely.

The ungulate fauna is represented by the only species — the *reindeer*. More details of the wild populations of reindeer are provided in subsection 7.6.3.7.

According to the information provided by the Administration of the Tazovskiy Municipal District, the territory of Salmanovskiy (Utrenniy) LA is a pastureland rich with reindeer forage. Therefore, over 12,000 domestic reindeer of the Gydan tundra herders graze there from spring till autumn. From April till July, mass calving of reindeer takes place in these pasture lands. From August till December, about 5,000 domestic reindeer graze in this area. In addition, the territory of the OGC field is crossed by the reindeer husbandry communities' migration after the herds.

7.6.3.7 Protected terrestrial mammal species

The reindeer *Rangifer tarandus* is included in the Red Data Book of YNAO under Category I as an endangered species. In the IUCN Red List, this species is classified as vulnerable (VU). From the 11th to the beginning of the 20th century the southern boundary of the species range which used to occupy the entire forest and tundra zones of the Western Siberia, was steadily shifting to the north. By the middle of the 20th century, the continuous range split into separate foci, some of which, including the Gydan population, are in threatened situation. In recent years, the population has divided into two groups: Yavai and Messoyakha. The first group inhabits the north of Yavai Peninsula, the Oleniy, Sibiryakova, Shokalskogo, Neupokoeva Islands; some animals have been noted in the basin of the Yuribey River in its middle reaches[346]. On the Mammonth Peninsula, no reindeer have been observed in recent years. The Messoyakha group is present in the basins of the Antipayutayakha, Tanama and Messoyakha Rivers. According to the records made in 1977, about 350-450 animals lived on the Gydan Peninsula and adjacent

[345] Shenbrot, G. I., & Krasnov, B. R. (2005). Atlas of the geographic distribution of the arvicoline rodents of the world (Rodentia, Muridae: Arvicolinae). Pensoft

[346] A. A. Gorchakovsky. Wild reindeer of the Gydan Peninsula // Game Management Newsletter, 2007, vol. 4 No. 3, pp.325-332.

islands. In late 1990s and early 2000s, the number of the Yavai group (according to the results of air surveys) was estimated at 400 individuals, and the Messoyakha group (route survey) — at about 100 individuals. The total number of wild reindeer in YNAO is estimated at 26 thousand[347].

There are less traces of reindeer presence on the Gydan Peninsula than in the neighbouring areas on the Yamal Peninsula. The field territory is outside the summer habitats of wild reindeer, however, according to the schematic maps compiled by A. A. Gorchakovskiy (2007), it falls within the area if winter pastures of the Yavai reindeer group. Calving pastures of this populations are located solely on the Shokalskogo island and in the northernmost part of the Yavai Peninsula[348].

As shown in Figure 7.6.68, the most suitable calving grounds are located outside the Salmanovskiy (Utrenniy) LA.

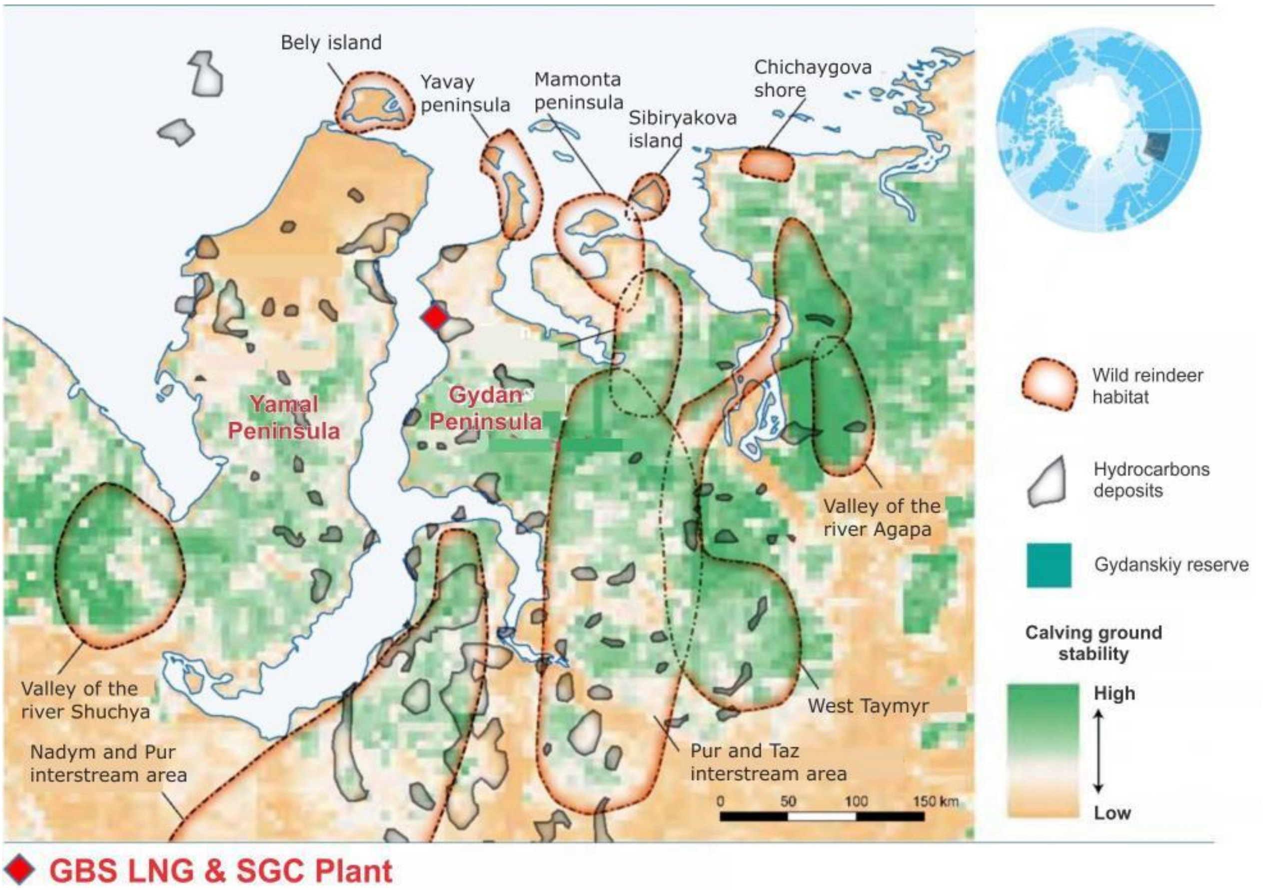


Figure 7.6.68: Map of wild reindeer population ranges and calving ground stability index

(Source: The Circle. Reindeer and Caribou: Herds and Livelihoods in Transition. #1, 2011)

A more recent study of suitability for calving concluded that the area of the Salmanovskiy (Utrenniy) LA is poorly suited for calving of wild reindeer[349].

Wild reindeer was not registered in the territory of the the Salmanovskiy (Utrenniy) LA neither in winter nor in summer. Given the active use of the area for grazing of domestic reindeer, the presence of wild population of the animal is extremely unlikely, and only occasional visits of single individuals may be expected.

[347] A. V. Davydov. Concise characteristic of populations of reindeer (*Rangifer tarandus* L.) in regions of Russia 4. Reindeer of Eastern Urals and Western Siberia // Game Management Newsletter, 2007, Vo. 4, # 3, pp.231-241

[348] A. A. Gorchakovsky (2015). Wild reindeer on the Shokahskogo island and Yavai peninsula (Yamal-Nenets Autonomous Okrug). Fauna of Urals and Siberia, (1).

[349] Kuemmerle, T., Baskin, L., Leitao, P. J., Prishchepov, A. V., Thonicke, K., & Radeloff, V. C. (2014). Potential impacts of oil and gas development and climate change on migratory reindeer calving grounds across the Russian Arctic. Diversity and distributions, 20(4), 416-429.

7.6.3.8 Faunal complexes

The license area includes the following biotopes: tundra, wetlands and coastal habitats. The area's biotopic diversity is presented in Table 7.6.20 and illustrated below (Figure 7.6.69).

Table 7.6.20: Types and proportions of animal habitats in the Salmanovskiy (Utrenniy) LA, and proportions of the areas

Habitat	Abundant species	Area, ha	% of the license area
1. Polygonal patterned and hummocky dwarf-shrub tundra	Red-throated pipit, horned lark, Lapland longspur, rough-legged buzzard, collared lemming, Siberian lemming, Arctic fox	43536.3	14.9
2. Sedge and graminoid moss tundra	Grey plover, snowy owl, red-throated pipit, Lapland longspur, snow bunting, Siberian lemming, collared lemming, narrow-skulled vole	138019.2	47.3
3. Subshrub (willow) tundras	Red-throated pipit, willow warbler, snow bunting, citrine wagtail, red-necked phalarope, Siberian lemming, collared lemming, Arctic fox	53925	18.5
4. Wetlands	Dunlin, little stint, long-tailed duck, greated white-fronted goose, wigeon, red-necked phalarope, Heuglin's gull, black-throated loon	52077.5	17.8
5. Sands on foreshores, deflated areas, fills	Ringed plover, greater golden plover, lesser golden plover, white wagtail, little stint	4598.7	1.6

The coastal biotopes, primarily, Arctic coastal lowlands (laidas occupied by grasses), are characterized by specific population of terrestrial vertebrates. Here, one can meet two species of geese, brant goose, eider ducks. Larine species are common and even numerous here: Heuglin's gull, glaucous gull, Arctic tern, and pomarine skua. Of waders, there are ringed plover and Temminck's stint. The passerines in this habitat are represented by snow bunting and white wagtail. Mammal species in the area are narrow-skulled vole, and occasionally varying hare. These biotopes are used for stops of birds on migration, in particular, rare and protected anseriformes may be encountered here.

The tundra habitats are populated very unevenly. Subshrub and grass-moss wet tundras have the richest species composition. In the subshrub tundra, a few species of charadriiformes (sandpipers) and passerines are quite abundant, such as red-throated pipit, little stint, red-necked phalarope and horned lark. The heave mounds and steep banks of rivers serve as nesting stations for rough-legged buzzard, short-tailed and long-tailed skuas. There are also the snowy owl, Arctic Fox, two species of lemmings, narrow-skulled vole, Middendorf's vole and tundra shrew.

It should also be noted that the Arctic skua, rough-legged buzzard, Arctic Fox, Siberian lemming and domestic form of reindeer can be found in almost all biotopes in the survey area, except the wetlands with excessive moisture.

In wet tundra, the fauna is enriched by a range of waders: dunlin, phalarope, ruff. The latter two species are numerous, and the dunlin is a common breeding species. Three skua species are also met here regularly, the most frequent of which is the Arctic skua. The Siberian lemming reaches the highest abundance in the wet tundra. Red-throated pipit can be observed, although it is not numerous here. In the water bodies of the wet tundra, and, less frequently, of the subshrub-moss tundra, there are long-tailed ducks, skuas, Heuglin's gulls, and Arctic loons.

Moss-lichen tundra is typical of dry habitats in the watersheds with sandy soils. In these biotopes, the minimum diversity and the minimum population density of vertebrates can be observed. The mammals are represented by Siberian lemming and Arctic Fox, and the birds — by rough-legged buzzard and Temminck's stint.

Subshrub-moss-lichen polygonal tundras are characterized by a combination of subshrub-moss-lichen vegetation on polygons and bog vegetation in interpolygonal hollows. Due to such a combination of tundra and bog biotopes, the fauna in these areas can be characterized as a combination of species inhabiting the corresponding biotopes. The background species are red-necked phalarope, ruff, Lapland bunting, red-throated pipit, and Arctic skua.

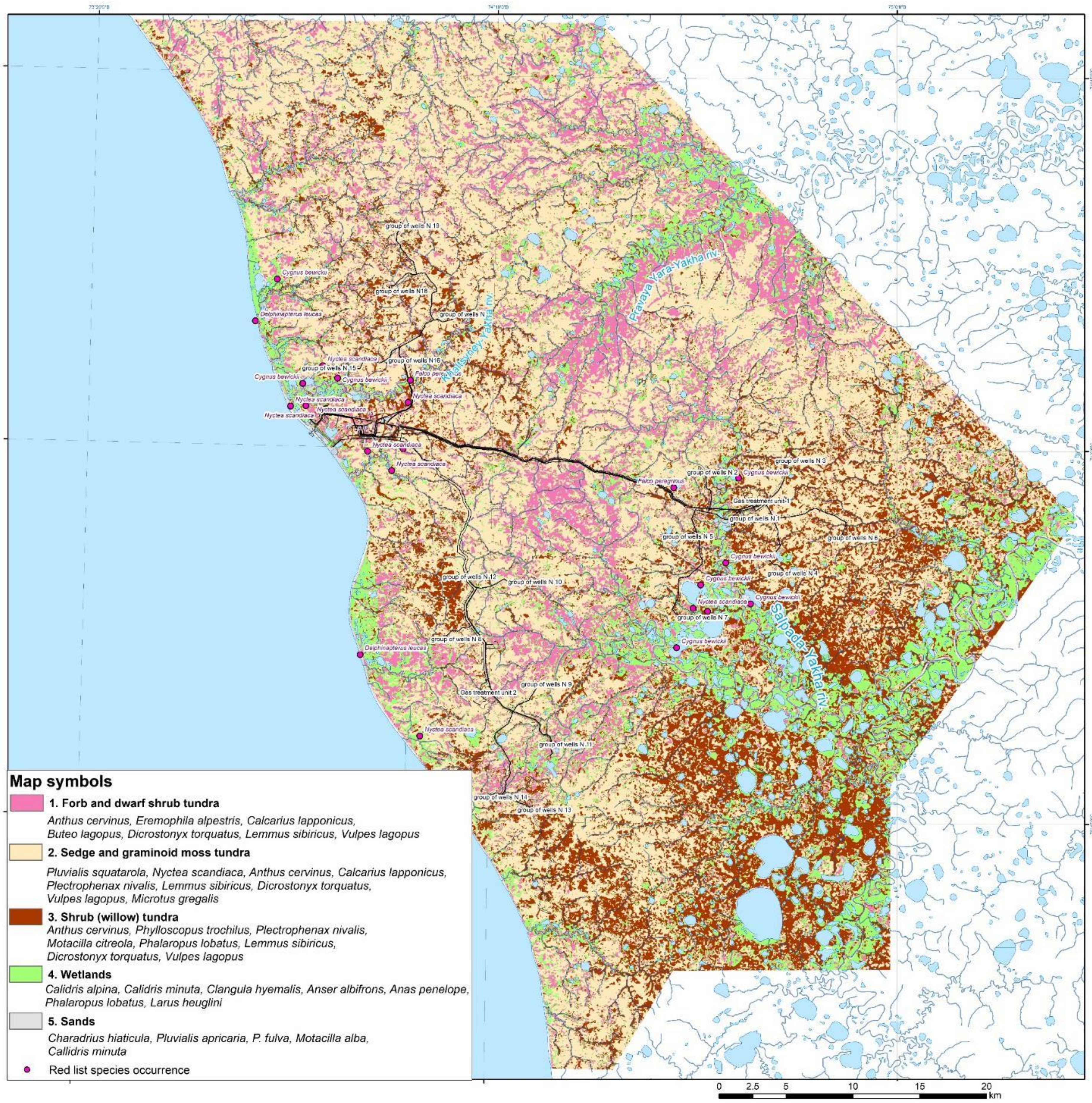


Figure 7.6.69: Schematic map of terrestrial vertebrate species in the LA territory

7.6.3.9 Fresh-water ecosystems of the Gydan Peninsula

Ecosystems of waterbodies and flows of the Gydan Peninsula are not well studied. The main sources of data on hydrobiological communities of surface waterbodies within the Salmanovskiy (Utrenniy) LA are the records of the local environmental monitoring by FSU R&D E "AeroGeologia" (2017) and IEPI JSC (2018-2019).

Phytoplankton

Species diversity in fresh-water waterbodies is not very rich, however biomass of some species may be high (Table 7.6.21). Species composition and dominants vary between seasons. According to the river phytoplankton studies, rivers in the study area are characterised by domination of diatom and euglena algae in summer (Bogdanov et al., 2015).

Phytoplankton species composition in rivers vary significantly between seasons. E.g. in the Khaltsyney-Yakha River, four algae species were found in June and 10 in August. The diatom algae biomass was 0.003 g/m^{3,} euglena algae – 0.006 g/m. The values increased in August: diatom algae 0.007 g/m^3, euglena - 0.009 g/m^3. A complex of dominant species was identified for the Khaltsyney-Yakha River in August. In the Nanyakha River, phytoplancton abundance was 101 M org/m^3, biomass – 0.245 g/m^3. The absolute dominant in terms of biomass was diatom algae *Aulacoseira islandica* (91%).

Nine algae species were found in a brook in the area of the Salmanovskoye (Utrenneye) OGCF. The diatom algae biomass was 0.04 g/m^3, i.e. 78% of the total biomass of phytoplankton. The blue-green algae biomass was 0.01 g/m^3, i.e. 17% of the total biomass of phytoplankton. The most massive organisms were diatoms: *Aulacoseira islandica, Nitzschia vermicularis,* blue-green *Planktothrix agardhii* (Table 7.6.21).

Six species of algae were found in the Yabtarmato Lake representing two systematic groups: Cyanophyta and Bacillariophyta. The phytoplancton abundance was 355 M org/m^3, biomass – 0.45 g/m^3 (Table 7.6.21).

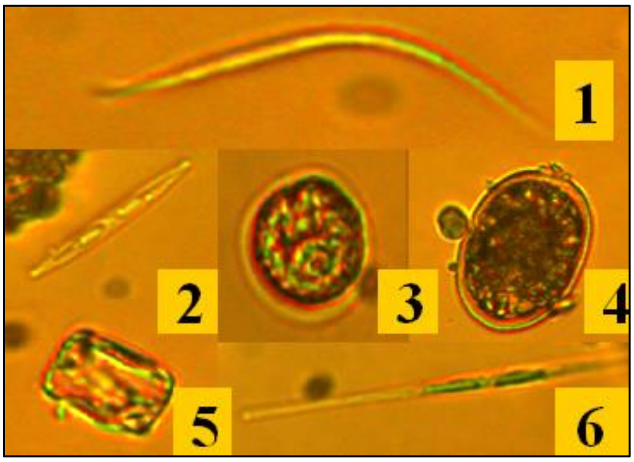


Figure 7.6.70: Phytoplankton species in sample taken from the Khaltsyney-Yakha River on 23.08.2019

1 – *Monoraphidium contortum*, 2 – *Nitzschia gracilis*, 3 – *Chlamydomonas monadina*, 4 – *Trachelomonas varians*, 5 – *Cyclotella* sp., 6 – *Nitzschia acicularis*

Table 7.6.21: Species composition and abundance* of phytoplankton in fresh waters of the Gydan Peninsula within the Salmanovskiy (Utrenniy) LA

Taxons	Lakes	Brooks	Rivers
	abundance/biomass		
Cyanophyta			
Anabaena planctonica Brunnthaler	-	-	2/0.008
Aphanizomenon flos-aquae Ralfs ex Bornet & Flahault	-	4/0.003	-
*Oscillatoria limosa C.*Agardh ex Gomont	-	-	20/0.025
Planktolyngbya limnetica (Lemmermann)	2/0.0001	-	-
Planktothrix agardhii (Gomont) Anagnostidis & Komбrek	-	6/0.005	247/0.207
Bacillariophyta			
Actinocyclus normanii (W.Gregory ex Greville)	-	-	46/0.038
Aulacoseira islandica (O.Mьller) Simonsen	40/0.016	80/0.157	4/0.057
Fragilaria heidenii Шstrup	20/0.0039	-	-
Navicula capitata Ehrenberg	4/0.0031	-	-
Navicula cryptocephala Kьtzing	2/0.0012	-	-
Navicula exigua W.Gregory	3/0.001	-	-
Navicula gracilis Ehrenberg	2/0.002	4/0.004	-
Nitzschia acicularis (Kьtzing) W.Smith	2/0.001	-	-
Nitzschia gracilis Hantzsch	2/0.001	-	-
Nitzschia holsatica Hustedt in A.W.F.Schimidt	-	-	2/0.0005
Nitzschia vermicularis (Kutzing) Grunow	-	2/0.019	-
Chrysophyta			
Syncrypta danubiensis (Schiller) Bourrelly	4/0.003	-	-
Chlorophyta			
Chlamydomonas monadina (Ehrenberg)	6/0.005	-	-
Closterium parvulum Nageli	2/0.002	-	-
Monoraphidium griffithii (Berkeley)	2/0.001	-	-
Cryptophyta			
Teleaulax acuta (Butcher) D.R.A.Hill		2/0.0005	-
Euglenophyta			
Euglena acus (O.F.Mьller) Ehrenberg		2/0.002	-
Euglena sp.	4/0.001		-
Trachelomonas volvocina (Ehrenberg) Ehrenberg		2/0.0001	-

* Abundance unit is M org/m^3, biomass — g/m^3

The total of 42 phytoplankton species of 6 systematic groups have been found in the surveyed waterbodies. The largest species diversity is reported for diatoms (Bacillariophyta) – 19 and euglena (Euglenophyta) – 9 species; species diversity is smaller in green (Chlorophyta) – 5 species, cryptophyte (Cryptophyta) – 3 species and blue-green algae (Cyanophyta) – 5 species; Chrysophyta were represented by one species. Lower abundance parameters were reported in rivers and lakes, which is explained by the natural seasonal patterns in ecosystems of this type. The "pure water phase" which is observed in rivers and lakes in summer is characterised by low quantitative parameters of phytoplankton.

Zooplankton

The total of 45 taxons of zooplankton have been found in the study area. The largest number of species belonged to copepods and rotifers. The maximum abundance and biomass of zooplankton is reported in brooks, the minimum - in the Khaltsyney-Yakha River. Analysis of the file materials and previous survey reports shows that, in terms of species composition, proportion of specific taxonomic groups, and quantitative parameters (abundance, biomass), zooplankton community in the examined waterbodies matches the seasonal background.

Species diversity of zooplankton in the examined freshwater waterbodies is richer than phytoplankton diversity.

E.g., 20 taxons of zooplankton were found in brooks, where*Polyarthra dolichoptera*, juvenile Cyclopoida and Harpacticoida, larvae Chironomidae dominated by both abundence and biomass. The abundance of zooplankton was 4980 ind./m^3, the biomass — 160.4 mg/m^3. Species composition, diversity indexes, proportions of taxonomic groups, abundance and biomass of zooplankton in the examined watercourses are typical of brook waters in the study area[350][351][352][353][354][355].

14 taxons of plankton organisms were found in the lakes. In terms of abundance and biomass, the dominants were *Notholca acuminata*, *Bosmina obtusirostris*, juvenile Cyclopoida, *Arctodiaptomus bacillifer*, *Eurytemora lacustris*, *Heterocope appendiculata* and *Eudiaptomus gracilis.* The abundance of zooplankton was 1660 ind./m^3, the biomass — 12.0 mg/m^3 (Table 7.6.22).

The total of 12 taxons of zooplankton were found in the rivers. *Euchlanis deflexa*, *Bosmina longirostris*, *Eurytemora lacustris*, juvenile Cyclopoida and larvae Chironomidae dominated by abundance and biomass. The abundance of zooplankton is on average 1460 ind./m^3, the biomass — 179.2 mg/m^3 (Table 7.6.22).

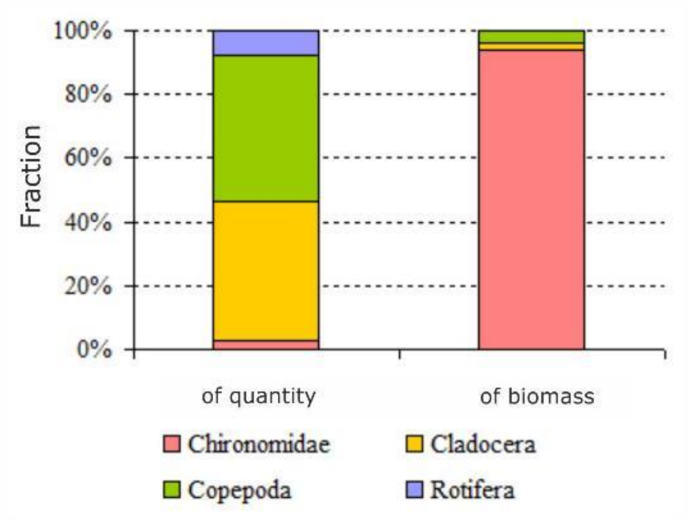


Figure 7.6.71: Proportions of main taxonomic groups in zooplankton abundance and biomass, Nanyakha River, 23.08.2019

Zooplankton species composition and biomass are also varying between seasons. For instance, in the Khaltsyney-Yakha River, in late June 2019 zooplankton was represented by only 3 taxons of Copepoda, whereas in August their taxonomic diversity increased to 8. Copepods dominated in both abundance and biomass. The abundance of zooplankton was 250 ind./m^3, the biomass — 1.05 mg/m^3; compared to the end of June 2019, abundance increased, whereas the biomass dropped due to the larger proportion of small rotifers and cladocerans.

---

[350] V. D. Bogdanov, Ye. N. Bogdanova, O. A. Gos'kova, I. P. Melnichenko. Retrospective review of ichthyological and hydrobiological studies on the Yamal Peninsula. Yekaterinburg, Yekaterinburg Publishers, 2000. 88 p.

[351] V. D. Bogdanov N. Bogdanova, I. P. Melnichenko. Hydrobiological monitoring at a gas industry facility on the Yamal Peninsula (Mordy'yakha River basin) // Biological resources and aquaculture development in waterbodies of the Urals and Western Siberia. Tyumen: SibrybNIIproject, 1996. pp. 27-28.

[352] V. D. Bogdanov, Ye. N. Bogdanova, I. P. Melnichenko, L. N. Stepanov, M. I. Yarushyna. Bioresource conservation challenges at the development of the Bonankovskoye gas condensate field // Regional Economy. 2012. No. 4. pp. 68–79.

[353] V. D. Bogdanov, I. N. Bolotov, Yu. V. Bespalaya, Ye. N. Bogdanova, I. P. Melnichenko, L. N. Stepanov, M. I. Yarushyna. Biodiversity of European sector of the Arctic and the Yamal Peninsula: first findings of multi-discipline project of UrO RAS // Research and conservation of fauna of the North: proc. of the All-Russka Conference with international participation (Syktyvkar, Komi Republic, Russia, 8-12 April 2013). Syktyvkar: Komi Science Centre of UrO RAS, 2013. pp. 22-24.

[354] N. I. Yermolaeva. Zooplankton in various waterbodies on the Yamal Peninsula in 2015 // Scientific Bulletin. 2016. No. 2 (91). pp. 56-62.

[355] Development of fish protection measures and estimation of damage to fishery, Project: Salmanovskoye OGCF Facilities Setup. Research Report. Tyumen Branch of FPFI "VNIRO". Tyumen, 2019. FRECOM. 141 p.

Table 7.6.22: Taxonomic composition, abundance and biomass of zooplankton in freshwater waterbodies on the Tydan Peninsula within the Salmanovskiy (Utrenniy) LA

Species/taxon	Rivers	Brooks	Lakes
Chironomidae	-		
Chironomidae	-	50/138.108	-
Cladocera	-	-	-
Arctodiaptomus bacillifer (Koelbel, 1885)	-	-	10/1.876
Chydorus sphaericus (O. F. Mueller, 1785)	40/0.212	-	-
Cyclopoida juv.	-	-	670/2.399
Cyclops sp. juv.	-	-	20/0.342
Eudiaptomus gracilis (G. O. Sars, 1862)	-	-	40/1.249
Eurytemora lacustris (Poppe, 1887)	-	-	80/1.579
Heterocope appendiculata (Sars, 1863	-	-	30/1.337
Megacyclops viridis (Jurine, 1820)	-	-	10/0.127
Nauplia Copepoda	-	-	70/0.064
Bosmina obtusirostris Sars, 1861	-	-	310/2.621
Acroperus harpae (Baird, 1834)	-	50/1.742	-
Alonella excisa (Fischer, 1854)	-	40/0.322	-
Bosmina obtusirostris Sars, 1861	-	10/0.115	-
Chydorus ovalis Kurz, 1874	-	10/0.044	-
Copepoda	-	-	-
Acanthocyclops vernalis (Fischer, 1853)	10/0.138	50/0.451	
Bryocamptus vejdovskyi (Mr6zek, 1893)	-	10/0.138	-
Canthocamptus glacialis Lilljeborg, 1902	-	-	-
Cyclopoida juv.	40/0.179	2000/8.93	-
Cyclops scutifer G. O. Sars, 1863	-	40/1.102	-
Cyclops sp. juv.	-	20/0.342	-
Diacyclops bicuspidatus (Claus, 1857)	10/0.055	60/0.472	-
Harpacticoida juv.	-	500/4.513	-
Nauplia Copepoda	40/0.02	1000/0.507	-
Paracyclops fimbriatus (Fischer, 1853)	20/0.367	-	-
Ostracoda	-	-	-
Ostracoda Latreille, 1802	-	10/3.154	-
Rotifera	-	-	-
Bipalpus hudsoni (Imhof, 1891)	-	-	-
Euchlanis alata Voronkov, 1911	70/0.065	-	10/0.14
Euchlanis deflexa (Gosse, 1851)	10/0.012	30/0.024	-
Euchlanis lyra Hudson, 1886	-	-	0.081/0.081
Kellicottia longispina Kellicott, 1879)	-	20/0.001	20/0.001
Notholca acuminata (Ehrenberg, 1832)	10/0.005	50/0.027	300/0.164
Notholca labis Gosse, 1887	-	10/0.005	-
Polyarthra dolichoptera Idelson, 1925	-	1000/0.28	-
Polyarthra *vulgaris* Carlin, 1943	-	-	50/0.014
Synchaeta grandis Zacharias, 1893	-	10/0.012	10/0.016

Macrozoobenthos

Figure 7.6.72: Larvae of Belgica antarctica (Chironomidae), background macro-zoobenthos species in waterbodies within the license area

Species diversity and biomass of benthic organisms in the surveyed waterbodies are low. Zoobenthos is represented by five taxons which are common and characteristic of the surveyed waterbodies. In general, total abundance and biomass of zoobenthos are low and fit within the known range for waterbodies of this type.

The richest benthic resources are present in bottom sediments of brooks. Zoobenthos in the samples was represented by single individuals of larvae Belgica antarctica (Chironomidae), oligochaeta *Limnodrilus hoffmeisteri* and gastropod *Anisus (Gyraulus) sp.* The total abundance of zoobenthos (average of three samples) was 40 ind./m^2, total biomass – 0.43 g/m^2.

In the bottom sediments of the Yabtarmato Lake, only one sample contained a single unit of relict crustacean – amphipod *Monoporeia affinis*. This species can be classified as nekton behthos (organisms that live both on ground surface and in the near-bottom layer of water). Total abundance was 13 ind./m^2, total biomass — 0.59 mg/m^2.

In the bottom sediments of rivers, zoobenthos was represented by larvae of Belgica antarctica (Chironomidae) and large cranefly larvae *Tipula (Arctotipula) sp*. which make the main contribution to the total biomass. The total abundance of zoobenthos (average of three samples) was 150 ind./m^2, total biomass – 3.89 g/m^2. A seasonal pattern was identified for Belgica antarctica abundance: in August it was higher than in June.

Ichthyofauna of freshwater ecosystems of the Gydan Peninsula

Freshwater fishes of the Gydan Peninsula belong to the class of bony fishes and are represented by seven orders and thirteen families. Of Acipenceridae family, only Siberian sturgeon was met in the rivers of the peninsula; small numbers of its immature individuals migrate there from the Ob Estuary for fattening.

Of Salmonidae family, the rivers and lakes of the peninsula are inhabited only by the Arctic char which lives in a relatively small number of lakes of relict marine genesis.

The Coregonidae family is represented by the largest number of species in the rivers and lakes. European whitefish in the water bodies of the Gydan Peninsula is related to the Siberian whitefish sub-species and has a lake/river and semi-anadromous ecological forms. The lake/river whitefish spends most part of its lifecycle in continental lakes connected to the river system; it fattens in lakes and partly in rivers, and spawns and winters in lakes. The semi-anadromous whitefish basically spend winter in the Ob Estuary, and in spring migrate for fattening in shallow river areas, and only small number of individuals — in lakes. Muksun is represented on the Gydan Peninsula only by semi-anadromous form and is extremely scarce. Broad whitefish is widespread all over the region. Peled has a lake and a lake/river forms. Siberian cisco is represented by semi-anadromous and lake forms in the system of rivers and lakes of the peninsula.

Taimen, tugun, Siberian white salmon and nerfling are extremely rare and are met only as single individuals when they migrate in small numbers in the rivers of the Gydan peninsula for fattening only. Arctic grayling is observed within the middlestream and upstream reaches of rivers and in deep drainage lakes, but it is scarce everywhere. Common pike is widespread and relatively numerous, especially in continental lakes.

Of Cyprinidae family, the lakes and rivers in the survey territory are inhabited by minnow (lake and river forms), and, locally, by roach.

Burbot migrates upstream the Ob Estuary rivers for fattening and spawning, and, together with the coregonidae, it forms the basis of ichthyocenoses in winter period.

Another widespread, but scarce species of no commercial value is nine –spined stickleback representing eponymous family.

Of Percidae family, two species live in the water bodies of the Gydan Peninsula – common ruff and river perch, which are generally small in numbers.

The Cottidae family is represented by one species, the four– horned sculpin, which migrates to rivers from the Ob Estuary, has a sedentary near-botton life pattern, and is not commercially valuable.

Findings of fishery survey in Khaltsyney-Yakha River in 2019 are provided in the operational environmental monitoring report of IEPI JSC.

Reportedly, in October 2019 ichthyofauna of Khaltsyney-Yakha River included five species of fish: Arctic cisco, Siberian whitefish, Siberian cisco, grayling and broad whitefish. The presence of grayling indicates a good environmental status of the river. Total catch produced using a combined net during the whole period of monitoring included 67 units of fish. The catch was used for biological analysis and consisted of 51 units of Arctic cisco, 9 units of Siberian whitefish, 5 units of Siberian cisco, 1 unit of broad whitefish, and 1 unit of grayling. Arctic cisco dominated and accounted for more than 70% of the total catch. The average share of Siberian whitefish was 13.4%, of Siberian cisco - 7.5%. Ichthyofauna density in the Khaltsyney-Yakha River varies within a vast range during the free-water period, due to the seasonal migration of fish. During the 3 days of monitoring, the density dropped from 156 kg/ha to 24 kg/ha. Such a decline is explained by the uneven migration of fish from the river to the wintering grounds. Reportedly, despite the technogenic load from the field development activity, the Khaltsyney-Yakha River currently maintains its fishery function, and status of its ichthyofauna is assessed as satisfactory.

Fishery characteristics of water bodies of the Gydan Peninsula

Fishery characteristics of the water bodies in the license area have been developed by the Nizhne-Obskiy Branch of FSUE GlavRybVod, based on the library data (Research reports by FSBSI GosRybTsentr on the water bodies of Tazovskiy Municipal District in 2003-2005).

Aquatic bioresources of small lakes in the territory of the planned activity and its area of influence are represented by aquatic invertebrates and algae. In these lakes, feeding, spawning and wintering of minnow are possible. Average biomass of zooplankton in these lakes is 95.1 mg/m^3, and the biomass of zoobenthos is 5.25 g/m^2. In larger lakes located in the Plant Project's area of influence (the minimum distances from the site boundaries are 20 and 130 m, respectively), the ichthyofauna is represented by Siberian cisco, broad whitefish, peled (comes for feeding), nine– spined stickleback, ruff and minnow. The average biomass of zooplankton is 95.1 mg/m^3, and the biomass of zoobenthos is 5.25 g/m^2.

Unnamed brooks serve as migration routes to feeding grounds in unnamed lakes for the Siberian cisco, broad whitefish and peled. In spring and summer, the ruff spawns in the brooks. There are no wintering grounds of fish fauna in the brooks. The average biomass of zooplankton is 0.05875 g/m^3, and the biomass of zoobenthos is 3.84 g/m^2.

In accordance with the Order no. 818 of the Federal Agency for Fishery, dated 17 September, 2009, "On determining the categories of water bodies of fishery value, and specific features of production (catching) the aquatic biological resources inhabiting them and considered as fishery species", the Nizhne-Obskiy Branch of FSUE GlavRybVod recommends to establish the following categories:

- fishery category **2** –for unnamed lakes located immediately within the Project boundaries;
- fishery category **1** –for unnamed brooks flowing within the survey area;
- fishery category **2** –for unnamed lakes located within the Project's area of influence; and
- **top** fishery category –for unnamed lakes located within the Project's area of influence.

7.6.3.10 Identification of critical habitats

Assessment of critical habitats as applicable to the Arctic LNG 2 Project is provided in this Section. The IFC Performance Standard 6 establishes five main criteria of critical habitats: (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

Spatial scope for identification of critical habitats depends on in-depth ecological processes that lie at the heart of the examined habitat, and are not necessarily confined to the Project's ecological footprint. Paragraph GN65 of the IFC Guidance Note 6 specifies that for Criteria 1 through 3, critical habitat is determined as a "discrete management unit" - an area with a definable boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas. GN65 provides further guidance for selecting a "discrete management unit":

"A discrete management unit may or may not have an actual management boundary (e.g., legally protected areas, World Heritage sites, KBAs, IBAs, community reserves) but could also be defined by some other

sensible ecologically definable boundary (e.g., watershed, interfluvial zone, intact forest patch within patchy modified habitat, seagrass habitat, coral reef, concentrated upwelling area, etc.). The delineation of the management unit will depend on the species (and, at times, subspecies) of concern".

The respective "discrete management unit" is determined in sub-sections below, as appropriate.

Criterion 1: Critically Endangered and Endangered Species

No endangered or critically endangered species were reliably identified by the field surveys in the license area during 2012-2019. In accordance with IFS PS6, critical habitats can be defined as areas supporting globally significant concentrations of 0.5 percent of the global population of endangered and critically endangered species, and also of vulnerable species if destruction of their habitats would change their status to "endangered" or "critically endangered". In the Project area, such species include Russian endemic species: red-breasted goose (*Branta ruficollis*) and lesser white-fronted goose (*Anser erythropus*), which are listed by IUCN as "vulnerable" (VU), and have their most important nesting habitats in the wetland areas of north-east Gydan and Taymyr. The available data, including records of aerial counting of anseriformes on the Gydan Peninsula (Rosenfeldt et al., 2018) indicate that nesting grounds of *Branta ruficollis and Anser erythropus* nearest of the LA boundary are located in the middle reaches of the Yuribey River and on the Mammonth Island, 26 km off the boundary of the license area (Figure 7.6.73). The main migration routes of these species do not pass through the LA territory. Despite the known presence of nesting grounds of lesser white-fronted goose in the license area, the LA does not play a major role in supporting the regionally or nationally important concentrations of this species.Therefore, no grounds are present for identification of critical habitats within the LA based on Criterion 1 of the IFC PS6.

The rare and protected species of fish (Siberian sturgeon and sterlet) have not been found within the license area and are not expected to appear in the territory on a regular basis. The range of Siberian sturgeon (species with status EN - "Endangered) is shown in Figure 7.6.74.

Criterion 2: Endemic and Restricted-range Species

According to the IFC GN6, "an endemic species is defined as "a species that has a limited distribution (limited distribution of localities)". A restricted-range species is defined as follows:

For terrestrial vertebrates, a restricted-range species is defined as those species which have an extent of occurrence of 50,000 km^2 or less;

For marine systems, restricted-range species are provisionally being considered those with an extent of occurrence of 100,000 km^2 or less;

For freshwater systems, standardized thresholds have not been set at the global level. However, an IUCN study of African freshwater biodiversity applied thresholds of 20,000 km^2 for crabs, fish, and mollusks and 50,000 km^2 for odonates (dragonflies and damselflies). These can be taken as approximate guidance, although the extent to which they are applicable to other taxa and in other regions is not yet known.

For plants, restricted-range species may be listed as part of national legislation. Plants are more commonly referred to as "endemic," and the definition provided in paragraph GN79 would apply.

The Ob Estuary is populated with species that have vast geographic ranges. The Gydan Peninsula is characterised by a low level of endemism, as most of its plants and animals are common in the Arctic area in general. No endemic or restricted-range species have been found in the Project area, therefore, no grounds are present for identification of a critical habitat based on the criterion of presence of endemic or restricted-range species.

Criterion 3: Migratory and Congregatory Species

The IFC GN6 provides the following definition of migratory and congregatory species:

"Migratory species are defined as any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem).

— Congregatory species are defined as species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis.

— Species that form colonies: Species that form colonies for breeding purposes and/or where large numbers of individuals of a species gather at the same time for non-breeding purposes (e.g., foraging, roosting)

— Species that move through bottleneck sites where significant numbers of individuals of a species pass over a concentrated period of time (e.g., during migration)

— Species with large but clumped distributions where a large number of individuals may be concentrated in a single or a few sites while the rest of the species is largely dispersed (e.g., wildebeest distributions)

— Source populations where certain sites hold populations of species that make an inordinate contribution to recruitment of the species elsewhere (especially important for marine species)."

To meet the requirements of a critical habitat, the habitat must support ≥ 1% of the global population of a migratory or schooling species at any stage of its life cycle, or support ≥ 10% of the global population during periods of stress associated with environmental conditions. These criteria are not met by any non-avifauna migratory or congregatory species recorded in the license area, as well as migratory species in the water area of the Ob Bay.Analysis of the published materials, including aerial counting reports and ornithological field studies, whows that the license area is located outside the main nesting habitats of anseriformes on the Gydan Peninsula - being important habitats in terms of sustaining the birds' populations in the Arctic region (Figure 7.6.73). Reportedly, migration routes of anseriformes nesting on the Taimyr and North-East Gydan pass through the LA territory. Geese (particularly white-fronted geese) stop in the wetlandareas in the lower reaches of rivers within the catchment basin of the Gydan Estuary (Khaltsyney-Yakha River, etc.), in the location area of the Project facilities, but do not form mass congregations there.

The water areas of a high environmental value are present which include critical habitats meeting Criterion 3 of the World Wildlife Fund[356] (Figure 7.6.74). These include ichthyofauna wintering grounds, as well as permanent or seasonal habitats of the key species for the Arctic ecosystems (whitefish, white whale, ringed seal). Distance from the LA boundary to such water areas is more than 110 km.

Criterion 4: Highly threatened and/or unique ecosystems

The IFC Guidance Note defines highly threatened or unique ecosystems as those

— that are at risk of significantly decreasing in area or quality;

— with a small spatial extent; and/or

— containing unique assemblages of species including assemblages or concentrations of biome-restricted species.

IFC Guidelines' Thresholds for Criterion 4: – Areas representative of ≥ 5% of the global range of an ecosystem type that meets the criteria of "endangered" or "endangered" according to the IUCN guidelines for defining rarity categories (Rodriguez et al., 2011).

The IUCN established a Work Group to develop a system of quantitative categories and criteria similar to those applied for species, which are applied for assigning the levels of threat to ecosystems at the local, regional and global level[357]. This system is based on the four main criteria:

A: Short-term decline in distribution or ecological function (within the next 50 years);

B: Historical decline in distribution or ecological function (in the last 500 years);

C: Small current distribution and decline in distribution or ecological function, or very few locations;

D: Very small current distribution.

As no actual information is available on the environmental changes in the Project area to analyse observations time series, evaluation of changes over past 500 years does not make sense. Therefore, only criteria A, C and D have been applied for the assessment of critical habitats.

Within the studied area, rare communities with limited range, relying on specific rare environmental conditions, are sparse forb/grass meadows on the seashore slopes. These rare plant communities develop in a narrow range of environmental conditions, occupy small territories and contain regional rare and protected species of plants listed in the Red Data Book of YNAO (2010). At least 5 species of the LA flora are present only as part of such plant communities. It is likely that these communities meet criterion C: restricted range and decline (of range or ecological function), in accordance with the Practical Guide to the Application of the IUCN Red List of Ecosystems criteria (Rodriguez et al., 2011). According to the available literary guidelines (Khitun, 2005; Gudovsky et al., 2016), incl. the growth of species that make up these communities, it can be concluded that on the Gydan Peninsula they are distributed along the cliffs of the

[356] Solovyev, B., Spiridonov, V., Onufrenya, I., Belikov, S., Chernova, N., Dobrynin, D., ... & Pantyulin, A. (2017). Identifying a network of priority areas for conservation in the Arctic seas: Practical lessons from Russia. Aquatic Conservation: Marine and Freshwater Ecosystems, 27, 30-51

[357] Rodrıguez, J.P., Baillie, J.E., Ash, N. et al. Establishing IUCN Red List Criteria for threatened ecosystems // Conserv. Biol. 2011. 25, 25-29.

sea coast and the valleys of large rivers. Given dynamic status of these communities the grounds for their identification as critical habitats with reference to Criterion 4 of the IFC PS6 are not sufficient.

Hydrobiological communities of the study area in the Ob Estuary do not meet Criterion 4, due to the

- poor taxonomic diversity, where euryhaline or brackish-water species that can live in a wide range of aquatic environments with varying levels of salinity dominate in terms of occurrence frequency and demonstrate the highest quantitative parameters;
- uneven distribution of species and significant spatial variability (and generally low level) of abundance and biomass;
- ephemery of benthos communities in coastal sections from water line to freezing depth, within so called "surf-beat-ice" zone exposed to erosion of bottom sediments under the impact of breaking waves and exaration in the period of development and disappearance of the ice shell (i.e. in such areas zoobenthos develops only during no-ice period);
- typicality of species in the study area (all identified species are common in the examined section of the Ob Estuary).

Criterion 5: Key Evolutionary Processes

Over a time, the structural attributes of a region, such as its topography, geology, soil and climate can influence the evolutionary processes. In the IFC GN6, this criterion is defined by:

- Spatial and ecological heterogeneity of the landscape, which determines the course of evolutionary processes; –
- The presence of important ecological gradients (ecotones) that determine the process of speciation;
- Unique edaphic conditions, as a result of which communities with rare species and a high level of endemism are formed;
- Ecological corridors supporting landscape connectivity, determining species migration and the flow of genetic material;
- Habitats that determine the importance from the point of view of adaptation of organisms to the conditions of a changing climate.

The license area and affected water of Ob Bay do not meet Criterion 5 (Key Evolutionary Processes) for the following reasons:

— Lack of isolation. The license area is located in the mainland part of a major continent, without any physical barriers for movement, distribution or colonisation.

— Spatial homogeneity. The plain terrain with relatively homogeneous soils and vegetation (although with significant variations at the micro and meso levels).

— Low endemism. The development history of the West-Siberian North landscapes is a history of marine transgressions, meaning that local flora and fauna communities are relatively young.

— Poor species composition, i.e. low level of biodiversity.

— Lack of subpopulations of species with distinct phylogenetic or morphogenetic attributes different from species in neighbour territories.

Therefore, conclusion about absence of ecosystems that would meet the criteria of critical habitats are present within the territories and water areas affected by the Project is confirmed by the engineering surveys and environmental monitoring results over the period 2012-2019.

Territories and water areas nearest of the Project area that partially include critical habitats are shown in Figures 7.6.73-7.6.74.

Such areas include the following:

1. Specially Protected Natural Areas (SPNA) of the Russian Federation (with a partial withdrawal of territories and water areas from economic use).

1.1. SPNAs of the Federal significance:

- Gydanskiy National Park.

1.2. SPNAs of the Regional significance:

- Yamalskiy State Wildlife Sanctuary.

2. Water areas meeting the scientific criteria of ecologically and biologically important marine areas under the UN Convention of Biological Diversity.

2.1. Ob-Yenisei estuarial system.

2.2. Priority protection water areas identified within the Ob-Yenisei estuarial system:

2.2.1. Within the scope of WWF research projects (Solovjev et al., 2016).

- Outer area of the Ob-Yenisei estuarial system of the Kara Sea (Area No.26);

- Ob-Taz sector of the Kara Sea (Area No.27).

2.2.2. Based on results of fishery research.

- Fishery conservation area in the Ob-Yenisei estuarial system of the Kara Sea planned by FSBSI GosRybTsentr (Matrovskiy et al., 2014).

3. Areas identified under the UN Convention on Wetlands of International Importance (Ramsar Convention)

3.1. Included in the List of wetlands of international importance.

3.2. Included in the Perspective (“Shadow”) List of wetlands of international importance.

4. Important bird areas of international importance identified by the Birdlife International.

5. Wetland areas in the Yuribey River valley providing important nesting grounds and the migration routes for rare and protected bird species with “vulnerable” status: red-breasted goose (*Branta ruficollis*) and lesser white-fronted goose (*Anser erythropus*), of which the most important nesting habitats are in the wetlands in the North-East Gydan and Taymyr Peninsula.

Summary information on the territories and water areas in which critical habitats are likely to be identified is provided in the table below (Table 7.6.23).

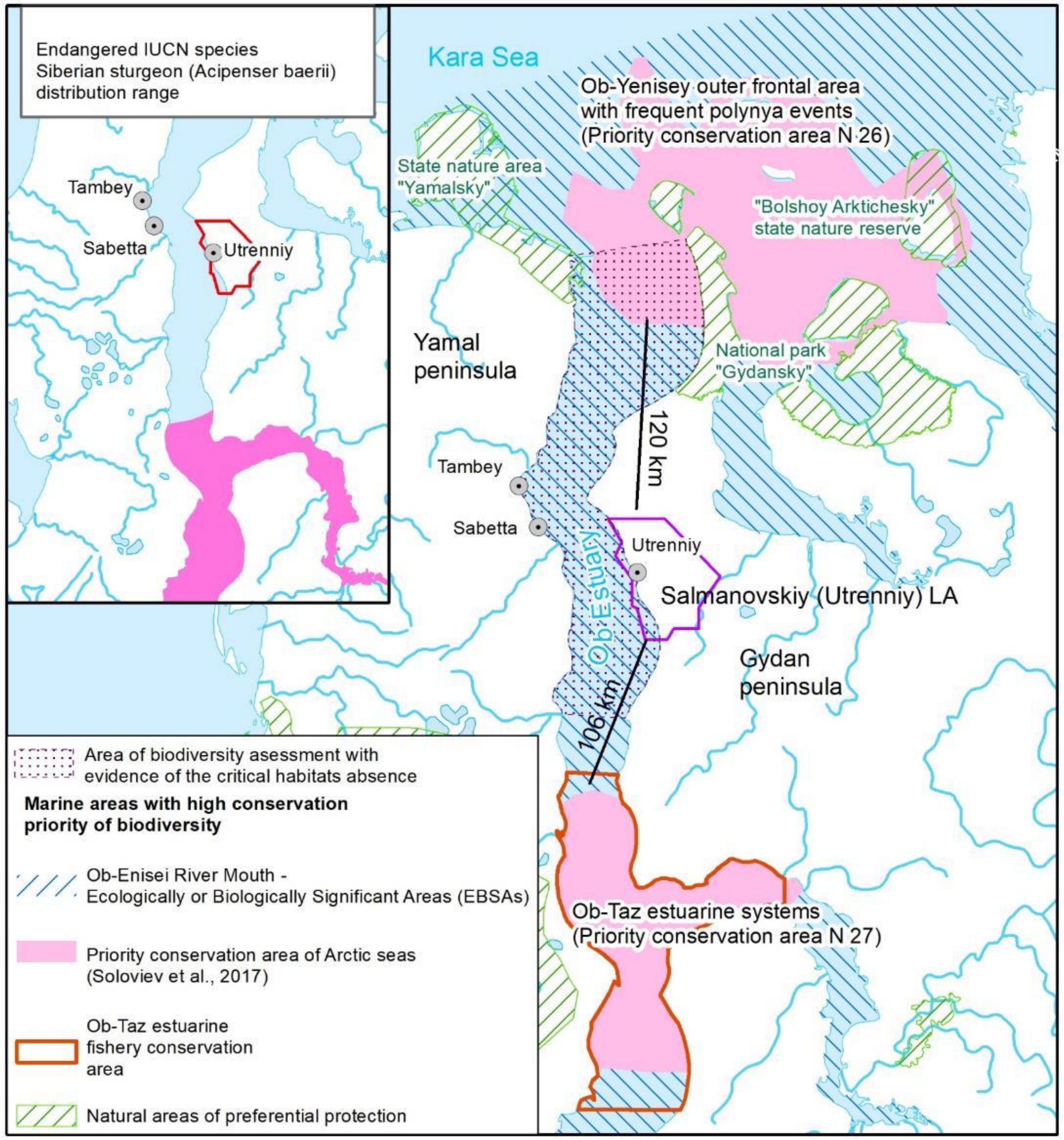


Figure 7.6.73: Water areas nearest of the Project area that partially include critical habitats

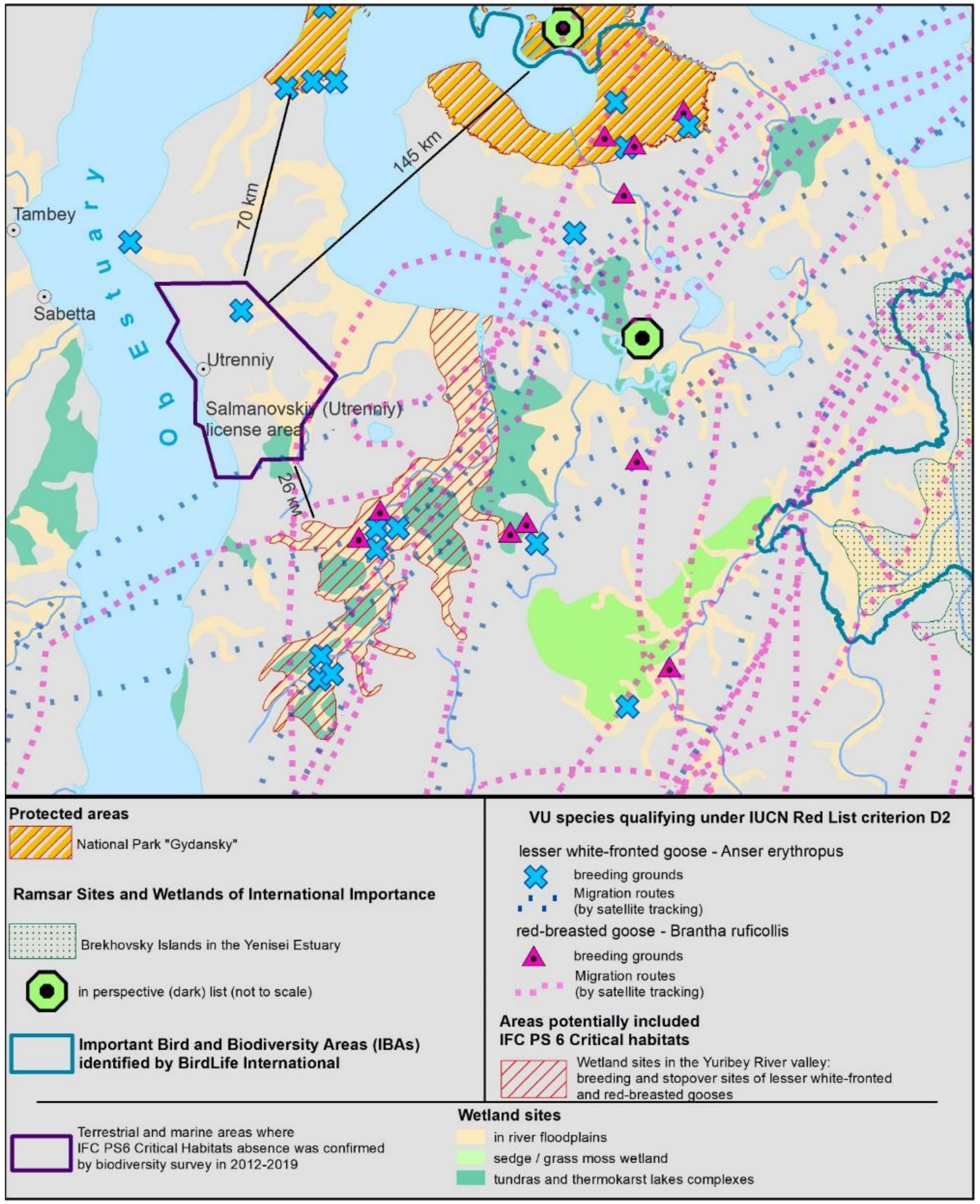


Figure 7.6.74: Territories and water areas nearest of the Project area that partially include critical habitats

Sources of migration data: Simeonov P., Nagendran M., Michels E., Possardt E., Vangeluwe D. Red-breasted Goose: satellite tracking, ecology and conservation // Dutch Birding. 2014. Vol. 36. P. 73-86; Aarvak T., Øien I., Shimmings P. A critical review of Lesser White-fronted Goose release projects //Norsk ornitologisk forening. 2016. P. 1-6; https://savebranta.org/en/birds-tracker

Table 7.6.23: Territories and water areas nearest of the Project area that partially include critical habitats

№	Territory / water area	Location	Description	Criteria of IFC PS6 matched
1	Outer area of the Ob-Yenisei estuarial system of the Kara Sea (Area No.26)	Shallow waters in the south of the Kara Sea at the northern tip of the Gydan Peninsula, from the eastern section of the Ob Estuary outlet to the western part of the Yenisei Estuary outlet (Ovtsyn Strait), as well as the islands of Shokalskogo, Vilkitsky, Neupokoeva, Oleniy, Sibiryakova. About 130 km from the Plant and Terminal	Biotic complexes and communities of the outer estuarine area. High biological productivity. The most important permanent and seasonal habitats for a number of Arctic species of key importance for the ecosystem (whitefish, white whale, ringed seal). Areas of polar bear habitat. Breeding and migration areas of migratory birds. Habitats and places of concentration of Arctic cod and navaga	3, 4, 5
2	Gydanskiy National Park / IBA (Oleniy Island and the coast of the Yuratskaya Bay (046: TM-009)	The northern tip of the Gydan Peninsula (Yavai Peninsula, north of the 72nd parallel). Northern and northwestern parts of the Mammoth Peninsula, Oleniy Peninsula, the coast of the Yuratskaya Bay, islands of Oleniy, Shokalskogo, Pestsovye, Proklyatye and Rovny). About 70 km from the LA boundaries	DCAs of the Federal significance. The key role in the conservation of the powerful East-Atlantic migration route of aquatic and semi-aquatic birds. Conservation of rare and protected bird species: (white-billed loon, Bewick's swan, lesser white-fronted goose, red-breasted goose, white-tailed eagle, peregrine falcon, ivory gull) and mammals (polar bear and Atlantic walrus)	1, 3
3	The Ob-Taz sector of the Kara Sea (Area No. 27) / Planned fishery conservation area	Middle part of the Ob Estuary at the confluence of the Taz Estuary. About 150 km from the Plant and Terminal	The most important permanent and seasonal habitats for a number of Arctic species of key importance for the ecosystem (whitefish, white whale, ringed seal) and species requiring special protection (Siberian sturgeon). Area ofwintering and survival (during the suffocative period) for whitefish and sturgeons of the entire Ob-Taz basin: Siberian sturgeon, omul, muksun, broad whitefish, Siberian whitefish, peled, Siberian cisco, Siberian white salmon, smelt	1, 3, 4
4	Wetlands of the Yuribey River valley	Middle course of the Yuribey River. 26 km from the LA boundaries	Important role in maintaining the migration route of Anseriformes. Important nesting and migration areas for rare and protected species of birds with the "vulnerable" status: red-breasted goose (*Branta ruficollis*) and lesser white-fronted goose (*Anser erythropus*). Essential for the reproduction of valuable whitefish	1, 3

7.6.4 *Territories and water areas with protected status*

7.6.4.1 Designated Conservation Areas of the RF

On the territory of Russia, biodiversity conservation is provided through the system of specially protected natural areas, where the protection status is established for both individual species of plants and animals, and the ecosystem as a whole. Despite the generally low diversity of species, the Arctic biota is distinguished for relatively higher evolutional, ecological and, in some cases, environmental significance of its individual species.

In the Yamal-Nenets Autonomous Okrug, there are 15 Specially Protected Natural Areas (SPNA), including two state nature reserves, 11 state wildlife sanctuaries, one natural monument and one ethnic territory with a special nature management regime. The total area of SPNA is 7,760,341 hectares, excluding the protected areas of some SPNA. The SPNA include three coastal protected areas with a total area of 2,408,174 hectares.

The SPNA nearest to the Plant Project area are the Gydanskiy state nature reserve (110 km, see Figure 7.1.1); the North Yamal cluster of the Yamal state wildlife sanctuary (170 km); the Messo-Yakhinskiy state wildlife sanctuary of regional importance (340 km); and the Nizhne-Obskiy state wildlife sanctuary of regional importance (470 km).

The Taz Estuary is a potential protected area in the YNAO, which can get the status of a state wildlife (ichthyological) sanctuary of regional importance. This large freshwater estuary is also included in the Perspective List of the Ramsar Convention. In this case, the protected animals will include: 1) invertebrates: small clams (sphaerium, pisidium, valvata), larvae of chironomids, gammarids, oligochaetes, small crustaceans, rotifers, etc.; 2) thirty-two ichthyofauna species: lamprey, Siberian sterlet, Siberian sturgeon, taimen, Arctic char, grayling, Siberian white salmon, muksun, broad whitefish, peled, Siberian whitefish, Arctic cisco, nerfling, ruff, pike, etc. The planned SPNA is located in 420 km south-eastwards of the survey area; therefore, it will be in no way affected by the planned activities.

The territorial planning documents of the Tazovskiy unicipal District include a planned SPNA of municipal significance Yuribey Protected Natural Landscape[358] (70 km SE of the Plant and Port, Figure 7.1.1). According to the scientific community[359], this SPNA is essential for conservation the highly valuable northern Hypo-Arctic natural tundra in this territory, as well as the associated spawning grounds of whitefish, breeding sites of waterfowl; and for preserving the conditions favorable for traditional nature management, i.e. large-scale nomadic reindeer herding and fishing. However, according to the information provided by the Administration of the Taxovskiy Municipal District, activity for establishing this SPNA has been cancelled.

The specified SPNA are situated at a considerable distance from the projected facilities; thus, the Project area does not lie within the boundaries of the existing and potential specially protected natural areas of federal, regional and local importance.

7.6.4.2 Ecologically and biologically significant areas

In 2014, in accordance with the procedures of the Convention on Biological Diversity, with the support of the Working Group of the Arctic Council on the Conservation of Arctic Flora and Fauna (CAFF) and the UN Environmental Programme (UNEP), the Ob and the Yenisei Estuaries, among 11 other major Arctic ecosystems, were included in the list of ecologically and biologically significant areas (EBSA[360]) requiring appropriate measures for their conservation and sustainable use in accordance with international law and national legislation. Its boundaries generally coincide with the boundaries of the Ob-Yenisei physico-geographical province specified in accordance with the Russian system of environmental zoning of the Arctic seas and coasts (Atlas of biological diversity of seas and coasts of the Russian Arctic. V.A. Spiridonov et al. (Eds.). M.: WWF Russia, 2011. 64 p.).

---

[358] https://tasu.ru/gradostroitelnaya-deyatelnost/dokumenty-territorialnogo-planirovaniya/skhema-territorialnogo-planirovaniya/

[359] Yu. V. Gudovskikh et al. The study of biota of the proposed Yuribey SPNA (Gydan Peninsula) // Vestnik Udmurtskogo Universiteta [Udmurtia University Bulletin]. 2016. Vol. 26. Issue 1. pp. 15-28

[360] Ecologically and Biologically Significant Areas (EBSAs). Official name of the water area is Ob– Enisei River Mouth EBSA, https://www.cbd.int/ebsa/)

7.6.4.3 Wetlands of international importance (Ramsar Convention List)

The Russian Ramsar network represents various types of wetlands in different climatic zones from the Arctic to the semi-desert; they are the most important habitats of waterfowl and shorebirds. Today, on the territory of Russia, there are 35 sites with the status of wetlands of international importance.

The wetlands nearest to Salmanovskiy (Utrenniy) LA are the islands in the Ob Estuary of the Kara Sea, located in the lower reaches of the Ob River northward of the Arctic Circle, in 15 km to the south from the town of Yar-Sale, the District center. The area includes the entire Narechi Island and most of the Yermak Island. The total area is 128 hectares. The area boundaries follow the boundaries of the Nizhne-Obskiy state reserve.

7.6.4.4 Prospective Ramsar Wetlands

The wetlands of so-called "shadow list" of the Ramsar Convention, nearest to the Project sites, are the following (Figure 7.6.61):

- The Taz Estuary (included in the list of potential marine and coastal specially protected areas as a state wildlife sanctuary of regional importance);
- The Yuribey River valley (Yuribei natural park of regional importance, reorganized in 2013 and conjoint with the territory of the Yamalskiy state wildlife sanctuary of regional importance);
- Lower reaches of the Messo River (Messo-Yakhinskiy state wildlife sanctuary of regional importance);
- The Belyi Island with the Malygina Strait (part of Yamalskiy state biological sanctuary of regional importance);
- Islands in the Kara Sea northwards of the Gydan Peninsula (part of Gydanskiy state nature reserve
- The Oleniy Island and the Yuratskaya Bay coast (part of Gydanskiy state nature reserve);
- Озёра северо-востока Гыданского полуострова.

7.6.4.5 Important Bird Areas

Identification of the Importany Bird Areas (IBAs) of Russia is a program implemented by the Russian Birds Conservation Union since 1994. Its international component is a part of the Important Bird Areas global programme developed in 1980s by the international association for birds and nature protection Birdlife International.

The IBA are the land or water surface areas most valuable for birds as their breeding, molting, wintering grounds and places to stop on migration. Their preservation will give the maximum effect in the conservation of certain species, subspecies or populations of birds.
The IBA include:

- habitats of globally endangered species;
- areas with high abundance of other rare and vulnerable species (subspecies, populations), including those listed in various Red Data Books;
- habitats of a large number of endemic species, as well as species whose distribution is limited to one biome;
- places of large breeding, molting, migratory, wintering and other bird clusters.

The IBA status is assigned on the basis of quantitative criteria developed by Birdlife International and uniform within large regions.

The existing IBA on the Yamal and Gydan Peninsulas are situated at a significant distance from the Project area (Figure 7.6.73). It is not planned to create a new KOT in this area. Characteristics of three KOT closest to the Project area are presented below.

Lower Yuribei (033: ЯН/YAN-006). Coastal tundra with vast laidas and flat shores with wide littoral zone. In summer, it is an area of mass concentration of waterfowl and shorebirds, and the breeding area for many species of the Arctic tundra biome. The total area is 41,000 hectares. The IBA is protected as a part of Yamalskiy state biological sanctuary of regional importance. The distance to the Plant Project area is 300 km.

Upper and Middle Yuribei (034: ЯН/YAN -007). The KOT is part of the “Yuribei River Valley" park listed in the "shadow list” of wetlands of international importance; it is also a part of Yamalskiy state biological sanctuary of regional importance. The total area is 400,000 hectares. This IBA is of international importance as a district of mass concentration of waterfowl and shorebirds in summer, and as a breeding area for many species of the Arctic tundra biome (criterion A3): red-breasted goose, greater white-fronted goose, Bewick's swan, greater scaup, long-tailed duck, common scoter, rough-legged buzzard, gray plover, spotted redshank, little stint, Temminck's stint, dunlin, Arctic skua, long-tailed skua, Heuglin's gull, glaucous gull, Arctic tern, snowy owl, red-throated pipit, Lapland bunting, etc. It is the only place on Yamal where the red-breasted goose breeds regularly. The distance to the Plant Project area is 270 km.

The Oleniy Island and the Yuratskaya Bay coasts (046: TM-009). This IBA covers the Oleniy Island, neighbouring small islands and the Yuratskaya Bay coast, including the lower reaches of the Mongocheyakha River. Typical tundra and tundra-bog complexes are represented on coastal plains and terraces with high density of lakes. There are a lot of salinas, shoals and lakes. Most part of the IBA is protected as part of the Mammonth Peninsula within the Gydanskiy state nature reserve, except an area eastwards of the Yessiayakha River mouth. There are large breeding and molting geese clusters (up to 20,000 birds), mainly of greater white-fronted goose and, to a lesser extent, of bean goose and brant goose. There are also large gatherings of different ducks. The distance to the Plant Project area is 260 km.

7.6.5 Ecosystem services

Ecosystem services are goods and services provided by ecosystems that are important for the well-being of people. The environment provides people with food, water and air essential for life, as well as natural resources and materials for economic activities and consumption. Less obvious services are air and water purification; storage and biological destruction of waste. In addition, the environment creates the conditions for recreation, physical and mental health. With regard to the concept of ecosystem services used in this paper, the ecosystem services are considered to fall into four sub-categories: provisioning; regulating; cultural; supporting. The supporting services (e.g., soil formation, primary production and genetic exchange) form the basis for the other three categories of services.

Generally, the concept of ecosystem services is aimed at a holistic approach to environmental decision-making based on considering the environment as a source of benefits that people obtain from the ecosystems. It is a pragmatic concept of practical actions, focusing on the goals that bring the greatest benefit to the environment at the minimum cost for the society and natural environment; its aim is to prevent any decisions that may have unpredictable secondary effects, be expensive, risky or harmful for the ecosystems and human well-being. The assessment of both desirable and undesirable consequences of the land-use approaches in terms of ecosystem services, will make it possible to identify the true value and usefulness of the conducted measures and policies more fundamentally.

According to the IFC performance standards, the ecosystem services of primary importance are divided into two priorities:

1. Services most likely to be affected by the Project, with adverse impacts on the disturbed communities.
2. Services that the Project implementation directly depends upon (e.g. water supply).

Moreover, if there is a probability that the disturbed communities will be affected, it is essential that they take part in determining the ecosystem services of paramount importance in accordance with the requirements for interaction with stakeholders, as defined in the Performance Standard 1. The ecosystem services relating to the Project's area of influence and classified as priorities no. 1 or 2 are summarized in Table 7.6.24.

Table 7.6.24: Description and ranking of ecosystem services in the Project area

Ecosystem services	
Provisioning	**Relation to the Project activities**
Animal husbandry	Priority 1 – reindeer herding
Fishing	Priority 1 – fishing in the Ob Estuary and rivers
Gathering wild edible plants	Priority 1 – mushrooms and berries
Hunting	Priority 1 – hunting for food and fur
Fresh water	Priority 1 – fresh water for local residents and reindeer
Genetic resources	Priority 1 – use of local vegetation as reindeer forage
Medicines of natural origin	Priority 1 – gathering medicinal plants, as well as plants used in manufacturing reindeer leather and furs.
Regulating	
Air quality regulation	Priority 1 – clean air

Ecosystem services	
Global climate regulation	Priority 1 – carbon resources in permafrost rock and soil
Regional/local climate regulation	Priority 1 – microclimate
Water regulation	Priority 1 – hydrology and groundwater tables
Erosion processes regulation	Priority 1 – vegetation cover to control the erosion caused by soil disturbance
Water treatment	Priority 2 – plant waste disposal
Morbidity regulation	Priority 1 – natural ecosystems are self-regulating in terms of diseases/pathogenic agents
Pest regulation	Priority 1 – natural ecosystems are self-regulating in terms of pests
Pollination	Priority 1 – pollination is important for wild edible plants reproduction
Disaster regulation	Priority 1 and 2 – vegetation cover, undisturbed soils and natural drainage are important for floods prevention
Cultural	
Sanctities or spiritual heritage monuments	Priority 1 – there are some sanctities in the Planned activity's area of influence
Religion sites	Priority 1 – religion sites
Aesthetical value	Priority 1 – local population like the territory

7.6.5.1 Provisioning (production) services

At present, the importance of ecosystem services in the social and economic development of Russian regions is determined mainly by the bioproductive properties of the landscape. Tundra is a biome of the Arctic belt, formed in cold humid climate at an average annual temperature below 0°C. The main factors affecting the vegetation cover development are short vegetation period, lack of warmth, and nitrogen deficiency; therefore, there are absolutely evident connections between the characteristics of the mineral substrate, soil, microclimate, moisture conditions and the composition, structure and productivity of plant communities.

<u>Feed resources</u>

Feed resources are quite important in the surveyed area. Forage base conservation for the reindeer husbandry development is an essential condition for preservation of traditional nature use by the indigenous population. Pasture lands cover moss, moss-lichen, lichen, subshrub, meadow-bog and other plant formations. Sedges, hare's tail cottongrass, bluegrass, foxtail, arctophila and small reed are also valuable for forage, as well as dwarf birch and willow leaves. Mosses (green moss, sphagnum, liverwort) are not forage, but in hungry years the reindeer do eat them.

The most and best consumed plants are: *Pedicularis* spp., *Nardosmia frigida, Lagotis minor, Bistorta elliptica, Hippuris lanceolata, Eriophorum lanceolata.* The best consumed are fruticose lichens of *Cladina* genus. At the second place are lishens of *Cetraria* group (gen. *Cetraria, Cetrariella, Flavocetraria*), at the third place — *Stereocaulon* genus (Yamal Peninsula. Vegetation …, 2006).

Depending on the season, the pasture lands can be winter, summer and transitional. Winter pasture is lichen tundra. Summer pastures are the formations with prevailing green forage (grass-moss, dwarf birch-moss, willow-grass-moss, grass-sedge-gramineous plants). In subshrub tundra, the feed reserves are not large, but due to thin snow cover, it is convenient for winter grazing; the reindeer willingly eat the dwarf birch and willow all the year round. They can be stored as woody forage. Flat frost-mound bogs serve as autumn pastures. Low-moor bogs and meadows are used as summer and winter pastures. In winter, the deer-feeding capacity of pasture lands is from 3 to 20 deer-days/ha, and in summer — from 2 to 6 deer-days/ha.

Suitability of the summer and winter pastures in the Project area is shown in Figure 7.6.75.

The most productive are lichen tundras which are mainly confined to river valleys. These pastures occupy minor areas within the LA, while they easily lose productivity. The high reserves of green fodder are confined to shrub tundra and sedge bogs.

<u>Animal husbandry</u>

Reindeer herding is an important traditional economic activity in YANAO. According to the Russian Federal State Statistics Service (Rosstat), in 2016, the total number of reindeer was 257,246 animals. The livestock population was continuously increasing from 197,334 animals in 2012 to 257,246 ones in 2016. Currently, the reindeer herding is represented by three main forms of management:

- Municipal enterprises;
- Community farms; and
- Private/family farms.

These forms of reindeer herding management are described in Chapter 8. It should be noted that most of the reindeer herds in the license area territory are domesticated, although some wild reindeer belonging to the protected populations as per the UICN and the Red Data Book of YNAO can be met as well. The territory within the Planned activity's area of influence is used mainly for seasonal migrations of reindeer herds. Most of herders live nomadically in tundra, i.e. they wander with their herds from one seasonal pasture to another depending on the season, and do not have permanent places of residence.

The business areas of Gydan Agricultural Enterprise "Gydaagro" are fishery and reindeer husbandry. Ninety-eight per cent of the enterprise employees are indigenous residents. The number of reindeer at the enterprise is over 2,000 animals. Antipayutinskiy community farm is the leader in venison production in the Tazovskiy Municipal District. The enterprise has reindeer raw materials processing facilities, as well as reindeer fur clothes manufacture. The reindeer herds amount to about 9,000 animals. Tazovskiy SPK (agricultural production cooperative) has been working in one of the most remote areas of Yamal since 1930s. In recent years, they managed to increase the number of reindeer up to 6,500 animals.

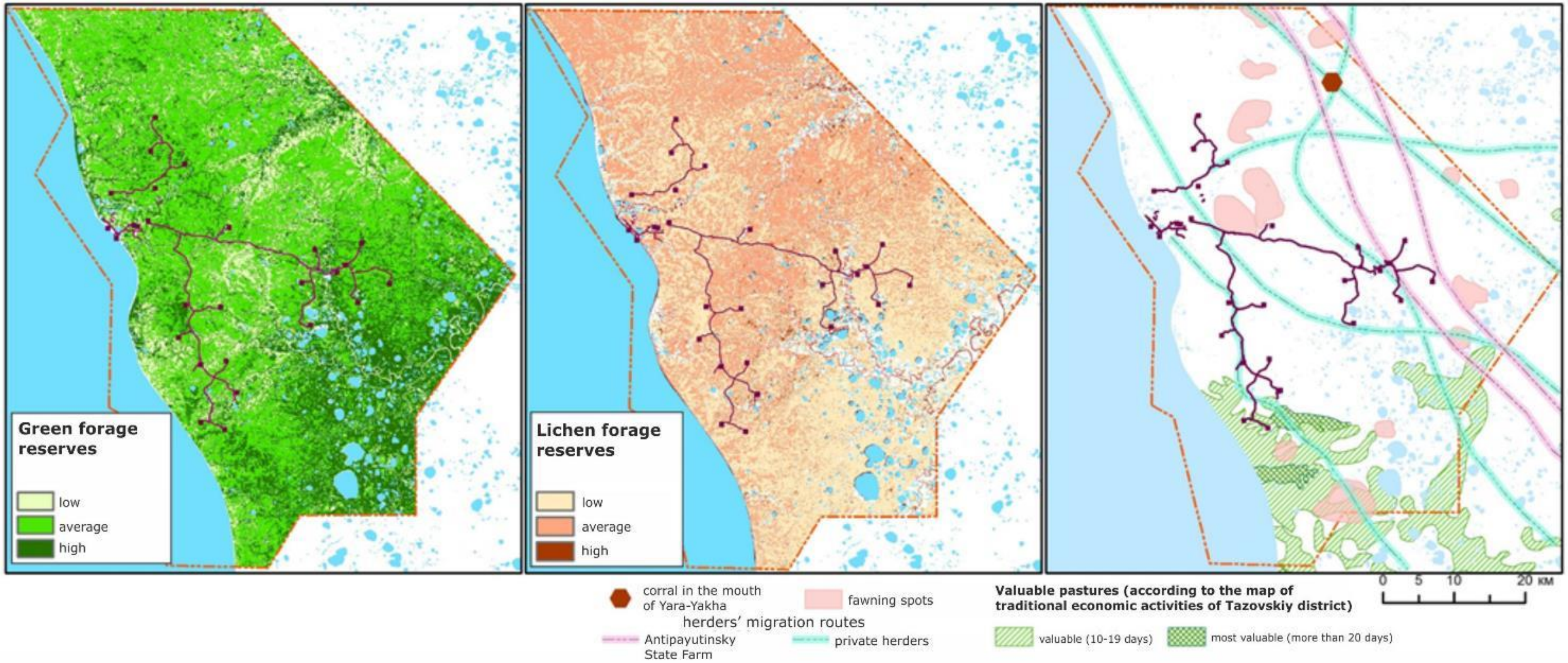


Figure 7.6.75: Forage reserves and location of valuable pasture lands within the Salmanovskiy (Utrenniy) LA

Prepared by the Consultant

Fishing

Fishery plays a notable role in the local economics. Fishery enterprises include both municipal and state companies, and private partnerships. Most of fishery workers are local residents. At present, commercial fishing is based on traditional seine methods; fishery workers often travel with their families from one catching area to another. Water bodies of fishery value are formally leased to fish farms; representatives of indigenous peoples catch fish without any special permit and without formal leasing of fishing areas.

In the water bodies in the survey area, fish is harvested mainly by local population and enterprises. Traditionally, the main commercial species are Coregonidae (muksun, peled, broad whitefish, Siberian white salmon, Siberian whitefish, Siberian cisco, Arctic cisco), as well as burbot and Arctic smelt. In 2014, muksun catching was restricted and prohibited due to depletion of its populations. From 1951 till 1980, the average volume of fish caught in the Ob Estuary was about 7.500 tons; in recent years it has decreased significantly and is about 1.600 tons.It is prohibited to harvest (catch) all kinds of aquatic biological resources all the year round in the Ob Estuary along the eastern coast to the north from the Sandib Cape, and along the western coast to the north from the Yam-Sale Cape, except for the following:

- from November 1 till April 1 — Siberian cisco within the area 90 km to the north and 60 km to the south of the administrative boundaries of Yaptik-Sale village;
- from April 1 till June 20 — Coregonidae and ordinary fish species, using fyke hoop nets and fixed trap nets, within the area from the Payuta Cape and up to 20 km northwards of the administrative boundary of Novyi Port town.

One of the main enterprises engaged in fishing in the Ob Estuary is Novoportovskiy Fishery; in addition, there are some small companies and communities dealing with fishery. Small indigenous peoples are engaged in fishing for personal consumption.

Novoportovsky Fishery takes the main catches in April-June (47.2 %) in the southern part of the Ob Estuary near Novyi Port. In this area, fishery is based on pre-suffocation gatherings of Coregonidae, Arctic smelt, burbot and ruff. Fishing is carried out with fixed trap nets and fyke hoop nets. The second equally important harvesting takes place in November-March (46.8 %) in the middle part of the Ob Estuary near Yaptik-Sale town. At this time, Siberian cisco is harvested with seines.

The most valuable species are Coregonidae (whitefish). Siberian cisco, a valuable coregonid, makes the main part of fish caught in the Ob Estuary, accounting for more than a half of the total catch volume. Arctic smelt and burbot also significant, making over 20%. Commercial value of the ordinary fish in the Ob Estuary is not high. Among these, the most notable is ruff which makes more than 10% of the total catch volume.

It should be taken into account that commercial fishing in the Ob Estuary is restricted only in its southern and middle parts. There is no commercial fishery in the northern part of the Ob Estuary. Northwards of the line between Seyakha village and the Khasrio Cape, only few reindeer herders catch the Arctic cisco in July-November in the coastal zone and in river mouths, for personal consumption.

Fishing for sturgeon in the Ob-Irtysh catchment is prohibited all over the region, since this species is listed in the Red Data Book of Russia. However, it is still caught by poachers. It is a valuable protected species whose number has dramatically reduced and continues declining. This fish can be found in the coastal waters of the Ob Estuary near the hydraulic structures of the Project being constructed. The longest migrations of this species were noted in the Ob and the Irtysh Rivers.

Location of the main fishing grounds used by local communities are shown in Figure 7.6.76.

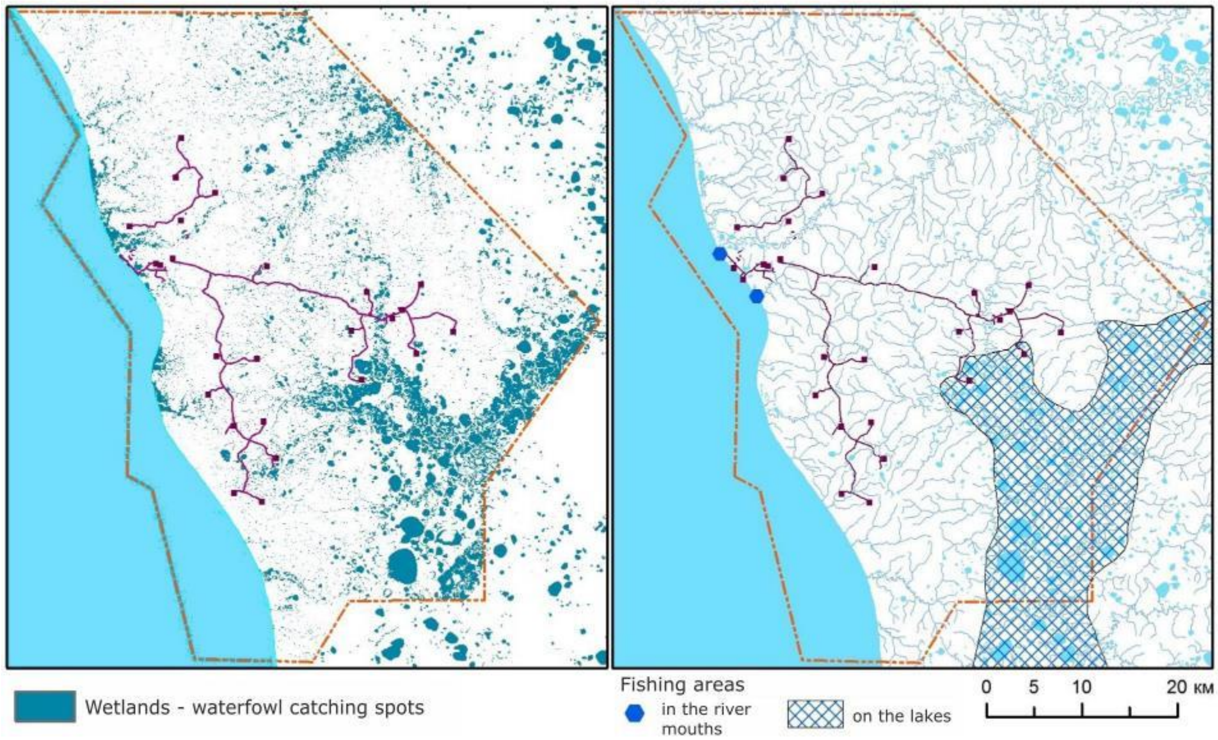


Figure 7.6.76: Seasonal hunting areas used by local communities (waterfowl hunting) - wetlands (left) and traditional fishing grounds (right) within the Salmanovskiy (Utrenniy) LA

Prepared by the Consultant

<u>Edible plants</u>

Constantly increasing level of human-induced impact on the populations of resource plant species leads to the need for rational sustainable use of resources of wild medicinal plants, berries and mushrooms, based on the materials on their yield, the laws of their territorial and temporal distribution, and reserves. The bioresource potential of the studied territory includes wild berries, mushrooms, and medicinal plants.

The main edible berry in the LA is cloudberry. Suitable areas for its picking for preservation are extremely limited (Figure 7.6.77) and occupy only about 3.4% of the LA territory.

According to interview data, cloudberry is the only berry that local people pick. No data is available on cloudberry productivity on the Gydan Peninsula. It is noted (Yamal Peninsula. Vegetation ..., 2006) that the yield of cloudberry in highland tundras of the Polar Urals is 0.54 t/ha, and in the tundras of the southern Yamal (Purovsk District) - 0.03-0.25 t/ha.

In yielding years, mushrooms can be found on 30-50% of the area of terrestrial ecosystems in the LA. Over a short vegetation season, the yield of mushrooms in the dwarf birch tundra does not exceed 8.5 kg/ha on average. In YNAO, the yield of mushrooms can reach 60 kg/ha and more.

<u>Hunting</u>

The main hunting resources on the territory of the Yamal-Nenets Autonomous District are the following species: hare, ermine, Arctic fox, wolverine, wetland (waders) and waterfowl (ducks, geese) game. The places of animals concentration (especially during spring and autumn migrations of birds) include the lakes of the lake-bog complex and floodplain lakes, and, to a lesser extent, the beds of large and medium rivers in their middle reaches (Figure 7.6.76).

Fishing for fur species is currently in decline due to lack of demand. Residents of the Gydan Peninsula have always hunted and still do for the purpose of traditional life support (mainly for meat). For local residents, hunting is mainly a hobby.

Nowadays, the key objects of hunting are polar fox and fowl. The main methods of polar fox hunting are trapping or occasional shooting. Annual prey is insignificant - 3-10 animals per hunter. Current value of a polar fox pelt is about 1000 rubles. Nenets people try to sell pelts where possible, however most of this material is used for making national clothes (fur hats, collars, etc.) for own use.

Traditional season for water fowl hunting (geeze, ducks) is the spring migration period. Success of this activity is always dependent on occasional circumstances. A common prey nowadays is 5-20 large birds and several dozens of ducks during a spring season.

Partridge and hare hunting is often practiced in February-April using traps and snares, as well as gun shooting.

Fresh water

Fresh water resources are used by the local population for their own needs and for reindeer herding.

Genetic resources

Many species of plants growing in the license area are forage. Lichens, mainly belonging to Cladonia, Cladina and Cetraria genera, are an important part of forage for domesticated reindeer.

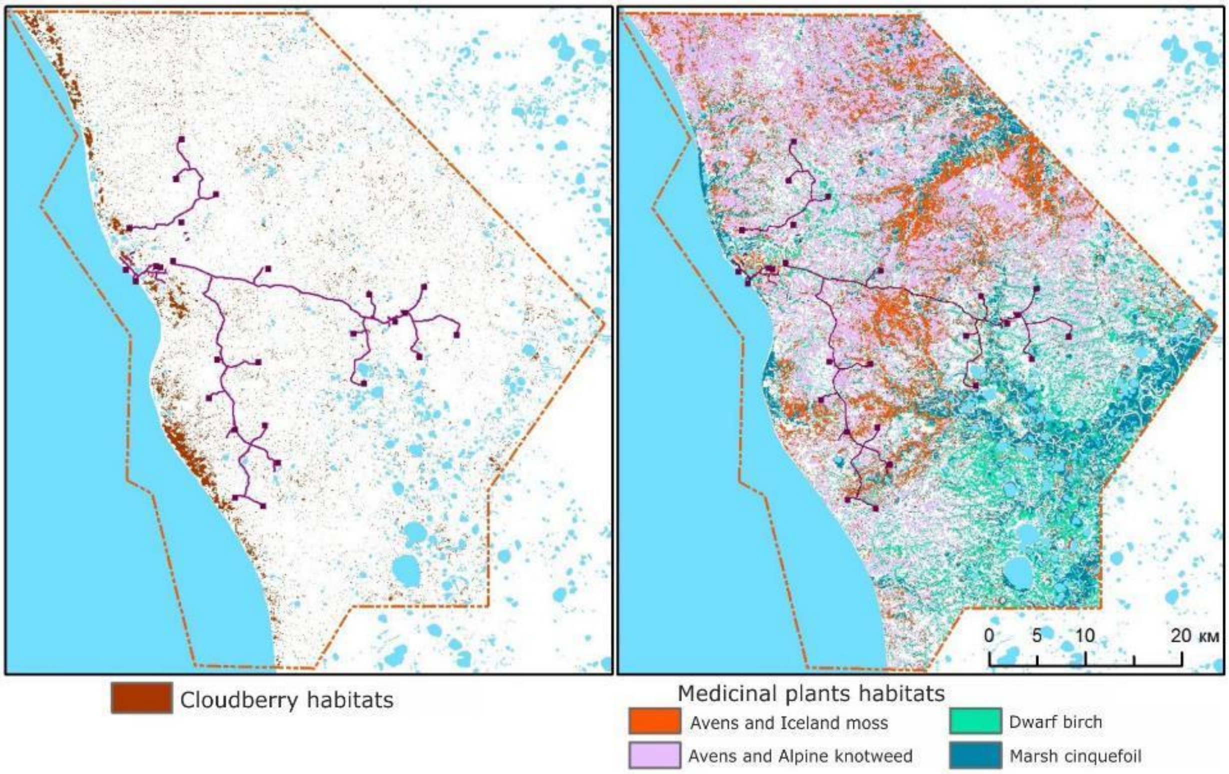


Figure 7.6.77: Cloudberry areas

sphagnum peat bogs, mainly on the 1st marine terrace and in river valleys (left); medicinal plant areas (right). Prepared by the Consultant

Medicines of natural origin

More than 10 species of medicinal plants grow on the territory of the Planned activity. Plants available for stocking: Iceland moss (*Cetraria islandica*), purple marshlocks (*Comarum palustre*), pointed avens (*Dryas punctata*), alpine bistort (*Bistorta vivipara*), dwarf birch (*Betula nana*).

7.6.5.2 Regulating services

Air quality regulation

Ecosystems take part in regulating the gas composition of the atmosphere by maintaining the balance of carbon dioxide and oxygen, and ozone which protects the Earth against hazardous ultraviolet radiation. Air quality is determined by the indicators of chemical inputs and content in the atmosphere (including those from emission sources), as well as their absorption. Degradation of plant communities, disturbance of the existing vegetation cover and its composition may affect their regulatory function.

Climate regulation

The problem of greenhouse gases or aerosols entering the atmosphere and their impact on local and global climate is well known. Marine and terrestrial ecosystems play an important regulatory role in their absorption from the atmosphere. In particular, this applies to carbon-containing compounds. A short vegetation season and cold climate limit the capacity of the Arctic plant communities to absorb carbon; on the other hand, cold climate also slows down the decomposition process. Permafrost formations contain significant quantities of methane, and rapid thawing of frozen rocks can result in its release into the atmosphere.

Tundra is particularly important as a carbon-intensive ecosystem with a high capability for carbon accumulation and long-term retention. With the tundra area being about 280 million hectares (16% of the country's territory), their total reserve is estimated at 28.6 Gt C. Noticeable carbon flow is characteristic of bogs, where the peat bogs generally deposit 210 Mt of carbon per year, at the rate of carbon deposition being 1.5 t C/ha per year.

Water regulation and protection

The ecosystems located in the Project area take part in providing the water runoff volume and its regulation, and in reducing the intensity of and damage from floods. Natural ecosystems influence the water quality, being a "biogeochemical barrier" to the water migration of pollutants, and contributing in water purification in natural water bodies (including through self-purification and dilution of water).

Erosion processes regulation

The integrity of ecosystems and, in particular, the vegetation cover, can influence the soil erosion processes, providing better protection of soils and sedimentary rocks. Arctic systems are exposed to specific erosion processes associated with cryogenic phenomena.

Pollination

Many species of insects, birds and mammals take part in flowering plants pollination; they also carry spores and seeds, which is important for wild plants reproduction. Since there is no crop farming in the region, the role of this service for the population is not as significant as in the southern regions. At the same time, decreased pollination may have a negative impact on the use of wild edible and medicinal plants, as well as on the stocks of some plant species consumed by reindeer.

Prevention and mitigation of natural disasters

Ecosystem integrity plays an important role in reducing the intensity and impacts of catastrophic events such as floods, devastating storms and landslides.

7.6.5.3 Cultural services

Sanctities and spiritual heritage monuments

Two cultural heritage sites have been discovered as a result of archaeological studies in the area of the Salmanovskoye (Utrenneye) OGCF, near Khaltsyneysalya Cape, eastern shore of the Ob Estuary - medieval settlement sites Khaltsyneysalya-1 and Khaltsyneysalya-2. The former site which is located within the designed site of the PLANT onshore facilities was the subject of an urgent archaeological research the output of which formed the basis for the decision to remove the site from the list of heritage. For Khaltsyneysalya 2 site which is not exposed to immediate impact of the Project, boundaries of the restricted use territory have been identified and registered in the cadastre.

No heritage sites were identified in other parts of the Salmanovskoye (Utrenneye) field. Results of the survey also indicate potential presence of other historical artefacts or objects.

Ethnographic survey in 2015 also identified sacred sites and burial sites of indigenous population in the territory of the Salmanovskoye (Utrenneye) field. As a rule, sacred sites of Nenets people are located at elevated places and include piles of antlers (normally with a wooden stake in the centre pointing to sun), skulls and bones of reindeer and other animals, and other things.

Recreational significance

The Project area does not have any potential recreational significance, and it is not planned to develop tourism business in this area. On the other hand, construction of multiple structures and infrastructure, such as access roads, berth structures, airport and helicopter pads, may in a longer term enhance the tourism potential of the territories and water areas affected by the Project.

Aesthetical value

Ecosystems are important for educational purposes, as a source of aesthetic pleasure and artistic inspiration. The Project area does not have any aesthetic advantages compared to other natural habitats of the Gydan Peninsula. The aesthetic value of the Planned activity’s area of influence is expected to increase in proportion to the increased number of personnel of the Operator, contractors and other stakeholders visiting this territory.

7.6.6 Assessment of the level of knowledge of the components of biodiversity of the Project territory and water area

Biodiversity of the northern part of the Ob Estuary and north of the Gydan Peninsula remained poorly studied for a long time (refer to Section 7.1 for more details). Studies for the Arctic LNG 2 and Yamal LNG projects provided new information about biota of the Ob Estuary, its spatial differentiation patterns and resilience to anthropogenic impact. At the level of entire Gydan Peninsula, biota studies have been local and selective, and information about the wildlife of the Project area is provided by the data array which has been accumulated since 2012, based on the results of engineering and environmental surveys and environmental monitoring. Compilation of all available information allows an estimate of the level of knowledge of biodiversity and identification of gaps in the available data.

The table below (Table 7.6.25) presents evaluation of the level of knowledge of the biodiversity of the Ob Estuary and terrestrial ecosystems of the Salmanovskiy (Utrenniy) LA and justifies the need for further special studies in the framework of monitoring. The level of knowledge is given on an arbitrary scale, where the Low level corresponds to absence of data for the region as a whole; the range from Low to Medium is where only qualitative data is available and quantitative data is lacking; Medium is the level where both qualitative and quantitative data are available, however, long-term observation series are deficient; High level is a hardly attainable. level, due to the long-term dynamics of biodiversity, the level of knowledge incidental to biological research divisions of universities and academic institutions.

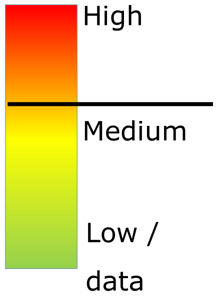
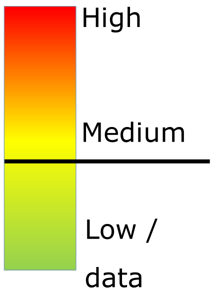
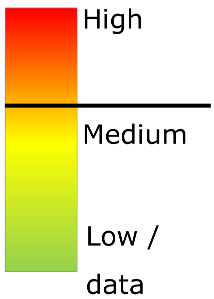
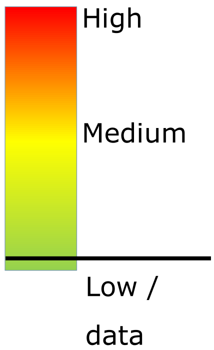
The purpose of additional studies is the implementation of an adaptive system for monitoring biological diversity, as well as taking measures to reduce risks to biological diversity. It is advisable to carry out additional studies in the area affected by the Project impact, it is indicated in section 9.5.

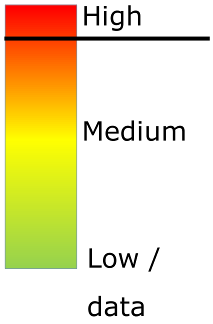
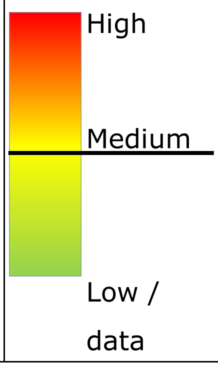
Consolidated recommendations for monitoring, including special studies, are discussed in Section 9.5.10.

Table 7.6.25: Knowledge of biodiversity in the Project area and need for further detailed studies

Biodiversity component	Baseline	Further research	Data deficiency assessment)
Ecosystems of the Ob Estuary			
Bacterioplankton	1. Information on bacteria abundance and biomass 2. Information on differentiation of communities, patterns of relationship with the parameters of the water area	No special studies are required	High Medium Low / data
Phytoplankton	1. Information on taxonomic composition, abundance, biomass 2. Information on differentiation of communities, patterns of relationship with the parameters of the water area	No special studies are required	High Medium Low / data

Biodiversity component	Baseline	Further research	Data deficiency assessment)
Zooplankton	1. Information on taxonomic composition, abundance, biomass 2. Information on differentiation of communities, patterns of relationship with the parameters of the water area	No special studies are required	High Medium Low / data
Zoobenthos	1. Information on taxonomic composition, abundance, biomass 2. Information on differentiation of communities, patterns of relationship with the parameters of the water area	No special studies are required	High Medium Low / data
Ichthyofauna	1. Information on taxonomic composition, abundance, biomass 2. Information on differentiation of communities, patterns of relationship with the parameters of the water area 3. Information on the interannual dynamics based onpublished and historical data, monitoring catches during the ice period are sporadic	No special studies are required	High Medium Low / data
Seabirds	1. Information about the species composition with the status of presence 2. Data on the abundance in late summer	No special studies are required	High Medium Low / data
Marine mammals	1. List of species 2. Information on the number based on observations from vessels and shore 3. Information on the number of seals and bearded seals based on aerial surveys	1. Investigate the status of the seal population of the Ob Estuary on the basis of molecular genetic studies 2. Study the migration of seals in the Ob Estuary using satellite telemetry methods 3. Identify toxicological and virological status	High Medium Low / data

Biodiversity component	Baseline	Further research	Data deficiency assessment)
Components of ecosystems of the Gydan Peninsula			
Vegetation cover	1. General information about the structure, diversity of community types 2. Vegetation map for the entire LA based on survey and monitoring data 3. List of vascular plants, including data on the growth of rare species 4. Information about the dynamics of coastal vegetation, the rate of vegetation restoration	1. Compile annotated lists of mosses, lichens and fungi through field surveys 2. Clarify the composition of vascular plants flora 3. Make a detailed map of vegetation based on field studies and ERS data 4. Clarify the distribution of rare plant species through in-depth field studies and modeling of habitat suitability 5. Conduct biomass research in the main types of plant communities	
Bird fauna	1. List of birds with data on the status of their presence in the LA 2. Information on the distribution of birds by biotopes 3. Facts of the presence of rare species without data on their nesting sites in the LA 4. General information about the places of stops and transit routes during the autumn migration 5. Abundant data on the species composition and number of migratory birds in autumn	1. Conduct research on the number of nests in different types of biotopes 2. Identify areas of nesting and molting concentrations of waterfowl 3. Study bird fauna on the spring migration 4. Determine nesting grounds and other important stations (forage, molting) of rare and protected species through a detailed study of suitable habitats 5. Determine the routes and directions of bird migration according to satellite telemetry and ringing data	
Teriofauna	1. List of species of mammals - registered and areographically expected 2. General data on the abundance of small mammals based on short-term capturing	1. Study the abundance of small mammals important for the functioning of Arctic ecosystems in different types of biotopes 2. Assess suitability of habitats on the Gydan Peninsula for wild reindeer	
Terrestrial invertebrates	1. Information about the fauna according to the data of hydrobiological studies (larvae living in waterbodies). The nearest survey areas are on the Yamal Peninsula	1. Study of soil mesofauna in different types of habitats 2. Make an annotated list of terrestrial arthropod fauna through field research	

Biodiversity component	Baseline	Further research	Data deficiency assessment)
Fresh-water ecosystems	1. Information about species composition, abundance and biomass of plankton and benthos of the main waterbodies and streams based on long-term observations 2. List of fish species present in waterbodies and watercourses	1. Ichthyological studies in the watercourses in the east of the LA (basin of the Gydan Estuary)	
Ecosystem services	1. General information on ecosystem services in the area, prospective areas based on the results of surveys of local communities and expert assessment in the absence of quantitative assessments	1. Assessment of reindeer capacity of pastures based on the results of field studies (including data on biomass), extrapolation using ERS data 2. Drawing up maps of ecological and economic value of types of reindeer pastures 3. Assessment of economically valuable plant resources (medicinal and food)	

7.6.7 Summary

1. The terrestrial ecosystems within the Salmanovskiy (Utrenniy) License Area of influence are represented by natural and locally transformed habitats. Forb dwarf-shrub moss, sedge and cottongrass moss tundras typical of the northern Hypo-Arctic tundra sub-zone of the Gydan Peninsula are common in the license area. Flora within the license area is poor. By species composition, it is similar to other floras of the northern Hypo-Arctic tundra sub-zone of the Yamal-Gydan region. Arctic and Arctalpine species play the most important role (48%) in the structure of flora, while the contribution of boreal species is the smallest. All flora species are native, no biological invasions are reported so far.

Over 20 plant species listed in the main pages of the Red Data Book of YNAO (2010) may be present within the Salmanovskiy (Utrenniy) license area. Based on the results of the focussed search for rare species in September 2020, 29 locations of valerium (*Polemonium boreale)* were identified (of which 25 are new), 9 localities of Vogul brome *Bromopsisvogulica*, 10 of tundra woodrush (*Luzula undricola),* 2 of tufted saxifrage (*Saxifraga cespitosa , 2 of Thymus reverdattoanus*. All these species are listed in the Red Data Book of YNAO under Category 3 - "rare species". At present, many of the identified populations are not exposed to negative impact of construction. . Within the framework of environmental monitoring, a number of local manifestations of exogenous processes have been established, in the development zones of which degradation of plant communities is observed. Based on the monitoring results, it is planned to take measures aimed at preventing the further development of exogenous processes, reclaiming the vegetation cover and monitoring the results of the measures taken.

Within the studied area, rare communities with limited range, relying on specific rare environmental conditions, are subshrub-moss tundra on perennial frost heave mounds, as well as sparse forb/grass meadows on the sandy seashore cliffs. These rare plant communities develop in a narrow range of environmental conditions, occupy extremely small territories and contain rare and protected species of plants listed in the Red Data Book of YNAO (2010). These plant communities develop in unstable habitats and are subject to environmental monitoring.

The terrestrial vertebrates fauna in the Project area is generally typical of the tundra zone. During the surveys, representative of three vertebrate species listed in the Red Data Books of the Russian Federation (2000) and Yamal-Nenets Autonomous Okrug (2010) have been encountered in the territory of the Salmanovskiy (Utrenniy) LA: Bewick's swan (*Cygnus bewickii*), peregrine (*Falco peregrinus*), snowy owl (*Nyctea scandiaca*). Apparently, these birds use the territory of the Salmanovskiy (Utrenniy) LA for nesting.

2. Marine ecosystems of the Ob Estuary. Due to the significant contribution of the Ob River runoff in the water balance of the Arctic Ocean and its proximity to the lower reaches of habitats and migration routes of a large number of rare and endangered animal species, the entire Ob Estuary is included in the list of *Ecologically or Biologically Significant Marine Areas, EBSA*) according to the Convention on Biological Diversity (Rio de Janeiro, 1992).It is also one of the most important fishing regions of Russia with the largest and most productive population of whitefish (muksun, chester, omul, etc.) and the habitat of the "Red Data Book" Siberian sturgeon.

This vast water area is characterized by pronounced heterogeneity of environmental conditions, composition and abundance of hydrobiont communities of all considered ecological groups. Based on the results of perennial research and monitoring of aquatic biological resources within this water area, the places most important for the development and reproduction of fish resources, including rare and protected species of the Ob catchment, have been identified. The closest of these to the Project area is a potential fishery conservation zone in 150 km upstream of the Ob River (i.e. southwards, Figure 7.6.74).

Engineering surveys in the Project water area conducted in 2012-2019 identified presence of three species of marine mammals widespread in the Arctic (bearded seal, ringed seal and white whale), and from 3 to 11 species of fish (of 55 species typical of the Kara Sea as a whole). The surveys showed a predominantly low density and uneven distribution of ichthyofauna across the water areas, with the migratory Arctic omul *Coregonus autumnalis,* semi-migratory Asian smelt *Osmerus mordax dentex* and Siberian vendas *Coregonus sardinella*, the bottom four-horned sculpin *Triglopsis quodricornis* dominating the catches. Less frequent were northern navaga, lamprey, Siberian whitefish, peled, broad whitefish, humpback salmon, and roach.

It has been found that the water area that will be affected by the the construction and operation of the Arctic LNG 2 Project has no relation to the biotopes preferred by the species listed above, i.e. places of permanent habitats, feeding and breeding of mammals, spawning or wintering of fish. The Ob Estuary water area affected by the Planned activity is of low importance for marine mammals and fish fauna of the Kara Sea, and its partial loss as a habitat due to the construction and operation of the offshore structures will not have any impact on the condition of populations of these hydrobionts.

The mouths of the Khaltsyney-Yakha and Nyaday-Pynche rivers are recognized as the nearest to the boundary of the Planned activity zones of seasonally increased density of ichthyofauna and fisheries. The former may be subject to the greatest impacts, since it is located 110 m north-west of the PORT within its sanitary protection zone[361]. The latter is 1350 m south-east of the GBS LNG & SGC Plant and therefore is considered less threatened. The Khaltsyney-Yakha river is exposed to the Project impacts related to construction of temporary road crossings, and the Nyaday-Pynche will be used as recipient for discharges of treated wastewater.These impacts will cause a local transformation of water circulation, lithodynamic and other processes in the river mouth areas and adjacent water area of the Ob Estuary.

Conclusion about absence of ecosystems that would meet the criteria of critical habitats are present within the territories and water areas affected by the Project is confirmed by the engineering surveys and environmental monitoring results over the period 2012-2019.

3. Ecosystem services. According to the terminology of the national standard GOST 17.8.1.02-88, the landscapes within the license area should be classified as agricultural and, locally, to industrial territories in terms of their social and economic functions. The agricultural landscapes generally correspond to natural habitat and are represented by reindeer pastures and associated lands, and the industrial landscapes are represented by the footprints of the existing, constructed and designed FIELD facilities. Following the same classification, the landscapes of the survey area should also be related to moderately continental, undifferentiated flatland, superaqual tundra landscapes, not immune to human-induced impacts and hardly varying due to anthropogenic activities. Their appearance depends on the season; in winter it is not contrast and generally does not differ from the Arctic deserts located in the north. When the snow cover disappears and the water bodies become free from ice, the appearance of the local landscape changes dramatically: the land is perceived as a combination of terrain and projective cover of its surface with mosses, lichens, to lesser extent grasses, and patches of shrubs, with pronounced alternation of phenological aspects. Moreover, due to the onshore location and high density of water bodies in the coastal area of the Gydan Peninsula, the studied landscape is characterized by a high aquatic aspect; the coastline is not indented,

[361] In the Khaltsyney-Yakha River valley, there will also be a few FIELD facilities, including the quarries for bulk construction materials production, excavated in the sink lakes; and water intake facilities.

but there is a wide tidal zone smoothly turning into a series of marine terraces with lake-bog complexes and river systems.

This type of coasts is not unique and is widely represented in the Russian Arctic region. In particular, in the Kara Sea basin, the total length of shallow accumulative lagoon-laida coasts is estimated at 470 km or 4.3% (The Kara Sea. Ecological Atlas. - M.: Arctic Research Center, 2016). The functions of these landscapes are generally limited to environmental and resource components. The main functions of the first component are soil (and permafrost) stabilization and water regulation, while in the second component, these are agricultural and fishery functions. The landscape and aesthetic role of this territory, on the contrary, is insignificant, since there is no permanent population and recreants due to mobility and low density of the nomadic population.

8. SOCIO-ECONOMIC BASELINE

8.1 Introduction

The Section provides information on the socio-economic background in Tazovskiy Municipal District and in the social area of influence of the Project. It has been sourced through various channels of both secondary and primary data. The Section discusses the following basic socio-economic aspects:

- Overview of the Project area;
- Local communities and the Project's social area of influence;
- Demography;
- Vulnerable groups;
- Key economic activities of local communities and in Tazovskiy District at large;
- Local labour market and employment;
- Land use;
- Indigenous population and traditional lifestyle;
- Tangible and intangible cultural heritage;
- Social infrastructure;
- Community morbidity rate; *and*
- Transport, housing and utility infrastructure.

Information on the background socio-economic characteristics of Tazovskiy District and Project's social area of influence was used to assess potential social impacts of the Project. The assessment results are given in Chapter 10. Information on stakeholder engagement (consultations, information disclosure, etc.) in relation to the Project is discussed in Chapter 4. Stakeholder engagement activities are described in more detail in the Stakeholder Engagement Plan which is a separate document.

8.1.1 Referenced sources

Information used for the Chapter was obtained from several sources to include data from the Federal State Statistics Service, legal and regulatory documents, reports of federal and local self-government authorities, scientific publications, and documents provided by the Client. Below are listed the key sources of information.

Sources at the federal and regional (YNAO) level:

- Statistical data available on the website of the Federal State Statistics Service (Rosstat);
- Draft Socio-Economic Development Strategy of Yamalo-Nenets Autonomous Okrug until 2030;
- Statistical data available on the website of the Federal State Statistics Service Department for Tyumen Region, Khanty-Mansi Autonomous Okrug-Ugra, and Yamalo-Nenets Autonomous Okrug (Tyumenstat);
- Results of the 2010 National Census;
- Comprehensive Regional Programme for Gas Supply of residential properties and utilities, industries and other organizations in Yamalo-Nenets Autonomous Okrug for the period 2017-2021;
- Report of the Federal Service for Supervision of Consumer Rights Protection and Human Welfare in YNAO (Rospotrebnadzor for YNAO): Assessment of impact of environmental factors on community health in Tazovskiy District on the basis of social and hygienic monitoring parameters, 2016; *and*
- Strategy for prevention of the spread of the disease caused by the human immunodeficiency virus in Yamalo-Nenets Autonomous Okrug until 2020.

Sources at the district and local level:

- Territorial Planning Scheme of Tazovskiy Municipal District, 2015;
- Passport of Settlements in Tazovskiy Municipal District, 2016;
- Socio-economic development forecast for Tazovskiy Municipal District for 2019-2021;
- Report on the socio-economic situation in Tazovskiy Municipal District for 2019;
- Draft Socio-Economic Development Strategy for YNAO until 2030;
- Tazovskiy District Investment Passport, 2019;
- Socio-economic development forecast for the Tazovskiy Municipal District for 2020-2022;
- Monitoring data on the socio-economic situation in the Tazovskiy Municipal District for 2016;
- Information provided by the Tazovskiy Municipal District Administration on request;
- Socio-economic development forecast for the Gyda Settlement Municipality for year 2020 and for the planning period 2021-2022;

- Report of the Head of the Tazovskiy Municipal District Administration on the achieved values for assessment of performance of local self-government authorities in Tazovskiy Municipal District for 2019 and the planned values for the period 2020-2022;
- Programme for comprehensive development of utility infrastructure systems of the Gyda Settlement Municipality for the period until 2023;
- Programme for comprehensive development of social infrastructure of the Gyda Settlement Municipality for 2016-2020 and for the period until 2025; *and*
- Act of the Antipayuta Settlement Administration No. 80 dated May 22, 2016 "On updating the water supply and sewerage scheme".

Other sources:

- 2018 ESHIA for the Complex (including information collected during consultations in 2018);
- Report on the Ethnographic Survey in Tazovskiy District of Tyumen Region in the territory of the Salmanovskoye (Utrenneye) Field, 2015;
- Findings of archaeological surveys conducted in 2015 and 2017;
- Information available on official websites of YNAO authorities, administrations of Tazovskiy Municipal District and rural residential localities;
- Information available on official websites of the Prosecution Office and Department of the Ministry of Internal Affairs (MIA) of YNAO; *and*
- Information available in public domain (in media, scientific publications, etc.), and other sources.
- Electoral passports of the settlements of Tazovskiy, Antipayuta and Gyda of 2018 (the passports are issued in July 2019).
- Information on socio-economic situation in Tazovskiy district received from Tazovskiy district administration in response to Ramboll's request.

References to the above and other sources of information are given in the text.

The obtained secondary data was supplemented and verified in the course of primary data collection through interviews with key stakeholders. Stakeholder meetings, during which the information used in this report was collected, are listed below (Table 8.1).

Table 8.1: Meetings with stakeholders for primary data collection

Stakeholder	Date	Topics of consultations
Tazovskiy Municipal District Administration	April 2 2018	Key socio-economic parameters of Tazovskiy Municipal District, Gyda, and Antipayuta. Key socio-economic characteristics of nomadic communities
Tazovskiy Municipal District Central Hospital	April 2 2018	State of healthcare infrastructure in Tazovskiy Municipal District, Gyda, and Antipayuta. Community morbidity rates. Special arrangements for provision of medical services to nomadic indigenous communities
Antipayutinskiy State Farm	April 12 2018	Main parameters of the entity. Information on reindeer herding and fishing activities
Administration of s. Antipayuta	April 12 2018	Key socio-economic characteristics of Antipayuta.
Antipayuta Community Hospital	April 12 2018	State of healthcare infrastructure in Antipayuta. Community morbidity rates. Specific arrangements for provision of medical services to nomadic indigenous communities migrating in the area of Antipayuta Tundra[362]
Administration of s. Gyda	April 17 2018	Key socio-economic characteristics of Gyda, Yuribey, Tadebya-Yakha, and Mangty-Yakha
Gyda Boarding School	April 17 2018	Main characteristics of school education in Gyda. Special features of education services for indigenous communities
GydaAgro / Gyda Consumer Association	April 18 2018	Main characteristics of the entities. Information on fishery operations and activities of the Consumer Association
Gyda kindergarten	April 18 2018	Main characteristics of pre-school education in Gyda and Yuribey. Special features of pre-school education services for indigenous communities
Gyda Community Hospital	April 19 2018	State of healthcare infrastructure in Gyda. Community morbidity rates. Specific arrangements for provision of medical services to nomadic indigenous communities migrating in the area of Gyda Tundra.

[362] "Antipayuta Tundra" and "Gyda Tundra" have not been recognised as official terms so far. However, these are used to describe vast areas within Tazovskiy District adjoining s. Antipayuta or s. Gyda.

A full list of the consultations conducted during the ESHIA process is provided in the Stakeholder Engagement Plan.

Information on indigenous communities within the Salmanovskiy (Utrenniy) LA is mainly based on findings of the Ethnographic Survey conducted by Purgeocom LLC in 2015. This information has been verified and updated through consultations with representatives of indigenous communities migrating within the Salmanovskiy (Utrenniy) LA, and with other stakeholders.

In particular, in the course of the 2018 ESHIA for the Complex, five representatives of ISPN communities that migrate in the area of the Salmanovskiy (Utrenniy) LA were interviewed. During one interview, members of three other ISPN families migrating within the license area were also present and confirmed validity of the information provided by the interviewee. The collected information on nomadic communities within the Salmanovskiy (Utrenniy) LA was further verified in the interview with a representative of the Gyda boarding school which annually collects its pupils from nomadic families for schooling. Information on the migration route of reindeer of the Antipayutinskiy State Farm within the Salmanovskiy (Utrenniy) LA was provided directly by representatives of the State Farm. Members of three ISPN families migrating within the Salmanovskiy (Utrenniy) LA were also interviewed during Stage 2 consultations on preliminary findings of the ESHIA for the Complex.

Also, consultations with indigenous communities in the framework of the 2018 ESHIA for the Complex were conducted on the Reindeer Herder's Day[363] in Tazovskiy, Antipayuta and Gyda in March-April 2018. Further consultations with ISPN representatives were timed to coincide with Fisherman's Day celebrations[364] in Yuribey and Gyda in July 2018 (for details refer to Chapter 4 or SEP).

This information was further verified within the ESHIA for the Arctic LNG 2 Project (2020) through the data requests to Tazovskiy Municipal District, Antipayutinskiy State Farm, Agricultural Enterprise GydaAgro LLC and Association 'Yamal-Potomkam!'.

8.1.2 Limitations in preparation of the Report

At the time of the report preparation, a visit to Tazovsky for meetings and interviews with representatives of the Tazovskiy district administration, non-governmental organizations and agricultural organizations was impossible due to the spread of coronavirus infection SARS-CoV-2. The necessary information was requested remotely; as of early June 2020, data on most of the issues indicated in the information request were provided. If additional information is received from stakeholders during the ESHIA disclosure period, the assessment may be supplemented.

8.2 Project Area Overview

Tazovskiy Municipal District where the Project will be implemented is one of the seven districts of Yamalo-Nenets Autonomous Okrug (YNAO). YNAO is part of Ural Federal District. It occupies a vast area of over 750 thousand sq. km in the Arctic zone and more than half of its territory is located beyond the Polar Circle. Its northern boundary washed by the Kara Sea waters is part of the state border of the Russian Federation[365]. In total, more than half a million people (544 thousand) live in YNAO, as of year 2020, of which 8% are indigenous[366].

The fuel and power sector is the core of the YNAO economy. The region is a major supplier of crude hydrocarbons both in Russia and in East and West European markets. YNAO accounts for over 80% of Russia's annual gas production, or one fifth of the global gas output. The YNAO contribution to oil and gas condensate production is 8% of the country's total[367]. Reindeer population in YNAO is about 790 thousand which is the largest in Russia and globally[368]. Reindeer herding is the main economic activity of the indigenous community of YNAO. Fishery is another important occupation in the Okrug.

---

363 Reindeer Herder's Day is the main festivity of nomadic communities when they gather in permanent settlements. The scope and time for the meetings were defined in close liaison with the Tazovskiy Municipal District Administration, Tazovskiy branch of ISPN Association "Yamal - potomkam!". and local Charity Foundation for Development of Indigenous Small-numbered Peoples of the North.

364 Fisherman's Day is the second important holiday (after the Reindeer Herder's Day) for indigenous communities and its celebrations attract multiple representatives of ISPN.

365 Refer to the official website of YNAO authorities: http://правительство.янао.рф/region/geography/.

366 Of the YNAO population total: Nenets – 5.7%, Khanty – 1.8%, Selkup – 0.4%. According to Socio-Economic Development Strategy of YNAO till 2020.

367 According to Socio-Economic Development Strategy of Yamalo-Nenets Autonomous Okrug till 2020.

368 According to Socio-Economic Development Strategy of YNAO till 2020.

YNAO consists of 7 districts and 6 cities of regional significance, including Salekhard, the Okrug administrative centre. Tazovskiy Municipal District is located in the north of YNAO, on the western shore of the Gydan Peninsula (Figure 8.1).

Figure 8.1: Tazovskiy Municipal District in the structure of YNAO

As noted in Chapter 1, Tazovskiy received an official status of a municipal district in April 2020[369]. It is composed of Tazovskiy township (administrative centre of the District), 4 settlements (Gaz-Sale, Nakhodka, Antipayuta, and Gyda), and 4 villages (Yuribey, Tadebya-Yakha, Matiuy-Sale, and Tibey-Sale).

The core economic activity in Tazovskiy Municipal District is development of oil and gas fields. The District is a place of residence of indigenous small-numbered peoples of the North. Nenets people account for more than half of the District population and are actively engaged in reindeer herding and other customary occupations.

The Salmanovskoye (Utrenneye) OGCF is located beyond the Polar Circle. Local weather conditions are severe for living: a sharp continental climate with long winters and relatively short and cool summers. The OGCF area is virgin tundra with rolling plains, small rivers and multiple tributary streams, and a great number of lakes.[370]

8.3 Local Communities and Social Area of Influence of the Project

8.3.1 Local communities

Information on settlements and other facilities of social significance located nearest to the Salmanovskiy (Utrenniy) license area (LA), and in the District administrative centre – township Tazovskiy – is provided below (Table 8.2).

[369] YNAO Law No. 39-ZAO dated 23.04.2020. The full name of the municipality is Tazovskiy Municipal District of Yamalo-Nenets Autonomous Okrug, the abbreviated – Tazovskiy Municipal District.

[370] Salmanovskoye OGCF Facilities Setup. Main technical solutions. Part 1. General data. Ranking and selection of infrastructure development options. Vol. l. 77.17.016.1-OTP1. Yuzniigiprogas Institute LLC, 2018.

Table 8.2: Settlements and other facilities of social significance located nearest to the Salmanovskiy (Utrenniy) LA and in the District administrative centre. Tazovskiy twp

Settlement / social facility	Approximate distance to the LNG and SGC Complex, km	Approximate distance to the boundary of the Salmanovskiy (Utrenniy) LA	Population number, capita*)	Approximate share of ISPN, %[371]
s. Gyda	170	120	3,747	98.5%
s. Antipayuta	240	200	2,768	94%
v. Yuribey	115	65	56/165**	100%
v. Tadebya-Yakha	70	40	36/57	100%
twp. Tazovskiy	430	390	7,209	35.3%

* Information on ISPN numbers and their share in total population is provided in the Demography subsection below.

** Population numbers for Yuribey and Tadebya-Yakha include both permanent residents of the villages and nomadic communities migrating in the vicinity (permanent/nomadic).

Relatively large settlements located nearest to the designed Complex and the Salmanovskiy (Utrenniy) LA are Gyda and Antipayuta.

As of 1st of January 2020, The population number of these two settlements reported by Tazovskiy district administration is 3,747 and 2,768, respectively, of which indigenous population accounts for more than 80-90%; however, these figures include both permanent residents and nomadic people migrating over vast areas of Gyda and Antipayuta Tundra. Only about 1,000 people, by data of 2018, permanently live in Gyda (Figure 8.2), i.e. 25-30% of the reported number. In Antipayuta (Figure 8.3), this number is about 1,500, i.e. almost 60%.

Indigenous people make up over 95% of the population in the two settlements.

Figure 8.2: General view of s. Gyda and residential houses

Social infrastructure in each of the settlements includes a school, a kindergarten, an outpatient clinic and a small community hospital, as well as a club and a library. There is a relatively large fishing enterprise in Gyda – GydaAgro, and a large reindeer herding enterprise in Antipayuta – Antipayutinskiy State Farm whose operations include fishing.

Figure 8.3: General view of s. Antipayuta and residential houses

Also, in the vicinity of the OGCF there are two villages – Yuribey and Tadebya-Yakha. Yuribey is located on the bank of the eponymous river, 115 km from the designed Complex and some 65 km from the boundary of the Salmanovskiy (Utrenniy) LA (Figure 8.4). The number of permanent residents of Yuribey reported in

[371] By data of Passport of Settlements in Tazovskiy Municipal District, 2016.

2020 is 56 and 165 more migrate in the surrounding area. According information received during the interviews with the Head of the Gyda Administration and confirmed in 2020, all residents of the settlement and surroundings are representatives of indigenous peoples. The residents of the settlement live in houses, "huts"[372], and chums (Figure 8.5).

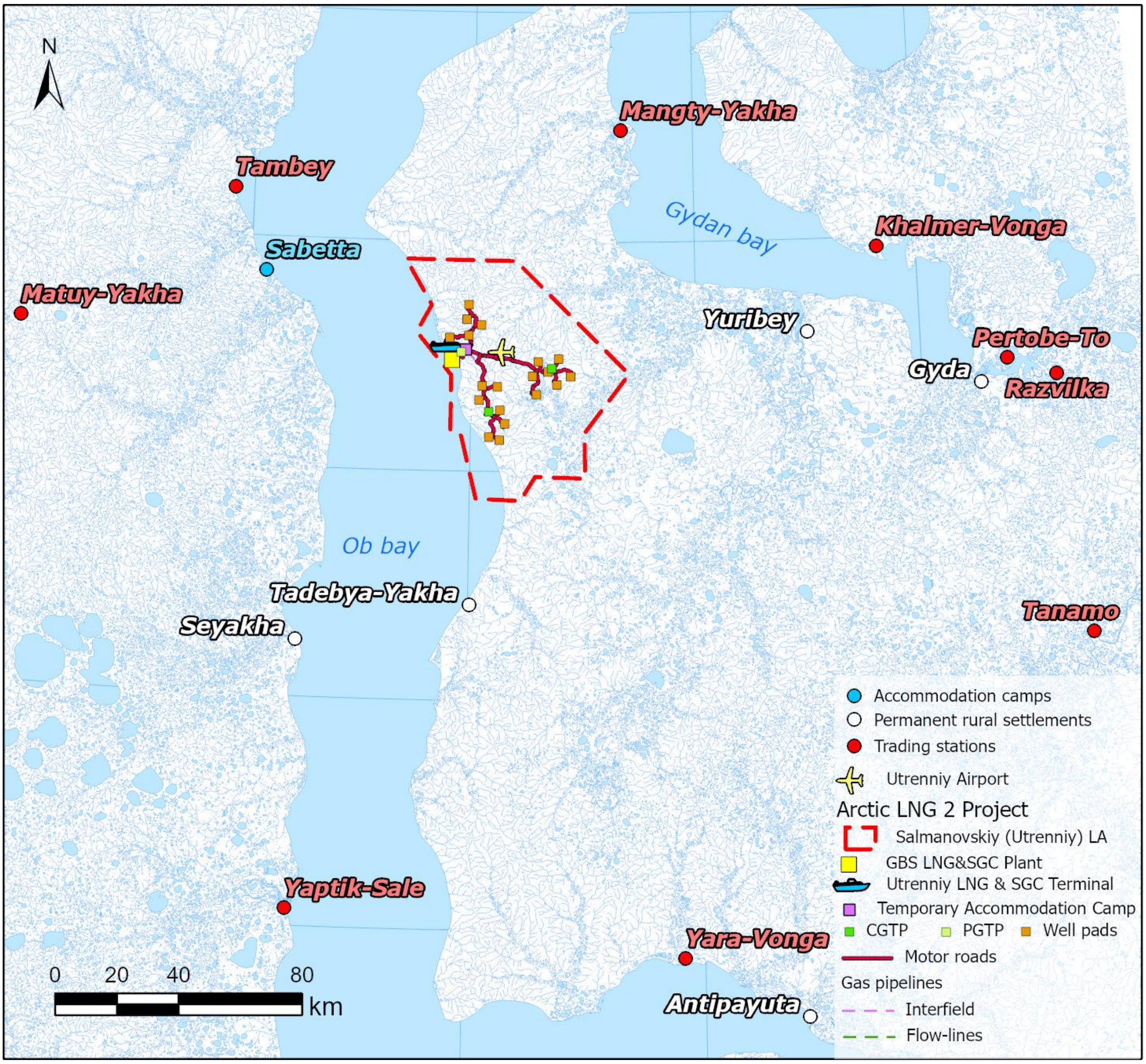


Figure 8.4: Settlements and other facilities of social significance located nearest to the Complex and the Salmanovskiy (Utrenniy) LA

There is a fishing depot of GydaAgro in Yuribey that provides employment for indigenous people, as well as a small shop and premises adapted for an outpatient clinic. A so called "nomadic group" of the Gyda kindergarten functions in the village.

[372] "Hut" is a "barrel", cabin or a shack, or the like, equipped for temporary residence (Figure 8.5).

Figure 8.5: Accommodation huts in Yuribey

Tadebya-Yakha village is located on the shore of the Ob Bay, at about 70 km south of the designed LNG & SGC Complex and at about 40 km from the boundary of the Salmanovskiy (Utrenniy) LA. Back in Soviet times, the village was used as a base camp for geological parties that could house up to 2,000 people. The camp was closed more than 20 years ago and most of the facilities were abandoned (Figure 8.6). At present, the village has 36 permanent residents and 57 more migrate in the vicinity. Like in Yuribey, all residents are indigenous people. The main economic activity of indigenous people in Tadebya-Yakha is fishing. The village is also used as a base camp by survey companies engaged in exploration of oil and gas deposits. A local subsidiary of Yamal Airlines (a fuel station) with 1 or 2 persons on the staff functions in the village. There is also a small shop in Tadebya-Yakha.

Figure 8.6: Abandoned facilities in Tadebya-Yakha[373]

According to administrations of Gyda and Tazovskiy Municipal District, there are plans to change the status of Yuribey and Tadebya-Yakha from a "village" to a "trading station". As of 2020, the status of the villages remained unchanged.

Some 15 trading stations are currently operational in Tazovskiy Municipal District. They function as market places where people from remote tundra can sell or exchange their products, buy goods or materials they need, etc. Also, trading stations play an important role both in internal relations of indigenous people and in their communication with the external world. They serve as a meeting point for indigenous people, for information sharing and dissemination, etc. The nearest trading stations in the vicinity of the designed Complex and the Salmanovskiy (Utrenniy) LA are Mangty-Yakha and Yara-Vonga. The former is located at the mouth of the Mangty-Yakha River, on the shore of the Gydan Bay, at about 90 km north of the designed Complex or 55 km from the boundary of the Salmanovskiy (Utrenniy) LA. The second trading station, Yara-Vonga, is situated relatively close to Antipayuta, at about 200 km south of the designed Complex or about 170 km from the boundary of the Salmanovskiy (Utrenniy) LA. Both trading stations are reported by administrations of Gyda and Antipayuta as non-functional. Nomadic communities buy goods in Gyda, Antipayuta, Yuribey, Tadebya-Yakha, and at the Tanamo trading station. The latter is located far away from the designed Complex and the Salmanovskiy (Utrenniy) LA (about 225 km and 180 km, respectively).

The administrative centre of the District Tazovskiy twp. with 7,209 residents by Rosstat data for 2019, is situated at a significant distance (more than 400 km) from the Project.

[373] The picture is sourced from public domain: http://n69p.ru/2012god/otchet-o-1-etape/item/137-полярст-тадебяяха-21082012г-обская-губа.

Indigenous communities also use the territory of the Salmanovskiy (Utrenniy) LA. Main economic activities of ISPN are reindeer herding, fishing, hunting and wild crop harvesting. Detailed information on the ISPN communities and their activities is provided below in Section 8.9.

8.3.2 Social area of influence of the Project

The social area of influence encompasses territories and communities which may be affected either by beneficial or by adverse impacts of the planned activity.

In view of special nature of social impacts and of the fact that geographic boundaries of the social area of their influence may be different from the area of influence on natural environment, the social area of influence is defined separately. A tentative social area of influence of the Project determined at the ESHIA Scoping Stage was adjusted in the course of socio-economic studies and stakeholder consultations. The social area of influence of the Project includes the following recipients potentially exposed to direct and indirect impacts of the planned activity:

Recipients potentially exposed to direct impacts

- Indigenous population migrating and practicing customary activities (reindeer herding, fishing, gathering, hunting, etc.) within the boundaries of construction sites of the Project and associated facilities;
- Agricultural enterprise Antipayutinskiy State Farm that can be a recipient both of positive and of negative impacts of the Project and associated facilities (refer to Chapter 10 of the ESHIA Report);
- Personnel of contractors employed for implementation of the planned activity.

Recipients potentially exposed to indirect impacts

- Gyda and Antipayuta (170 km and 240 km from the Complex, respectively). Relatively large settlements located nearest to the Complex, where indigenous people migrating in the territory of the Salmanovskiy (Utrenniy) LA are often registered, use medical services, come for shopping, etc.;
- Yuribey and Tadebya-Yakha (115 km and 70 km from the Complex, respectively). These small villages are also located relatively close to the Project, and here may also live indigenous nomadic people migrating within the Salmanovskiy (Utrenniy) LA. Additionally, nomads visit shops in the two villages and a medical and obstetric station (MOS) in Yuribey;
- Indigenous communities in Gyda Tundra and Antipayuta Tundra in general who hold on to customary lifestyle. The Project and associated facilities may entail a change in customary migration routes of reindeer herders within the Salmanovskiy (Utrenniy) LA. This may in turn affect economic activities of other indigenous communities in Gyda Tundra and, to a less extent, in Antipayuta Tundra;
- Agricultural Enterprise GydaAgro LLC. The planned activity may affect operations of the company, in case personnel of the Project and associated facilities unofficially buy products (fish) from employees of GydaAgro;
- Companies that run fishing operations in the Ob Bay and may be affected by the planned activity.

The social area of influence of the Project does not include:

- Yara-Vonga and Mangty-Yakha trading stations. According to the Territorial Planning Scheme of Tazovskiy Municipal District, the two trading stations are located close to the Salmanovskiy (Utrenniy) LA, however, information collected in the ESHIA process indicates that they are non-functional;
- Tanamo trading station. Apart from the fact that the trading station is sometimes used by indigenous nomadic communities migrating in the area of the Project and associated facilities (Tanamo facilities include houses and huts used as residences, a storage, a shop, a bakery, and a health post), Tanamo was excluded from the social area of influence of the Project due to its remote location; however, ISPN representatives who use the trading station are considered jointly with other indigenous communities of Gyda Tundra and Antipayuta Tundra at large (see above).

The composition of the Project’s social area of influence may be subject to revision as required during ongoing planned activities.

8.4 Demography

8.4.1 Natural demographic development and migration flows

The total number of population in Tazovskiy Municipal District reported in 2020 is 17,549[374] where more than a half is indigenous people (refer to below). Since the 2000-s, the demographic situation in the District has been variable, with both increases and declines of population numbers. The main cause for such instability is migration processes associated with immigration and emigration of workforce. The migrant workforce for the most part is represented by personnel engaged in development of oil and gas fields[375].

If the workforce migration flows are ignored, the number of permanent residents in the District appears to be stable[376]. The District demonstrates natural growth, i.e. the number of births is higher than the number of deaths[377].

Key demographic characteristics of Tazovskiy Municipal District and settlements within the social area of influence of the Project are given below (Table 8.3).

Table 8.3: Demographic characteristics of settlements in the social area of influence of the Project, and in administrative centre Tazovskiy[378]

Parameter	Tazovskiy Municipal District	Tazovskiy	Gyda	Antipayuta	Yuribey village / nomadic communities in the vicinity	Tadebya-Yakha village / nomadic communities in the vicinity
Population number	17,405	7,209	7,747	2,768	56/165	36/57
Birth rate per 1000 capita	19.3‰	17.4‰	23.8‰	22.6‰	N/A	N/A
Death rate per 1000 capita	7.4‰	5.8‰	6.6‰	13‰	N/A	N/A
Natural increase per 1000 capita	11.9‰	11.6‰	17.2‰	9,6‰	N/A	N/A
Immigration rate per 1000 capita	44.92‰	65.61‰[379]	17.6‰	12.56‰	N/A	N/A
Emigration rate per 1000 capita	46.99‰	71.57‰	14.6‰	19.94‰	N/A	N/A
Migration gain/loss per 1000 capita	-2,07‰	-5,96‰	3‰	-7.29‰	N/A	N/A
Average household size, capita	3.3	2.6	3	3	4	4

The reported population number in Gyda and Antipayuta is 3,692 and 2,707, respectively, as of 2019.[380] As mentioned above, only about 1,000 people permanently live in Gyda, i.e. 25-30% of the reported population number, and 70-75% of the settlement population conduct nomadic life in Gyda Tundra[381]. The percentage of permanent residents in Antipayuta is about two times higher – almost 60% or 1,500 persons, whereas the rest of the settlement population conduct nomadic life in Antipayuta Tundra.[382]

Over the period 2010-2019, the population number in the two settlements increased, mainly due to relatively high birth rates. According to Rosstat, birth rates in Antipayuta and Gyda (and in Tazovskiy

[374] Report of the Head of Tazovskiy Municipal District on the achieved values for assessment of performance of self-government authorities in Tazovskiy Municipal District in 2019 and the planned values for years 2020-2022.

[375] Website of Tazovskiy Municipal District https://www.tasu.ru/society/943/_aview_b1114. Viewed on: 10.03.2018.

[376] Territorial Planning Scheme of Tazovskiy Municipal District. Vol. 2. Explanatory memo. Arkhivarius LLC. Magnitogorsk 2015.

[377] Tyumenstat data.

[378] Rosstat (data on the total population of Tazovskiy district are reported for the end of 2019; average household size - all data reported in 2010). Information on Gyda, Antipayuta, Yuribey and Tadebya-Yakha were provided by Administration of Tazovskiy district in June 2020.

[379] Ramboll calculated migration gain/loss and growth ratios from Rosstat data in public domain for 2018.

[380] Rosstat data. Link:

http://www.gks.ru/scripts/db_inet2/passport/table.aspx?opt=719234062010201120122013201420152016 2017 and

http://www.gks.ru/scripts/db_inet2/passport/table.aspx?opt=719234032010201120122013201420152016 2017.

[381] Resolution on approval of the Comprehensive Social Infrastructure Development Programme of Gyda Settlement Municipality for the period 2016-2020 and till year 2025.

[382] Resolution of Antipayuta Settlement Administration No. 80 of 22 May 2016 on updating the water supply and sewerage scheme.

Municipal District in general) are higher than average rates in YNAO[383] and Russia[384]. Migration reported for both settlements over the recent years has been variable, with alternating periods of migration gains and losses.

A better demographic situation is reported in Gyda. The population in the settlement has grown by 20% since 2010. Assumingly, those high rates are attributable to the nomadic communities. The population of Antipayuta in the same period increased either, though only by 6%. Statistical reports indicate a rather high death rate in the settlement – it has remained above 10‰ over the last years; however, no explanation for this phenomenon is found in the socio-economic studies. According to information received from local authorities and healthcare institutions, death rates in Antipayuta are similar to those in Gyda and in the District at large.

The number of permanent residents in Yuribey reported in 2018 is 56 persons, and 165 more conduct nomadic lifestyle in nearby territories. The current number of population in Tadebya-Yakha is 36 residents and 40 nomads. Both Yuribey and Tadebya-Yakha villages are fully populated with indigenous people. More detailed information on the demographic characteristics of the two villages is unavailable.

8.4.2 Ethnic structure

According to the National Census of 2010, the number of indigenous population in YNAO is 41.2 thousand, i.e. 8% of the population total. A very high concentration of indigenous people is reported in Tazovskiy District, especially in Antipayuta and Gyda. Local indigenous people are Nenets who make up the largest group. Information on indigenous people numbers in Tazovskiy Municipal District and the surveyed settlements is provided below (Table 8.4).

Table 8.4: Numbers of indigenous small-numbered peoples of the North, 2016[385]

Parameter	Tazovskiy Municipal District	Tazovskiy twp.	Antipayuta	Gyda
Number of indigenous small-numbered peoples of the North (capita), including:	10,392	2,546	2,599	3,691
Nenets	10,343	2,522	2,589	3,679
Khanty	47	22	10	12
Selku	2	2	0	0

To sum up, as of 2020, indigenous people account for around 60% of the total number of population in Tazovskiy Municipal District. This proportion is substantially higher than the YNAO average. In fact, the surveyed rural settlements are almost fully populated with indigenous people. A share of ISPN in the total number of population is 98,5% in Gyda and 94% in Antipayuta. The indigenous community in Tazovskiy township, the administrative centre of the District, account for 35%. As mentioned above, all residents of Yuribey and Tadebya-Yakha villages are indigenous people.

Overview of the indigenous people's lifestyle is provided in Section 8.9.

In general, population of Tazovskiy Municipal District is represented by more than 30 ethnic groups. Russians are the second largest ethnic group in the District (about 30%). Other ethnic groups are Ukrainians, Tatars, Nogais, Azerbaijani, Chuvashes, etc.

8.5 Vulnerable Groups

The vulnerable category includes persons who may be exposed disproportionate impact of construction and operation of the Project and associated facilities, or may be affected more severely than other groups due to their vulnerable status.

---

[383] Progress report and evaluation of the effectiveness of implementation of the State Programme of Yamalo-Nenets Autonomous Okrug "Healthcare Development for 2014-2024", 2019.

http://tumstat.gks.ru/wps/wcm/connect/rosstat_ts/tumstat/resources/a294968044877d568badeb68838f846c/25024_01_2018.pdf.

[384] Rosstat. http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/population/demography/#.

[385] Passport of Settlements in Tazovskiy Municipal District, 2016.

This status may originate from ethnicity, property, level of income, economic situation, gender, language, religion, national or social origin, age, culture, literacy, physical or mental disability, and dependence on the unique natural environment and resource.

The following list[386] has been prepared based on the definition of this stakeholder category within the social area of influence of the Project:

- ISPN individuals and their families engaged in customary economic activities in the territories included in the social area of influence of the Project. The vulnerable status of such families is defined by the reliance on public subsidies and on the status of certain components of ecosystem services;
- Low-income individuals and families whose welfare depends on public social support;
- Minor and senior individuals; *and*
- Individuals with ill health, disabilities and/or diagnosed socially sensitive diseases (tuberculosis, HIV/AIDS, etc.).

It is important to note that the Company makes efforts to take into account the opinions of vulnerable groups by conducting surveys of tundra residents, including indigenous people, persons with poor health, low-income persons and elderly people. It should be noted that the impact on vulnerable groups within the social area of influence may also be positive (for example, as a result of the Company's corporate social responsibility programmes).

Description of each vulnerable group is given in the below sections.

8.5.1 Individuals and families of indigenous people

This vulnerable category includes representatives of indigenous peoples involved into traditional economic activities, including nomadic activities, within the social area of influence of the Project; therefore, they are dependent on the status of components of ecosystem services and highly sensible to potential impacts on the environment.

There is a risk that indigenous communities may experience difficulties if they have to adapt themselves to changes associated with the Project, and their capability to protect their interests may be relatively limited. In general, ISPN have a low income and rely on state subsidies. Indigenous communities may encounter certain problems related to their integration into the socio-economic life of the District and participation in consultations on the Project and its potential impacts.

As mentioned before, indigenous peoples make up about 60% of population in Tazovskiy Municipal District and a vast majority of residents of Gyda and Antipayuta (95% and more). About 70% of inhabitants of Gyda and 40% of Antipayuta hold on to the nomadic lifestyle.

Yuribey and Tadebya-Yakha villages are populated with purely indigenous communities and, by various data, up to 60 ISPN families migrate within the Salmanovskiy (Utrenniy) LA (for details refer to Section 8.9).

8.5.2 Low-income individuals and families within the social area of influence of the Project

Well-being of low-income individuals and families may heavily depend on public social support. There is a risk that this category may experience difficulties in adapting to changes associated with the Project and may have limited resources to protect their interests.

The number of low-income residents of Tazovskiy Municipal District was 6,419 or 36.8% of the total population number, as of 2019. As of end of 2017, in Gyda, 2,835 people or 80% of the total number of population were registered as the low-income category; in Antipayuta – 1,027 people or 39% of population. The subsistence minimum in 2017 was 16,027 rubles; by Quarter 1 of 2020, this indicator increased to 16,318 rubles.[387] By the end of 2018, number of welfare recepients was 7,202 persons in Tazovskiy district.

Given that about 70% and 40% of Gyda and Antipayuta population, respectively (refer to the above), lead nomadic life there should be a certain correlation between the nomadic lifestyle and low-income status among indigenous people in the two settlements.

[386] The list of vulnerable groups may alter throuout the Project implementation.

[387] According to dfate provided by Tazovskiy district administration in June 2020 in response to Ramboll's data request.

However, it should be noted that indigenous people may fail to declare their income from sale of reindeer herding and fishing products. If these incomes are taken into account, the actual number of low-income people may be less.

8.5.3 Minor and senior residents within the social area of influence of the Project

Minor and senior individuals may be highly sensible to various impacts of projects, in particular those with health effects. In 2019, the number of population below the working age in Tazovskiy Municipal District was 5,875 people; above the working age – 1,936. Of note is that 68.13% of the employable population are women. As of 2018, average monthly pension payments were 16,483 rubles.

This category may also have limited access to information due to lack of adequate knowledge of Russian language or skills for using modern communication devices. Also, they may have difficulties visiting consultation venues.

8.5.4 Persons with ill health, disabilities and/or diagnosed socially sensitive diseases within the social area of influence of the Project

Persons with ill health, disabilities and/or diagnosed socially sensitive diseases are categorised as a separate vulnerable group. The socially sensitive diseases are tuberculosis, HIV/AIDS, etc.

The number of persons with disabilities in Antipayuta and Gyda reported in 2016 is 83 and 98, respectively, including 12 and 16 children. People with diagnosed socially sensitive diseases are also registered in the two villages, both among indigenous communities and among labour migrants.

8.6 Economic Situation

In 2018, gross regional product (GRP) of Yamalo-Nenets Autonomous Okrug amounted to 2 trillion rubles. The Okrug is among Russia’s leader regions in terms of GRP per capita and one of the few donor regions with a high fiscal capacity[388]. As mentioned above, the fuel and power sector is at the core of the YNAO economy: YNAO accounts for 18% of global proven gas reserves and for 65% of such in Russia.

Totally, 236 hydrocarbon fields were discovered in the territory of YNAO. 89 of them are under development for commercial production and 147 fields are under exploration. The YNAO oil and gas sector has a great potential for development, as only 12% of its original gas deposits, 5% of oil deposits, and 2% of condensate deposits have been developed so far. Main oil producers in the Okrug are subsidiaries of Gazprom Neft PJSC and NK Rosneft PJSC.[389]

The reindeer population in YNAOi is about 790 thousand, which is the largest in Russia and globally. Reindeer herding is the key economic activity of indigenous communities of YNAO. Fishery is another important sector of ISPN activities in the Okrug.

8.6.1 Tazovskiy Municipal District

The main economy sector of Tazovskiy Municipal District is industrial production (more than 551 billion rubles[390] in 2019), especially minerals production that accounts for 86% of the total[391]. Producing industry and its auxiliary infrastructure are chiefly concentrated in the southern area of the District. A share of goods volume shipped in Tazovskiy District in 2019 accounts for 16.2% of the same indicator for YNAO.

Total annual gas production in the District in 2019 is almost 127.713 bcm of natural gas, which is 0.7% higher than in 2018[392]. Main subsoil users in the District are subsidiaries of Gazprom PJSC, Lukoil JSC, and Novatek PJSC[393]. There currently are 35 proven hydrocarbon fields in the District, including 8 offshore fields[394].

---

[388] According to Yamalo-Nenets Autonomous Okrug Socio-Economic Development Strategy till 2020.

[389] Ibid.

[390] Value of goods, works and services supplied.

[391] Report on the socio-economic situation in Tazovskiy Municipal District for 2019.

[392] Ibid.

[393] Territorial Planning Scheme of Tazovskiy Municipal District. Vol. 2. Explanatory memo. Arkhivarius LLC. Magnitogorsk 2015. Link: www.alt.tasu.ru/3828/3829/3838/3844/.

[394] Investment Passport of Tazovskiy Municipal District, 2017.

Even though a role of agriculture in the economy of Tazovskiy Municipal District is small (0.75 billion rubles in 2020)[395], agricultural lands make up 80% of the overall area of the District[396]. Totally, there are 6 agricultural enterprises in Tazovskiy Municipal District, including GydaAgro in Gyda and the Antipayutinskiy State Farm in Antipayuta. Agriculture is also the main sphere of employment for local indigenous communities. Reindeer herding is the basis of the ISPN customary economic activity; however, other occupations such as fishing, hunting and wild crop harvesting are also common (refer to Section 8.9 for details).

As of 2018, there are 149 designated fishing areas in Tazovskiy Municipal District[397]. The fishing areas are located in stream courses, mouths or arms of rivers, lakes, as well as in the Gydan and Taz Bays. The areas with known positions (133 out of 149) are located away from the Salmanovskiy (Utrenniy) LA boundaries. The State Fishery Register of agreements on provision of fishing grounds for commercial and near-coast fishing in Tazovskiy Municipal District[398] contains information about 118 fishing areas. Positions of 106 areas have been identified: all of them are remote from the LA boundaries.

Also, according to information received from the Federal Agency for Fishery (Rosrybolovstvo)[399], 7 agreements for provision of fishing grounds in the Ob Bay have been signed. All these are located far to the south of the Project sites (refer to Figure 8.7). A distance from the boundary of the Salmanovskiy (Utrenniy) LA to the nearest fishing area is about 130 km.

---

[395] Socio-economic development forecast for Tazovskiy Municipal District, 2018-2020.

[396] Investment Passport of Tazovskiy Municipal District, 2017.

[397] List of designated areas for commercial and near-shore fishing in Tazovskiy Municipal District. Provided on request by Tazovskiy Municipal District Administration in April 2018

[398] Provided on request by Tazovskiy Municipal District Administration in April 2018

[399] In accordance with the letter or Rosrybolovstvo No. У05-1611 of 27.09.2017 on provision of information from the State Fishery Register.

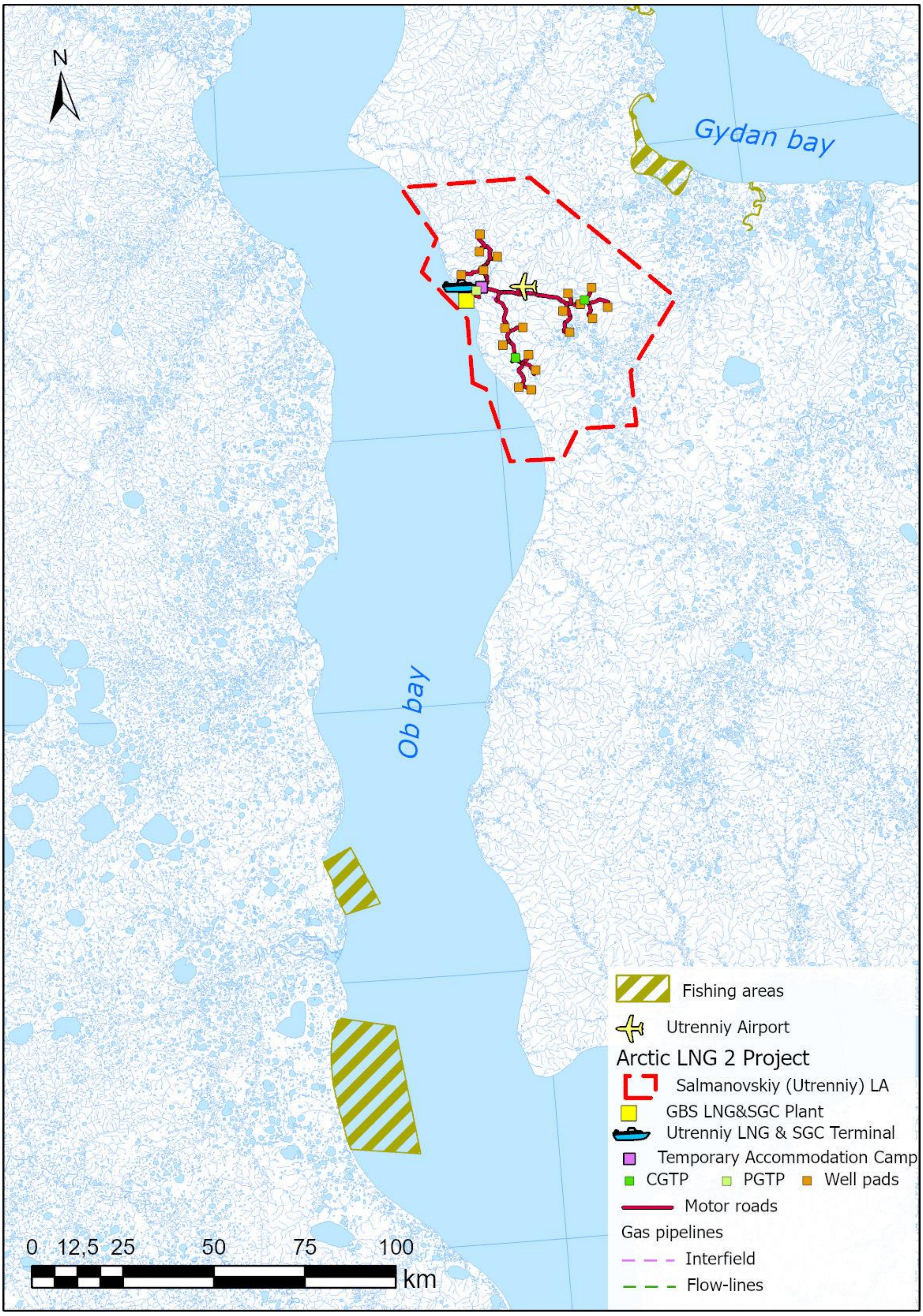


Figure 8.7: Boundaries of fishing areas in the Ob Bay

8.6.2 Gyda settlement

Main businesses in Gyda are fishery enterprise GydaAgro LLC and the Gyda Consumer Association. Additionally, the first line of a modern slaughtering-and-refrigeration facility with a capacity 200 livestock units per shift was built and commissioned in the settlement with the finance provided by Arctic LNG 2 LLC. Several small retail shops operate in the settlement.

8.6.2.1 GydaAgro

Although GydaAgro is legally established as a commercial entity, it is a socially-oriented enterprise (an employer for indigenous people) which relies on government subsidies. The company's history dates back to the 1930-s. After a series of institutional changes, it acquired a legal status of a limited liability company which is apparently the most appropriate for the kind of operations.

Until recently GydaAgro was also engaged in reindeer herding; however, in 2016, it transferred its reindeer stock and herders to the Antipayutinskiy State Farm (refer to below). Nowadays, fishing is the sole area of GydaAgro operations.

According to management of GydaAgro and administration of Tazovskiy district, the company employs 123 persons (as of June 2020), of which majority (82 persons) are directly engaged in fishing (the rest are administrative staff, etc.). During the "putina" season[400] (late July – early October and late October – late December), GydaAgro hires further 35-50 fishermen. Therefore, the annual average number of personnel is 160-185. In general, the company runs fishing operations from March till December. A vast majority (97%) of personnel employed by GydaAgro are indigenous people. The company provides fishermen with fuel, working clothes, and fishing nets.

In 2020, GydaAgro received a quota for catching approximately 721 tons of fish per year, while its actual catch, as a rule, is 340-360 tons per year. Valuable commercial fish species is vendace, alongside with other species, e.g. rockling, pydschjan (Siberian whitefish), omul, pike, syrok (peled), round-nosed whitefish, etc. The company holds fishing permits which are valid in 15 areas both in the Gydan Bay and in the rivers and lakes of the Gydan Peninsula. GydaAgro does not run operations within the Salmanovskiy (Utrenniy) LA; however, one of its fishing areas is located on the Yarayakha River whose tributaries flow across the LA (Figure 8.8). The fish species that the company catches in the Yarayakha River are omul, round-nosed whitefish, and vendace.

[400] Putina is a high fishing season.

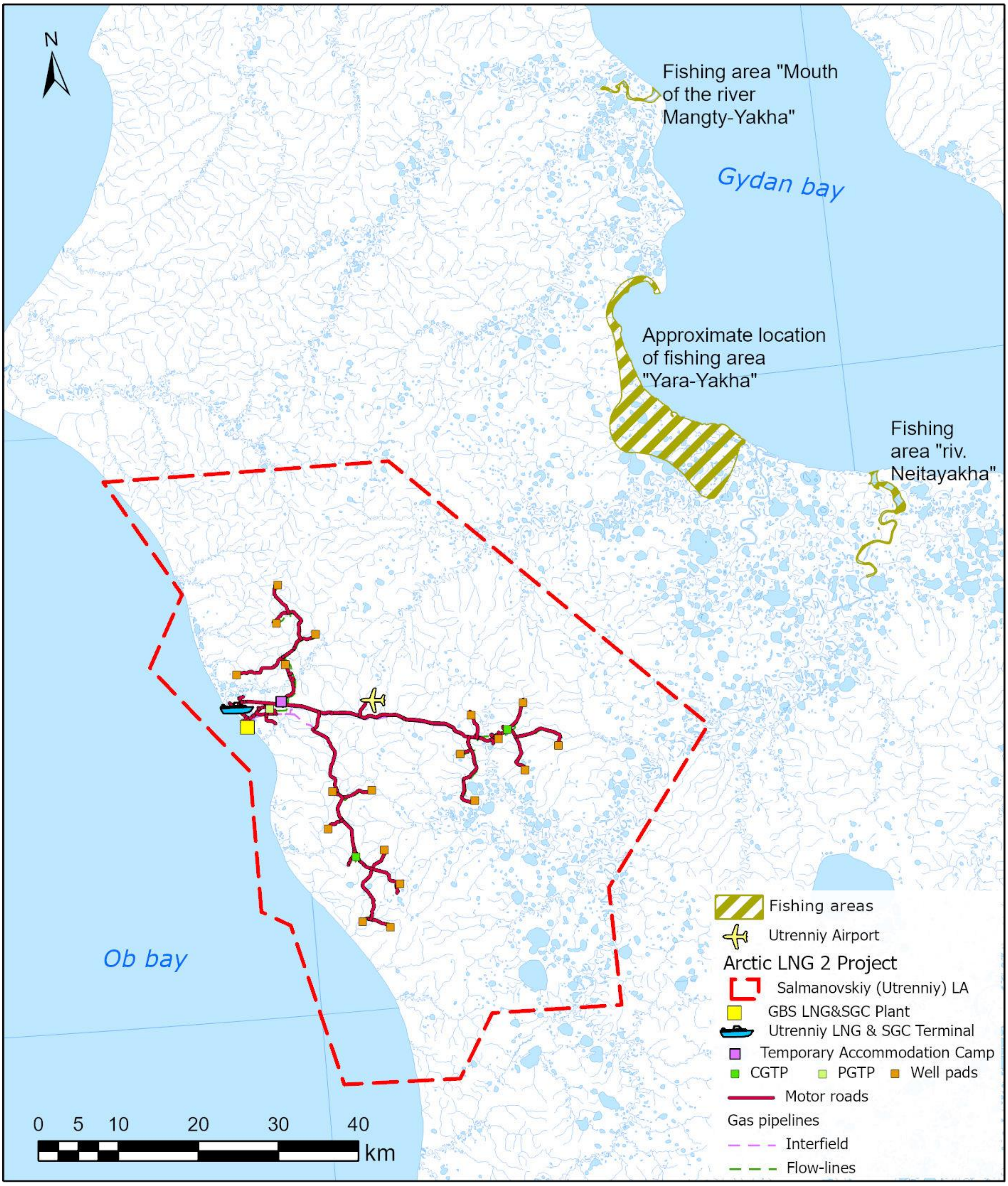


Figure 8.8: Location of the GydaAgro fishing areas located nearest to the Salmanovskiy (Utrenniy) LA

GydaAgro is not engaged in fish processing. The catch is frozen and sold to other companies.

8.6.2.2 Gyda Consumer Association

The Gyda Consumer Association provides year-round supply of food and basic commodities (including household chemicals and clothes) to Gyda settlement and three trading stations (villages) – Yuribey, Tadebya-Yakha and Tanamo, where permanent retail shops function. In the future, the Association's service area will also cover trading stations of Mangty-Yakha and Khalmer-Vonga (Khalmer-Vonga trading station is located about 100 km from the boundary of the Salmanovskiy (Utrenniy) LA, on the opposite shore of the Gydan Bay). The Association collects requests from retail shop managers and arranges delivery of the requested goods several times a year by air, sea, or other transportation modes.

Operations of the trading stations rely on government support, with subsidies provided from public budgets of the District or Okrug. In June 2020, the Gyda Consumer Association was staffed with some 43 people, including personnel of the trading stations, about half of which were indigenous people.[401]

Social and utility infrastructure development plans of Gyda provide for construction of a water intake and water treatment plant, a gym, a fuel store, a kindergarten, and a new school.

8.6.3 Antipayuta settlement

Main businesses in Antipayuta are the MUE Antipayutinskiy State Farm, slaughter facility of Tazovskiy Agricultural Complex LLC, and Antipayuta Consumer Association. Several small retail shops function in the settlement.

8.6.3.1 Antipayutinskiy State Farm

The Antipayutinskiy State Farm is a public-owned enterprise with the personnel number 130 (as of June 2020), if wchich 92% are representatives of ISPN. The core operations of the State Farm are reindeer herding (63 herders are employed) and fishing (31 fighermen are employed; additionally, in 2019-2020 four fishermen were retained by the farm on a temporary basis).

The number of reindeer of the State Farm was 6,508 as of June 2020 (in 2018 the herd's number was 8,828). In June, the reindeer population increases by approximately 25 % due to the animal yield. About 20-30% of the reindeer are slaughtered each year. According to the information received from the farm management, by 2020 the number of reindeer had decreased for a number of reasons: change of climatic conditions, lack of winter pastures, increase in the predators' population (especially, white fox), use of winter pastures in summer period and active periods of gnats in spring, lack of fodder due to icing of the upper layer of snow cover during thaws. In previous years, the number of reindeer owned by the State Farm has been increasing over the recent years, with the only exception of year 2017 when mortality resulted in a loss of more than 4 thousand animals. According to the State Farm Director, the mortality was probably caused by oxfly invasion.

The State Farm employs 7 teams with the total personnel number 63 for reindeer herding operations; each team consists of 8-12 employees. It should be noted that, apart from the livestock owned by the State Farm, herders have their own herds. The total number of reindeer in Antipayuta Tundra is 48 thousand; therefore, by that time the livestock owned by the State Farm was making only about one fifth of the total number of Antipayutinskaya tundra reindeer. One of the migration routes used by herders of the Antipayutinskiy State Farm runs through the Salmanovskiy (Utrenniy) LA. On this route, the State Farm personnel graze the Farm reindeer together with their own herds. Therefore, the total number of reindeer on the route is about 1,314, including more than 886 animals owned by the State Farm. Detailed information is provided in Sections 8.8 and 8.9 below.

The State Farm sells products of reindeer herding through the slaughter facility of Tazovskiy Agricultural Complex LLC in Antipayuta.

The Antipayutinskiy State Farm is also engaged in fishing. The Farm employs 31 fishermen and 10 temporarily retains 4 temporary workers under fixed-term contracts for the period of ice fishing (November-April). The State Farm annually obtains quotas for production of about 200 tons of fish per year. In 2017-2019, the actual catch of the Farm was:

- 2017 – 163,017 tons;
- 2018 – 150,422 tons;
- 2019 – 62,23 tons.

The main species in catch are syrok, pydschjan, and round-nosed whitefish. Fishing activities are conducted only in winter and in the sole fishing area of the company located in the Taz Bay. Commercial fishing grounds are absent at tundra rivers and lakes within Salmanovskiy (Utrenniy) LA. State Farm 'Antipayutinskiy fishery produce is traded in retail networks of Tazovskiy district and YaNAO.

---

[401] Information provided by Acting Director of the Gyda Consumer Association.

8.6.3.2 Slaughter facility of Tazovskiy Agricultural Complex LLC and Antipayuta Consumer Association

The Tazovskiy Slaughter Agricultural Complex in Antipayuta is the main facility that provides reindeer slaughter services for herders of Antipayuta Tundra (viz. Antipayutinskiy State Farm and private herders). The facility employs about 30 persons[402] and processes up to 200 livestock units per day[403]. Operations of the Antipayuta Consumer Association are similar to those described above in the section on the Gyda Consumer Association.

Antipayuta infrastructure development plans of 2018 included construction of a boarding school dormitory for 260 beds, a water intake and water treatment plant, a fuel store, and a bath-house[404].

8.6.4 Yuribey village

As mentioned above, Yuribey village is populated with indigenous people. There is a fishing depot of GydaAgro in Yuribey that includes the following facilities: a refrigeration unit with a capacity of 150 tons (so called "permafroster", i.e. an underground facility for refrigeration and storage of fish), 8 huts and 2 houses for fishermen, and a fishing supervisor's house. It is difficult to accurately determine the number of fishermen employed at this site, as GydaAgro may relocate its personnel at any time, depending on a season and abundance of fish.

Other facilities in Yuribey include a retail shop of the Gyda Consumer Association and a bakery which provide employment for 2-4 persons.

8.6.5 Tadebya-Yakha village

All residents of Tadebya-Yakha village are indigenous people whose main economic activity is fishing. The village is also used as a base camp by survey companies engaged in exploration of oil and gas deposits. The number of personnel of survey companies may vary from 2 to 30 (in summer)[405]. A local subsidiary of Yamal Airlines (a fuel station) staffed with 1-2 persons functions in the village. There is a retail shop in Tadebya-Yakha, managed by the Gyda Consumer Association, with 1 person on the staff.

8.7 Labour Market

The average number of employed population in Tazovskiy Municipal District reported in 2019 was 25,444[406] (in 2018 – 24,972 and in 2016 – 22,000[407]). The fact that the employed population number is almost twice higher than the population total suggests that a significant number of people are employed on a rotational basis.

The majority are employed in construction (22.4%), minerals production (25.5%), and transport and communications (8%). 13% of the employed population work in publicly funded institutions, e.g. in public authorities, education, healthcare, culture, sports and recreation organizations[408].

Only 2.6% of the working population are officially employed in agriculture, forestry, and hunting. Since reindeer herding and fishing are the main economic activities of indigenous minorities, one may conclude that the majority of ISPN are engaged in such activities informally.

The level of unemployment in YNAO is among the lowest in Russia. In 2019, the YNAO Employment Authority reported the unemployment rate of 1.9%, which is lower than that in Russia (4.8%). In 2019, 40 persons (or 0.16%)[409] were officially registered in Tazovskiy Municipal District as unemployed. According to the Employment Authority, the number of vacant jobs is several-fold greater than the number of job seekers. However, there may be a gap between a level of skills of local job seekers and employer expectations. The Employment Authority provides professional training for jobs in most demand in the local market. In 2020, employment center managed to supply jobs for 480 out of 850 job-seekers applied.

---

[402] Information from public domain: https://www.youtube.com/watch?v=utPPvpecLqU

[403] Information provided by Director of the State Farm Antipayutinskiy.

[404] Investment Passport of Tazovskiy Municipal District.

[405] Information provided by an employee of Yamal Airlines in Tadebya-Yakha.

[406] Report on the socio-economic situation in Tazovskiy Municipal District for 2019.

[407] Passport of Settlements in Tazovskiy Municipal District, 2016.

[408] Rosstat data, 2020: https://www.gks.ru/scripts/db_inet2/passport/table.aspx?opt=719230002017201820192020

[409] Investment Passport of Tazovskiy Municipal District, 2019.

Average wage reported in the District in year 2019 was 98.8 thousand rubles. However, there are notable variations of labour compensation between sectors of economy. For instance, oil and gas producing companies pay to their employees more than 130 thousand rubles per month, the while average wage in agriculture and fishery is about 35 thousand rubles. These are exactly the sectors that provide employment for indigenous communities. On the other hand, as mentioned above, indigenous people may also have informal sources of income.

Average pension in Tazovskiy Municipal District in 2019 was just above 17 thousand rubles.

As of 2018, a majority of working population in Gyda are employed by GydaAgro for fishing (about 113); other jobs are available with the Gyda Consumer Association (about 43), at school (about 194.6 positions are filled) and kindergarten (about 24 positions are filled), at hospital (about 18), and in the local administration (about 20). In addition, as of 2018, a significant number of labour migrants (about 500) worked in the construction sector.

There are no officially registered unemployed residents in Gyda, as of 1 January 2017. In 2016, 62 persons sought assistance in finding a new job; 49 of them got employed, however, only for temporary jobs[410].

Residents of Antipayuta are employed by the Antipayutinskiy State Farm (about 130), slaughter facility (about 30), school (159.5 positions are filled) and kindergarten (36.3 positions are filled), hospital (17), Antipayuta Consumer Association (48), and local administration (23).

As of 1 January 2017, 9 persons were officially registered as unemployed in Antipayuta. In 2016, 100 persons sought assistance in finding a new job. Sixty-two of them got employed, including 56 for temporary jobs[411].

8.8 Land Use

The Salmanovskiy (Utrenniy) LA is located in the inter-settlement territory of Tazovskiy Municipal District. As mentioned above, the area is virgin tundra with small rivers and tributary streams, and multiple lakes.

According to information provided by Arctic LNG 2 LLC, a subsoil use license for the Salmanovskiy (Utrenniy) LA is issued to Arctic LNG 2 LLC for the period till 2120. The area allocated for future onshore facilities of the GBS LNG & SGC Complex is 57.31 ha, including 21.91 ha for temporary facilities of the construction phase. The area of Port facilities is 162.21 ha, including operational berth facilities – 33.96 ha, Port extension – 85.06 ha, and temporary construction facilities – 43.19 ha. The facilities layout is shown in Figure 8.9. The Field facilities are distributed over the area of 43x47 km. The total area allocated to the airport is 118.75 ha, including 15.04 ha of temporary land allotment.

According to information available in the public cadastral map of the Federal Service for State Registration, Cadastre and Cartography (Rosreestr), the area of the Arctic LNG 2 Project was located in the agricultural land of Tazovskiy Municipal District[412]. However, by the time of the ESHIA studies, the category of certain land plots in the Salmanovskiy (Utrenniy) LA has changed to the industrial land category[413] for the purpose of subsequent implementation of the Arctic LNG 2 Project. At the time of the ESHIA studies, the Company entered into lease agreements for 472 land plots (from less than 1 ha to 2,047.79 ha in area) with a total area 8,320.87 ha. Part of these land plots has been leased up until 2021-2031; the other part – up until 2065-2068. All of the above plots are categorised as industrial land. The owners of these are Tazovskiy Municipal District or Yamalo-Nenets Autonomous Okrug.

The Salmanovskiy (Utrenniy) LA is located in the area of so called "Gyda Tundra" (major part of the area) and "Antipayuta Tundra" (south of the area) (Figure 8.9):

[410] Information provided by the Administration of Tazovskiy Municipal district.

[411] Information provided by the Administration of Tazovskiy Municipal district.

[412] Information from the Public Cadastral Map of YNAO: http://roscadastr.com/map/yamalo-nenetskij-avtonomnyj-okrug.

[413] Full name of the category is "land designated for industry, energy, transport, communications, radiobroadcasting, television, information technology, support land for space activities, defence and security land, and other land of special designation".

Figure 8.9: Gyda Tundra, Antipayuta Tundra, and boundaries of the Salmanovskiy (Utrenniy) LA

Gyda Tundra is municipal land, for which the Antipayutinskiy State Farm holds a perpetual lease. Antipayuta Tundra falls within Okrug's lands which are also leased by the Antipayutinskiy State Farm (the lease agreement was valid till year 2019; the State Farm initiated prolongation of the lease agreement for further use of the territory in March 2020)[414].

As mentioned above, reindeer herding is the core business of the State Farm. According to the State Farm Director, most of migration routes of the herds owned both by the State Farm and by private herders fit within the area of Antipayuta Tundra. However, one of the routes used by the herds that the State Farm took over from GydaAgro in 2016 runs through the Salmanovskiy (Utrenniy) LA. This route is shown in Figure 8.13. It is used both by the State Farm's herds and by reindeer privately owned by personnel of the State Farm.

Table 8.5: Information on herders (personnel of the Antipayutinskiy State Farm migrating with reindeer owned by the State Farm and their private herds) within the Salmanovskiy (Utrenniy) LA[415]

Full name	Size of family (capita)	Number of reindeer	Status of reindeer livestock
Antipayutinskiy State Farm	-	886	Property of the State Farm
Family of Worker 1[416]	10	251	Owned by State Farm employee
Family of Worker 2	4	177	Owned by State Farm employee

There are no permanently populated localities in the Salmanovskiy (Utrenniy) LA. The nearest settlement is a small village of Tadebya-Yakha located 40 km off the LA boundary, at a distance of 70 km from the designed Complex. A distance from the LA boundary to a larger settlement, Gyda, is approximately 120 km.

However, indigenous communities are actively engaged in customary economic activities in the territory of the Salmanovskiy (Utrenniy) LA. No sections of the LA have been officially assigned to ISPN individuals, communities or organizations (one tentative exception is the above mentioned Antipayutinskiy State Farm: indigenous people make up a vast majority of the State Farm personnel, although the Farm is a municipal enterprise owned by Tazovskiy District Municipality). Indigenous people conduct their activities under the conventional rights which are respected in the area of the Salmanovskiy (Utrenniy) and throughout Tazovskiy Municipal District officially recognised as an area of customary residence and practices of indigenous peoples of Russia.[417]

Information on the lifestyle and customary activities of indigenous communities (including those within the Salmanovskiy (Utrenniy) LA) is provided in Section 8.9 below.

8.9 Indigenous People

The Ethnographic Survey conducted by Purgeocom LLC in 2015 within the Salmanovskiy (Utrenniy) LA is the main source of information for this Section. In the course of the 2018 ESHIA studies for the Complex, this information was verified and updated through consultations with representatives of indigenous communities migrating within the LA boundaries. In particular, five ISPN representatives migrating within the Salmanovskiy (Utrenniy) LA were interviewed in the framework of the socio-economic studies in 2018. During one interview, members of three other ISPN families migrating in the same area were also present and confirmed validity of the information provided by the interviewee. The collected information on nomadic communities within the Salmanovskiy (Utrenniy) LA was further verified in the interview with a representative of the Gyda boarding school which annually collects its pupils from nomadic families for schooling. Information on the migration route of reindeer of the Antipayutinskiy State Farm within the Salmanovskiy (Utrenniy) LA was provided directly by representatives of the State Farm in 2018 and was specified by the Administration of Tazovskiy District in 2020. Representatives of three ISPN families migrating within the Salmanovskiy (Utrenniy) LA were also interviewed during consultations on preliminary ESHIA findings in 2018. Information on ISPN was further updated in the course of the ESHIA for the Arctic LNG 2 Project in 2020 through engagement with the Tazovskiy District Administration.

[414] Information provided by the Administration of Tazovskiy Municipal District on 10.06.2020 under request.

[415] *Ibid.*

[416] Names of the workers are not provided due to confidentiality reasons.

[417] The list of customary residences and economic activities of indigenous small-numbered peoples of the Russian Federation approved by the RF Government Resolution of 08.05.2009 No.631-r.

8.9.1 Overview

Tazovskiy Municipal District of YNAO is a customary area of residence and activities of indigenous small-numbered peoples of the Russian Federation[418]. Until the 1970-s, indigenous people, for the most part Nenets, accounted for more than half of the District population. A share of indigenous people in the population structure of Tazovskiy Municipal District diminished since the start of extensive development of oil and gas deposits back in the Soviet times. However, the numbers of Nenets people began to restore during the recent decades. Nowadays, Nenets, being the title people of YNAO, make up more than half of the total population number in Tazovskiy Municipal District – 10,021 persons[419]. Therefore, the District is the place of residence for about 20% of the total number of this indigenous people[420]. In Gyda and Antipayuta, which are two settlements included in the social area of influence of the Project, Nenets people are the majority (above 94%). ISPN account for about one third of the total population number in the District administrative centre Tazovskiy. Both Yuribey and Tadebya-Yakha villages are fully populated with indigenous people. Apart from Nenets, other ISPN live in Tazovskiy Municipal District, namely 47 Khantys and 2 Selkups.

Indigenous communities conduct customary economic activities within the Salmanovskiy (Utrenniy) LA. At the time of the ESHIA studies, the area was used for customary activities of private reindeer herders and for operations of the Antipayutinskiy State Farm. About 65 nomadic families, i.e. more than 300 people, are present in the area (the exact number of nomadic families may slightly vary between years). A size of private herds in the area varies from 60 to 1,800 reindeer. The total number of reindeer is over 23 thousand. According to information provided by the Administration of Tazovskiy District in June 2020, 33 out of 65 families migrate at the territory of the Salmanovskiy (Utrenniy) LA during summertime (tentatively from late June till late September) on permanent basis and 32 – on temporary basis. Almost all the families migrating at the territory of the Salmanovskiy (Utrenniy) LA in summer don't migrate at this territory during wintertime (i.e. from late September till late June) but migrate at the area of Tanamo, Yuribey, etc.[421] According to information available by the time of preparation of this report, approximately 16 families migrate at the territory of the Salmanovskiy (Utrenniy) LA during wintertime[422]. In should be noted that 4-6 families may migrate within the Salmanovskiy (Utrenniy) LA during wintertime on permanent basis[423] (see below).

Customary occupations of tundra Nenets are reindeer herding, fishing, hunting, and harvesting of wild crops. Historically, Nenets followed two economic patterns: one focused on large-scale reindeer herding and the other on fishing. In many cases, impoverished herders had to switch over to fishing, therefore fishing was traditionally treated by Nenets as a less "prestigious" occupation. It was often regarded only as a temporary solution needed to raise the necessary resource and get back to more prestigious herding. The size of a reindeer herd is the measure used by Nenets to describe a level of welfare and prosperity.

The Salmanovskiy (Utrenniy) LA is located in so called Yavaisalinskaya Tundra.[424] Details of main customary economic activities of Nenets people in this area are described below.

8.9.2 Reindeer herding

Main features of reindeer herding practices of tundra Nenets are a large size of herds, high degree of specialisation of economy, use of reindeer for transportation (sledge draught), use of reindeer herding dogs, established system of seasonal migrations with reindeer herds, and living in portable homes – chums (Figure 8.10).

---

[418] According to the list of customary residences and economic activities of indigenous small-numbered peoples of the Russian Federation approved by the RF Government Resolution of 08.05.2009 No.631-r.

[419] National Census of the Russian Federation, 2010.

[420] *Ibid*.

[421] Information provided by the Administration of Tazovskiy Municipal District on 10.06.2020 under request.

[422] According to the results the Ethnographic Survey conducted by Purgeocom LLC in 2015 within the Salmanovskiy (Utrenniy) LA that were specified by Ramboll in 2018 as part of socio-economic survey during interviews with representatives of indigenous families migrating within the Salmanovskiy (Utrenniy) LA.

[423] According to information obtained by Ramboll in 2018 as part of socio-economic survey during interviews with representatives of indigenous families migrating within the Salmanovskiy (Utrenniy) LA; and according to information provided by the Administration of Tazovskiy Municipal District on 10.06.2020 under request.

[424] Yavaisalinskaya Tundra is named after the Yavai Peninsula. It is located in the north-west of the larger Gydan Peninsula and its boundaries are conventional.


Figure 8.10: Nenets chum (on the left) and traditional reindeer sledge team (on the right)

Currently, private reindeer grazing is mainly carried out within the Salmanovskiy (Utrenniy) LA. The only exception is the Antipayutinskiy State Farm that uses one migration route running across the Salmanovskiy (Utrenniy) LA (refer to Figure 8.12 below). The reported number of the State Farm's reindeer on the route is 886 in 2020[425]. In addition, the workers of the State Farm herd their own reindeer (over 400) using this migration route. The number of reindeer in private herds in Yavaisalinskaya Tundra varies between 50 and 1,800 per Nenets household. A minimum size of herd which can be regarded as the main economic activity to support a Nenets family is 300-400. This number is considered optimum, as it secures sufficient resource to satisfy household needs for reindeer skins (clothes, chum covers, beds) and meat without reducing the herd size, and the required number of drawing reindeer for 10-20 sledges. Therefore, herders of modest means have always tried to minimise reindeer butchering and procure food for themselves and for herding dogs from other sources, of which fishing is the primary source and hunting – the secondary.


Figure 8.11: Herd of 300 reindeers

Reindeer herding practiced by indigenous people has always been focused on keeping the animals in the conditions that resemble their natural living environment as much as possible. Reindeer migration routes are fixed; however, each route always has several variations to allow a certain time for regeneration of pastures after seasonal use. Accordingly, herders use specifically established river crossing points, pastures, fawning grounds, camping and household equipment storage sites, and fishing and hunting areas. Boundaries between pastures of different reindeer herders are regulated by traditional laws. Given multiple factors that influence the grazing conditions and pace of nomadic migration, layout patterns and routes may vary between years. To avoid accidental intermingling, herders tend to graze their reindeer at a minimum distance 5 km from neighbours because a subsequent separation is a tedious process which takes several days of hard work. Information on herders' migration routes within the Salmanovskiy (Utrenniy) LA is shown in Figure 8.12 below.

[425] According to information provided by the Administration of Tazovskiy Municipal District on 10.06.2020 under request.

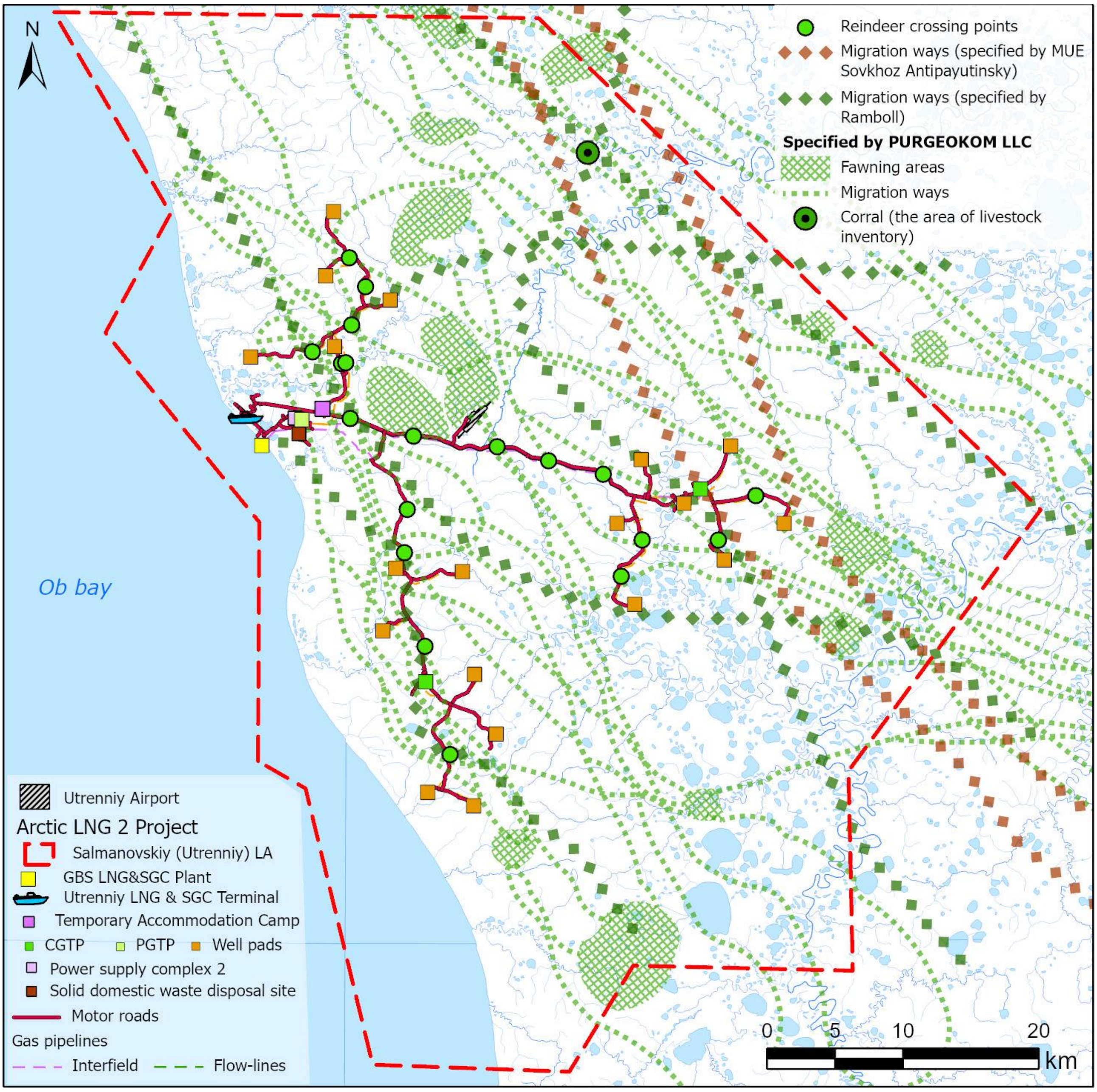


Figure 8.12: Reindeer herd migration routes within the Salmanovskiy (Utrenniy) LA

Annual migration routes commonly used by reindeer herders are meridional – from south to north (or south-east to north-west) and back. The migration is dependent on the herd size: larger herds have to move faster due to the forage depletion. In the past, large reindeer farms could cover a distance of 1,000 km every year and used 40-60 camp sites on the way. Nowadays these values have reduced by 1.5-2 times in the mean.

In the process of the socio-economic studies of 2018, one representative of indigenous people migrating within the Salmanovskiy (Utrenniy) LA mentioned that 4 herder families were always present within the LA "in wintertime" (i.e. from late September till late June). All other families only pass through the LA on their migration routes and stay in the area for just a short time. One of those families also regularly migrates in the area "in summertime" (tentatively from late June till late September). This information was ascertained by representatives of three other ISPN families migrating within the Salmanovskiy (Utrenniy) LA who were present at the interview. The migration areas of the 4 families are shown in Figure 8.13 below. These findings supplement the information on the ISPN migration routes shown in the previous figure and may be used for the identification of those ISPN families that are most active within the Salmanovskiy (Utrenniy) LA.

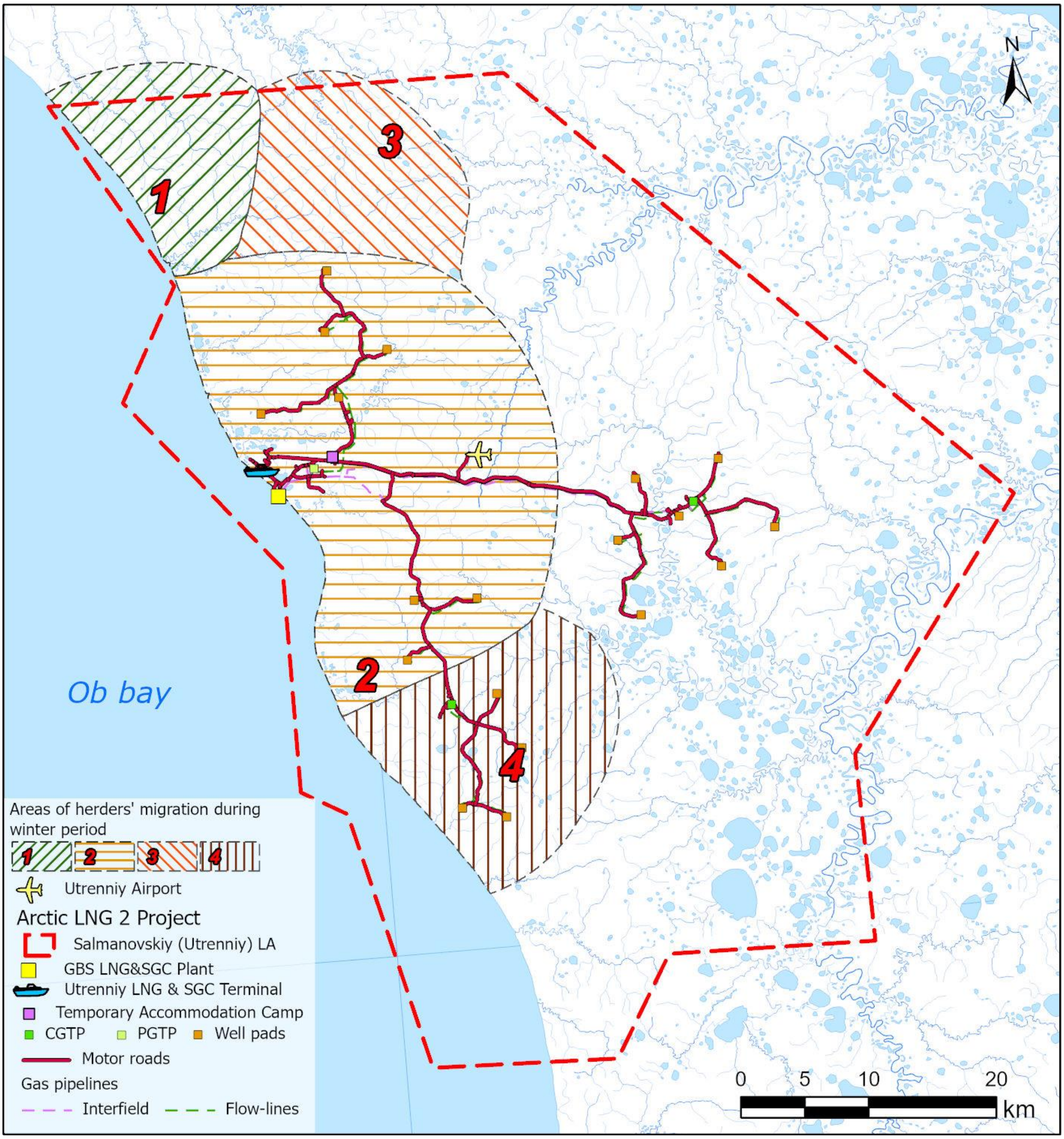


Figure 8.13: ISPN families whose economic activities in wintertime are concentrated within the Salmanovskiy (Utrenniy) LA

It should be noted that one of the described families is extended and consists of two nuclear/immediate families migrating together[426].

In addition, according to information provided by the Administration of Tazovskiy District in June 2020, another indigenous family which migrates at the territory of the Salmanovskiy (Utrenniy) LA on permanent basis in summer, migrates at the area or Netai-Yakha River in winter and therefore may also migrate within the territory of the LA.

There is also a grading corral (stock pen) at the upper reaches of the Yarayakha River in the Salmanovskiy (Utrenniy) LA which is used for reindeer counting, immunisation, and check-ups before issuing sanitary and epidemiological conformity certificates required for official sale of reindeer meat. Nomadic communities visit the corral in September. Reindeer herders migrating within the Salmanovskiy (Utrenniy) LA commonly

[426] Extended family is a structure which, besides the nuclear family (marriage partners and children) includes other relatives, such as parents, sisters and brothers, grandchildren, cousins.

use this corral. However, some herders use similar facilities in other places: near Antipayuta, on the Yuribey River, etc.

Sale of reindeer husbandry products (meat, ossified and unossified antlers) is the main source of income for nomadic communities. Herders bring the reindeer intended for sale to the butchery in Antipayuta (refer to Section 8.6 above) and to a newly built butchery in Gyda commissioned in 2019[427]. One more butchery is situated in the vicinity of the Tanamo trading station. Massive sale of reindeer for the meat market takes place in November-December. Herders consign from 4-5 to several dozens of reindeer, depending on the size of their herds and need for cash. Sale price of a reindeer (without antlers) is more than 7 thousand rubles. Therefore, cash revenue from sale of reindeer meat is in the range from 100 to 200 thousand rubles. This is the main annual income of cash which is normally spent on bulk purchase of food, fuel, spare parts, and essentials. Nenets families migrating within the Salmanovskiy (Utrenniy) LA buy food and basic commodities in Gyda, Antipayuta, Yuribey, Tadebya-Yakha and Tanamo, and from helicopter-based itinerant shops organised by the Gyda Consumer Association. For purchase of expensive machinery, chiefly snow-going vehicles, herders may "save" reindeer for several years before bringing them to slaughter, or otherwise they may cooperate with the family. In such situation, a hundred of more reindeer may be slaughtered. Dealers (individuals and companies) use overland and air transport to visit herders and buy up velvet and mature antlers. For own consumption, herders slaughter reindeer themselves. In general, representatives of nomadic communities and of the District Administration interviewed in 2018 noted that trade with personnel of power sector companies is an important auxiliary channel for sale of reindeer husbandry products and this activity may also influence herders' migration routes. For instance, as was noted, implementation of major investment projects south of Tazovskiy twp. motivated herders to shift their routes and adjust them to the location of fuel and energy industry facilities to facilitate trade.

8.9.3 Fishing

Net fishing in tundra rivers and lakes and in the Ob Bay is a customary activity of tundra Nenets. Main objects of local customary fishing are round-nosed whitefish, grayling, omul, and syrok. The greatest diversity of fish is reported in the largest of the nearby rivers – Yuribey River located east of the Salmanovskoye (Utrenneye) OGCF. Here local communities practice commercial fishing of round-nosed whitefish, pydschjan, vendace, syrok, omul, muksun, nelma, pike, and rockling. Fishing, along with reindeer herding, is among the key economic activities of nomadic communities.

Nenets people have been developing fishing practices for a long time in close integration with reindeer herding. Impoverished herders often took on fishing. To earn money needed for restoration of herds, they left their few reindeer in the care of the family or companions and switched over to fishing in the catchment of the Yuribey River or in the Gydan Bay. Nomadic herders, especially owners of medium-size or small herds, have always been actively engaged in fishing aiming to minimise own consumption of reindeer meat by substituting it with fish in their diet. Nenets people also had historically established schemes for the exchange of products between fishers and reindeer herders.

In summer, the produced fish was preserved by drying or smoke-curing. The main preservation method in autumn was salt-curing. The largest stocks of fish were produced in winter when the catch was simply frozen. Nenets fishermen consumed significant part of the catch for their own needs – as food for themselves and their sledge dogs. Fishermen who left their few reindeer in the care of herders used some part of the catch to pay for the service. They exchanged the remaining fish in kind or sold it.

Nowadays, herders practice net fishing in estuaries of rivers discharging to the Ob Bay and in deep tundra lakes and rivers. They normally use small nets 10-20 m in length transportable on sledges and snow-going vehicles. The smaller is the herd, the longer time its herder devotes to fishing, and the more he gravitates to fish-rich lakes and rivers on the migration route. A good or bad catch directly influences the number of reindeer to be slaughtered for food. Fish is also a critically important source of protein nutrition for herding dogs.

Due to the shortage of fishing water bodies within the Salmanovskiy (Utrenniy) LA, few herders have a chance to fish in summer and only for a short period of camping near a suitable lake or river. The catch mainly consists of valuable species (round-nosed whitefish, omul, and grayling). Its volume is rather small and sufficient just for current consumption, therefore not much surplus is left to be preserved for the future. The catch is small because of repeated fishing in local water bodies each year, whereas, in the areas with more abundant fish resources, Nenets people regularly let the water bodies "have a rest" to restore their fish population. Fishing is most active in the middle of autumn in the Neita-Yakha River, its tributaries and

[427] According to the Investment Passport of Tazovskiy Municipal District of YNAO, 2019.

floodplain lakes, in the Yuribey River, and other water bodies east of the LA. The layout of the fishing areas is shown below Figure 8.14.

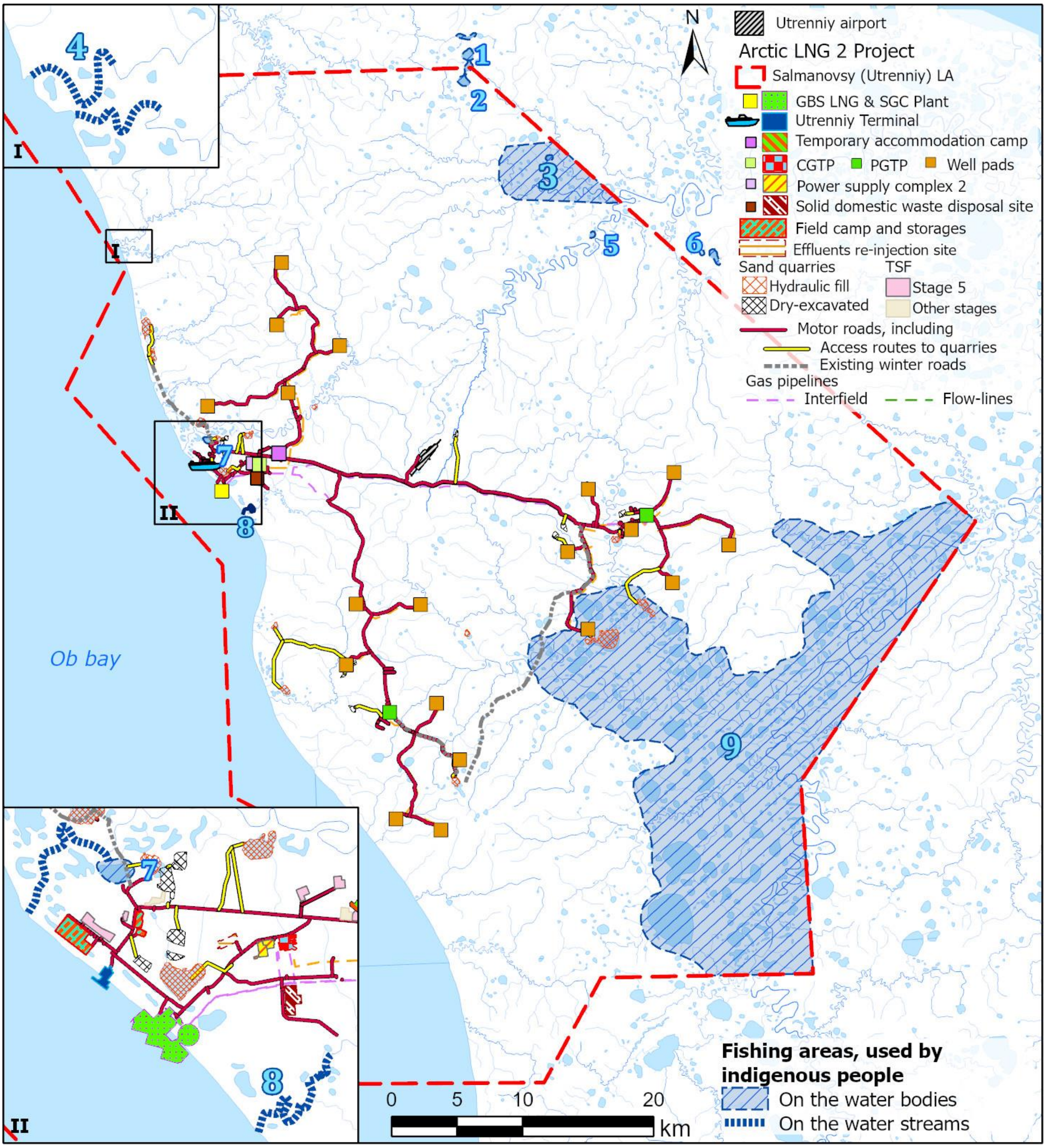


Figure 8.14: Fishing areas within the Salmanovskiy (Utrenniy) LA

The customary fishing areas of indigenous communities within the license area and nearby are:

- Section of the Khaltsyney-Yakha River near the estuary and floodplain Lake Khaltseyakha-Khasre (No.7 in Figure 8.14) – located nearby the designed GBS LNG & SGC Complex;
- Section of the Nyaday-Pynche River near the estuary (No.8) – located nearby the designed GBS LNG & SGC Complex;
- Sections near the estuaries of Syabuta-Yakha Rivers 2 and 3 (No.4);
- Lek-Lempto – three lakes in the upper reaches of the Mangty-Yakha River (No. 2);
- Yara-Yakha River and the lake on the right side of the Lekseda-Yakha River (No.3);
- Khalya-To Lake to the north of the Right Yara-Yakha River (No.5);
- Netai-Yakha River, its tributaries and floodplain lakes (No.9);
- Lekjambto (Yambale) Lake to the north of the license area boundary (No.1); and

- Two lakes on the right side of the Syabire-Yakha River, to the east of the license area boundary (No.6).

Net fishing method is used. Most of the catch is intended for own consumption.

Information on the fishing areas is based on the results of the Ethnographic Survey conducted by Purgeocom LLC in 2015 that were partly confirmed as part of ESHIA process conducted in 2018 during consutlations with indigenous peoples migrating at the territory of the LA. In addition, during these consultations another fishing area (No.8) was identified, which is used at least by one indigenous family.

8.9.4 Hunting

Hunting is another important customary economic activity of Nenets people, though less significant than reindeer herding and fishing. No areas specifically assigned for hunting have been identified within the Salmanovskiy (Utrenniy) LA – indigenous people practice hunting along the migration routes of reindeer herds. Nowadays, the key game is polar fox and fowl. The main methods of polar fox hunting are trapping or occasional shooting. Annual prey is insignificant – some 3-10 animals per hunter. The cost of a polar fox peltry currently is about 1,000 rubles. Nenets people try to sell furs where possible; however, they use most of them for making their own national clothes (fur hats, collars, etc.).

Traditional season for water fowl hunting (geese, duck) is the spring migration period. Success of this activity is always driven by chance. Currently, common prey is 5-20 large birds and several dozens of ducks during a spring season. Most prey is immediately used for current consumption. The practice of bird eggs gathering has always been limited in Yavaisalinskaya Tundra due to the lack of nesting sites.

Partridge and hare hunting are often practiced in February-April, using traps and snares, as well as gun shooting. Nenets people in Yavaisalinskaya Tundra hardly engage in sea mammals and polar bear hunting.

Hunting products of indigenous people migrating within the Salmanovskiy (Utrenniy) LA mainly go to their household’s consumption.

8.9.5 Gathering

Gathering has always played a purely auxiliary role in the subsistence of tundra Nenets. Edible plants are only consumed seasonally, as food or brew. Harvesting of wild crops is mainly practiced by children and women.

The most common berry in the Salmanovskiy (Utrenniy) license area is cloudberry. Blueberry and cowberry are also encountered in a few places in the north-western part of the Gydan Peninsula, however, in small quantities. No other edible berries grow in this high-latitude area. Gathering has never been of commercial value for tundra Nenets. Just a few families harvest cloudberry (July-August) in high-yield years. Nevertheless, wild crops are an important additional source of vitamins and minerals in the diet of peoples of the North and possess valuable curative and preventive properties.

8.9.6 Other

As mentioned above, sale of reindeer husbandry products is the key source of income for nomadic indigenous communities. This income is supplemented by financial social support from the government. People who lead nomadic life get a monthly “nomadic allowance” of about 5 thousand rubles per person older than 14 years.[428] Nenets also get minor subsidies for purchase of fuel. Further financial support is provided to low-income households and families with many children. Families with children who do not use kindergarten services also get a small compensation. Even though the total amount of financial support is not large, it still makes an important contribution to family budgets of indigenous people. In addition to financial support, residents of tundra areas are provided with portable power generators, tarpaulin to cover chums, cloth to make clothes, stoves, leather to make harness, and first aid kits. Snow-going vehicles and fishing nets are distributed to pensioners.

8.10 Cultural Heritage

This Section provides information on items of both tangible and intangible cultural heritage[429]. It is based on the reports of archaeological, historical and cultural surveys conducted within the Salmanovskiy

[428] According to data published on the official website of the Department for ISPN of YNAO: https://dkmns.yanao.ru/presscenter/news/18402/.

[429] According to IFC PS 8, cultural heritage refers to (i) tangible forms of cultural heritage, such as tangible moveable or immovable objects, property, sites, structures, or groups of structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic, and religious values; (ii) unique natural features or tangible objects that embody cultural values, such as sacred groves, rocks, lakes, and waterfalls; and (iii) certain instances

(Utrenniy) LA, information on conducted rescue archeological survey, information of the Administration of Tazovskiy District and the Department of IT and Communications of YaNAO, as well as on the findings of the Ethnographic Survey of 2015 which were verified by the socio-economic studies as part of the ESHIA process.

8.10.1 Tangible cultural heritage

8.10.1.1 Archeological sites

A series of archaeological, historical and cultural surveys were conducted in years 2015 and 2017 within the Salmanovskiy (Utrenniy) LA and in the coastal area. Their results are summarised in Table 8.6.

Table 8.6: Previous archaeological, historical and cultural surveys

Object	Offshore/onshore survey area	Survey conclusion	Year of survey activities
Complex	Offshore	No cultural heritage sites (CHS) identified[430]	2017
Complex	Onshore	1 CHS identified (medieval settlement Khaltsyneysalya-1)[431]	2017
Utrenniy Terminal	Offshore	No CHS identified[432]	2015
Berth facilities	Offshore	No CHS identified [433]	2017
Area of the Salmanovskoye (Utrenneye) OGCF	Onshore	2 CHS identified (medieval settlements Khaltsyneysalya-1,2)[434]	2015

Two cultural heritage sites, viz. Khaltsyneysalya-1 and Khaltsyneysalya-2 medieval settlements (Figure 8.15), have been discovered by archaeological expeditions in the area of the Salmanovskoye (Utrenneye) OGCF, near the Khaltsyneysalya Cape, on the eastern shore of the Ob Bay. Khaltsyneysalya-1 is a pentagonal plot 1,450 m^2 in area. Khaltsyneysalya-2 is a tetragonal plot of 630 m^2. The survey company recommended that construction, design and other activities should be carried out with due consideration of the layout of the identified CHSs and that any economic or other operations within the boundaries of the two sites should be avoided.

A rescue archaeological project in the mode of excavations of the Khaltsineisalya-1 site was developed with the aim to preserve information about the site with its subsequent exclusion from the Register of identified CHSs. The works were carried out in 2018[435]. In 2019, information about the boundary of the Khaltsyneysal-1 CHS was excluded from the Unified State Register of Real Estate[436].

---

of intangible forms of culture that are proposed to be used for commercial purposes, such as cultural knowledge, innovations, and practices of communities embodying traditional lifestyles. Therefore, cultural heritage may include not only officially registered objects.

[430] Plant on Gravity-Based Structures for Liquefied Natural Gas and Stabilized Gas Condensate Production, Storage, and Offloading. Historical and cultural studies. Final technical report on results of historical and cultural studies. Offshore area. INJGEO LLC, 2017.

[431] Technical report on results of historical and cultural studies for the object: «Plant on Gravity-Based Structures for Liquefied Natural Gas and Stabilised Gas Condensate Production, Storage, and Offloading». TsGEI LLC. Saint Petersburg, 2017.

[432] The Utrenniy liquefied natural gas and stabilised gas condensate terminal. Field report on results of archaeological survey. ОТД.301.17.ПО4-0008-К031-17. FERTOING LLC 2017.

[433] Provision of berth facilities at the Salmanovskoye (Utrenneye) OGCF. Field report on results of the archaeological survey. ОТД.319.17.ПО4-0008-К031-17. FERTOING LLC 2017.

[434] Archaeological studies in Tazovskiy Municipal District of Tyumen Region, 2015 (Contract "Archaeological studies in the area of the Utrenneye OGCF". Vol. 1. Purgeocom LLC, Non-profit Partnership "Ethno-Ecological and Technological Studies Centre of Siberia". Tyumen, 2015.

[435] Plant on Gravity-Based Structures for Liquefied Natural Gas and Stabilized Gas Condensate Production, Storage, and Offloading. Design documentation. Section 8. List of environment protection measures. Book 1. Environmental impact assessment. 2017-423-M-02-OOC1. Novaengineering. Moscow, 2019.

[436] In accordance with the letter No. 01-08-03/1848 dated 27.05.2019 of the YNAO Office of the Federal Service for State Registration, Cadastre and Cartography.

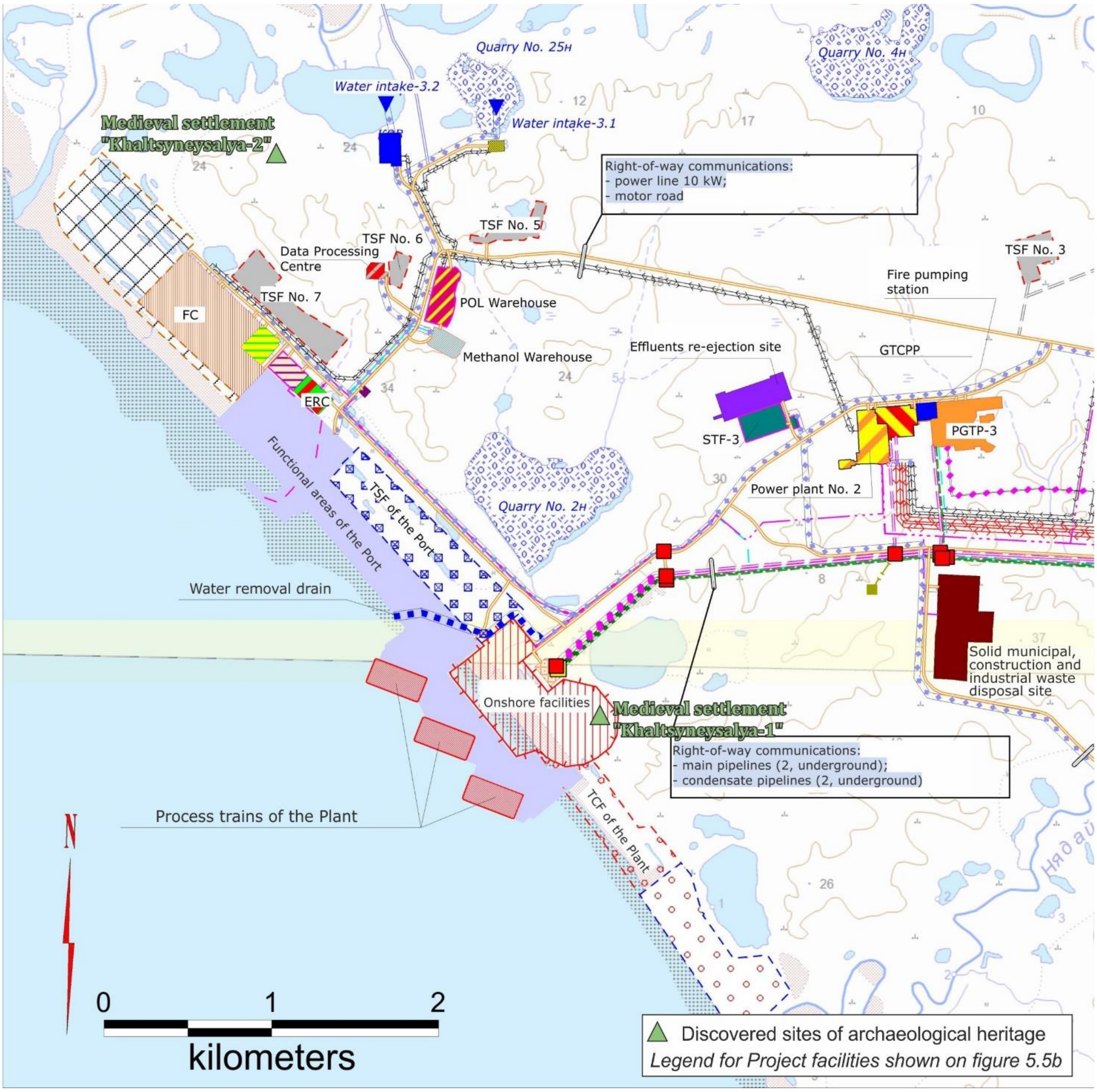


Figure 8.15: Location of the identified archaeological sites

No other CHSs have been identified in the area of the Salmanovskoye (Utrenneye) OGCF. The survey further concluded that there was still a chance to find historical artefacts or sites in the area of future construction.

8.10.1.2 Sacred sites of indigenous people

Sacred sites *(khebidya-ya)* of tundra Nenets are diverse. For instance, those include sanctuaries of family, ancestral or area guardian spirits, often with ceremonial images. Another group of sites are sacred places of spirits named 'lords-of-place'. These are natural objects – a lake, a cape, a hillock, etc. There is a category of sacred sites where women are not allowed. A separate group is sacrificial sites of spirits-lords of vast lands often located on hunting/fishing and herd migration routes. A particular feature of Nenets religious beliefs is that the most important sanctuaries are the least visited because "initiates" only may have access to them. For this reason, the lack of visible signs of frequent visits to a sacred ceremonial site may produce a misleading impression of somewhat "neglect" or insignificant status of the place.

Figure 8.16: Sacred site (on the left) and burial ground (on the right)

Sacred sites of indigenous peoples are easily recognisable and have the following attributes. Sacred sites of Nenets are usually located on terrain elevations and include heaps of antlers (with a wooden stake in the centre pointed toward the sun), skulls and bones of reindeer and other animals, suspended offerings (metal chains, skins of animals), coins, and empty alcohol bottles. Other common attributes are old sacred sledges with cultic items and symbolic models of chum carcasses made of metal rods (Figure 8.16). Sacred places may also contain cultic images such as wooden anthropomorphic sculptures. Large stones may also be used as sacred site markers.

The ethnographic survey revealed information on sacred sites known by local Nenets. The presence of some of the sacred sites identified by the survey was further verified in the interviews with ISPN representatives in April 2018. Information on sacred sites in the District area was provided by the Administration of Tazovskiy Municipal District in the course of the socio-economic studies conducted as part of ESHIA for the Plant in 2018 and as part of ESHIA for the Project in 2020. Totally, the information was collected on 38 sacred sites in the Salmanovskiy (Utrenniy) LA and adjacent areas. The summary of the identified sacred sites is provided in Appendix 3. The layout of the sacred sites is shown in Figure 8.17.

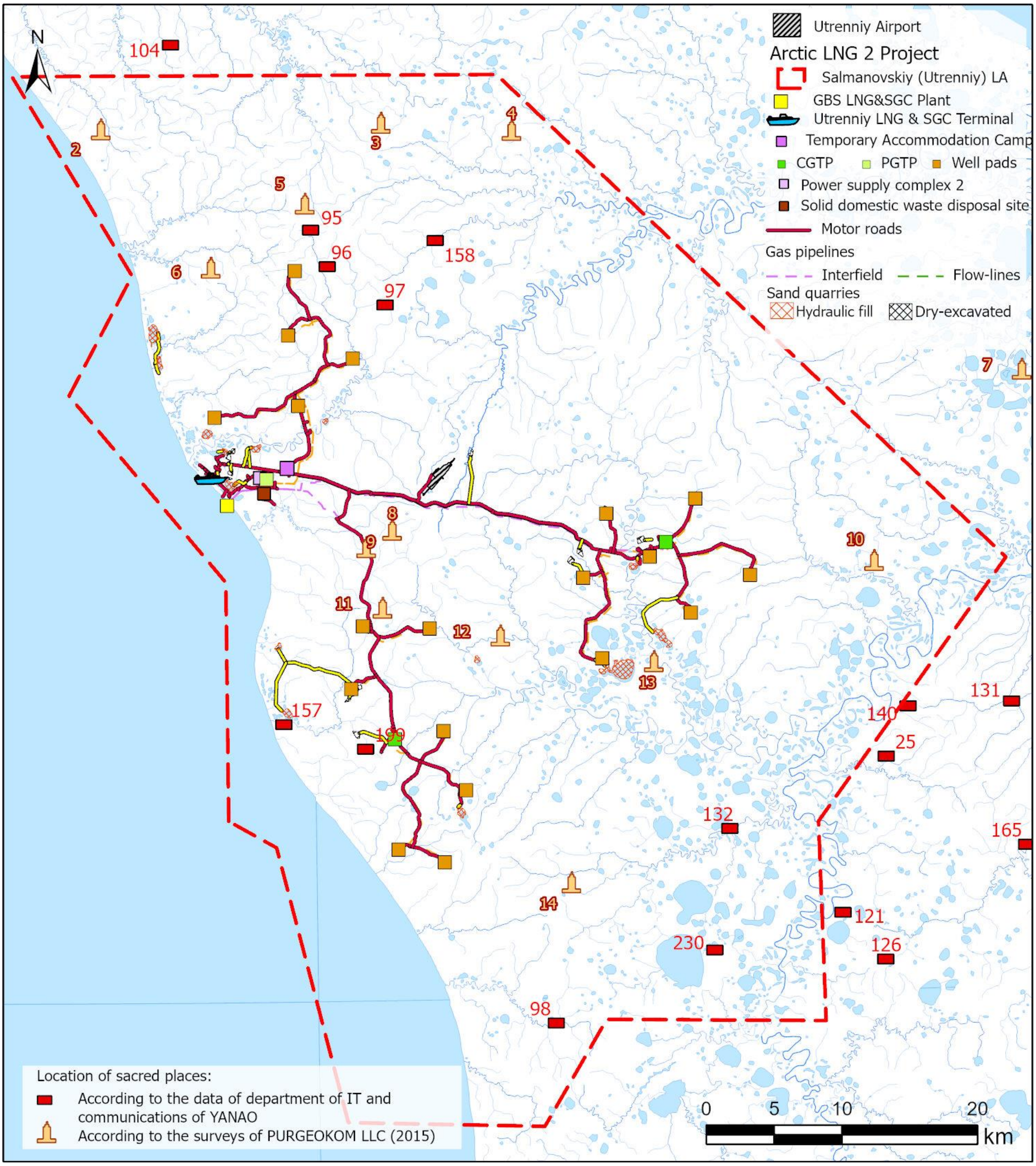


Figure 8.17: Layout of sacred sites within the Salmanovskiy (Utrenniy) LA and in adjacent areas

(full list and names of the sacred sites are given in Appendix 3)

As shown in the figure above, about 20 known sacred sites are situated within the boundaries of the Salmanovskiy (Utrenniy) LA. The nearest sites to the Field and other facilities (including roads) are:

- Varku' ngeva khebidya-ya ('brown bear's head sacred site'), No.8 in the schematic map – The site is located at the upper reaches of the Nyan-Yakha-2 River, near a small stream which Nenets people call Varkungevayakha. This is a sacrifice site used by several clans, including Vanujto and Yadne. Objects at the site are 3-4 skulls of brown bear, wooden anthropomorphic sculptures, and a heap of antlers of sacrificed reindeer. The site is located at a distance of 1,100 m from the Field line facilities and 10,130 m from the GBS LNG & SGC Complex;
- Tatngamla ('becalmed' or a 'stop'), No.9 – The site is located on a rise at the upper reaches of the Parejlak-Yakha River and is surrounded by cliffs. According to an ancient legend, a group of Nenets warriors stopped here to have a rest after defeating Mantu (Enets). The site contains a heap of

sacrifice reindeer antlers and old shamanic attributes. Clan attribution of the site is unknown. The site was last used for a sacrifice ceremony a long time ago. The site is located at a distance of 900 m from the Field line facilities and 8,600 m from the GBS LNG & SGC Complex;

- Oleg khebidya-ya ('Oleg's sacred site'), No.11 - A hummock at the upper reaches of the Parejlakyakha River, not far from one of its left-side tributaries. There is a small lake and an old well nearby. This individually worshipped sacred site was found out about 20 years ago by a local reindeer herder from the Salander clan who saw "something strange" there. The site objects are a small chum carcass made of metal rods and several antlers. The site is located at a distance of 100 m from the Field line facilities and 11,600 m from the GBS LNG & SGC Complex;
- Khurekho' seda, No.157 (no information on characteristics of the site is available); and
- Id' Erv' khekhe'' ya, No.199 (no information on characteristics of the site is available).

It should be noted that the information on sacred sites within the Salmanovskiy (Utrenniy) LA is not final. Results of the ethnographic survey indicate a high density of sacred sites in the LA and surrounding areas, many of which are objects of veneration of individual families. Therefore, other sanctuaries may well be present in the area. They may be only known to certain families, including those residing outside the subject area. The difficulty of identifying sacred sites is caused by the attitude of Nenets who are trying to conceal sacred sites from strangers. The confidentiality and taboo status are the main principles of indigenous people's behaviour in relation to their sacred sites. They often adhere to these principles even in situations of a risk of loss of a sacred site.

Elements of traditional clothes of Nenets people (malitsas, belts, fur shoes, etc.) are objects of material culture directly linked to intangible cultural heritage (refer to the description below). During the cold season, traditional clothing elements are indispensable elements of the nomadic peoples' costume. In summer, Nenets combine traditional clothes with trivial items which they buy in shops (anti-encephalitic costumes, coats and trousers of rubberised cloth, headwear with mosquito nets, etc.). Another element of Nenets culture is their customary dwelling – a chum (Figure 8.10).

Burial sites of tundra Nenets *(khalmer)* are often arranged on terrain elevations. They may include from 1-3 to several dozen graves. The graves are above-ground rectangular boxes made of wooden boards without use of nails (Figure 8.16). A small bell is suspended on a special strip over the grave. Various objects may be placed beside the grave, including overturned sledges, harness, boats, dishes, tables, antlers, bones, etc. Such burial sites are very common throughout the area of the Salmanovskoye (Utrenneye) OGCF, as Nenets often bury their decedents in the immediate vicinity of the place of death.

For indigenous peoples of the North, sacred sites and burial grounds are tokens of land possession and of a continuous link between the community and its area of residence.

8.10.2 Intangible cultural heritage

In accordance with the requirements of the International Finance Corporation (IFC), intangible cultural heritage includes knowledge, innovations and experience of communities whose lifestyle is based on traditions.

The native language of Nenets people is Nenets, though most of them (except for elderly residents of tundra) are equally fluent in Russian. Children of school age among themselves often speak Russian.

Among traditional beliefs and conventions of Nenets people, the best preserved are ceremonies related to maternity and burial. Tundra reindeer herders, being the main guardians of religious traditions, still practice main ceremonies and offerings that accompany the seasonal cycle of activities. Most local Nenets families always carry sacred sledges with cultic items during migration and keep worshipped images of ancestors (*ngytarma*) and mistresses of chum (*myad pukhutsya*) in their chums.

One of the key characters in Nenets religious beliefs is Num – spirit of the sky. A white reindeer is victimised for this spirit in spring and autumn. There is a sacred reindeer in each herd which nobody may touch. Nenets people worship various spirits of earth, water, river, lake and forest which bring luck in customary activities. Indigenous people also worship spirits of mountains (sometimes boulder stones may be regarded as figures of spirits). Nenets use small bells and pendants on clothes to deter evil spirits (of diseases and death) by tinkling.

Main festive celebrations of tundra Nenets take place on the Reindeer Herder's Day each spring. Celebrations are arranged in several settlements of Tazovskiy Municipal District where herders arrive from various places to talk to each other, take part in celebrations and competitions, as well as to use medical, government and municipal services. The competition programme includes reindeer sledge racing, jumps over sledges and other traditional contests of the North peoples. The second significant holiday is the Fisherman's Day celebrated in summer.

8.11 Social Infrastructure

8.11.1 Education

Educational institutions in the studied residential localities are represented by pre-school and secondary education establishments. Boarding schools are common in YNAO, as nomads make up significant part of the local community. More than 20 boarding schools operate in the Okrug and provide services to about 9 thousand children from nomadic families.[437] As a rule, children leave their families and stay at schools for nine months or longer periods. All costs associated with education (including helicopter transfers from tundra, accommodation and food) are covered by public budget. Children who receive education outside the traditional environment and away from families have limited access to customary knowledge and skills and are often reluctant to resume customary lifestyle after finishing school. In order to preserve distinct culture of indigenous peoples of the North, "nomadic schools" are established in the areas where nomadic communities are present. This approach is recognised as a priority pattern of the local education system, since it better meets the needs of indigenous communities by providing education services without separating children from customary environment and families. Nomadic schools are established at settlements of reindeer herders, hunters and fishers, or even migrate with herds[438]. 17 kindergartens and 5 schools for more than 200 children were established in YNAO within the scope of the Nomadic School Project over seven years of its existence[439]. At present, nomadic schools provide pre-school and elementary level education.

According to the 2016 Report of the Head of the Tazovskiy Municipal District Administration, 10 kindergartens function in the District. There also are five general education institutions for full cycle secondary education and one primary school in the District[440]. At present, people have to queue for kindergarten services and, by 1 January 2017, there were 633 children on the waiting list. The longest waiting list of 418 children is in the District administrative centre Tazovskiy.[441] As known from information received at consultations with the District Administration, there are no nomadic schools in Tazovskiy Municipal District. However, nomadic short-term groups function at local kindergartens in Gyda, Antipayuta, and Nakhodka[442].

In Gyda, there is a kindergarten "Severyanochka" and a boarding school. In 2018, the kindergarten was "overloaded", i.e. the number of pupils exceeds its designed capacity. In 2015-2016, a nomadic short-term group was established in Yuribey which functions in summer. In 2018, the group was staffed with two teachers and serves 19 children at the age from 2 to 7 years. About half of the group is children from families of permanent residents of Yuribey village (including personnel of fishing company GydaAgro). The other half is children from nomadic families migrating past Yuribey who use the kindergarten services for a short period of stops during migration[443].

Since the boarding school in Gyda was also "overloaded", additional boarding school was built and fully financed by the Company. This school was opened in 2018[444]. The capacity of the school is 800 children, whereas in 2018 it had 631 children[445].

---

[437] As of 2018. According to data published on the official site of the YNAO authorities: http://правительство.янао.рф/news/lenta/radical_people/detail/124730/.

[438] Nomadic school: Innovative projects. Part 1 / Compiled by G. I. Vanujto, V. N. Nyaruj, G. V. Lymar - Salekhard: GAOU DPO YNAO RIRO, 2014.

[439] Nomadic education: children in Arctic regions of Russia can study in chums, TASS, 06.04.2017. Link: http://tass.ru/arktika-segodnya/4160534.

[440] Website of the YNAO Department for Youth Policy and Tourism: http://yamolod.ru/mou/tazov/.

[441] Report of the Head of Tazovskiy Municipal District, 2016.

[442] Nomadic education atlas of YNAO. http://www.dkmns.ru/usr/kultura-i-nauka/%D0%90%D1%82%D0%BB%D0%B0%D1%81%20%D0%BA%D0%BE%D1%87%D0%B5%D0%B2%D0%BE%D0%B9%20%D1%88%D0%BA%D0%BE%D0%BB%D1%8B.pdf.

[443] Information received from the interview with Director of kindergarten in Gyda that manages the nomadic group in Yuribey.

[444] According to information provided on the official website of the school. http://mkoungshi.ru.

[445] According to Electoral Passport of Gyda, July 2019.

Figure 8.18: One of the kindergarten buildings in Gyda (on the left) and the building for the nomadic group in Yuribey (on the right)

In Antipayuta, there is a kindergarten "Zvezdochka" and a boarding school. The kindergarten was “overloaded” in 2018. Two nomadic pre-school groups functioned at the kindergarten in the summer period of years 2015 and 2016. The groups were staffed with two teachers and provided services to 8 children of pre-school age. One group functioned at a distance of about 1.5 km from Antipayuta and the other was at the Khalmer-Yakha trading station, 35 km south-west of the settlement. The capacity of the school is 530 children, whereas in 2018 it had 316 children[446].

Six "nomadic" pre-school groups also functioned in summer in the kindergarten "Snezhinka" in Nakhodka. They were based near Nakhodka (mainly at the trading stations)[447].

By data published on the official website of the District Administration, there are five kindergartens and two schools, including one boarding school, in Tazovskiy twp[448].

8.11.2 Healthcare

Access to medical services for local communities in Tazovskiy Municipal District is complicated by a population density and vast area of the District. Doctors and paramedics of the regional mobile medical department provide services for nomadic indigenous communities which make up a significant share in the total number of population. Rural district hospitals and health posts at the trading stations are used for operations of the mobile medical department. Emergency medical services for nomadic population are provided by five aero-medical units based in Salekhard, Nadym, Tarko-Sale, Tazovskiy, and Seyakha.

Information on healthcare institutions in residential localities within the social area of influence of the Project and in Tazovskiy township is summarised in Table 8.7.

Table 8.7: Medical institutions in the social area of influence of the planned activities and in the District administrative centre Tazovskiy[449]

Settlement	Type of institution	Number of medical personnel	Number of beds
Gyda	Rural community hospital Outpatient clinic	4 doctors (including pediatrician and therapist, surgeon) 14 paramedics	9
Antipayuta	Rural community hospital Outpatient clinic	3 doctors (two paediatricians and therapist) 14 paramedics	9
Yuribey	Medical and obstetric station (MOS)	1 paramedic (of mobile team)	-
Tazovskiy twp.	District Central General Hospital Outpatient clinic	46 doctors 157 paramedics	121

Medical services for residents of inter-settlement territoriess are provided by mobile teams assigned to the above healthcare centres. The mobile teams use portable fluorography equipment. The MOSs are equipped with physiotherapeutic, electrocardiographic apparatus, and with inhalation devices.

---

[446] According to Electoral Passport of Antipayuta, July 2019.

[447] Nomadic education atlas of YNAO. http://www.dkmns.ru/usr/kultura-i-nauka/%D0%90%D1%82%D0%BB%D0%B0%D1%81%20%D0%BA%D0%BE%D1%87%D0%B5%D0%B2%D0%BE%D0%B9%20%D1%88%D0%BA%D0%BE%D0%BB%D1%8B.pdf. Nomadic education atlas of YNAO (presentation edition). http://doyamal.com.ru/images/111/atlaskochevogoobrazovaniya.pdf.

[448] According to Electoral Passport of Tazovskiy twp, July 2019.

[449] Information on Tazovskiy settlement is based on the Passport of Settlements in Tazovskiy Municipal District, 2016; information on Gyda and Antipayuta was provided at interviews with managers of the local healthcare centres.

Doctors of required specialisations (a dentist, ORT, etc.) travel to hospitals in Gyda and Antipayuta approximately twice a year, in spring and in autumn. One of the visits is normally planned to coincide with the Reindeer Herder's Day when multiple nomads arrive to villages for celebrations. Preventive activities are scheduled for the period of the Fisherman's Day celebrations (in the middle of summer). In addition, the hospitals provide preventive vaccination of population in accordance with the vaccination schedule. Vaccination activities are conducted in the settlements and in inter-settlement territories.


Figure 8.19: Hospital buildings in Antipayuta (on the left) and Gyda (on the right)

The Gyda hospital manager reported the critical state of the building as of 2018. He also highlighted the lack of medical personnel, as the hospital also serves temporary construction workers who are accommodated in Gyda. On the other hand, the hospital manager noted that equipment available in the hospital is sufficient to serve the healthcare needs of the local community.

The state of the hospital in Antipayuta according to the Acting Manager of the hospital is suboptimal either. However, the acting manager of the hospital noted that the institution has adequate resource in terms of personnel and medical equipment[450].

Nomadic indigenous communities migrating within the Salmanovskiy (Utrenniy) LA have access to medical service in rural community hospitals, MOSs in Yuribey and Tanamo, as well as to services of aero-medical units based in Tazovskiy twp. As not all indigenous people have satellite phones, when they need to call for the aero-medical service, they seek help of other local ISPN families or rotational personnel who have such communication devices. Indigenous people do not seek medical assistance on a regular basis due to difficult access and call for aero-medical service only in exceptional cases.

Free medications are provided to indigenous people, including nomadic reindeer herders. Provision of medical supplies is based on the regional standards of minimal material security of indigenous and small-numbered peoples of the North and includes, inter alia, first aid kits and satellite communication equipment with the appropriate service package.

8.12 Community Morbidity Rates

8.12.1 Overall morbidity rates

Overall morbidity rates of all age groups reported by the Tazovskiy Municipal District Administration in 2017 were higher than the average for the Okrug. More detailed information on morbidity rates of Tazovskiy District in 2015-2019 is shown in Table 8.8.

[450] The interview took place within the ESHIA studies for the Complex in 2018.

Table 8.8: Overall community morbidity rates (per 1,000 capita)

Population group	2015		2016		2017		2018		2019	
	Overall morbidity	including ISPN	Overall morbidity	including ISPN	Overall morbidity	including ISPN	Overall morbidity	including ISPN	Overall morbidity	including ISPN
Adults	1,827.4	1,570	2,179	1,894	1,927.4	1,090.9	1987.4	1745.9	2178.8	1890.6
Adolescents	3,639	2,689	3,917	3,094	3,183.6	2,703.7	3134.2	2790.2	3232.1	2797.7
Children	3,372	2,844	3,623	3,086	3,151.9	2,847.4	3642.2	2082.4	4075.4	2881.2

In 2017, prevailing diseases in the structure of morbidity in children were respiratory diseases, diseases of the digestive system (due to dental caries), and of the eye and adnexa. By analogy, in the age group of adolescents, the most common diseases were respiratory, eye and adnexa diseases, as well as mental disorders. The structure of morbidity in adults, apart from respiratory diseases, includes diseases of the circulatory and genitourinary system.

By Rospotrebnadzor data (2020[451]), the incidence of ARVI in YNAO (41,250.1 people per 100 thousand capita) more than twice exceeds the similar indicator in the Russian Federation. Tazovskiy district is among the YNAO leaders by this indicator (55,525.4 people per 100 thousand capita).

The forecast of the socio-economic development of the Gyda Settlement Municipality for 2020 and for the planning period 2021 and 2022 particularly indicates that diseases caused by "hypothermia, ultraviolet insufficiency, exposure to low temperatures, sharp fluctuations in atmospheric pressure, and low oxygen content in the air prevail in the local community".

8.12.2 Specific indicators of community health status in Tazovskiy Municipal District

The following diseases demonstrated growth of morbidity rates in Tazovskiy Municipal District over the period 2015-2017: acute enteric infections, acute and chronic virus hepatitis, tuberculosis, influenza, community-acquired pneumonia, hospital-acquired and intrauterine infections, gonococcal infection, and parasitic diseases of the digestive system.

Causes for increased parasitic disease morbidity reportedly (according to Rospotrebnadzor) include violation of slaughtering regulations and untimely dehelmintization of dogs.[452] Among the sources of contamination mentioned in the Rospotrebnadzor Socio-Hygienic Monitoring Report of 2016 are deviations from sanitary-chemical and microbiological water quality standards in tap water and natural water, which cause adverse impact on community health.[453]

The increased incidence of genitourinary system diseases mentioned in the above section may proceed from the poor quality of drinking water in Tazovskiy Municipal District. In particular, findings of a survey of the drinking water supply system in Antipayuta[454] highlight a risk of diseases that may be caused by the increased iron content in drinking water in several settlements of Tazovskiy Municipal District, including hepatopathy and hemopathy, allergy, infarction, decrease in fertility. High levels of iron in water may increase the risk of atopic dermatitis and hypozincemia.

As reported by Tazovskiy Municipal District Hospital, indigenous people account for a vast majority of tuberculosis cases (up to 85%). Despite the decrease in the tuberculosis incidence in 2017, its rate in the District is still higher than the average in YNAO by 57%.[455] Tuberculosis morbidity in children in Tazovskiy Municipal District is 4.5 times higher than the Okrug's average. There is a pressing need for examination

---

[451] Rospotrebnadzor 2020 Report "On the state of the sanitary-epidemiological well-being of the population in the Yamalo-Nenets Autonomous Okrug in 2019".

[452] Dehelmintization is a system of medical treatment and preventive measures aiming to remove invasive material (eggs, larva) from the environment and helminths from organisms of animals and people.

[453] Rospotrebnadzor Department for YNAO (2016). Assessment of influence of environmental factors on community health in Tazovskiy Municipal District based on socio-hygienic monitoring parameters. (https://tasu.ru/info/3734/) Viewed on: 27.02.2018.

[454] Ye. V. Agbalyan et al., Chemical parameters of water quality in Tazovskiy District of Yamalo-Nenets Autonomous Okrug. Scientific newsletter of Yamal-Nenets Autonomous Okrug, Issue No.2 (91), Salekhard, 2016.

[455] Socially sensitive diseases, op.cit.

of children on a computerised tomography scanner which is only available in the Okrug Hospital in Salekhard. The main method for detecting tuberculosis in children and adults is a fluorography apparatus.

By Rospotrebnadzor data, Tazovskiy District ranks among the YNAO leaders in the incidence of tuberculosis.[456] According to the Report on the socio-economic situation in Tazovskiy District for 2019, the indicator twice exceeds the average for the Okrug. At the same time, the Report notes that the coverage by fluorography in Tazovskiy District (75.6%) is the lowest in YNAO (93.6%), assumingly, because of the remote residence of indigenous communities. In 2019, 68.8% of indigenous population in Tazovskiy District had a fluorography examination (81.6% of the total in the Okrug).

Table 8.9: Morbidity rates per 100 thousand capita in YNAO and Tazovskiy Municipal District [457]

Disease	YNAO					Tazovskiy District				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Tuberculosis	48.1	45.9	46.26	N/A	N/A	N/A	88.5	72.4	N/A	709
HIV	38.15	50.01	52.6	42.7	36.4	61.2	144.8	108.7	94.2	98.2

The incidence of HIV in Tazovskiy Municipal District remains high. In 2019, the HIV morbidity rate in the District exceeded the YNAO average by 87%. According to information of 2018, 80% of the infection was detected in representatives of indigenous small-numbered peoples.[458] In 2018, 78 out of 110 residents of Tazovskiy District living with HIV were ISPN representatives.[459]

Key groups exposed to the risk of HIV infection are ISPN communities and workforce employed on a rotational and expedition basis.[460] The most common pathway of the disease transmission in Tazovskiy Municipal District is sexual. Migration flows from other regions of Russia and CIS countries brought the infection which spread across the local indigenous community.[461] It should be noted that the known cases have been diagnosed in sedentary population, therefore, preventive measures should be taken among all tundra communities.[462]

In the course of consultations in 2018, representatives of healthcare institutions in Gyda and Antipayuta marked similar morbidity rates in indigenous people who have permanent residence in the settlements or lead nomadic life. A high extent of alcoholisation is reported in the communities. The increased incidence of alcoholism (1.581.5 people per 100 thousand capita) is typical for the District at large: the morbidity rate exceeds the Okrug average by 34.7%. By data of 2018, another serious problem in the two settlements is tuberculosis. In particular, child tuberculosis cases are reported in nomadic families. A few isolated cases of HIV reported in the settlements have a direct link to the arrival of migrant workforce from other regions. Narcological diseases in the communities are only reported as isolated cases. However, according to the results of a survey conducted in 2017 (were provided by the Administration of Tazovskiy District), 29% of Gyda residents and 25% of Antipayuta residents named the spread of alcoholism and drug addiction as the key problem in their communities.

The infant mortality index in YNAO reduced from 10.7 in 2011 to 4.7 in 2019. The most common cause for infant mortality is certain conditions originating in the perinatal period.[463] In the Tazovskiy Municipal District, 4 babies died in 2019 (all from indigenous minorities) under the age of 1 year due to respiratory diseases and accidents. The infant mortality rate was 12.1 cases per 1,000 live births. According to data provided by the Tazovskiy District Central Hospital during consultations in 2018, the severe living environment of nomadic families in combination with the inadequate level of immunisation pose a constant

[456] Rospotrebnadzor 2020 Report "On the state of the sanitary-epidemiological well-being of the population in the Yamalo-Nenets Autonomous Okrug in 2019".

[457] Referenced sources: 1. HIV infection epidemiological situation in Tazovskiy Municipal District// Tazovskiy Municipal District Central Hospital http://tazmed.ru/novosti/stopspid/.

[458] Tazovskiy Municipal District socio-economic monitoring data, 2016 // Official site of local self-government bodies of Tazovskiy Municipal District (https://tasu.ru/evolution/3133/3295/).

[459] HIV infection epidemiological situation in Yamalo-Nenets Autonomous Okrug for 2018/ website of the YNAO AIDS Centre (http://aids.yamalzdrav.ru/index.php?option=com_content&view=article&id=336&Itemid=139).

[460] YNAO Governor Resolution of 2016 "On approval of Strategy for prevention of the spread of the disease caused by the human immunodeficiency virus". Op. cit.

[461] Ibid.

[462] Ibid.

[463] Period counted from 22nd week of gestation to 7 full days after birth.

threat of infant mortality[464]. Representatives of healthcare institutions in Gyda and Antipayuta note the high infant mortality rate in the two settlements. To prevent infant mortality, medical personnel make efforts to avoid deliveries in inter-settlement territories (in chums) – such situation is treated as an emergency. Instead, arrangements are made to make sure that acts of delivery take place in the hospital in Tazovskiy twp., or at least in rural community hospitals in Antipayuta or Gyda. In 2016, Antipayuta reported zero infant mortality.

Main causes for mortality in employable age people in Tazovskiy Municipal District are cardiovascular diseases, as well as accidents and injuries. In particular, the District reported two fatalities in traffic accidents on winter roads in 2017.[465]

Massive preventive measures against anthrax were implemented in 2016 in response to a suspect case of the disease in the area of the Pyakyakhinskoye OGCF in Tazovskiy Municipal District. The measures included immunisation of indigenous people and personnel of the fuel and power sector companies.[466] It is reported that in 2016 the number of visits to medical institutions for treatment of the disease reduced, while more people sought preventive examination.[467] As mentioned above, preventive vaccination of local communities is provided in villages and inter-settlement territories in accordance with the approved schedule.

The driver for the enhanced preventive measures against anthrax was an outbreak of the disease in Yamal Municipal District. In 2016, various contacts with dead/ill animals in this district resulted in 36 cases of anthrax in people, which is far beyond any earlier reported outbreaks. For instance, 24 and 22 cases were reported in Russia in years 2008 and 2010, respectively. The total number of anthrax cases recorded in the entire territory of the Russian Federation is 84 over the period 2006-2015. In 2016, urgent anti-epidemic measures taken by competent authorities and institutions in Yamal Municipal District proved to be effective: the focus of disease was promptly localised and further epidemic development was prevented.[468] Most cases were registered among rural residents and the main infection pathways were contacts with animals during compulsory slaughter and butchering of infected animals[469], as well as consumption of blood, meat and meat products.

The above human morbidity was provoked by the greatest epizootic outbreak of anthrax in reindeer in YNAO. 2,650 reindeer died in the Okrug during July-August 2016, including 2,649 in Yamal District and 1 in Tazovskiy District. Mortality of 600 reindeer was reported in Tazovskiy District in the same year; the diagnosed cause was not "anthrax" but "pasteurellosis".[470] All carcasses were incinerated and over 450,000 reindeer were vaccinated. However, some researchers believe that in the absence of effective preventive measures and due to other factors, e.g. climate change, the situation with anthrax may still be uncertain, and there is a risk that a supportive environment may be created for development of epizootic diseases even in the northern areas which have a relatively trouble-free history in this respect.[471] It is the emergency situation with anthrax developed in YNAO in 2016 that, according to scientists, indicates the absence of a stabilisation trend.

Potential abnormal weather conditions, such as in July 2016, may activate anthrax foci in soil which have been known since the end of 19th – early 20th century (there are no known cases of anthrax foci in soil within the Salmanovskiy (Utrenniy) LA). A potential spread of anthrax may enhance as a result of free reindeer grazing in the anthrax-prone areas. It should be noted that one of the recent epizootic outbreaks of 1941, described in historic publications, occurred in the coastal area of the Taz Bay.[472] Another factor, indicated in scientific publications, that provoked the anthrax outbreak in YNAO is the cessation of mass

---

[464] Medical services for indigenous communities // Official site of Tazovskiy Municipal District Central Hospital: http://www.tazmed.ru/ob_org/info1/medicinskoe_obsluzhivanie_korennogo_naseleniya/. Viewed on: 12.03.2018.

[465] Socially sensitive diseases// PFHI Tazovskiy Municipal District Central Hospital (http://www.tazmed.ru/ob_org/info1/social_no-znachimye_zabolevaniya/) Viewed on: 11.03.2018

[466] Medical services for indigenous communities, op.cit.

[467] Statistical data of Healthcare Department of Yamal-Nenets Autonomous Okrug, 2016. A digression of number of visits per 1000 capita (-30.2) and an increase of preventive visits (14.1) is reported Tazovskiy Municipal District.

[468] A. G. Ryazanova et al. Epidemiological and Epizootological Assessment for Anthrax in 2016, and forecast for 2017. FGHI "Stavropol Antiplague Research Institute", Stavropol, Russian Federation, 2017.

[469] Z. F. Dzhugarzhapova et a. Anthrax: epizootological/epidemiological situation at the global level, in the former Soviet Union Republics and the Russian Federation in 2011–2016. FGHI "Irkutsk Antiplague Research Institute of Siberia and Far East, 2017.

[470] A. V. Golovnev. Risks and Manoeuvres of Yamal Nomads, Siberian History Studies, No.4, 2016

[471] A. G. Ryazanova et al. Epidemiological and Epizootological Assessment for Anthrax in 2016, and forecast for 2017. FGHI "Stavropol Antiplague Research Institute", Stavropol, Russian Federation, 2017.

[472] E. G. Simonova et al. Anthrax on Yamal: Epizootological and Epidemiological Risks Assessment, Moscow, 2017.

immunisation of reindeer in the Okrug in 2007 (immunisation practice resolved after the outbreak) coupled with gradual growth of the livestock population, increasing deficit of pastures, and limited control over summer migration routes of reindeer.

According to Rospotrebnadzor, no new cases of anthrax were detected in 2019. Regular preventive measures are taken to counteract anthrax (vaccination of reindeer and people). Vaccination primarily takes place in Tazovskiy and Yamal Municipal Districts which are recognised as dysfunctional with respect to anthrax. A list of nine "anthrax" burials, where animals were buried during the anthrax epizootic in 2016 in Yamal District, is available. The burials are properly controlled by the YNAO Department of Property Relations. Primary information about anthrax is disseminated among reindeer herders and rotational personnel in YNAO (including in Tazovskiy Municipal District),

8.12.3 SARS-CoV-2

According to official data provided by the operational headquarters for coronavirus infection, 1,806 cases of COVID-19 were detected in the YNAO by 19 May 2020. Of these, 3 people died; 251 people recovered. Information on the daily detection of COVID-19 cases is shown in Figure 8.20.

Figure 8.20: The number of COVID-19 cases detected daily in YNAO (21.04-19.05.2020)

The COVID-19 morbidity rates in Tazovskiy District were as follows in March-May 2020:

- Infected: 14 persons;
- Recovered: 2 persons;
- Deaths: none;
- No COVID-19 cases related to nomadic population were reported.

8.13 Transport and Communications

Motor roads, air and water transport communications function in Tazovskiy Municipal District. Local overland transport infrastructure is scarce. The only road link between the District and the "Mainland" is Novy Urengoy – Tazovskiy. The road route passes through Korotchayevo (a residential complex in Novy Urengoy city), Urengoy settlement, and Novozapolyarny rotational camp. The road is paved with asphalt concrete[473] and has a branch towards Gaz-Sale settlement in Tazovskiy Municipal District.

No road links are available or planned for transport communication with Nakhodka, Gyda, and Antipayuta.[474] The settlements can be only accessed by seasonal winter roads. A peculiarity of the District is that winter roads here are very long whereas there are areas completely without roads. Supplies are delivered to trading stations and settlements using caterpillar vehicles, tractor-and-sledge trains, or aircraft. Public bus transport is available only in Tazovskiy and in Gaz-Sale.

[473] Territorial Planning Scheme of Tazovskiy Municipal District. Vol. 2. Explanatory memo. Arkhivarius LLC. Magnitogorsk 2015.

[474] Report of the Head of Tazovskiy Municipal District, 2016.

Railway communication is unavailable in the District. The nearest railway station Korotchayevo is located at a distance of 170 km from Tazovskiy township. Therefore, 50% of the District inhabitants live in settlements without regular bus or railway communication. The District Territorial Planning Scheme provides for construction of a railway line from Korotchayevo via rotational camp Novozapolyarny to the north of the Gydan Peninsula[475]; however, representatives of the District Administration mentioned in the interviews in April 2018 that this plan will hardly be implemented in the mid-term. During interaction with the Administration of Tazovskiy District in May-June 2020, there was no evidence showing that either the already planned or new projects of transport infrastructure development in Tazovskiy District are to be implemented.

The lack of proper overland communication infrastructure brings about a need for air transportation. Air transportation in Tazovskiy Municipal District is arranged via the airport of Novy Urengoy. Since January 2012, the existing airfield in Tazovskiy has been only used as a landing site. At present, airplane transportation is not practiced. Helicopter pads in the District are available in Tazovskiy, Nakhodka, Gyda, Gaz-Sale, Antipayuta, and Tadebya-Yakha. Intensity of helicopter operations increases during inter-season periods when overland communication between Tazovskiy and other settlements is unavailable. Regular flights are carried out on the routs Tazovskiy – Nakhodka – Antipayuta - Gyda. Regular flights from Tazovskiy to settlements located further to the north (Nakhodka, Antipayuta and Gyda) are scheduled for two times a week (occasionally additional flights might be arranged)[476]. The main disadvantages of the helicopter service are the remote location of pads from residential areas, difficult access, seasonal factors, and high cost[477].

Water transport is mainly used for cargo carriage. Berth facilities are available in Tazovskiy, Gaz-Sale, Nakhodka, and Gyda. The berths also serve fishing boats. In summer, there is passenger traffic by water between Antipayuta and Salekhard[478].

Megafon, Tele-2, T2 Mobile, Ekaterinburg 2000 and Motiv are mobile communication providers in Tazovskiy District. According to information provided by the District Administration, they also operate in Antipayuta and Gyda[479]. Yamaltelecom JSC is the provider of fixed telephone and internet services in the two settlements. Mobile communication is unavailable in inter-settlement territories. There are public payphones in Yuribey, Tanamo, Tibey-Sale and Messo that provide free communication with emergency services and access to paid long-distance and international telephone communication services using dial-up cards. However, local residents complain about unreliable functioning of the payphones.[480] The District Administration is taking measures to supply nomadic communities with satellite phones for better communication in tundra in emergencies.

8.14 Housing and Municipal Services

Housing facilities in Tazovskiy Municipal District include apartment blocks, single-family houses, traditional dwellings (chums), and temporary accommodation (cabins and huts). A vast majority of local settlement residents live in apartment blocks (96%, as of 2019), and only 4% live in individual houses[481].

The following utility service coverage is reported in the District (as of 2019): power supply - 100%, water supply - 92%, and gas networks - 72%[482].

Many houses in the District are dilapidated or in disrepair. Various sources cite different proportions of such housing ranging from 25%[483] to 60%[484] (according to information provided by the Administration of

---

[475] Territorial Planning Scheme of Tazovskiy Municipal District. Vol. 2. Explanatory memo. Arkhivarius LLC. Magnitogorsk 2015.

[476] According to information provided by the Administration of Tazovskiy District on 04.06.2020 under request.

[477] Territorial Planning Scheme of Tazovskiy Municipal District. Vol. 2. Explanatory memo. Arkhivarius LLC. Magnitogorsk 2015, ref.: www.alt.tasu.ru/3828/3829/3838/3844/.

[478] Ibid.

[479] According to information provided by the Administration of Tazovskiy District on 04.06.2020 under request.

[480] Trading stations in Tazovskiy District: yesterday, today, tomorrow (2016) // Sovetskoye Zapolarye. http://sov-zap.ru/?module=articles&action=view&id=7117. Viewed on: 13.03.2018.

[481] According to information provided by the Administration of Tazovskiy District on 04.06.2020 under request.

[482] Ibid.

[483] Passport of Settlements in Tazovskiy Municipal District, 2016.

[484] Programme "Sustainable Development of Rural Settlements in Tazovskiy Municipal District for the period 2014-2017 and until year 2020": https://tasu.ru/government/921/960/_p118_aview_b3746.

Tazovskiy District in 2019 – 38%), i.e. from one quarter to more than half of the total number of dwellings are dilapidated or in disrepair. To fix this problem, the District Administration undertakes actions to extend the pool of available accommodation by construction of low-rise apartment blocks and single-family houses.

Before reviewing the housing stock in Antipayuta and Gyda, one should note that only 60% and 30% of the reported residents, accordingly, actually reside in these settlements, and the rest live in the inter-settlement territory. Therefore, information in the table below refers only to actual residents of the settlements.

Table 8.10: Housing facilities in Antipayuta and Gyda[485]

Settlement	Housing	Number of houses	Percentage in the housing stock total	Number of residents	Percentage of dilapidated houses and houses in disrepair
Antipayuta	Apartment blocks	57	94%	1425	56%
	Single-family houses	31	6%	225	55%
Gyda	Apartment blocks	31	99,6%	1206	15%
	Single-family houses	3	0,4%	10	0%

The above tabulated data show that a majority of residents of Gyda and Antipayuta settlements live in apartment blocks. More than a half of the Antipayuta housing was in the dilapidated condition, whereas in Gyda in such condition was just 15% of the apartment blocks.

By data of April 2020, the waiting list for improvement of housing conditions included 1,127 residents of Antipayuta and 2,812 of Gyda, which is 41% and 75% of the settlements' residents[486]. According to information provided by the Head of Gyda Settlement Administration in 2018, these figures include both actual residents of the settlements in need to improve housing conditions and nomads who seek permanent dwellings.

Figure 8.21: Residential houses in Antipayuta

The District Sustainable Development Programme for the period 2014-2020 provides for connecting Antipayuta and Gyda to the gas supply network. Gas pipeline to Antipayuta will be constructed from the Toto-Yakhinskoye field and to Gyda from the Ladertoyskoye field.[487] As of June 2020, both settlements were not provided with gas supply[488].

Centralised cold water is supplied to Antipayuta from the Antipayuta-Yakha and Payeta-Yakha rivers, meanwhile no centralised hot water supply is provided.[489] Water quality studies in the settlement identified increased iron and manganese concentrations in drinking water which may pose a health risk (refer to Section 8.12). In particular, high iron content may increase the risk of hepatopathy and hemopathy, allergy, and infarction. In Gyda, by analogy with Antipayuta, there is only cold water supply from surface water body intakes on the Yuntose and Gyda rivers. Earlier in both settlements, river water was distributed

[485] Programme "Sustainable Development of Rural Settlements in Tazovskiy Municipal District for the period 2014-2017 and until year 2020": https://tasu.ru/government/921/960/_p118_aview_b3746.

[486] According to information provided by the Administration of Tazovskiy District on 04.06.2020 under request.

[487] YNAO Governor Resolution of March 6 2017 "Comprehensive Regional Programme for Gas Supply of residential properties and utilities, industries and other organizations in YNAO for the period 2017-2021".

[488] According to information provided by the Administration of Tazovskiy District on 04.06.2020 under request.

[489] LEX-Consulting LLC (2016) Programme Document: Comprehensive Programme on Infrastructure Development in Antipayuta Settlement Municipality for 2017-2025.

straight to the users without any treatment and did not meet the applicable water quality standards[490]. However, water treatment facilities were installed in Antipayuta and Gyda in 2018 and 2020 to supply their residents with drinking water[491]. No centralised sewers are available in settlements, therefore, sanitary sewage is collected in septic tanks[492].

Figure 8.22: Residential houses in Gyda

District heating services provided by Tazovskiy subsidiary of Yamalkommunenergo JSC cover 100% of the total housing space in Antipayuta. The service provider operates two diesel-fired boiler houses. In Gyda, coverage by centralised heating is 100%, also using two boiler houses.

Construction of a new power plant for 3.2 MW is planned in the east of Antipayuta. At present, power supply is provided via the single transmission line from a power plant located at a distance of 19 km from the settlement. Equipment is outdated and depreciated. The development plan of Tazovskiy Municipal District also provides for construction of cogeneration plants in Gyda and Antipayuta, and at all trading stations.[493] As of June 2020, these plants have not been constructed. According to information provided by the Administration of Tazovskiy District, construction of power station of another type for 4 MW is planned in Antipayuta.

Residents of Tadebya-Yakha village live in huts and chums. Housing facilities in Yuribey village comprise a few houses, huts and chums (Figure 8.5).

Nomadic Nenets live in chums. These are customary portable dwellings made of long poles arranged to shape a conical structure (Figure 8.10). Traditional fur covers ("nyuki") are used in winter. In summertime, chums are covered with tarpaulin and other water- and wind-proof materials. A stove or a stone fireplace is arranged in the middle. Some families live in trailer huts equipped for residential needs. A desperate need for housing is experienced by old-age pensioners from among those who, prior to retirement, led nomadic life and now have to switch to a settled lifestyle, as well as by people with disabilities from indigenous minorities. Stand-alone generators, if any, are used for power supply.

8.15 Public Order and Law Enforcement

As reported by the Tazovskiy Municipal District Department of the MIA of Russia,[494] most of the crimes registered in the District (331) in 2019 were crimes of minor gravity – 139 cases (60.7%). In 2019, 54 grave crimes were committed, which is 2.5 times higher than the same indicator in 2018. In 2019, 887 offenses were recorded, of which more than 50% fall under Art. 20.21 of the Administrative Code (Appearance in public in a state of alcoholic intoxication) and Art. 20.1 of the Administrative Code (Petty hooliganism).

By data of the Administrative Area No. 10 of the MIA Department for Tazovskiy Municipal District[495] that exercises policing in Gyda settlement and Gyda Tundra, 14 crimes were committed in the territory in 2018,

[490] Decision of Tazovskiy District Court of YNAO dated July 20 2016.

(http://zpp.rospotrebnadzor.ru/Show/File/24906/решение%20по%20делу%20№%202-07-2016.pdf).

[491] According to information provided by the Administration of Tazovskiy District on 04.06.2020 under request.

[492] Ibid.

[493] Arkhivarius LLC. Op. cit. P. 23.

[494] Information and analytical memo on performance of Police Commissioners and Juvenile Justice Department in Tazovskiy Municipal District for 12 months of 2019: https://89.xn--b1aew.xn--p1ai/document/19384515

[495] Information and analytical memo on performance of Police Commissioners and Juvenile Justice Department in Tazovskiy Municipal District for 2018 (Administrative Area No. 10): https://89.xn--b1aew.xn--p1ai/document/15978784

of which 12 were solved. In addition, there were registered 29 offenses, of which neither related to the use of narcotic and psychotropic substances; however, 10 offenses were committed under alcoholic intoxication.

By data of the Administrative Area No. 11[496] in charge of policing in Antipayuta settlement and Antipayuta Tundra, 13 crimes were committed in the territory in 2018; all crimes were solved.

In total, 14 police officers are employed in the MIA Department for Tazovskiy District.

Voluntary watch groups are involved in the public order and law enforcement activities in accordance with the Federal Law of 02 April 2014 No. 44-FZ "On Community Participation in Public Order and Law Enforcement". There is also a Cossack squad in Tazovskiy which patrols streets in the township. The Community Council of Antipayuta provides assistance in maintaining public order at night time[497]. The Community Council of Gyda is involved in discussing programmes of public events, fire safety plans, and flood preparedness measures[498].

According to public domain data for 2019[499], 143 traffic accidents were recorded in Tazovskiy Municipal District, in which 22 people were injured. In 2018, 11 accidents that involved indigenous peoples were reported on winter roads, whereas in 2019 – 1 accident[500]. More than five thousand cars are registered in the District.

---

[496] Information and analytical memo on performance of Police Commissioners and Juvenile Justice Department in Tazovskiy Municipal District for 2018 (Administrative Area No. 11): https://89.xn--b1aew.xn--p1ai/document/15978852

[497] Information and analytical memo on performance of Police Commissioners and Juvenile Justice Department in Tazovskiy Municipal District for 2017 (Administrative area No. 11)// Official site of YNAO Department of MIA (https://89.мвд.рф/document/12042603)

[498] Information and analytical memo on performance of Police Commissioners and Juvenile Justice Department in Tazovskiy Municipal District for 2017 (Administrative area No. 11)// Official site of YNAO Department of MIA (https://89.мвд.рф/document/12042496).

[499] Krasny Sever newspaper "It was found out in Tazovskiy district which drivers more often get in a traffic accident" // website https://ks-yanao.ru/proisshestviya/v-tazovskom-rayone-vyyasnili-kto-iz-voditeley-chashche-popadaet-v-avarii.html

[500] According to information provided by the Administration of Tazovskiy District in response to the Ramboll inquiry.