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UNEP/GEF Project:
"Russian Federation: Support to the National Program of Action for the Protection of the Arctic Marine Environment"
NPO "Polar Foundation"

FINAL REPORT
for CONTRACT No. CS-NPA-Arctic-20/2010 of August 31, 2010
within the framework of pilot project
INVENTORY OF POLLUTION SOURCES AT THE AREA OF DECOMMISSIONED MILITARY SITES ON NEW SIBERIAN ISLANDS

For Contractor
Executive Director

_____Yu.F. Sychev
“16” December 2010

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Customer:	Institution “National Pollution Abatement Facility Executive Directorate”.
Contractor:	Non-Profit Organization “Foundation of Polar Research “Polar Foundation”.

Moscow, 2010

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ABSTRACT

Customer:	Institution "NATIONAL POLLUTION ABATEMENT FACILITY EXECUTIVE DIRECTORATE". (NPAF ED)
Base:	Contract No. **CS-NPA-Arctic-20/2010 of August 31, 2010**
Site:	Area of decommissioned sites of the RF Ministry of Defense on New Siberian Islands
Location:	Russia, Republic of Sakha (Yakutia), New Siberian Islands archipelago, Bolshoy Lyakhovsky and Kotelny Islands
Start of work:	01 September 2010
End of work:	30 November 2010
Scope of work:	Development of technology for the inventory of pollution sources at the area of decommissioned sites of the Russian Arctic. Assessment of pollution levels of the areas of decommissioned military sites on Bolshoy Lyakhovsky and Kotelny Islands.
Report:	Final report in Russian and English containing proposals for the elimination of pollution sources and remediation of contaminated soil areas in the surveyed area
Keywords:	Ministry of Defense sites, infrastructure, equipment, aerial photography, positioning, tank, drum, technical liquids, fuel and lubricant, pollution, sample, chemical analysis, PH, PAH, PCB, identification, remediation
Contractor's manager:	Executive Director Yu.F. Sychev

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INTRODUCTION

Decommissioned military sites are among the most important pollution sources in the high-latitude Arctic. Among them are the Ministry of Defense sites located on New Siberian Islands.

Twenty years have passed from the date of the withdrawal of military units from Bolshoy Lyakhovsky and Kotelny Islands. The waste has not been disposed and the areas have not been remediated. The environmental agencies of the Republic of Sakha (Yakutia) do not have necessary technical and financial capabilities to survey and remediate them.

The Global Environment Facility (GEF) through its United Nations Environmental Program (UNEP) funds the Project “Russian Federation: Support to the National Program of Action for the Protection of the Arctic Marine Environment” (UNEP/GEF Project). The Steering Committee of the Project at its meeting in Reykjavik on February 04-05, 2010 made a decision to continue work in this field and approved a project proposal aimed at recovering the environment at the area of decommissioned military sites on New Siberian Islands.

The work has been agreed upon with the General Staff of the RF Ministry of Defense.

Taking into account that the inventory of pollution sources are carried out for the first time and special expensive logistic operations are required for its implementation, in the course of planning the decision was made to increase the scope of work in order to provide the maximum cover of infrastructure facilities, which are potential pollution sources.
On Kotelny Island, in addition to the air-defense base, the area of the civil aerodrome Temp commissioned in 1949 and actively operated until the early 1990s was surveyed. Besides Kotelny Island the inventory of pollution sources was carried out at the area of a decommissioned MD site on Bolshoy Lyakhovsky Island.
The work performed allows to achieve to the fullest extent the objectives stated in the pilot project.

This pilot project continues a series of studies on the inventory of pollution sources at the former military sites of the Ministry of Defense in the Russian Arctic carried out by Non-Profit Organization “Foundation of Polar Research “Polar Foundation” in 2004-2008.

1. CHARACTERISTICS OF THE STUDY AREA

New Siberian Islands is an archipelago located in the Arctic Ocean between the Laptev and East Siberian Seas – Figure 1.1. They were discovered in the eighteenth century. The area of the islands is about 38 thousand square kilometers. Administratively, they belong to the Republic of Sakha (Yakutia).

Figure 1.1 – New Siberian Islands archipelago

The archipelago consists of more than 20 islands united in three groups:

- Lyakhovsky islands on south (6,1 thousand square kilometers);
- New Siberian Islands proper or Anzhu (29 thousand square kilometers), including Novaya Sibir and Belkovsky Islands, the largest in the archipelago Kotelny Island and Faddeyevsky Island both linked by Bunge Land;
- De Long Island.

The archipelago islands consist of rocks different in age and lithology. Paleozoic limestones, Mesozoic slates, sand rocks and granitoids prevail. Quaternary alluvial, lake and marine sediments penetrated by subsurface ice sheets are found everywhere.

The terrain was created in the Mesozoic Era and consists of plateau-like surfaces with separate hills of up to 426 m (Bennett Island) and sunken plains. Frost wedging and eolation occurs on all islands resulting in formation of stone figures and agglomerate of sharp-edged fragments of bedrock.

Contemporary glaciation takes place on De-Long Island only; however, subsurface ice is widely spread on all islands. On Bolshoy Lyakhovsky Island, they occupy 80% of the area. Vertical ice wall rises tens of meters above the sea. The remains of mammoths, rhinoceros and plants are found

in subsurface ice. On south of Bolshoy Lyakhovsky Island, a protective zone of mammoth fauna was established.

The landscape of the islands is Arctic deserts and tundras. Soil cover is weakly developed. Herbaceous vegetation forms separate turfs consisting of rockfoil, tormentil, yellow Iceland poppy, icy bennet, mountain avens, herbs among which mosses and lichen grow.

The main flora species are polar bears, lemmings, wolves, foxes and wild deers. Many of them move to the mainland in wither. In summer, a lot of birds migrate there. In the seas close to the coast, there are walruses and seals. Also there are many rare animals and birds from the Red Book.

Bolshoy Lyakhovsky and Kotelny Islands differ from most archipelago islands. Their surface crosses stony hills, the hydrographic network is well developed, river and creek valleys are well cut-in. The rocky precipices are well developed on Kotelny Island. The highest point of Kotelny Island is Mount Malakatyn Tas (374 m); that of Lyakhovsky Island is Mount Emy Tas (311). The driftwood is in abundance on the coast beaches. There are many herds of wild deer are many there since the deers prefer drier elevated areas.

Before up to 50-60 people lived on the island at the same time, including geologists, geophysicists, surveyors and hunters. Small population of the New Siberian Islands gravitated to the settlement of Temp on Kotelny Island, which is an informal capital of the archipelago. Polar stations worked on the islands, including those on Lyakhovsky from 1933. The Ministry of Defense sites have functioned for a long time.

Currently, the islands are practically uninhabited. Temp is abandoned just as the areas of former military sites. Only polar stations are working. Quasi-legal hunting of Arctic fox takes place. The nearest population center is Tiksi.

The archipelago's climate is arctic and severe formed under the influence of surrounding icy seas, Arctic front and cyclones from the Barents Sea. The Asian maximum and Siberian glades also affect the climate, from which winds blow to cause fogging.

Tables 1.1 – 1.3 and Figure 1.2 show the islands' temperature conditions.

Table 1.1 – Air temperature, º C

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Bolshoy Lyakhovsky, Shalaurov Cape													
average monthly and yearly	-30.9	-31.4	-28.5	-20.7	-8.8	-0.1	2.5	2.4	-0.5	-10.2	-22.5	-28.0	-14.7
average maximum	-27.6	-28.3	-24.8	-16.7	-5.8	2.2	5.4	4.7	1.0	-8.0	-19.5	-24.9	-11.9
average minimum	-34.2	-34.0	-31.8	-24.4	-11.8	-1.9	0.4	0.6	-2.2	-12.9	-25.8	-31.2	-17.4
Kotelny													
average monthly and yearly	-30.2	-30.6	-28.2	-20.9	-9.3	-0.4	2.6	1.9	-1.8	-11.5	-22.3	-27.0	-14.8
average maximum	-26.7	-27.8	-24.6	-17.2	-6.7	1.5	5.4	4.1	-0.3	-8.8	-19.1	-23.7	-12.0
average minimum	-33.6	-34.1	-31.6	-24.8	-12.2	-2.1	-0.5	0.0	-3.7	-14.8	-25.9	-30.4	-17.8

Table 1.2 – Dates of temperature transition through 0º C

Bolshoy Lyakhovsky	*Kotelny*

spring		autumn		spring		autumn	
early date	late date	early date	late date	early date	late date	early date	late date
29/V	26/VI	18/VIII	30/IX	02/VI	13/VII	04/VIII	29/IX

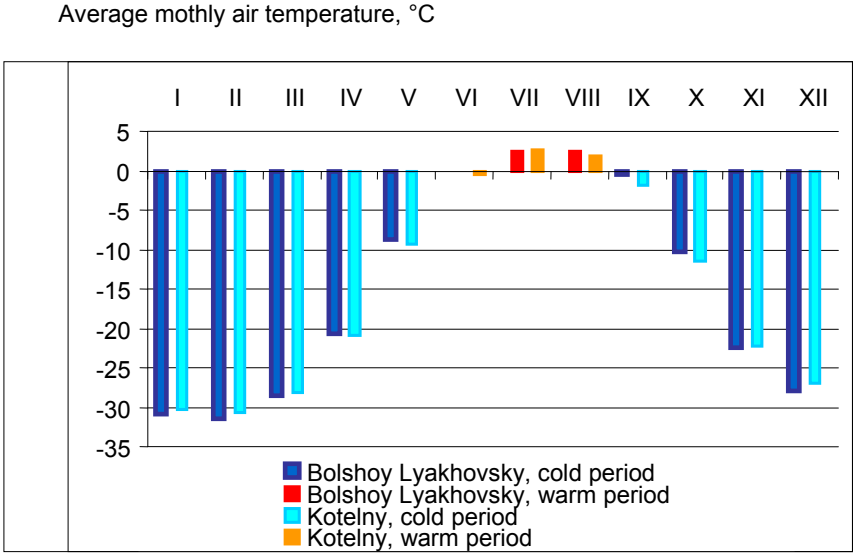


Figure 1.2 – Annual variation of air temperature

Table 1.3 – Number of days per year with a temperature below the established values

Temperature	-45 ° C	-40 ° C	-35 ° C	-30 ° C
Bolshoy	0.5	10.5	46.9	97.9
Kotelny	0.1	8.0	41.9	97.6

An average annual temperature on the islands is close to -15 ° C. More than 3 months per year temperature is below -30º C, about 10 days – below -40º C. The coldest months are January and February. Summer on the islands is short and cold. Average monthly temperature of the warmest July and August does not exceed 3º C. A frost-free season does not occur on Kotelny Island with a probability of 94%; on Bolshoy Lyakhovsky – wih a probability of 92%. Freezing is possible the year round.

Sunshine duration is from 1100 to 1300 a year. The biggest number of sunny days is observed in April – from 250 to 300 hours.

Strong wind blowing is a distinctive feature of the islands. South winds prevail in winter; north winds – in summer. Tables 1.4 and 1.5 give the main parameters of wind conditions.

Table 1.4 – Wind speed characteristics, m/s

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Bolshoy Lyakhovsky, Shalaurov Cape													
$V_{average}$	5.1	4.7	4.8	5.6	5.9	6.0	5.9	6.0	5.8	5.6	5.0	5.0	5.5
$V_{maximum}$	34	27	38	24	26	28	24	24	27	28	30	34	38
Kotelny													
$V_{average}$	5.6	5.5	5.5	5.6	6.0	6.2	6.0	6.3	6.5	6.1	5.4	5.7	5.9
$V_{maximum}$	28	25	31	34	26	24	25	24	22	28	20	28	34

Table 1.5 – Number of days per year with wind speed equal to or exceeding the established values

Speed, m/s	≥ 8	≥ 15	≥ 20
Bolshoy Lyakhovsky	176.4	25.8	6.5
Kotelny	197.4	39.3	5.8

Squalls (V≥15 m/s) are observed on Bolshoy Lyakhovsky and Kotelny Islands 26 and 39 days a year in average. The maximum speeds reach 38 and 34 m/s respectively. In terms of the annual distribution the strongest winds blow in summer and autumn months

Table 1.6 and Figure 1.3 show the main parameters characterizing the area.

Table 1.6 – Characteristics of precipitation

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Bolshoy Lyakhovsky													
monthly and yearly total, mm	10	8	8	10	16	17	28	30	23	20	13	10	193
average daily maximum, mm						5	9	8	5				
duration of precipitation, hour	90	71	78	82	147	96	102	132	144	205	110	91	1348
Kotelny													
monthly and yearly total, mm	11	11	11	10	13	15	30	27	17	16	12	11	184
average daily maximum, mm						5	9	8	4				
duration of precipitation, hour	122	119	126	141	240	140	123	156	195	269	180	143	1954

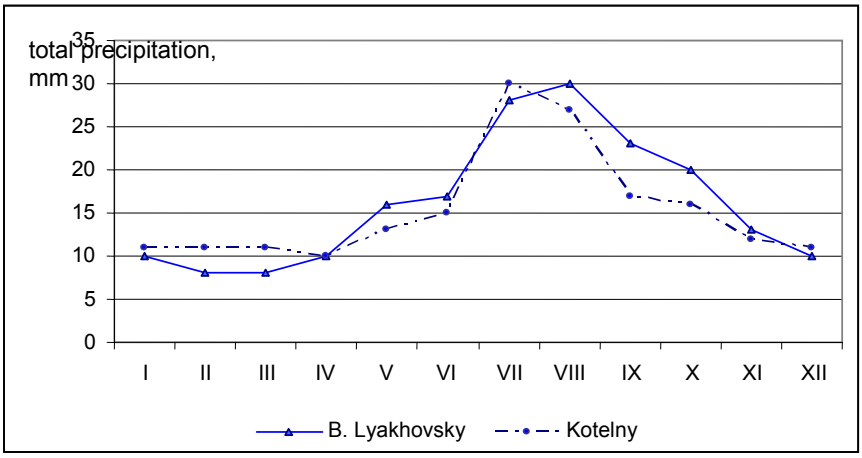


Figure 1.3 – Annual distribution of precipitation

Annual precipitation on the islands does not exceed 200 mm; average daily maximums – 10 mm. Within the year precipitation is distributed irregularly: monthly totals in summer month are 2.5-3 higher than those in winter.

Snow cover on the archipelago is present for 9 months of the year. An average number of snow cover days is 268±13 on Bolshoy Lyakhovsky and 278±13 on Kotelny Island. Snow depth is not high. Most part of winter, its depth does not exceed 20 cm; the maximum value in winter is 40-48 cm – Table 1.7.

Table 1.7 - Depth of snow cover, cm

Month	X	XI	XII	I	II	III	IV	V	Maximum in winter		
									aver.	max	min
Bolshoy Lyakhovsky	10	11	13	14	16	17	19	23	26	40	17
Kotelny	12	17	19	21	22	23	26	24	28	48	21

2. MAJOR PROJECT OBJECTIVES AND PROCEDURES FOR THEIR ACHIEVEMENT

2.1 Major Project objectives

Figure 2.1 shows the location of decommissioned sites of the Ministry of Defense. They are located in west end of Bolshoy Lyakhovsky (Kigilyakh Cape) and north-west part of Kotelny Island close to the Stakhanovtsev Arktiki Bay.

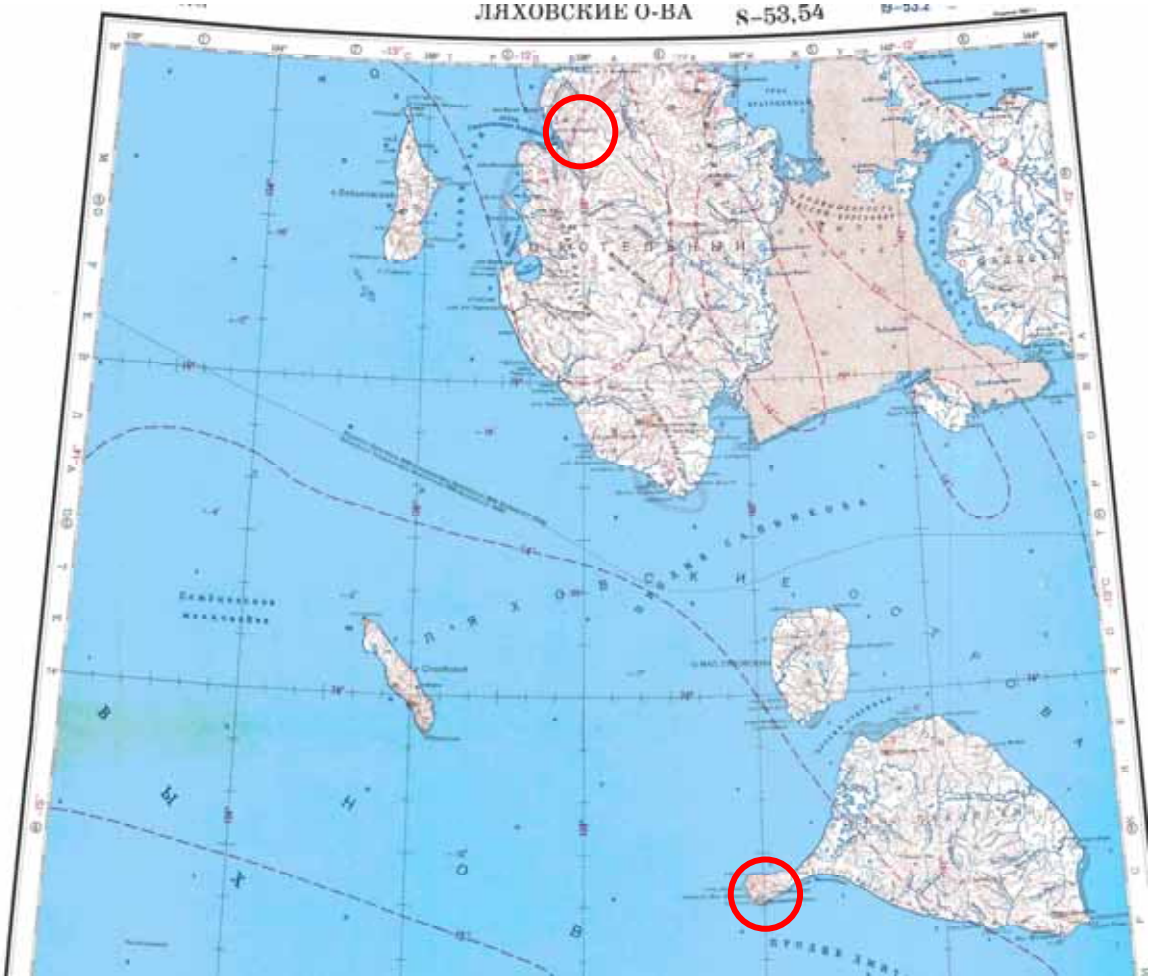


Figure 2.1 – Location of former military sites on Bolshoy Lyakhovsky and Kotelny (sheet S-53,54 M 1:1000000)

The sites were commissioned in the 1960s and have been operated for a long time negatively impacting the environment. Mass delivery of fuel surely caused an accidental spill during its transportation and storage to lead to pollution of soil cover with petroleum hydrocarbons (PH). Fuel combustion resulted in emission of combustion gases into the environment, the most toxic of which are polycyclic aromatic hydrocarbons (PAH). Due to low temperatures (average annual temperature is about -15 º C) and relatively dry climate (less than 200 mm of precipitation per year), the decay of organic matter is very slow and its discharge by land runoff is insignificant. So one may expect that the level of pollution, achieved during the operation of the sites, remains high enough.

According to information from environmental agencies of the Republic of Sakha (Yakutia), the sites have not been operated for about 20 years. After the withdrawal of military units, there were abandoned infrastructure facilities, building of different purposes, military equipment, airfield, radar and other technological equipment, numerous accumulations of 200-L metal drums with oil products, spent oils and different technical liquids, cisterns for fuel and lubricant storage, domestic and construction waste.

The conservation of the sites, disposal of waste and remediation of the area has not been done. The sites were intensively degraded. In spite of the inaccessibility of the islands, the marauding took place. As a result, a significant amount of pollutants is released into the environment. In spite of the point character of pollution, pollutant fluxes are overlapped and mixed due to a large number of sources and their intensive migration with their dispersion towards slope runoff. Pollution acquires an areal character.

Due to deteriorating equipment and containers, the current level of man-made impact both in intensity and composition of chemical substances released into the environment may significantly exceed that of the previous period.

On this basis, the main objective of the Project is to take inventory of the current state of the Ministry of Defense sites with the assessment of environmental pollution in the affected area

2.2 Procedures for the inventory of former military sites

The procedures have been developed taking into account the sites' specific features. Their key points are given below:

1. The areas to be studied occupy a significant area. The sites themselves are located at a distance of several hundreds of meters from the coast. Pollutant migration occurs within the sea slope. There are a lot of abandoned equipment, accumulations of drums and other containers on the coastal strip. This territory is considered an affected area and is subject to mapping.

2. Work conditions practically exclude the terrestrial geodetic survey. In this connection, aerial photography from helicopter is used for mapping with further positioning of the images using satellite receivers (at least 5 points for a block of images).

3. Aerial photography is complemented with terrestrial survey. The composition of the objects present at the site is determined (infrastructure elements, technological equipment, accumulations of drums, fuel and lubricant storage facilities, dumps, and abandoned

equipment), their state, extent of equipment and container wear and presence of leaks is recorded. The sampling points are determined according to the results of reconnaissance.

4. The indicator of the level of man-made impact in the pollution source impact area is the state of depositing environments (soils, bottom sediments) able to accumulate pollutants. Soil samples were taken within the sites, i.e. in the places of compact locations of the sources and adjacent areas in pollutant accumulation zones (drainless terrain depressions and dishes) and migration zones (narrows, hollows and creeks).

5. The state of the sites is assessed according to an accumulation level of pollutants in soil, which are of priority for this site:

5.1. The main ones in the list of potential pollutants are petroleum hydrocarbons (PH). PH pollution has an areal character. There are accumulations of drums, cisterns and other containers both at the sites and adjacent territory up to the coastal area. Due to cold climate PH can be found in wet soils for a long time with no decay. With surface runoff, oil pollution is transported ashore and then into the sea. Due to the ice and low chemical and biological activity of Arctic waters, oil remains in sediments and on shore for a significantly longer period (10 years and more) than in temperate or tropical climate where oil can remain in water for about 6 months.

5.2. The second most important pollutants are polycyclic aromatic hydrocarbons (PAH). Their emission into the environment as applied to the sites under study is caused by fuel combustion. The sources were Diesel plants, boiler houses, combustion engines of military vehicles as well as petroleum hydrocarbons released into the environment. The substances belonging to the PAH group are of hazard class I since they have a high chemical stability and strongest mutagenic, teratogenic and cancerigenic potential. The integrated toxic effect on humans allows consider PAH as the agents transforming the biosphere due to their strong negative impact on present and future generations of organisms. In Arctic conditions the processes of destruction of these chemical compounds are very slow, which is an additional factor increasing their hazard for the environment. The following priority substances are distinguished in the PAH group: naphthalene, benzo(a)pyrene, acenaphthylene, acenaphthene, fluoranthene, fluorene, phenanthrene, anthracene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h) anthracene, indeno(1,2,3-c,d)-pyrene, benzo(g,h,i)perylene

5.3. There is technological equipment at the sites containing polychlorinated biphenyls (PCB). PCB make part of a group of 12 compounds and a group of compounds recommended by the UNEP (United Nations Environmental Project) for determining in the environment components in the course of environmental studies. This list was a result of a number of international consultations and forums. The main result of work was the adoption and signing of the Convention on Persistent Organic Pollutants (POP) in Stockholm, on May 23, 2002, which Russia joined. PCB are one of the most widely spread POP. They have been widely produced and used since 1929. Since then and until 1986, when their

production was banned, about 2 millions tons of PCB have been produced. Currently, pollution with these xenobiotics covers the entire biosphere. Physico-chemical properties provide PCB's long lifetime (years and decades) in abiotic environments and their ability to accumulate in sediments, soils, and fatty tissue of living organisms. The main routes of PCB release into the environment of the sites under study are leaks from transformers, condensers, heat-exchangers, pumps and other PCB-containing equipment; ignition of equipment; dumps in which there can be found condensers and build-up systems of some types of fluorescent lamps; burning of domestic and industrial waste. 209 PCB distinct congeners exist having a formula $C_{12}H_{10-n}Cl_n$, where n=1-10. Up to 100 distinct congeners can be usually detected in the environment (air, aquatic biota, bottom sediments, soil and plants), among which the following ones are of priority: #28, #31, #52, #99, #101, #105 , #118, #128, #138, #153, #156, #170, #180, #183, #187, #209.

5.4. Heavy metals (HM) are also of priority for the sites under study. The main source of their release into the environment was fuel combustion. The other ones, significantly less intensive, are the burning of garbage, engine emissions, leaks of technical liquids and destruction of technological equipment. Heavy metals accumulate in soils and are very slowly removed with dealkalization, consumption by plants (especially in Arctic conditions), erosion and deflation. The period of semi-removal for zinc is from 70 to 510, for cadmium from 13 to 110, for copper from 310 to 1500 and for lead from 740 to 5900 years. Hazard class 1 have been included in the HM group to be detected in soils (mercury, cadmium, lead, zinc); hazard class 2 – (copper, nickel, cobalt, chrome) and hazard class 3 – (manganese).

6. For reliable differentiation of man-made component of soil pollution with heavy metals and benzo(a)pyrene (the most stable PAH in the environment), baseline samples are taken. The geochemical background characterizes an average natural content of chemical substances and compounds in natural bodies within a homogeneous geological and landscape-geochemical area. When selecting a background area, its farness from pollution sources and absence of visible signs of economic activity are taken into account.

7. To assess potential hazard of environmental pollution, the presence of fuel and lubricant residuals is determined in stored and scattered containers at the area. PCB-containing equipment and tanks with different types of liquid waste (spent oils and others) and technical liquids are revealed. The above pollution sources are visually inspected and the liquids are selected for chemical analysis.

8. The samples selected are studies in the laboratory. PH (priority pollutant), PAH – selectively (total and composition for 16 components, PCB (14 congeners) and heavy metals are determined in soil samples. The samples of technical liquids are identified and then selectively analyzed for PCB and HM.

9. The data of chemical analysis are interpreted and pollution level is assessed using common system of criteria. During the assessment, the preference is given to a concentration factor C_f, expressing the element content in soil in fractions of background concentration:

$C_c = C_i / (C_i)_b$ (1), where

C_i - concentration of i element in natural body;

$(C_i)_b$ - background concentration of the same element.

This parameter takes into account regional geochemical properties of the area. The comparison with health standards plays role of auxiliary assessment the use of which is difficult due to an underdeveloped MPC system for pollutants in soil.

10. 1:1000 scale orthophoto maps are created according to aerial photography results. Infrastructure elements and main pollution sources are assessed using orthophoto maps terrestrial survey materials; the area of man-made disturbed zones, number of drums and other containers in the locations of their compact storage and direction of pollutant migration is visually assessed

11. For visualization of quantitative indices of the environment state, digital thematic maps are generated, using which the territory is approximately differentiated according to pollution level.

3. SCOPE OF WORK AND PROCEDURES FOR ITS IMPLEMENTATION

In addition to the air-defense base on Kotelny and Bolshoy Lyakhovsky Islands, the area of the civil aerodrome Temp was surveyed.

3.1 Preparatory stage

The following work has been done during the preparatory stage:

1. Collection and analysis of cartographic materials (1:100000, 1:500000, 1:200000 scale maps of the study areas).
2. Development of the field work program.
3. Field team equipment:
    - purchase of the tools for soil sampling (shovels and knives), containers for their storage and further transport;
    - purchase of Cordless Driver-Drill *Makita* model 6347DWAE for opening containers with fuel and lubricants and technical liquids; Ø 85 mm drill heads; two power supplies *Makita 1822 18 V, 2.0 Ah,* each of which is enough for 20 minutes of off-line operation; DC1804T charger;
    - manufacturing of samplers for technical liquid sampling, purchase of expendable materials (disposable gloves and cones) and containers for samples;
    - purchase of expendable materials (waterproof markers, scotch tape and packing material).
4. Safety briefing for the field team about work in Arctic conditions and handling of liquid and solid waste and toxic substances.
5. Organizational arrangements for the transportation of the field team to the study area and back.
6. Making of contracts with subcontractors including those for aerial photography of the islands and analytical treatment of samples.

3.2 Field work

Aerial and terrestrial survey of decommissioned military sites on Kotelny and Bolshoy Lyakhovsky Islands was performed September 28-30, 2010 by a 4-people field team.

The equipment and expeditionary team was transported from Tiksi to New Siberian archipelago by the Research Vessel "Mikhail Somov". The 2nd Arkhangelsk United Aviation Division's helicopter MI-8T based on the expeditionary vessel was used for the transportation of the field team to the study area and aerial photography. After the completion of work the field team was brought to polar station Valkaray and then to Pevek Port by off-road vehicle.
The field work at the sites included as follows:

- ground mapping;

- terrestrial survey and photo-documenting of the state of infrastructure facilities, technological equipment and main pollution sources;
- soil sampling;
- technical liquids sampling;
- baseline soil sampling.

Ground mapping was carried out by an expert from LLC Aeroekologia. The license for geodetic activity is shown in Appendix 1.

Using an inhabited aircraft (helicopter MI-8) the site was shot by a calibrated digital camera Canon EOS 5D (13 Mpix). The photography was carried out through a hatch in the helicopter floor with the following settings:

Bolshoy Lyakhovsky:	Exposure	-	1/1000s
	Sensitivity	-	ISO 1600
	Stop	-	f/10 – f/13
	Height	-	1000m
	Between routes	-	400m
	Number of images	-	76 pcs
	Resolution of images	-	20cm/pixel
Kotelny:	Exposure	-	1/2000s
	Sensitivity	-	ISO 800
	Stop	-	f/2.8 – f/4.6
	Height	-	500m
	Between routes	-	200m
	Number of images	-	314 pcs
	Resolution of images	-	10cm/pixel

The compilation survey was performed using 2 geodetic satellite GPS-GLONASS receivers (Topcon Hiper+ GGD). One of them was used as a base station. The second one was used for receiving the coordinates of reference points. The both receivers were initialized after the cold start. The base station remained stationary during the entire survey and recorded data. The second receiver recorded the coordinates of the site's reference points in Stop-and-Go mode. A stay in each of them lasted at least 5 minutes.

The reference points were well-decipherable contour points. The substantiation was performed in a false grid system (approximated to UTM WGS 84).

In the course of terrestrial survey the main pollution sources were revealed at each site, i.e. Diesel plants, boiler houses, radar stations, military equipment, technological equipment, 200-L drum storage places, cisterns for fuel and lubricants, containers with technical liquids and waste, dumps, etc. The state of pollution sources was visually assesses and photo-documented.

Following the results of reconnaissance survey, the soil sampling points were selected. The samples were taken:

- close to local sources, in the place with visual pollution (at the bottom of large accumulations of drums, under the gantries, near buildings and processing installations);
- on the outer contour of contaminated territory at the area of pollutant migration (sea boundary, areas with lower terrain;
- in pollutant accumulations (drainless terrain microdepressions and dishes);
- at the areas of pollutant transport (valley bottom and blind creeks)

Soil and ground samples were collected according to GOST 17.4.3.01-83, 17.4.402-84. A 1x1 m area was cleaned from snow. The coordinates were determined using GPS receiver (determination accuracy – 5 m). The samples were collected from the upper 20 cm layer using an "envelope" method. Individual samples were mixed, cleaned from large stones, pebbles, blocks of ice, chips and other mechanical garbage and then were packed in previously numbered containers. The weight of a final sample was at least 2 kg. A container number was assigned to the sample and was recorded in GPS. Then the sample number and brief description of the sampling point were recorded in a recorder.

For sampling of technical liquids, the containers were previously differentiated based on their volume and appearance. Their integrity and fullness were assessed. Different liquids, if possible, were selected for identification and chemical analysis. The containers were opened using a professional instrument to make the orifices of about 10 cm in diameter. The orifices were drilled above the liquid level. A one-use kit was used for sampling (gloves, sampler and funnel). If the level of liquid in a drum was low, the container was filled through this orifice. In other cases, the sampler was used to extract the liquid consisting of a 0.5-L plastic container put on a long stick. The volume of sample is 1 L (two containers of 0.5-L each). After the sampling, the orifice was closed with polyethylene film.

Mechanisms and processing installations were not opened. Their type was determined, if possible, and the presence of labels was documented. Extent of wear and presence of leaks were visually assessed.

A water sample was taken from a creek accumulating the runoff from sites No. 4 (radar station) and No. 6 on Kotelny Island to assess pollution migration.

Baseline samples were taken on each island to be surveyed at the areas not exposed to pollution source impact. The location of a baseline area was selected from helicopter. The distance from the Ministry of Defense sites exceeded 10 km. Baseline sample consisted of 10 individual samples collected using an "envelope" method from two sites located within a relatively plain area having an underlying surface identical to that of the main site.

The samples are transported and stored at a temperature of 0-6°C until their delivery to the laboratory

3.3 Chemical-analytical study

Chemical-analytical study of soil and technical liquid specimens was carried out at the following laboratories:

1. Environmental Center of the RF Ministry of Defense. The Certificate and Accreditation Scope are given in Appendix 2. In the Center laboratory, soil samples were chemically analyzed for PH content. The analysis was made according to PNDF 16.1:2.21-98 (version 2007) Technique of measurement of mass fraction of oil products in soil and ground samples by fluorimetric method using a liquid analyzer "Fluorat-02". Information on the used analytical equipment calibration is given in Table 3.1.

Table 3.1 – Information on the Environmental Center of the RF Ministry of Defense equipment calibration

No.	Analytical equipment	Information on calibration
1	Equal-arm laboratory balance VLR-200, serial No. 813	Valid till 14.05.2011
2	Liquid analyzer "Fluorat-02", serial No. 2110	Valid till 21.10.2011

2. LLC "I.K.M. Engineering's" Test Laboratory "Marintest". The Certificate and Accreditation Scope are given in Appendix 3. In the Center laboratory, soil samples were chemically analyzed for the identification; selective determination of PCB and HM in liquid and soil samples and determination of PAH (composition) in soil samples.

A list of tools, equipment and reference specimens used for chemical-analytical study is given in Appendix 4.

A list of regulatory and procedural guidelines for quantitative chemical analysis is given in Appendix 5.

The composition and properties of oil products, transformer and condenser oils were determined according to regulatory documents used for input and acceptance control and also ISO and ASTM.
The content of polychlorinated biphenyls in technological liquids and heavy metals was analyzed according to ASTM D6160-98, IP470/03, ASTM D6160-97 ASTM D3831-98.

Chemical-analytical study of soils was made according to the methodologies included in the State Register of Quantitative Chemical Analysis Methods (Quantitative Chemical Analysis of Water. Quantitative Chemical Analysis of Soils and Wastes. Quantitative Chemical Analysis of Atmosphere Air and Atmospheric Discharge. Toxicological Control Methods. M. GUAK (State Department for Analytical Control) 1998, with amendments of 1999 – 2009)

A brief description of the analysis methods of soil and technical liquid samples is given in Tables 3.2 and 3.3.

Table 3.2 – Soil sample analysis methods*

Index, substance	Method	Lower limit of operating range, mg/kg	Determination error on the lower limit of operating range**, %
Heavy metals *(specimen weight 10 g)*			
mercury	AAS with analyzer RA 915	0.0050	±45
lead, cobalt, copper, manganese	Atomic absorption spectrophotometer	0.2	±30
cadmium		0.01	±30
nickel		0.3	±30
zinc		1.0	±30
chrome		0.5	±30
Polycyclic aromatic hydrocarbons PAH (composition) *(specimen weight 0.5 kg)*			
benzo(a)pyrene, acenaphthylene, acenaphthene, fluoranthene, fluorene, phenanthrene, anthracene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene	High-efficiency liquid chromatography	0.0012	±40
dibenzo(a,h)anthracene, indeno(1,2,3-c,d)-pyrene benzo(g,h,i)perylene	High-efficiency liquid chromatography	0.0012	±50
Polychlorinated biphenyl (PCB) *(specimen weight 50 g)*			
#28, #31, #52, #99, #101, #105, #118, #128, #138, #153, #156, #170, #180, #183, #187, #209	Gas-liquid chromatography	0.000050	±40

** - to perform analysis, soils were dried down to a constant weight using freeze dryer Alpha-1-4*
*** - determination errors for other concentration within the operating range are given in the metrological certificate of Measurement Procedures*

Table 3.3 – Technical liquid analysis methods

Index to be determined	Regulatory document, regulating the analysis	Notes
density at 20 º C	GOST 3900-85 Oil and oil products. Methods for determination of density using areometric method	corresponds to ISO 3675:1998 (E)
density at 15 º C	GOST R 51069-97 Oil and oil products. Methods for determination of density and relative density in API degrees using areometer	corresponds to ASTM D 1298-99
density	ISO 12185:1996 Crude oil and oil products – determination of density. Oscillation U-Tube Method	vibration meter VIP 2-M
** areometric method is arbitrary*		
viscosity	GOST 33-2000 Oil products. Transparent and opaque liquids. Determination of kinematic viscosity and calculation of dynamic viscosity	corresponds to ISO 3104-94 and ASTM D 445-97
viscosity index	GOST 25371-97 Oil products. Calculation of viscosity index by kinematic viscosity	corresponds to ISO 2909-81
flash and ignition points in open crucible	GOST 4333-87 Oil products. Methods for determination of flash and ignition points in open crucible	corresponds to ISO 2592-73 and ASTM D 92-98a
flash and ignition points in closed crucible	GOST 6356-75 Oil products. Methods for determination of flash and ignition points in closed crucible	corresponds to ASTM D 93-00

water content	GOST 2477-65 Oil products. Methods for determination of water content	corresponds to ISO 3733-76
water content	Potentiometric Karl Fischer titration method according to ISO 6296:2000	
*** GOST 2477-65 distillation method is arbitrary*		
mercaptan and hydrosulphuric sulphur	GOST 17323-71 Methods of test for mercaptan and hydrosulphuric sulphur by potentiometric titration	corresponds to ASTM D 3227-04a
acidity	GOST 5985-79 Oil products. Methods of test for acidity and acid number	corresponds to ASTM D 664-95
alkali neutralization number	GOST 11362-96 «Oil products and lubricants. Alkali neutralization number. Potentiometric titration method	corresponds to ISO 6619-88 and ASTM D 4739-96
presence of water-soluble acids and alkalis	GOST 6307-75 Oil products. Methods of test for the presence of water-soluble acids and alkalis	
mechanical admixtures	GOST 6370-83 Oil, Oil products and admixtures. Methods of test for mechanical admixtures	corresponds to ASTM D 473-81 (1995)
sulphur content	GOST 51947-2002 Oil and oil products. Determination of sulphur by energy-dispersive X-ray fluorescence spectrometry method	corresponds to ASTM D 4294-2003
pour point	GOST 20287-91 Oil products. Methods of test for flow point and pour point	corresponds to ASTM D 97-96a
ash content	GOST 1461-75 Oil and oil products. Methods of test for ash content	corresponds to ASTM D 482-00a
sulphated ash in oils	GOST 12417-94 «Oil products. Methods for determination of sulphated ash	corresponds to ISO 3987-80

Quality control of data on the content of PAH and HM included analysis of blank samples, standard solutions, duplicated specimens, specimens with the same matrix composition having a known content of target components and also control of calibration by standard solution of the compounds to be analyzed.

Russian-made state standard samples were used as calibration standards; certified standard solutions made by the ULTRA Scientific (USA) were used to control the calibration.

Quality control of data obtained on the content of PCB in soils and technical liquids included the calibration of the chromatographic analytical system by standard solutions having an international certificate and a similar scope of work on the analysis of blank samples, standard solutions, specimens with the same matrix composition having a known content of target components and duplicated specimens of soils and technical liquids

Certified standards made by the ULTRA Scientific (USA) and Russian-made state standard samples were used as calibration standards.

The specimens distributed within the QUASIMEME Program were used as matrix specimens.

3.4 Processing and interpretation of chemical analysis results

The following notions and criteria were used during the processing of analytical materials whose mean is explained below.

Background element content (BC) is a local characteristic, which is an average content of chemical elements in natural bodies determined based on data of the study of their natural variation within a homogeneous geological and landscape-geochemical area.

Concentration factor (Cf) is a degree of element accumulation comparing to the natural background:

$Cf = Ci / (Ci)b$,

C_i - concentration of i element in natural body; $(C_i)_b$ – its background concentration of.

Man-made geochemical anomaly is a territory, within which statistical parameters of chemical elements distribution of one of its natural bodies definitely differ from the geochemical background. The concentration factor is a numerical expression of the anomaly intensity. A value Cf = 2-3 corresponds to a definite difference.

Total pollution index Zc is a quantitative characteristic of man-made anomaly of polyelemental composition:

$Zc = \sum_{i=1}^{n} (Kf)i - (n - 1),$ where *n* is a number of components to be accounted (priority pollutants).

Series of accumulations is priority pollutants listed in decreasing order of C_f.

Maximum permissible concentration (MPC) and approximate permissible concentration (APC) are parameters established by Rospotrebnadzor regulatory documents:

- Health Standard 2.1.7.2041-06. Maximum permissible concentrations (MPC) of chemical substances in soil;
- Health Standard 2.1.7.2042-06. Approximate permissible concentrations (APC) of chemical substances in soil.

The Russian regulatory documents establish MPC and APC (according to individual values or sum of compounds of a specific group) for 14 chemical elements (compounds) only out of all pollutants detected in soils of decommissioned sites. In this connection, according to Appendix B in addition to Building Regulations SP 11-102-97 "Engineering environmental site investigations for construction", international criteria of environmental assessment of soil pollution according to Neue Niederlandische Liste. Altlasten Spektrum 3/95 and Brandenburgische Liste. AbschluBentwurf 27.7.1990 were used. Niederlandische Liste and Brandenburgische Liste establish permissible concentrations (PC) and intervention level (IL) concentrations. The values of pollutant MPC and APC permissible concentrations (PC) and intervention level (IL) concentrations are given in Table 3.4.

Table 3.4 – MPC, APC, PC and IL of pollutants in soils

Pollutant	Class of hazard	Standard according to Health Standards 2.1.7.2041-06 and 2.1.7.2511-09		Standards, established by Neue Niederlandische Liste. Altlasten Spektrum 3/95**	Permissible concentrations, mg/kg, established by Brandenburgische Liste.AbschiuBentwurf 27.7.1990
		MPC, total, mg/kg	APC. total, for different types of soil, mg/kg		

								category*		
			Sandy and sandy-loam	Acidic (loam and clay). pH KCl<5.5	Close to neutral. neutral (loam and clay). pH KCl>5.5	PC mg/kg	IL mg/kg	I	II	III
Mercury	1	**2.1**	NE	NE	NE	**0.3**	**10**	0,5	1	10
Lead	1	**32.0**	**32**	**65**	**130**	**85**	**530**	100	500	600
Cadmium	1	NE	**0.5**	**1.0**	**2.0**	**0.8**	**12**	2	10	20
Cobalt	2	NE	NE	NE	NE	**20**	**40**	100	200	300
Nickel	2	NE	**20**	**40**	**80**	**35**	**210**	200	250	300
Copper	2	NE	**33**	**66**	**132**	**36**	**190**	200	300	600
Zinc	1	NE	**55**	**110**	**220**	**140**	**720**	500	2000	3000
Manganese	3	**1500**	NE	NE	NE	NE	NE			
Chrome total	2	NE	NE	NE	NE	**100**	**380**	150	400	600
Oil products (total)	3	NE	NE	NE	NE	**50**	**5000**	300	3000	5000
Benzo(a)pyrene	1	**0.02**	NE	NE	NE	NE	NE			
Total PAH		NE	NE	NE	NE	**1**	**40**	10	50	100
Total PCB	1	NE	NE	NE	NE	**0.02**	**1**	1	3	5

* *Site categories: 1- water protection area; II- ancient river valleys; III – watersheds*

*** The most rigorous foreign standards have been selected (Neue Niederlandische Liste)*

Assessing the level of soil pollution, the preference is given to a concentration factor $\mathbf{C_f}$ taking into account regional geochemical properties of the area. Comparison with health standards plays a role of auxiliary assessment, which is less correct due to the imperfection of current MPC (APC) system.

The soil pollution is assessed according to an assessment scale shown in Table 3.5.

In case of pollution with several elements the hazard level assessed for the most toxic element whose content in soil is the highest.

Table 3.5 - Assessment of the level of soil chemical pollution

Pollution category	Total Pollution Index (Zc)	Content in soil (mg/kg)					
		Hazard class I		Hazard class II		Hazard class III	
		Organic compounds	Organic compounds	Organic compounds	Organic compounds	Organic compounds	Organic compounds
Clean *	-	from background to MPC	from background to MPC	from background to MPC	from background to MPC	from background to MPC	from background to MPC
Permissible	<16	from 1 to 2 MPC	from 2 background values to MPC	from 1 to 2 MPC	from 2 background values to MPC	from 1 to 2 MPC	from 2 background values to MPC
Moderately hazardous	16-32					from 2 to 5 MPC	from MPC to C max
Hazardous	32-128	from 2 to 5 MPC	from MPC to C max	from 2 to 5 MPC	from MPC to C max	> 5 MPC	> C max

Extra hazardous	>128	>5 MPC	>C max	>5 MPC	>C max		

Notes:

Cmax - the maximum value of permissible level of the element content by one of the four nuisance values;

** Contamination class is related to higher risk.*

The assessment chemical soil pollution using international standards was performed by the comparison of the values obtained of the content of the indices to be monitored with the PC and IL values (Health Standards 11-102-97, Appendix B). The soils, in which the pollutant content is less than PC are considered clean or permissibly contaminated. The content of pollutants in the range between PC and IL values is classified as hazardous pollution level. If the concentration of pollutants exceeds the intervention level the soils are considered hazardously polluted to be in fact solid waste and are subject to removal.

3.5 Orthophoto mapping, creation of digital maps

The aerial photography data were processed in a digital photogrammetric system PhotoMod (Rakurs, Moscow). The processing of images is divided into the following stages:

1. Creation of network. At this stage, a set of images is formed. Survey routes are created. Each route is oriented toward the flight direction; the images are rotated through their respective angles.

2. Measurement of network. At this stage, an inner orientation of images is made, the camera parameters are entered (focal distance and coordinates of the optical center and parameters of geometric distortion of the image caused by the lens distortion. Then wing points are selected between routes and stereo pairs. At least 5 points between pairs of images were used to link routes. At least 18 points per pair were used to link the stereo pairs (to ensure the triple overlap by the points). A catalog of reference points is prepared; the points are measured on the images; the accuracy is preliminarily checked.

3. Adjustment of network. At this stage, the network is adjusted. The accuracy is checked and measurement errors are corrected. The mean square deviations from the reference points did not exceed 30 cm in plan view and not exceed 65 cm in height.

4. Processing of network. At this stage, the terrain model is built based on a triangle irregular network (TIN) for each stereo pair. Then the fragments are joined together to make a global TIN. The correction is made and based on the model obtained; a digital elevation model and lines of equal elevation (horizontals) are built. Based on the altitude matrix obtained an orthophoto map is created. The elevation angles at the moment of photography and distortions caused by the terrain are removed from the images. This results in an only image (mosaic) of a set resolution made of the photos.

The orthophoto maps were prepared in Autodesk AutoCAD in scale 1:1000. The image was placed in an AutoCAD coordinate space based on information on PhotoMod positioning system. The horizontals and additional information are placed in separate layers.

To visualize digital information on the level of soil pollution and determination of the spatial regularity of the distribution of main pollutants for each site, three digital thematic maps have been built. Their list and methods of initial data visualization are given in Table 3.6.

Table 3.6 – Thematic maps of soil pollution

Name	Soil pollution with oil hydrocarbons (mg/kg)	Content in soil of benzo(a)pyrene in MPC fractions (0.02 mg/kg). PAH in PC fractions (1 mg/kg) and PCB in PC fractions (0.02 mg/kg)	Content of heavy metals in soils (Ci) and level of chemical soil (assessment by Zc value)
Methods of visualization	Contour lines of 3000 and 5000 mg/kg. Inside the contour of 5000 mg/kg PH concentrations are given in each point (3000 - PC from Neue Niederlandische Liste, 5000 – IL)	Point display mode as column diagram. If the standard value is exceeded the rate of exceeding is given	Point display mode as column diagram. Values corresponding a hazardous and extremely hazardous level are indicated

4. INVENTORY OF POLLUTION SOURCES AT THE DECOMMISSIONED MINISTRY OF DEFENSE SITE ON BOLSHOY LYAKHOVSKY ISLAND

4.1 Characteristics of the study area

The survey of the decommissioned Ministry of Defense site on Bolshoy Lyakhovsky Island was made on September 29, 2010. The site is located in south part of Kigilyakh Cape - Figure 4.1.

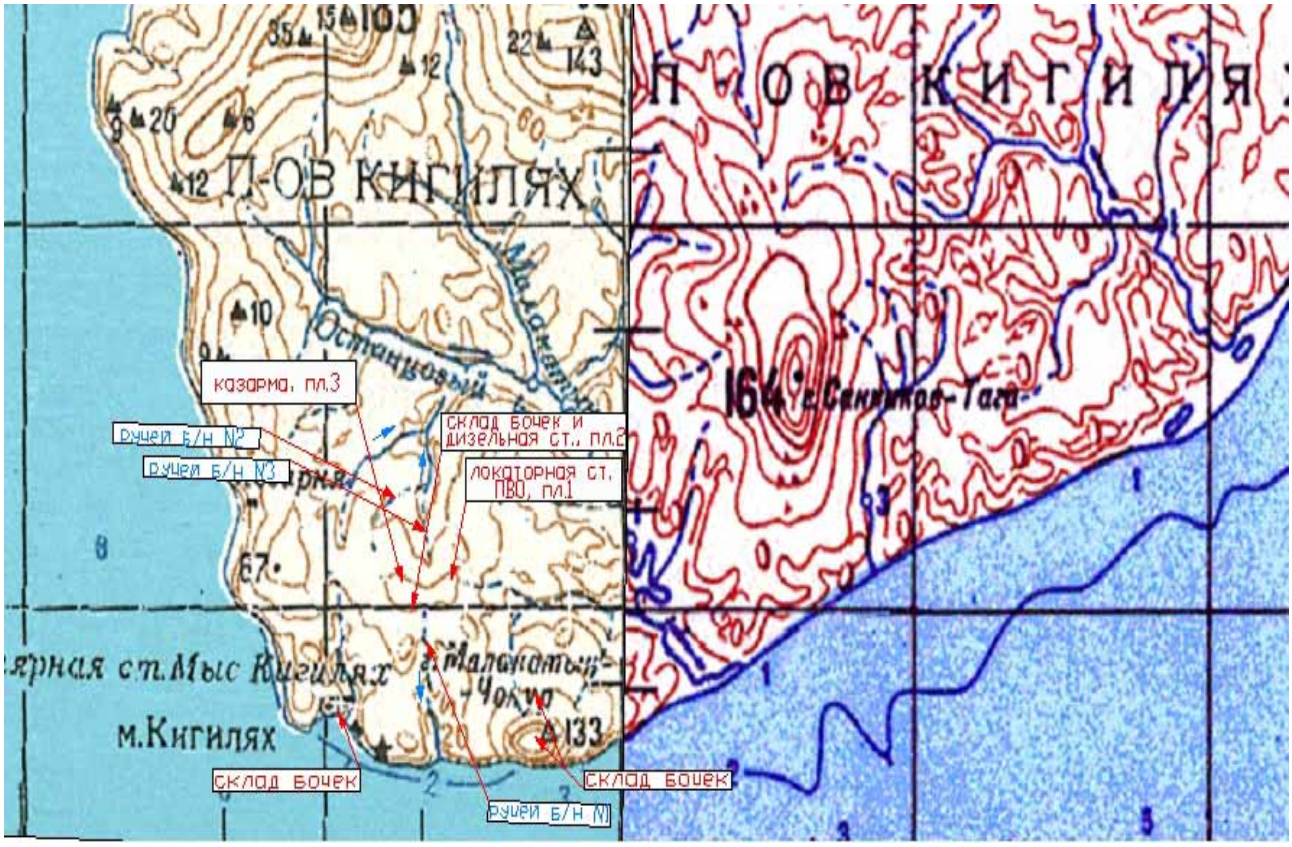


Figure 4.1 - Location of the Ministry of Defense sites on Bolshoy Lyakhovsky Island.

The terrain of the area is bald mountains. The hydrographic network is well developed. The sites under study are situated on the watershed of no-name creeks No. 2 and 3 (first order streams of the Ostantsovy Creek), no-name creek No. 1 (runs into the Malakatyn Bay) and no-name creek (first order streams of the Malakatyn River)

A 65 cm deep hole was drilled to get to know the characteristics of the area soils – Figure 4.2. The type of soils was determined according to the 2004 Russian Soil Classification and Diagnostics System (L.L. Shishov et al, edited by G.V. Dobrovolsky) – Table 4.1.

5 groups of densely located pollution sources were revealed; three of them are proper territory of the former military site (sites 1-3) and the other two are vast storage facilities of drums and other containers ashore.

All sites have marauding traces.

Figure 4.2 - 65 cm deep hole

Table 4.1 – Characteristics of the area soils

Topology	Soil	
	type	separate
Tops and slopes of hillocks	cryoturbated	coarse humus, gleyic cryogenic soils
Depressions between hillocks, graded and slightly caved-in tops of hillocks	cryoturbated	gley soils

Gley soils belong to acid soils.

Table 4.2 shows a list of the sites where mapping and terrestrial survey with sampling was conducted.

Table 4.2 – Main sites to be studied on Bolshoy Lyakhovsky Island

No. of site	Description
1	Radar station (air-defense radar unit, drum storage area and Diesel plant)
2	Drum storage area and Diesel plant
3	Barrack (boiler-house and Diesel plant, drum storage area)

4.2 Scope of work and main results

The scope of the inventory of pollution sources at the former Ministry of Defense site on Bolshoy Lyakhovsky Island is shown in a summary list – Table 4.3.

Table 4.3 – Summary list of work on Bolshoy Lyakhovsky Island

No.	Name of work	Unit of measurement	Volume	Note
Field work on the terrain mapping				
1	Number of routes	pcs	2	
2	Number of images (main, panoramic, technical)	pcs	76	
3	Survey area	ha	25	
4	Points of reference	pcs	9	
Land works				
5	Photo-documenting	photograph	103	
6	Soil sampling	sample	40	
7	Soil baseline sampling	sample	1	
8	Technical liquid sampling	sample	9	
Chemical analytical study				
9	Determination of PH in soil samples	sample	40	
10	Determination of PAH in soil samples (composition and total)	sample	18	16 substances
11	Determination of PCB in soil samples	sample	7	15 congeners
12	Determination of heavy metals in soil samples	sample	7	10 elements
13	Determination of heavy metals in baseline samples	sample	1	10 elements
14	Identification of technical liquids	sample	9	(25 parameter)
15	Determination of PCB in technical liquids	sample	5	16 congeners
16	Determination of heavy metals in technical liquids	sample	5	9 elements
Cameral work				
17	Creation of 1:1000 orthophoto map (raster map)	photograph	13	Main images
18	Processing of chemical analysis results	parameter	752	
19	Creation of soil pollution maps	map	3	
20	Creation of digital pollution source map	map	1	

Physical and geological map based on 1:1000 orthophoto map is shown on chart 1. Coordinates of reference points are given in Table 4.4.

Table 4.4 – Coordinates of reference points (*UTM 54N coordinate system)*

No. of point	Coordinates			No. of point	Coordinates			No. of point	Coordinates		
	X	Y	H		X	Y	H		X	Y	H
1	465704.666	8140816.698	63.506	4	465849.012	8140862.231	61.116	7	465032.526	8140770.544	61.344

2	465716.421	8140902.133	61.401	5	465430.514	8140730.183	59.307	8	465051.779	8140846.447	63.228
3	465857.525	8141055.648	59.643	6	465168.836	8140635.578	58.429	9	465275.103	8140825.127	63.474

The Registers of soil and technical liquid samples are given in Tables 4.5 and 4.6, respectively.
The results of the chemical analytical study are given in the following summary tables:

- content of petroleum hydrocarbons (PH) in soil cover – Table 4.7;
- content of PAH in soil cover – Table 4.8
- content in soil of HM and PCB – Table 4.9;
- results of identification of technical liquids with conclusion – Table 4.10;
- content of PCB and HM in technical liquids – Table 4.11.

Table 4.5 – Register of soil samples

No. of sample	Coordinates *		Sample date	Sampling point	Characteristics of specimen			Parameters to be determined			
	x	y			smell	color	consistency	PH	PAH	PCB	HM
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
1	465928	8141063	29.09.10	dish near drums north of site 1	no	dark grey	liquefied	+			
2	465871	8141133	29.09.10	dish near drums north of site 1	boggy	dark grey	liquefied	+			
3	465855	8141078	29.09.10	dish north of site 1	no	dark grey	liquefied	+			
4	465828	8141022	29.09.10	dish north of site 1	weak boggy	dark grey	wet semi-solid	+			
5	465813	8140961	29.09.10	dish north of site 1	weak boggy	dark grey	wet semi-solid crumbling	+			
6	465718	8140942	29.09.10	narrow north of site 1	weak boggy	dark grey	wet semi-solid	+			
7	465683	8140961	29.09.10	end of narrow (dish) near site 1	no	dark grey	wet semi-solid	+	+		
8	465723	8140911	29.09.10	site 1 under gantry	no	dark grey	wet semi-solid	+			
9	465738	8140851	29.09.10	site 1 Diesel room	no	dusty	wet semi-solid crumbling	+	+	+	+
10	465773	8140796	29.09.10	site 1 dish near drums	no	dusty	wet semi-solid crumbling	+	+		
11	465745	8140821	29.09.10	site 1 under cisterns	weak oil product	deep-brown	wet, friable with rock fractions of less than 2 mm in diameter	+	+		
12	465706	8140817	29.09.10	site 1 Diesel room	weak oil product	black	wet friable	+	+		
13	465703	8140825	29.09.10	site 1 drums near Diesel room	weak oil product	dark grey	wet crumbling	+	+		
14	465640	8140830	29.09.10	site 1 big dish	no	dark grey	wet semi-solid crumbling	+	+		
15	465645	8140779	29.09.10	site 1 near drums	no	dark grey	wet crumbling	+			
16	465677	8140734	29.09.10	site 1 dish near drums	no	dark grey	wet crumbling	+	+	+	+
17	465637	8140711	29.09.10	narrow west of site 1	no	dark grey	wet crumbling	+			
18	465735	8140761	29.09.10	narrow below drums south of site 1	no	dark grey	liquefied	+	+		
19	465730	8140725	29.09.10	narrow west of site 1	no	dark grey	wet crumbling	+			
20	465714	8140707	29.09.10	slope near drums south of site 1	no	dark grey	wet semi-solid	+			

Continuation of Table4.5

1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
21	465674	8140659	29.09.10	creek valley below site 1	no	dark grey	wet semi-solid	+	+		
22	465661	8140569	29.09.10	creek valley below site 1	no	dark grey	wet semi-solid	+			

23	465671	8140486	29.09.10	creek valley south of site 1	no	dark grey	wet semi-solid	+			
24	465461	8140659	29.09.10	hollow below site 3	no	dark grey	wet semi-solid	+	+		
25	465418	8140725	29.09.10	between site 1 and 3	weak boggy	dark grey	wet semi-solid	+			
26	465300	8140886	29.09.10	between site 1 and 3	no	dark grey	wet semi-solid	+			
27	465250	8140817	29.09.10	between site 1 and 3	no	dark grey	wet semi-solid	+			
28	465297	8140655	29.09.10	edge of site 2	no	dark grey	wet semi-solid	+			
29	465258	8140603	29.09.10	dish near west edge of site 2	no	dark grey	wet semi-solid	+	+	+	+
30	465233	8140529	29.09.10	dish south of site 2	weak boggy	dark grey	wet semi-solid	+			
31	465192	8140581	29.09.10	narrow south of site 2	weak boggy	dark grey	wet semi-solid	+			
32	465172	8140619	29.09.10	site 2 Diesel room	strong oil product	dark grey	wet oily semi-solid	+	+	+	+
33	465178	8140641	29.09.10	site 2 near leaking drums	weak oil product	dark grey	wet semi-solid	+	+		
34	465130	8140639	29.09.10	site 2 cisterns	weak oil product	deep-brown	wet friable with rock fractions of less than 2 mm in diameter	+	+		
35	465207	8140678	29.09.10	site 2 dish near drums	strong oil product	black	wet oily semi-solid	+			
36	465053	8140854	29.09.10	site 3 boiler-house	no	black	wet semi-solid crumbling	+	+	+	+
37	465073	8140902	29.09.10	site 3 dish	no	grey	wet semi-solid	+	+		
38	465021	8140917	29.09.10	site 3 dish near drums	no	brown	wet semi-solid	+			
39	465119	8140945	29.09.10	hollow north of site 3	no	grey	wet semi-solid	+	+	+	+
40	465119	8140996	29.09.10	narrow north of site 3 (runoff from site)	no	taupe	wet semi-solid	+			

** coordinate system:*
Bolshoy Lyakhovsky - UTM 54N

Table 4.6 – Register of liquid samples

No. of sample	Sample date	Coordinates*		Sampling point	Identification	Parameters to be determined	
		x	y		liquids	PCB	HM
1	29.10.10	465683	8140823	drums near Diesel room, site 1	+	+	+
2	29.10.10	465070	8140915	accumulation of drums, site 3	+	+	+
3	29.10.10	465701	8140828	accumulation of drums, site 1	+		
4	29.10.10	465706	8140824	inside Diesel room, site 1	+	+	+
5	29.10.10	465703	8140825	sinker inside Diesel room, site 1	+	+	+
6	29.10.10	465776	8140878	accumulation of drums, site 1	+		
7	29.10.10	465626	8140835	accumulation of drums, site 1	+		
8	29.10.10	465176	8140638	accumulation of drums, site 2	+	+	+
9	29.10.10	465196	8140643	accumulation of drums, site 2	+		

** coordinate system:*
Bolshoy Lyakhovsky - UTM 54N

Table 4.7 – Content of PH in soil, mg/kg

No. of sample	PH content	No. of sample	PH content	No. of sample	PH content	No. of sample	PH content
1	13	11	7500	21	2920	31	104
2	112	12	31200	22	3900	32	102000
3	62	13	67000	23	2040	33	56000
4	20	14	15	24	15	34	7400
5	14	18	6300	25	166	35	87000
6	50	19	4100	26	34	36	39700
7	37	15	670	27	19	37	101
8	580	16	92	28	252	38	53
9	5000	17	4700	29	169	39	19
10	62	20	1780	30	154	40	3500

Table 4.8 – Content of polycyclic aromatic hydrocarbons in soil, mg/kg (lower value of the operating range <0.0012)

Parameter to be determined	No. of sample																	
	7	9	10	11	12	13	14	16	18	21	24	29	32	33	34	36	37	39
Naphthalene	0,0281	0,0011	0,0264	0,0074	0,0538	0,0208	0,0211	0,0067	0,0217	0,0281	0,0232	0,0024	0,0124	0,5042	0,0071	0,1074	0,0264	0,1293
Benzo (a) pyrene	0,0078	<0.0012	0,0064	0,0064	0,0028	0,0062	0,0060	0,0005	0,0077	0,0072	0,0079	<0.0012	0,0088	<0.0012	0,0053	0,0039	0,0080	0,0243
Acenaphthylene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Acenaphthene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Fluoranthene	0,0651	<0.0012	0,0581	0,0175	<0.0012	0,0672	0,0658	<0.0012	0,0532	0,0518	0,0581	<0.0012	0,0467	0,0417	0,0125	0,0360	0,0630	<0.0012
Fluorene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	0,0341	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Phenanthrene	0,0454	0,0272	0,0529	0,0017	<0.0012	0,0443	0,0417	<0.0012	0,0529	0,0481	0,0411	0,0042	0,8443	0,0496	0,0013	0,0639	0,0454	0,0257
Anthracene	0,0188	<0.0012	0,0184	<0.0012	<0.0012	0,0174	0,0188	<0.0012	0,0180	0,0147	0,0165	<0.0012	<0.0012	0,3202	<0.0012	<0.0012	0,0178	<0.0012
Pyrene	<0.0012	<0.0012	<0.0012	<0.0012	0,1066	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	0,0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Benzo(a)anthracene	<0.0012	0,0002	<0.0012	<0.0012	0,0037	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	0,1478	<0.0012	<0.0012	<0.0012	<0.0012	0,0502
Chrysene	<0.0012	0,0143	<0.0012	<0.0012	0,0239	<0.0012	<0.0012	0,0011	<0.0012	<0.0012	<0.0012	<0.0012	0,0856	<0.0012	<0.0012	0,0249	<0.0012	0,0121
Benzo(b)fluoranthene	0,0349	0,0015	0,0341	<0.0012	<0.0012	0,0264	0,0319	0,0055	0,0286	0,0261	0,0275	0,0023	0,0897	<0.0012	<0.0012	0,1059	0,0275	0,0699
Benzo(k)fluoranthene	0,0075	<0.0012	0,0061	<0.0012	<0.0012	0,0073	0,0069	<0.0012	0,0066	0,0065	0,0072	<0.0012	0,0025	<0.0012	<0.0012	<0.0012	0,0075	0,0196
Dibenzo(a, h)anthracene	<0.0012	<0.0012	<0.0012	0,0024	<0.0012	<0.0012	<0.0012	0,0032	<0.0012	<0.0012	<0.0012	<0.0012	0,0062	<0.0012	0,0020	0,0024	<0.0012	<0.0012
Indeno(1,2,3-c, d)-pyrene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	0,0026	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Benzo(g, h, i)perylene	<0.0012	<0.0012	<0.0012	0,0092	<0.0012	<0.0012	<0.0012	0,0005	<0.0012	<0.0012	<0.0012	<0.0012	0,0755	<0.0012	0,0069	0,0092	<0.0012	0,0144
Total PAH	0,2076	0,0424	0,2024	0,0446	0,1908	0,1896	0,1922	0,0202	0,1887	0,1825	0,1815	0,0090	1,3548	0,9157	0,0351	0,3536	0,1956	0,3456

Table 4.9 – Content of heavy metals and PCB in baseline and main soils samples

Parameter to be controlled	Unit of measurement	Lower value of the operating range	Number of sample							
			background 1	9	12	16	29	32	36	39
Mercury	mg/kg	< 0.005	0.030	0.053	0.054	0.019	0.020	0.032	0.062	0.023
Lead	mg/kg	< 0.20	15.56	23.85	221.97	21.63	15.88	129.24	280.39	36.76
Cadmium	mg/kg	< 0.010	0.013	0.052	1.519	1.277	0.062	0.418	1.524	0.097
Cobalt	mg/kg	< 0.20	14.77	16.63	13.96	14.19	14.69	13.50	9.74	18.94
Nickel	mg/kg	< 0.30	15.50	23.03	28.85	18.57	21.40	26.15	382.11	19.84
Copper	mg/kg	< 0.20	11.12	12.58	122.72	12.46	14.91	43.25	173.55	17.87
Zinc	mg/kg	< 1.0	45.5	62.8	349.3	60.7	61.6	260.3	718.3	122.3
Manganese	mg/kg	< 0.20	368.20	287.04	241.41	304.38	527.71	361.13	428.43	380.79
Chrome total	mg/kg	< 0.50	22.42	23.70	33.85	22.18	23.26	24.31	131.09	33.04
Tin	mg/kg	< 0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.62	0.64
#28	mg/kg	< 0.000050	-	0.000478	0.000848	0.000627	0.001216	0.000206	0.000795	0.001614
#31	mg/kg	< 0.000050	-	<0.000050	0.006191	0.001572	0.002329	<0.000050	0.002042	0.003903
#52	mg/kg	< 0.000050	-	<0.000050	0.007545	0.000920	0.001133	0.000654	0.000683	<0.000050
#99	mg/kg	< 0.000050	-	<0.000050	<0.000050	0.000340	0.000174	<0.000050	0.001256	0.000721
#101	mg/kg	< 0.000050	-	<0.000050	<0.000050	<0.000050	0.000253	0.001206	0.002746	0.001437
#105	mg/kg	< 0.000050	-	<0.000050	0.006111	0.000625	0.000384	0.002083	0.000834	0.000825
#118	mg/kg	< 0.000050	-	<0.000050	0.004791	0.000288	0.000276	<0.000050	0.000451	0.000455
#128	mg/kg	< 0.000050	-	<0.000050	0.003551	0.000210	0.000069	0.002001	0.000837	0.000332
#138	mg/kg	< 0.000050	-	<0.000050	0.010680	0.000384	0.000098	0.006092	0.002320	0.000991
#153	mg/kg	< 0.000050	-	<0.000050	0.003430	0.000273	0.000160	0.004414	0.001316	0.001185
#156	mg/kg	< 0.000050	-	<0.000050	0.001730	<0.000050	<0.000050	0.000646	0.000291	0.000165
#170	mg/kg	< 0.000050	-	<0.000050	0.000158	<0.000050	<0.000050	0.000269	<0.000050	0.000058
#180	mg/kg	< 0.000050	-	<0.000050	0.000760	<0.000050	<0.000050	0.000915	0.000236	0.000131
#183	mg/kg	< 0.000050	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
#187	mg/kg	< 0.000050	-	<0.000050	<0.000050	<0.000050	<0.000050	0.000505	0.000515	<0.000050
#209	mg/kg	< 0.000050	-	<0.000050	0.000794	<0.000050	<0.000050	0.000053	0.000209	<0.000050
Total 7 PCB*	mg/kg	< 0.000050	-	0.000478	0.028054	0.002492	0.003137	0.013488	0.008548	0.005812
Total 9 PCB*	mg/kg	< 0.000050	-	0.000478	0.035895	0.003117	0.003521	0.016216	0.009672	0.006803
Total 15 PCB*	mg/kg	< 0.000050	-	0.000478	0.045795	0.005238	0.006093	0.018486	0.013807	0.011817

Table 4.10 - Results of identification of technical liquids with conclusion

Parameter to be controlled	Number of sample								
	1	2	3	4	5	6	7	8	9
Density at 20°C, kg/m³	894,8	814,8	836,3	872,3	842,5	812,0	-	891,0	822,9
Density at 15°C, kg/m³	898,2	818,3	839,8	875,7	846,0	815,5	-	894,6	826,4
Viscosity at 20°C, centistokes	-	2,35	3,25	4,96	4,24	2,43	-	-	2,42
Viscosity at 40°C, centistokes	59,19	-	-	3,21	2,81	-	-	56,24	-
Viscosity at 50°C, centistokes	-	-	-	-	-	-	-	-	-
Viscosity at 100°C, centistokes	13,42	-	-	-	-	-	-	13,96	-
Viscosity index	236	-	-	-	-	-	-	260	-
Fractional composition (50%), °C	-	206,4	258,4	298,6	-	201,3	-	-	222,8
Fractional composition (end boiling	-	305,9	305,9	353,2	-	263,2	-	-	309,1
Flash and ignition points in open crucible,	254	-	-	102	116	-	-	256	-
Flash and ignition points in closed crucible,	-	51	78	56	96	36	-	-	69
Pour point, °C	-24,2	<-40	-23,6	<-40	-28,5	<-40	-	-27,2	<-40
Cloud point, °C	-	<-30	-12,0	<-30	-20,0	<-30	-	-	<-30
Leak-off coefficient	-	1,2	1,2	3,1	1,66	1,13	-	-	1,12
Sulphur, %	-	0,195	0,103	0,112	0,106	0,188	-	-	0,161
Sulphurated hydrogen, ppm	-	abs.	abs.	-	-	abs.	-	-	abs.
Water, %	0,136	abs.	abs.	abs.	1,023	abs.	99,976	0,109	abs.
Mechanical admixtures, %	0,053	0,0687	abs.	abs.	0,0124	abs.	-	0,0375	abs.
Sulphated ash, %	0,84	-	-	-	-	-	-	0,81	-
Ash content, %	-	0,017	0,032	-	-	0,022	-	-	0,020
Alkali neutralization number, mg KOH/g	11,73	-	-	1,14	0,10	-	-	7,78	
Acid number, mg KOH/g	-	-	-	0,38	0,07	-	-	-	-
Acidity, mg KOH/100 g	-	2,005	4,950	-	-	1,298	-	-	2,530
Iodine number, g I/100 g	-	1,2	2,4	1,1	1,4	1,1	-	-	1,5
Presence of water-soluble acids and alkalis	-	abs.	abs.	-	-	abs.	-	-	abs.
Conclusion	Motor oil for Diesels M-14V	Winter Diesel fuel	Summer Diesel fuel	Winter Diesel fuel with PPD	Mixture of spent oils and Diesel fuel	Winter Diesel fuel	Water	Motor oil for Diesels M-14V2	Winter Diesel fuel

Table 4.11 – Content of HM and PCB in technical liquids

Cadmium	< 0.010	0.011	< 0.010	0.090	< 0.010	0.012
Cobalt	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	< 0.30	17.94	28.63	20.49	15.85	12.94
Copper	< 0.20	0.20	0.40	5.10	2.02	0.20
Zinc	< 1.0	426.71	1.33	78.68	1.0	467.39
Manganese	< 0.20	0,20	0,20	0.37	< 0.20	0,20
Chrome total	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Tin	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
#28	< 0.000050	0,008447	0,013112	0,009131	0,018651	0,017874
#31	< 0.000050	0,041608	0,036867	0,023376	0,034893	0,041673
#52	< 0.000050	0,000646	0,000474	0,000246	0,001691	0,006809
#99	< 0.000050	0,000236	0,000257	0,000156	0,000423	0,001221
#101	< 0.000050	0,000728	0,000575	0,000556	0,001174	0,002572
#105	< 0.000050	0,001341	0,000773	0,000633	0,001239	0,001682
#118	< 0.000050	0,000338	0,000642	0,000151	0,000460	< 0.000050
#128	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050
#138	< 0.000050	0,001629	0,001323	0,000796	0,001363	0,002223
#153	< 0.000050	0,000966	0,000720	0,000490	0,000964	0,001391
#156	< 0.000050	0,000304	0,000222	< 0.000050	0,000293	0,000192
#170	< 0.000050	0,000288	0,000222	0,000064	0,000293	0,000231
#180	< 0.000050	0,000322	0,000183	0,000097	0,000230	0,000231
#183	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050
#187	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050
#209	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050
Total 7 PCB*	< 0.000050	0,013075	0,017028	0,011466	0,024534	0,031098
Total 9 PCB*	< 0.000050	0,014721	0,018023	0,012100	0,026066	0,032972
Total 15 PCB*	< 0.000050	0,056852	0,055369	0,035697	0,061675	0,076097

4.3 Inventory of pollution sources following the results of terrestrisl survey

The inventory of the main pollution sources is shown on a schematic map given in chart 2.

4.3.1 Site No. 1

Panoramic images of site No. 1 are given on photos **4.1 and 4.2**.

On the area under study there are as follows: air-defense radar station (the radar lays on the ground **see photos 4.2, 4.3, 4.4**), Diesel plant, which was the power supply of the site (photo **4.2, 4.3**).

40 m west of the air-defense base there is an accumulation of drums of different degree of fullness (**see photo 4.3**). After opening one of the drums, technical liquid sample No. 6 was taken.

35 m south of the radar station, a Diesel plant building is located, around north part of which there are scattered drums of different degree of fullness (**see photo 4.5**). Two drums were revealed in the building, from which samples No. 4, 5 (**see photos 4.6, 4.7**) were taken. At the entry and near the north side of the building, 6 empty cisterns are located, beyond which there is a local accumulation of empty drums. To the south there is an empty drum storage area (**see photos 4.2, 4.3, 4.8**).

Soil around the Diesel plant building heavily polluted with fuel and lubricants.

A timber trestle with inscription "storage", in which condensers and transformers not containing PCB were found, is also located in the area (**photo 4.10**). 240 m north-west of the radar station, there are three air-defense mobile control centers (**see photo 4.2**).

The site is littered with metal scrap. Along the west boundary of the site, a path made of empty drums is situated.

No condensers and transformers containing PCB have been revealed at site 1.

Generally, the state of the drums is satisfactory, however, there are local accumulations of drums with a high degree of corrosion causing multiple leaks of liquids containing in them (mainly fuel and lubricants).

Photo 4.9 shows the air-defense mobile control centers locating near the site.

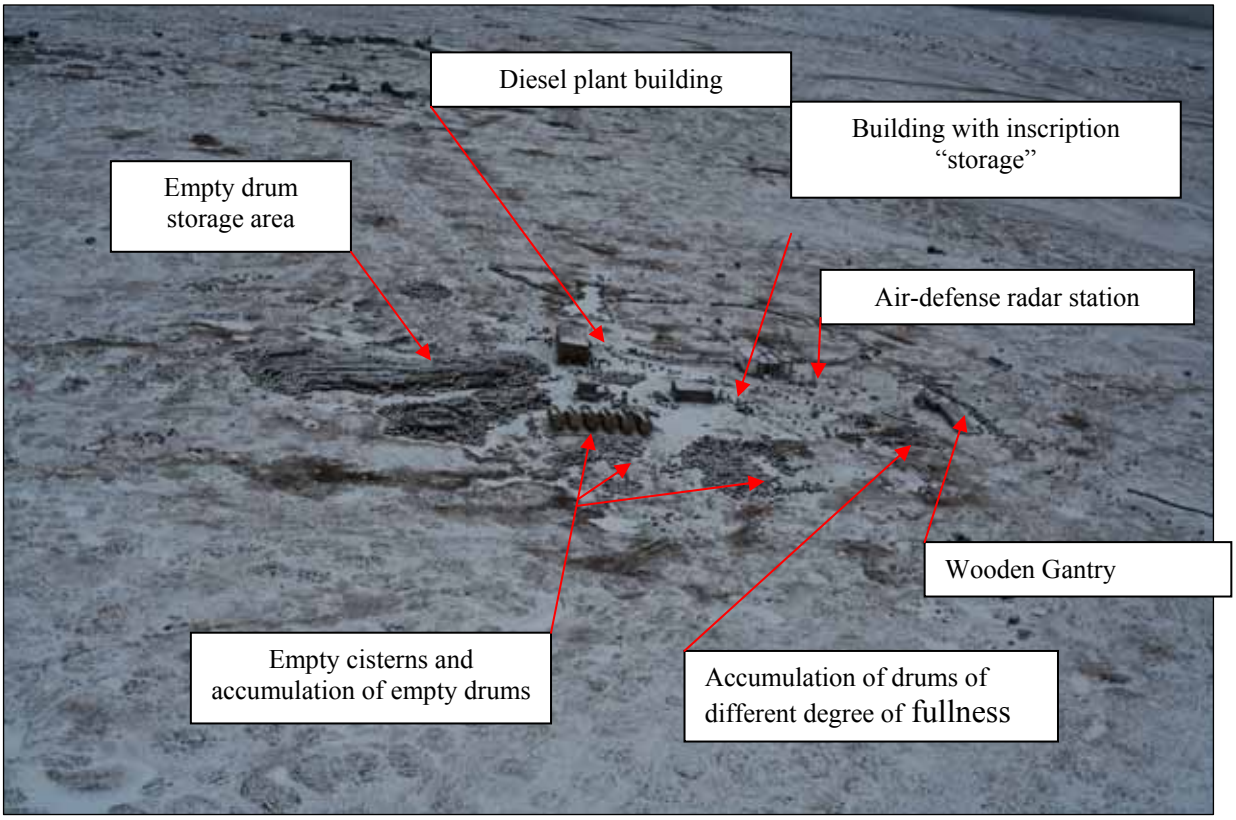


Photo 4.1 Panoramic image of site No. 1

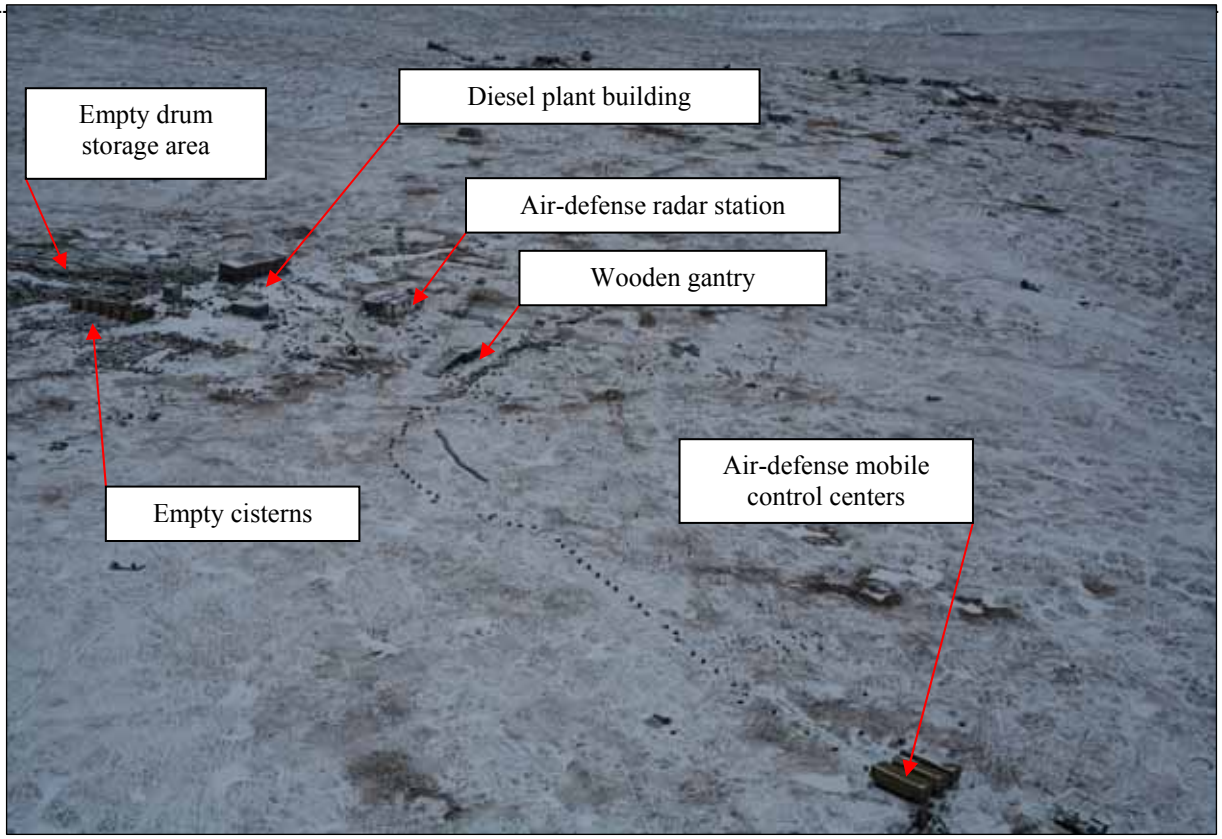


Photo 4.2 Panoramic image of site No. 1

Photo 4.3 Air-defense radar station

Photo 4.4 Panoramic image of the radar station (center) and Diesel plant (right)

Photo 4.5 View of the Diesel plant building from the north side

Photo 4.6 Inside the Diesel plant building

Photo 4.7 Cisterns near the Diesel plant

Photo 4. 8 Empty drum storage area located on the south side of the Diesel plant

Photo 4.9 – Air-defense mobile control centers

Photo 4.10 Storage of different equipment

In Table 4.12, the results of approximate evaluation are given of the number of drums located within and near site 1.

Table 4.12 – Results of approximate calculation of drums at site No. 1

Object	Number	Area, km^2
empty drum storage area near the south side of the area-defense station	11000-12000	0.00276
empty drums south-west of the Diesel plant	1000-1100	0.00013
accumulation of empty drums behind the cisterns	2500-3000	0.00089
accumulation of empty drums on the east side of the Diesel plant	150-200	0.00036
scattered drums of different degree of fullness around the north and west side of the Diesel plant	15-25	0.00029
scattered drums of different degree of fullness south-east of the gantry	180-200	0.00033
paths made of empty drums	500-550	0.00048

4.3.2 Site No. 2

Panoramic images of the site are given on photos **4.11** and **4.12**.

The Diesel plant is located in the study area. Inside the building, no equipment and containers for fuel and lubricants have been revealed, the building is half destroyed (**see photo 4.13**).

To the south-east of the building, the drums for fuel and lubricants having different degree of fullness are chaotically scattered (**see photo 4.14**), from which technical liquid samples No. 8, 9 were taken. 6 empty cisterns were found at the site. Most 200-L drums have traces of corrosion; fuel and lubricant leaks have been revealed (photo **4.15).**

The main migration path of pollutants is by hollows into no-name No. 1 running into the Malakatyn Bay (panoramic **photo 4.12**).

No condensers and transformers containing PCB have been revealed at the area under study.

In Table 4.13 the results of approximate evaluation of the number of drums are given located within and near site No. 2.

Table 4.13 – Results of approximate calculation of drums at site No. 2

Object	Number	Area,km^2
accumulation of drums in front of the Diesel plant	1600-2000	0.00123
empty drum storage area at 43 m east of the Diesel plant	4000-4500	0.00093
accumulation of empty drums at 47 m north of the Diesel plant	140-200	0.00004
accumulation of empty drums at 47 m north of the Diesel plant	300-400	0.00015

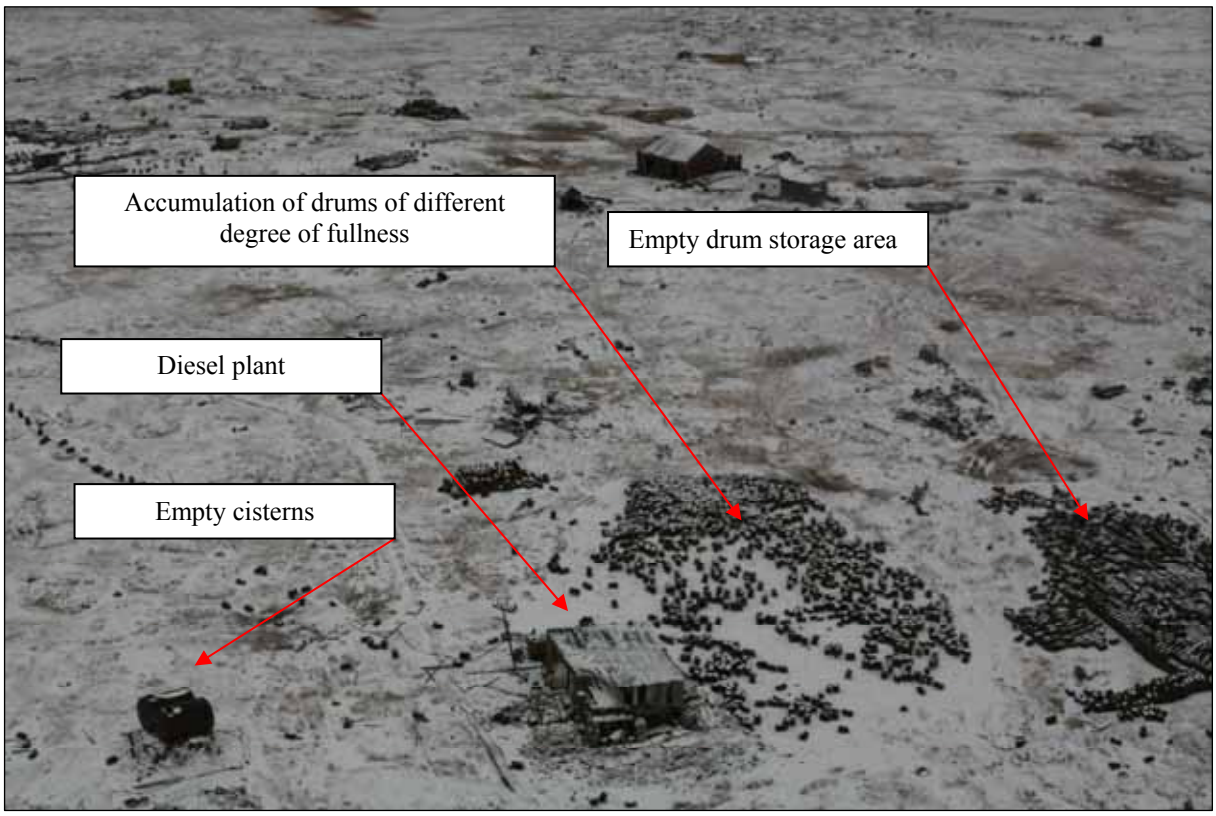


Photo 4.11 Panoramic image of site No. 2

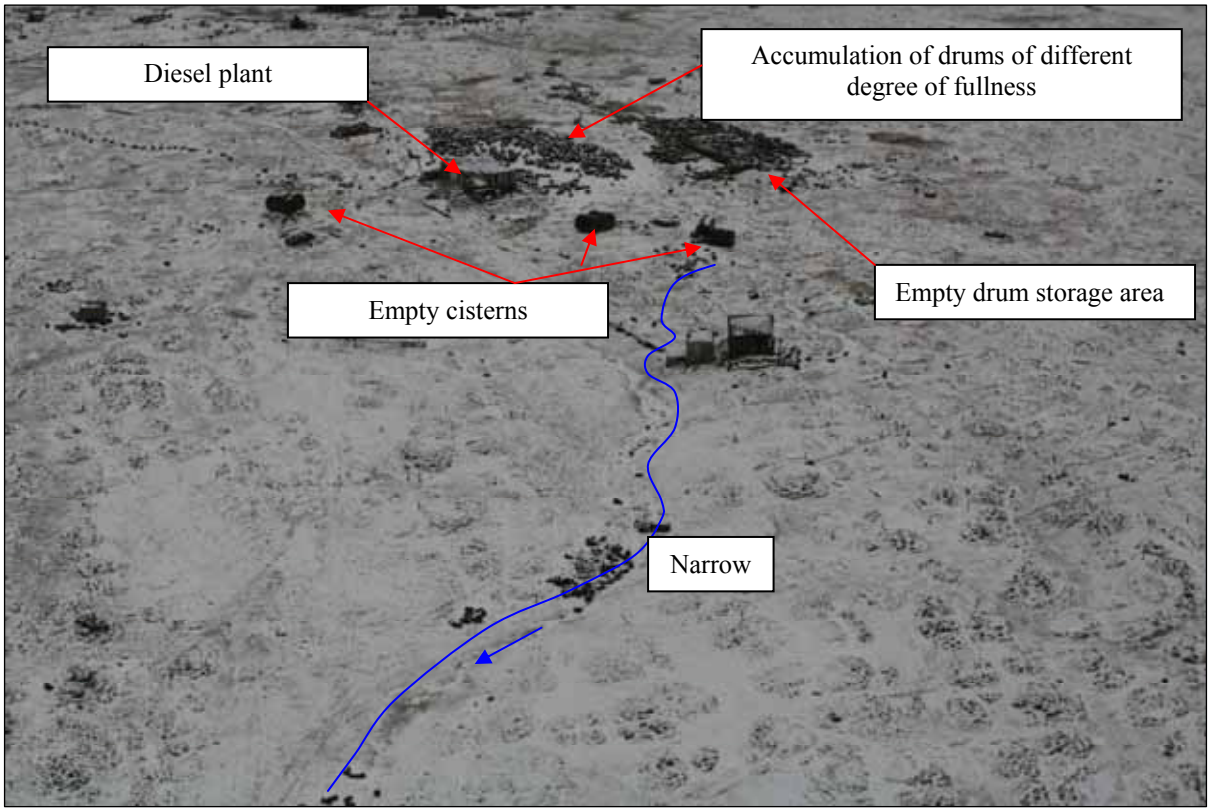


Photo 4.12 Panoramic image of site No. 2 and subjacent slope

Photo 4.13 Destroyed Diesel plant building

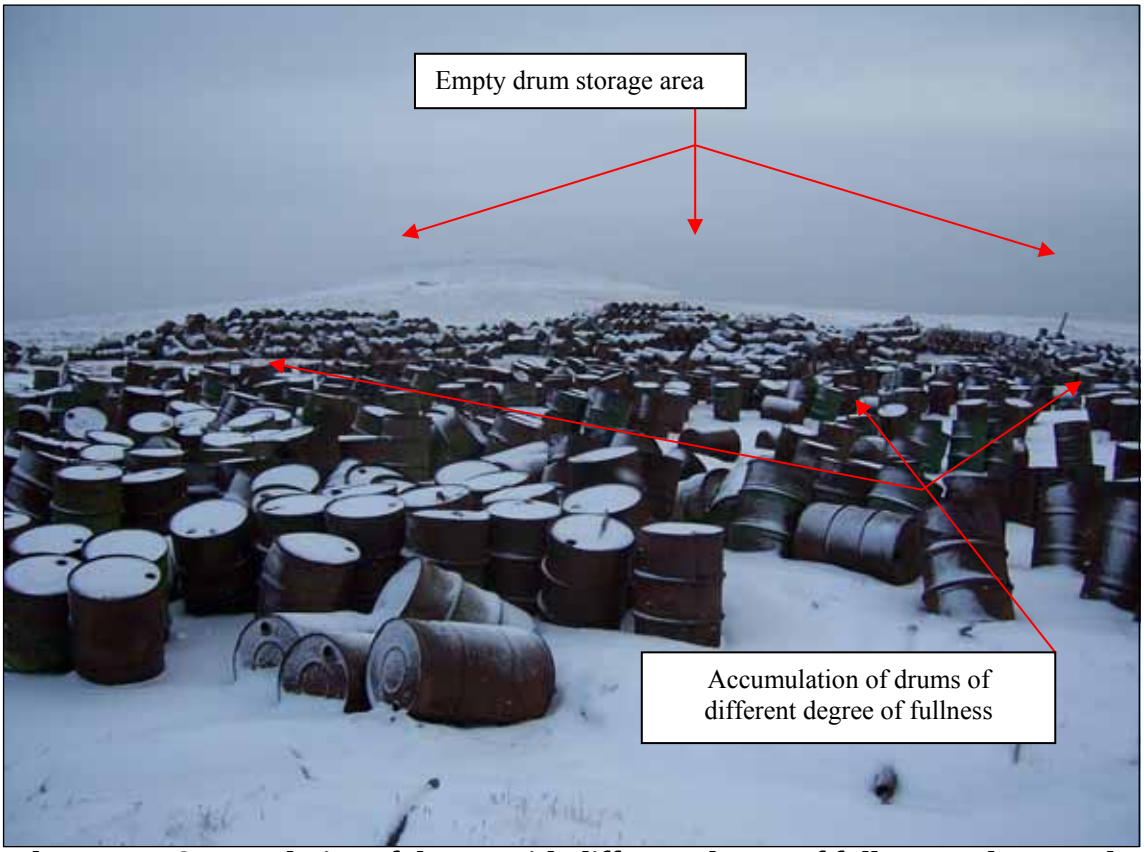


Photo 4.14 Accumulation of drums with different degree of fullness and empty drum storage area

Photo 4.15 Fuel and lubricant leaks from breaking drums

Photo 4.16. Abandoned equipment

4.3.3 Site No. 3

Photos 4.16 and **4.17** show panoramic images of site No. 3. The following infrastructure facilities are located at the site: domestic premises, barrack, storage area, food unit, canteen and also the main life support systems: Diesel plant and two boiler-houses (**photo 4.18**).

Behind the barrack, there is a large empty drum storage area. Accumulations of drums are found also in the east part of the study area. The state of most of them is satisfactory. Some started breaking down. The traces of fuel and lubricant leaks are present. The paths of empty drums are laid between the buildings.

The drums for fuel and lubricants having different degree of fullness are chaotically scattered across the site. Technical liquid sample No. 2 has been taken in one of such areas. Near the canteen at a distance from the site, there are cisterns.

The site is littered with metal scrap (photo **19**).

No condensers and transformers containing PCB have been revealed at the area under study.

A mobile radar set was found there.

The main migration path of pollutants is through no-name creeks No. 2 and 3, which belong to the Ostantsovy Creek basin.

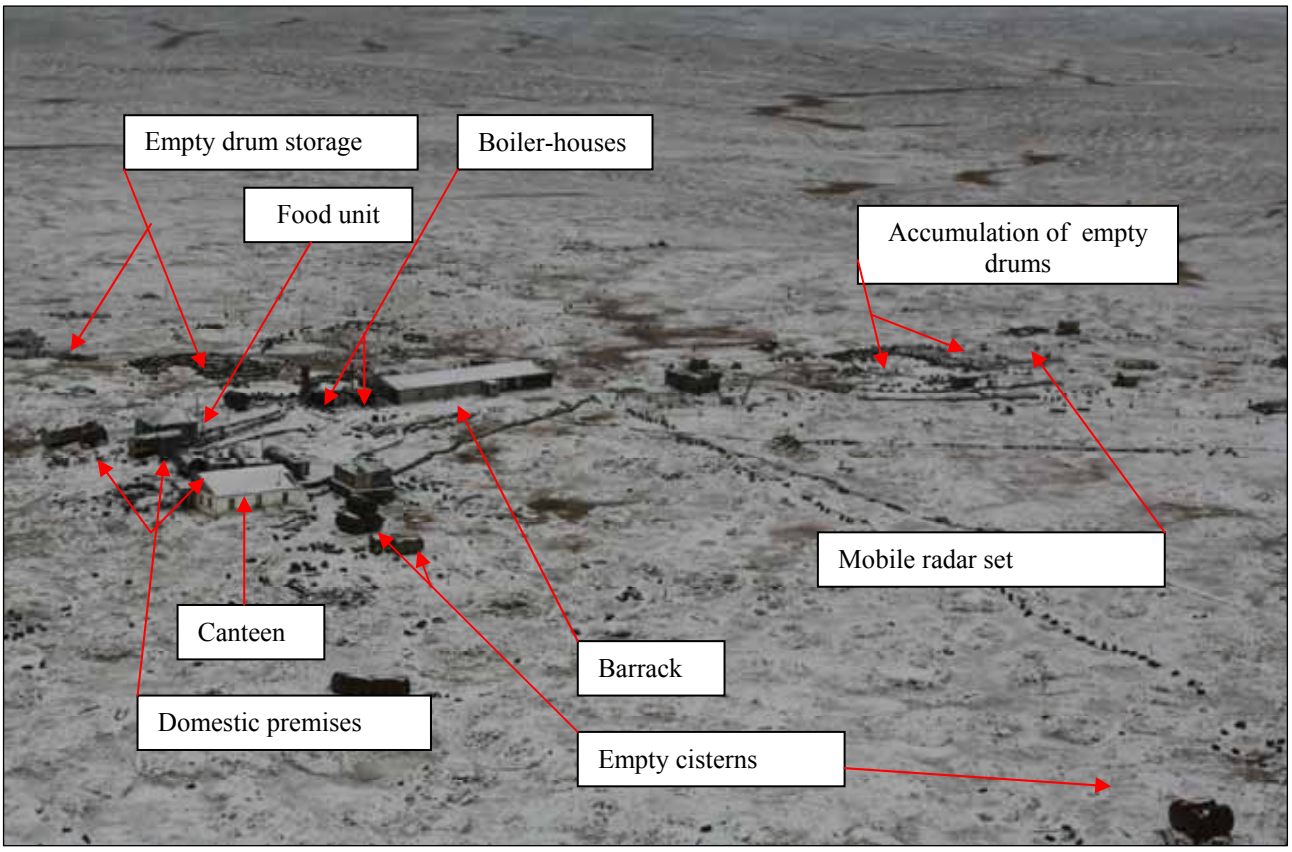


Photo 4.17 Panoramic image of site No. 3

Photo 4.18 Panoramic image of site No. 3

Photo 4.19 Boiler-house and Diesel plant near the barrack

Photo 4.20 Accumulation of metal scrap near the canteen

Photo 4.21 empty cisterns near the canteen

In Table 4.14, the results of approximate evaluation are given of the number of drums located within and near site No. 3.

Table 4.14 – Results of approximate calculation of drums at site No. 3

Object	Number	Area,km^2
two empty drum storage areas north-west of the barrack	4000-4500	0.00085
scattered drums of different degree of fullness near the north-west side of the barrack	80-100	0.0005
accumulation of empty drums 81 m north-east of the barrack	1100-1500	0.00033
accumulation of empty drums 130 m north-east of the barrack	250-300	0.00017
accumulation of empty drums 154 m east-north-east of the barrack	850-900	0.00018
accumulation of empty drums 136 m south of the barrack	200-300	0.00006
accumulation of empty drums near the supply room	130-150	0.00021

4.3.4 Register of infrastructure facilities and pollution sources at the area of the former air-defense base

The Register of infrastructure facilities and pollution sources at the area of the former air-defense base with indication of the coordinates of the centers composed based on the schematic map presented in the chart is shown in summary table 4.15.

Table 4.15 – Register of infrastructure facilities and main pollution sources at the area of the former air-defense base Bolshoy Lyakhovsky Island *(UTM 54N coordinate system)*

No. on map	Name of object	Coordinates of the center	
		X	Y
1	**2**	**3**	**4**
1	Military equipment	465851.91	8141087.84
2	- » -	465867.43	8141065.99
3	Air-defense mobile control centers (3 pcs.)	465851.60	8141060.92
4	Drum storage area (strip of about 30 m)	465780.59	8140938.00
5	Drum storage area (strip of about 45 m)	465711.42	8140912.57
6	Gantry	465721.55	8140904.17
7	Radar	465686.11	8140885.11
8	Drum storage area (arc of 65 m)	465646.09	8140903.77
9	Radar station	465697.23	8140869.39
10	Drum storage area (strip of about 25 m)	465634.71	8140853.61
11	Drum storage area (strip of about 32 m)	465623.56	8140824.53
12	Diesel plant	465695.23	8140824.17
13	Dump of drums	465711.74	8140829.87
14	- « -	465727.69	8140836.32
15	- « -	465732.81	8140826.83
16	Storage building	465725.18	8140844.65
17	Storage building	465727.57	8140820.82
18	Cisterns (6 pcs.)	465747.96	8140818.04
19	Accumulation of drums	465768.00	8140840.81
20	- « -	465761.91	8140814.73
21	Small accumulation of drums	465779.52	8140816.72
22	Large accumulation of drums	465715.41	8140776.26
23	Small accumulation of drums	465637.01	8140793.70
24	- « -	465647.43	8140761.92
25	- « -	465627.13	8140741.09
26	Accumulation of drums (strip)	465277.51	8140670.71
27	Military equipment	465272.31	8140684.18
28	Small structure	465260.93	8140688.37
29	- « -	465263.71	8140669.51
30	Large accumulation of drums	465222.36	8140630.15
31	Large accumulation of drums (partially scattered)	465194.25	8140667.22
32	Small accumulation of drums	465176.08	8140684.87
33	Building	465161.95	8140641.14
34	Diesel plant	465161.75	8140630.37
35	Cisterns 2 pcs	465126.18	8140637.79
36	Cisterns 2 pcs	465072.95	8140610.80
37	Cisterns 2 pcs	465161.73	8140597.84
38	Small structure	465175.20	8140594.17
39	Cisterns 2 pcs	465175.06	8140583.42

Continuation of Table 4.15

1	2	3	4
40	Two structures	465133.82	8140536.97
41	Small accumulation of drums	465072.52	8140496.78
42	Structures	465051.37	8140698.57
43	Abandoned equipment	465357.00	8140753.98
44	Small accumulation of drums	465367.17	8140814.54
45	- « -	465297.73	8140780.37
46	- « -	465296.64	8140805.03
47	- « -	465278.47	8140776.69
48	Structures	465276.31	8140791.62
49	Storage area	465268.95	8140817.14
50	Structures	465251.21	8140784.48
51	- « -	465236.66	8140795.61
52	Small accumulation of drums	465226.07	8140845.69
53	- « -	465256.84	8140896.75
54	- « -	465262.94	8140921.31
55	Small accumulation of drums	465210.58	8140942.15
56	Mobile radar set	465212.95	8140930.29
57	- « -	465204.99	8140871.51
58	Accumulation of drums (two lines)	465173.09	8140860.32
59	Large accumulation of drums	465177.32	8140905.89
60	Accumulation of drums	465159.53	8140904.88
61	Structures	465120.01	8140867.51
62	2 small structures	465056.23	8140755.20
63	2 cisterns	465052.32	8140770.64
64	Canteen	465034.63	8140779.54
65	Domestic premise	465054.96	8140790.68
66	Group of domestic premises	465035.46	8140804.98
67	Domestic premise	465023.88	8140822.23
68	Food unit	465023.76	8140832.16
69	Domestic premise	465011.83	8140830.86
70	- « -	465008.05	8140835.58
71	2 boiler-houses	465053.30	8140851.26
72	Barrack	465075.47	8140864.05
73	Scattered drums	465059.18	8140870.02
74	Accumulation of drums	465068.78	8140915.63
75	- « -	465074.90	8140931.84
76	- « -	465068.71	8140946.19
77	Large accumulation of drums	465033.33	8140904.21
78	- « -	464990.16	8140931.05
79	Small accumulation of drums	465004.91	8140974.00
80	Structures	464904.12	8140936.30
81	3 small structures	464768.96	8140923.30
82	2 small accumulations of drums	464757.91	8140939.05

4.3.5 Pollution sources outside the air-defense base

The military units were evacuated by both air and water transport, so the cargo and equipment were intensively transferred from the home base to the shore areas.

On the Malakatyn Bay at 1.6 km to the south-east of site No. 3, large accumulations of drums, cisterns with fuel and lubricants and abandoned equipment were found – **photo 4.21**.

Accumulations of drums also take place on the top of Malakatyn-Chokur Mountain and its base – **photo 4.22**.

No aerial photography of these objects was done.

Table 4.16 shows the results of approximate calculation of containers and other objects found at the areas.

Table 4.16 - Results of approximate calculation of pollution sources

Object	Number	Area, km^2
Area near the Malakatyn Bay, at 1.6 km to the south-east of site No. 3		
drum storage area	3600-4000	-
cisterns	9	-
units of equipment	8	-
containers (crew boxes?)	12	
Drum storage area on Malakatyn-Chokur Mountain		
on the top of mountain	550-600	-
on the base of mountain	1050-1200	-

Photo 4.21 Drum storage area on the Malakatyn Bay coast

Photo 4.22 Drum storage area on Malakatyn-Chokur Mountain and its base

4.4 Assessment of pollution level of the former Ministry of Defense site

The level of soil cover pollution at the former Ministry of Defense unit home station was assessed by 4 parameters: PH, PAH, PCB and HM.

PH. The main pollutants are petroleum hydrocarbons. Only 10% out of 40 samples taken in sites No. 1-3 and adjacent areas have PH content less than PC (50 mg/kg), 67.5% fall into PC-IL range, 22,5% exceed IL (5000 mg/kg). Pollution has an areal character. Figure 4.3 shows the distribution of samples by a range of PH concentrations (mg/kg).

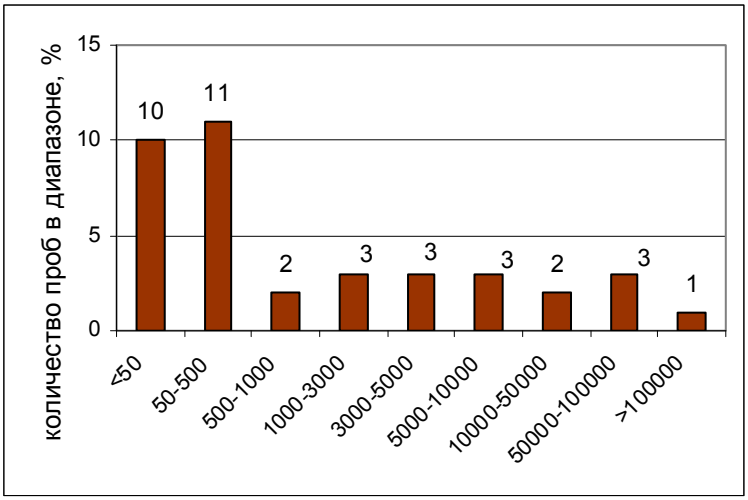


Figure 4.3 – Distribution of samples by a range of PH concentrations

Table 4.17 shows the main results of statistical processing of chemical analysis data.

Table 4.17 – Average and maximum content of petroleum hydrocarbons in soils in fractions of the intervention level (5000 mg/kg)

Excess	site 1	site 2	site 3
av.	2,7	12,6	2,7
max.	13,4	20,4	7,9

PH spatial distribution in the study area soils is shown in **chart 3**. Contour lines show the areas with PH concentration of 3000 and 5000 mg/kg, where 3000 – PC (Brandenburgische Liste) and 5000 – IL. Pollution level higher than PC equal to 50 mg/kg (Neue Niederlandische Liste) takes place practically across the entire study area.

The highest pollution level is observed at proper sites. Their territory is found inside a contour line equal to 5000 mg/kg. Besides the sites, pollution level higher than 3000 mg/kg is observed in below areas due to pollution migration with surface flow (south of site No. 1 and north of site No. 3).

The area, within which the level of pollution with petroleum hydrocarbons exceeds the intervention level is equal to:

- site No.1 – 1.17 ha
- site No.2 - 0.81 ha
- site No.3 – 2.62 ha

total for the site – 4,6 ha

The total area occupied by accumulations of drums at the same territory (Tables 4.12-4.14) is equal to ~ 1 ha.

The map of soil pollution with the substances of **PAH and PCB** groups is given in **chart 4**.

PAH. Total PAH exceeds PC (1 mg/kg) by 1,35 times in one sample only out of 18. The following substances are present in the site's soil: naphthalene, benzo(a)pyrene, fluoranthene, phenanthrene, benzo(b)fluoranthene benzo(k)fluoranthene. Other components were detected in single samples. An average content of benzo(a)pyrene is 0,0073 mg/kg (0,37 MPC). MPC (0.02 mg/kg) excess is detected in a single sample (by 1.22 times).

The level of the site pollution with PAH is permissible (classification - Table 3.5)

PCB. Due to a small number of samples, the soil sampling for PCB was diagnostic. An average concentration of total PCB is 0.0224 mg/kg (at a level of PC=0.02 mg/kg). 2 samples out of 7 (~30%) exceeded the permissible level by 2.3 and 3.1 times (concentration - 0.046 and 0.061 mg/kg, respectively).

Among the congeners to be determined the following ones have the highest concentration: #138, #153, #101, #99, #105, # 52 (average concentrations 0.0046; 0.0032; 0.0029; 0.0027; 0.0026; 0.0023, respectively). The highest concentration is: #101- 0.016; #105-0.011; #138 – 0.015; #153 – 0.016 mg/kg.

The results obtained make it possible classify PCB as priority pollutants for the study area, the level of pollution is hazardous (Table 3.5).

HM. The level of soil pollution with heavy metals is given in Tables 4.18 and 4.19.

The map showing their distribution across the area is given in **chart 5**.

Table 4.18 – Association of the main HM with the level of accumulation $Ci > 2.5\ C_b$

No. of sample	Concentration factor C_i						Z_c
	Lead	Cadmium	Nickel	Copper	Zinc	Chrome total	
9	-	4.0	-	-	-	-	**6**
12	14.3	117	-	11.0	7.7	-	**149**
16	-	98.2	-	-	-	-	**99**
29	-	4.8	-	-	-	-	**6**
32	8.3	32.2	-	3.9	5.7	-	**48**
36	18.0	117	24.7	15.6	15.8	5.8	**193**
39	-	7.5	-	-	2.7	-	**12**
Ci_{max}	**18**	**117**	**25**	**16**	**16**	**6**	
Range of accumulations: Cd; Ni; Pb; Cu; Zn; Cr							

Table 4.19 – Excess of MPC and APC of the main HM in soil (MPC, APC – in mg/kg)

No. of sample	Lead MPC= 32	Lead APC= 65	Cadmium APC=1	Nickel APC=40	Copper APC=66	Zinc APC=110
9	-	-	-	-	-	-
12	6.9	3.4	1.5	-	1.9	3.2
16	0.7	-	1.3	-	-	-
29	0.5	-	-	-	-	-
32	4.0	2.0	-	-	-	2.4
36	8.8	4.3	1.5	9.6	2.6	6.5
39	1.1	-	-	-	-	1.1

In spite of a diagnostic character of sampling, its results provide strong evidence that the area soil is contaminated with heavy metals. A hazardous level of pollution was detected in 2 samples out of 7; an extremely hazardous level – in 2 samples. The highest concentrations of heavy metals were detected in soils of sites No. 1 and 3. The elements of toxic groups I (cadmium, lead, zinc) and II (copper, nickel, chrome) are presented in the association.

Summary Table 4.20 shows the results of sampling data processing for all components to be determined.

Technical liquids. The winter (including those with PPD) and summer Diesel fuel, motor oils, mixtures of spent oils were detected in 9 coniainers. One of the drums contained water polluted with oil products penetrated there due to a loss of drum integrity. There were detected in large amounts: zinc (in 2 samples – more that 400 mg/dm^3) and nickel, in fewer amounts - lead and copper. An average content of total PCB is 0.057 mg/dm^3; the maximum one is 0.077 mg/dm^3. The prevailing congeners in the liquids are #28 b#31. The state of containers identified based on the terrestrial survey results indicates the presence of a potential hazard of soil pollution with metals and PCB due to their content penetration into the environment.

Table 4.20 – Content of pollutants in soils of the former Ministry of defence site on Bolshoy Lyakhovsky Island

No. of sample	soil sampling point	PH content			average for the area			heavy metals			total 15 PCB		benzo(a)pyrene		total PAH	
		concentration mg/kg	in PC fractions 50 mg/kg	in IL fractions 5000 mg/kg	concentration mg/kg	PC excess 50 mg/kg	IL excess 5000 mg/kg	total pollution index Zc	pollution class	background excess ny the main HM: Ci=K/Kb	concentration mg/kg	PC excess 0,02 mg/kg	concentration mg/kg	MPC excess 0,02 mg/kg	concentration mg/kg	PC excess 1 mg/kg
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	dish near drums north of site 1	13	0.3	0.00												
2	dish near drums north of site 1	112	2.2	0.02												
3	dish north of site 1	62	1.2	0.01												
4	dish north of site 1	20	0.4	0.00	**44**	**0.9**	**0.0**									
5	dish north of site 1	14	0.3	0.00												
6	narrow north of site 1	50	1.0	0.01												
7	end of narrow (dish) near site 1	37	0.7	0.01									0.0078	0.39	0.2076	0.21
8	site 1 under gantry	580	11.6	0.1												
9	site 1 Diesel room	5000	100	1.0				6	permiss.		0.0005	0.03	<0.0012		0.0424	0.04
10	site 1 dish near drums	62	1.2	0.0									0.0064	0.32	0.2024	0.20
11	site 1 under cisterns	7500	150	1.5									0.0064	0.32	0.0446	0.04
12	site 1 Diesel room	31200	624	6.2	**13529**	**270.6**	**2.7**	**149**	extr. hazardous	Pb - 14 Cd - 117 Cu - 11 Zn - 8	0.0460	2.30	0.0028	0.14	0.1908	0.19
13	site 1 drums near Diesel room	67000	1340	13.4									0.0062	0.31	0.1896	0.19
14	site 1 big dish	15	0.3	0.0									0.0060	0.30	0.1922	0.19
18	site 1 near drums	6300	126	1.3									0.0077	0.39	0.1887	0.19
19	site 1 dish near drums	4100	82.0	0.8												
15	narrow west of site 1	670	13.4	0.1	**2300**	**46.0**	**0.5**		hazardous	Cd - 98						
16	narrow below drums south of site 1	92	1.8	0.0				**99**			0.0050	0.25	0.0005	0.03	0.0202	0.02
17	narrow west of site 1	4700	94.0	0.9												
20	slope below drums south of site 1	1780	35.6	0.4												
21	creek valley below site 1	2920	58.4	0.6									0.0072	0.36	0.1825	0.18

22	creek valley below site 1	3900	78.0	0.8												
23	creek valley south of site 1	2040	40.8	0.4												

Continuation of Table4.20

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
24	hollow below site 3	15	0.3	0.00									0.0079	0.40	0.1815	0.18
25	between site 1 and 3	166	3.3	0.03	**59**	**1.2**	**0.0**									
26	between site 1 and 3	34	0.7	0.01												
27	between site 1 and 3	19	0.4	0.00												
28	edge of site 2	252	5.0	0.05												
29	dish near west edge of site 2	169	3.4	0.03	**170**	**3.4**	**0.0**	6	permiss.		0.0610	3.05	<0.0012		0.0090	0.01
30	dish south of site 2	154	3.1	0.03												
31	narrow south of site 2	104	2.1	0.02												
32	site 2 Diesel room	102000	2040	20.4				**48**			0.0180	0.90	0.0088	0.44	1.3548	1.35
33	site 2 near leaking drums	56000	1120	11.2	**63100**	**1262**	**12.6**		hazardous	Pb - 8 Cd - 32 Cu - 4 Zn - 6			<0.0012		0.9157	0.92
34	site 2 cisterns	7400	148	1.5									0.0053	0.27	0.0351	0.04
35	site 2 dish near drums	87000	1740	17.4												
36	site 3 boiler-house	39700	794	7.9				**193**			0.0140	0.70	0.0039	0.20	0.3536	0.35
37	site 3. dish	101	2.0	0.02	**13285**	**266**	**2.7**		extr. hazardous	Hg-2 Pb-18 Cd -117 Ni-25 Cu-16 Zn-16 Cr-8			0.0080	0.40	0.1956	0.20
38	site 3 dish near drums	53	1.1	0.01												
39	hollow north of site 3	19	0.4	0.00				12	permiss.	Pb-3 Zn-3 Cd-7,5	0.0120	0.60	0.0243	1.22	0.3456	0.35
40	narrow north of site 3 (runoff from site)	3500	70.0	0.7	**1760**	**35.2**	**0.4**									

5. INVENTORY OF POLLUTION SOURCE ON KOTELNY ISLAND

5.1 Characteristics of the study area

The survey of Kotelny Island was made on September 29, 2010. The main study object, the decommissioned Ministry of Defense site area, is located on a slope near the Stakhanovtsev Arktiki Bay in front of Usuk-Kaoga Island. The civil Temp Airport is located south of it separated by the Pshenitsyna Lagoon – Figure 5.1.

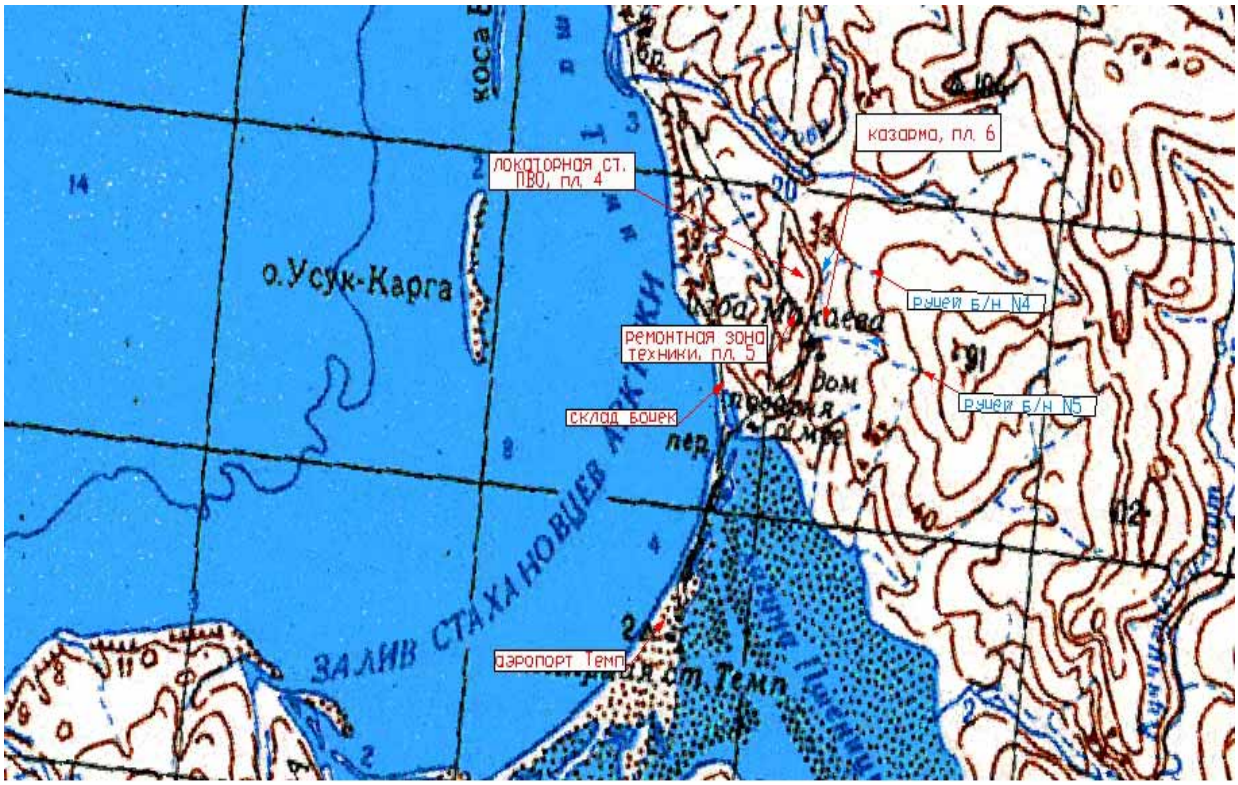


Figure 5.1

The terrain of the area is bald mountains. The hydrographic network is well developed. The air-defense is situated on the watershed of creek No. 4 and its stream - creek No. 5 running into the Pshenitsyna Lagoon.

A 30 cm deep hole was drilled to get to know the characteristics of the area soils – Figure 5.2. The type of soils was determined according to the 2004 Russian Soil Classification and Diagnostics System (L.L. Shishov et al, edited by G.V. Dobrovolsky) – Table 5.1. The soils of the area are sour.

Table 5.1 – Characteristics of the area soils

Topology	Soil	
	Type	Separate
Hill crests, no-name creek slopes and valley	humus petrozems	underdeveloped
Dishes with stagnant water conditions	humus petrozems	gley soils

Figure 5.2 - 30 cm deep hole

3 groups of densely located pollution sources were revealed at the area of air-defense base sites 4, 5 and 6. The composition of pollution sources is given in Table 5.2.

All sites have marauding traces. Service and domestic premises are half destroyed. The marauding traces are visible (doors and windows have been taken off and removed; electronic packages have been disassembled and scattered, furniture has been broken).

Table 5.2 - Main sites to be studied on Kotelny Island

Area	No. of terrestrial survey site	Description
Kotelny Island	4	Radar station (air-defense radar unit, drum storage area)
	5	Equipment repair area (drum storage area, Diesel plant)
	6	Barrack (boiler-house, Diesel plant, drum storage area)
	7	Temp Airport (flight control tower, boiler-house and drum storage

5.2 Scope of work and main results

The scope of the inventory of pollution sources at the former Ministry of Defense site on Kotelny Island is shown in a summary list – Table 5.3

To map all the infrastructure and pollution sources, the survey area was increased from the planned 25 ha to 65 ha.

On Kotelny Island, in addition to the air-defense base, a 40 ha area of the civil Temp Airport commissioned in 1949 and actively operated until the early 1990s was surveyed.

Table 5.3 – Summary list of work (air-defense base / Temp Airport)

No.	Name of work	Unit of measurement	Volume	Note

Field work on the terrrain mapping				
1	Number of routes	pcs	5 / 2	
2	Number of images (main, panoramic, technical)	pcs	314 / 32	
3	Survey area	ha	65 / 40	
4	Points of reference	pcs	11	
Land works				
5	Photo-documenting	photograph	89 / 133	
6	Soil sampling	sample	53 / 7	
7	Soil baseline sampling	sample	1	
8	Technical liquid sampling	sample	9 / 1	
9	Water sampling	sample	1	
Chemical analytical study				
10	Determination of PH in soil samples	sample	53 / 7	
11	Determination of PAH in soil samples (composition and total)	sample	19 / 2	16 substances
12	Determination of PCB in soil samples	sample	9 / 1	15 congeners
13	Determination of heavy metals in soil samples	sample	11 / 1	10 elements
14	Determination of heavy metals in baseline samples	sample	1	10 elements
15	Identification of technical liquids	sample	9 / 1	(25 parameters)
16	Determination of PCB in technical liquids	sample	5 / -	16 congeners
17	Determination of heavy metals in technical liquids	sample	5 / -	9 elements
18	Chemical analysis of water sample	sample	1	
Cameral work				
19	Creation of 1:1000 orthophoto map	photograph	64 / 25	main images
20	Processing of chemical analysis results	parameter	1051	
21	Creation of soil pollution maps	map	3/1	
22	Creation of main pollution source schematic map	map	1	

Physical and geological map of the air-defense base based on 1:1000 orthophoto map is shown on chart 6. Coordinates of reference points are given in Table 5.4.

Table 5.4 – Coordinates of reference points *(UTM 53N Coordinate System)*

No. of point	Coordinates			No. of point	Coordinates			No. of point	Coordinates		
	X	Y	H		X	Y	H		X	Y	H
1	572346.847	8415419.249	54.757	5	572227.918	8414949.61	51.828	9	572928.699	8415165.351	31.449
2	572365.066	8415511.413	54.341	6	572382.984	8415001.684	50.202	10	573239.059	8415409.915	54.951
3	572216.706	8415382.679	53.316	7	572859.669	8415066.422	29.29	11	573244.63	8415456.703	55.885
4	572360.266	8415108.837	52.732	8	572998.869	8415073.355	33.234				

The Registers of soil and technical liquid samples are given in Tables 5.5 and 5.6. The results of chemical analytical study are given in the following Tables:

- content of petroleum hydrocarbons (PH) in soil– Table 5.7;
- content of PAH in soil cover – Table 5.8
- content of HM and PCB in soil cover – Table 5.9;
- results of identification of technical liquids with conclusion – Table 5.10;
- content of PCB and HM in technical liquids – Table 5.11;
- chemical analysis of water sample (junction of creeks No. 4 and 5) – Table 5.12.

Table 5.5 – Register of soil samples

No. of sample	Coordinates *		Sample date	Sampling point	Characteristics of specimen			Parameters to be determined			
	x	y			smell	color	consistency	PH	PAH	PCB	HM
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Temp Airport											
41	570893	8411320	30.10.10	under cistern	oil products	brown	oily semi-solid	+			
42	570931	8411289	30.10.10	leak from drum	weak boggy	brown	wet friable with rock fractions of Ø <1 mm	+			
43	571039	8411109	30.10.10	airdrome boiler-house	no	black	wet friable	+	+	+	+
44	570685	8411049	30.10.10	leak from drums	weak oil product	black	pebbles	+			
45	570710	8411100	30.10.10	leak from drums	weak oil product	black	pebbles	+			
46	570892	8411496	30.10.10	airdrome coast near barge	no	taupe	wet semi-solid crumbling	+	+		
47	570961	8411521	30.10.10	leak from drums	weak oil product	black	pebbles	+			
Air-defense base											
48	572325	8415362	30.10.10	site 4 dish near west edge	weak boggy	grey-black	wet semi-solid	+			
49	572330	8415390	30.10.10	site 4 dish near west edge	no	dark grey	wet semi-solid	+	+	+	+
50	572320	8415089	30.10.10	site 5 accumulation of drums in site's north-west part	weak boggy	dark grey	liquefied	+			
51	572380	8415086	30.10.10	site 5 gantry in site's north-east part	no	grey	dry crumbling with rock fractions 30x20x10 mm	+			+
52	572333	8415032	30.10.10	site 5 cisterns with fuel and lubricant	weak boggy	dark grey	wet semi-solid	+			
53	572322	8415028	30.10.10	site 5 drum storage area	weak boggy	dark grey	wet semi-solid	+			+
54	572340	8414990	30.10.10	site 5 drums	weak boggy	dark grey	wet semi-solid	+			
55	572324	8414982	30.10.10	site 5 generator	weak boggy	dark grey	wet crumbling	+	+		
56	572354	8415020	30.10.10	site 5 tractor	no	grey	wet semi-solid	+			
57	572381	8415004	30.10.10	site 5 slope under drums	no	grey	wet semi-solid	+	+	+	+
58	572438	8414980	30.10.10	below site 5 drums on slope	no	grey	dry crumbling gravel chippings	+			

Continuation of Table5.5

1	2	3	4	5	6	7	8	9	10	11	12
59	572416	8414928	30.10.10	below site 5 creek on slope	no	light-gray	dry crumbling with gravel chippings	+	+		
60	572487	8414920	30.10.10	below site 5 creeks crossing	no	light-gray	dry crumbling with gravel chippings	+			
61	572749	8414988	30.10.10	creek on base site 6	weak oil product	light-gray	dry crumbling with gravel chippings	+	+		
62	572809	8415042	30.10.10	site 6 dish near drums	no	grey	wet semi-solid	+	+	+	+
63	573012	8415116	30.10.10	site 6 dish near drums	no	taupe	wet semi-solid with pebbles	+			
64	572950	8415070	30.10.10	site 6 boiler-house	weak boggy	dark grey	wet semi-solid with pebbles	+	+		
65	572945	8415084	30.10.10	site 6 Diesel station	weak boggy	dark grey	wet semi-solid with pebbles	+	+		
66	572924	8415080	30.10.10	site 6 cisterns with fuel and lubricant	weak oil product	dark grey	wet friable with pebbles	+			
67	572879	8415046	30.10.10	site 6 Diesel station 2	no	dark grey	wet semi-solid crumbling	+	+	+	+
68	572864	8414934	30.10.10	site 6 drums in south part	no	grey	wet semi-solid with pebbles	+	+		
69	572767	8414792	30.10.10	south of site 6 near MAZ lorry	weak boggy	grey	wet semi-solid with pebbles	+			
70	572642	8414728	30.10.10	south of site 6 under gantry	weak oil product	grey	liquefied with small gravel chippings	+	+		
71	572403	8415424	30.10.10	site 4 crane near cisterns	weak oil product	dark grey	wet semi-solid crumbling	+			
72	572387	8415422	30.10.10	site 4 Diesel station	weak boggy	dark grey	wet semi-solid with small gravel chippings	+	+		
73	572369	8415425	30.10.10	site 4 drums near building	weak boggy	black	wet semi-solid crumbling with pebbles	+			
74	572362	8415429	30.10.10	site 4 drums near building	no	grey	wet semi-solid crumbling with gravel chippings	+	+	+	+

Continuation of Table5.5

1	2	3	4	5	6	7	8	9	10	11	12
75	572352	8415469	30.10.10	site 4 Radar station	no	grey	wet semi-solid with small gravel chippings	+			

76	572330	8415429	30.10.10	site 4 separate drums	no	dark grey	wet semi-solid crumbling	+			
77	572318	8415421	30.10.10	site 4 accumulation of drums	weak oil product	grey	wet semi-solid	+	+	+	+
78	572409	8415368	30.10.10	site 4 drum storage area	weak oil product	grey	wet semi-solid	+	+		
79	572361	8415393	30.10.10	site 4 drum storage area	weak oil product	grey	wet semi-solid	+	+		
80	572375	8415398	30.10.10	site 4 drum storage area	**2**	**3**	**4**	+			
81	572396	8415393	30.10.10	site 4 drum storage area	weak oil product	grey	wet semi-solid	+			
82	572408	8415400	30.10.10	site 4 drums near cisterns	weak oil product	grey	wet semi-solid	+			
83	572380	8415339	30.10.10	site 4 drum storage area in site's south part	no	grey	wet semi-solid	+	+	+	+
84	572366	8415345	30.10.10	site 4 drum storage area in site's south part	no	grey	wet semi-solid	+			
85	572417	8415308	30.10.10	site 4 dish near site's south edge	no	grey	wet semi-solid crumbling	+	+		
86	572306	8415306	30.10.10	site 4 drums in site's south-west part	no	grey	wet semi-solid crumbling with small gravel chippings	+			
87	572397	8415260	30.10.10	below site (between site 4 and 5)	no	grey	wet semi-solid crumbling with small gravel chippings	+			
88	572541	8415314	30.10.10	narrow between site 4 and site 6	weak oil product	grey	wet semi-solid crumbling with small gravel chippings	+			
89	572613	8415310	30.10.10	narrow between site 4 and site 6	weak oil product	grey	wet semi-solid crumbling with small gravel chippings	+			

Continuation of Table5.5

1	2	3	4	5	6	7	8	9	10	11	12
90	572662	8415287	30.10.10	narrow between site 4 and site 6	no	grey	wet semi-solid crumbling with small gravel chippings	+			
91	572666	8415267	30.10.10	dish between site 4 and site 6	weak oil product	grey	wet semi-solid crumbling with gravel chippings	+	+	+	+

92	572732	8415249	30.10.10	narrow between site 4 and site 6	no	grey	wet semi-solid crumbling with gravel chippings	+			
93	572767	8415104	30.10.10	hollow west of site 6	no	grey	wet semi-solid crumbling with gravel chippings	+			
94	572811	8415217	30.10.10	dish near site's 6 north-west edge	no	grey	wet semi-solid	+			
95	572923	8415161	30.10.10	site 6 north part	no	light-gray	wet semi-solid crumbling with small gravel chippings	+			
96	572983	8415169	30.10.10	site 6 north of barrack	no	grey	wet semi-solid	+	+	+	+
97	572811	8415165	30.10.10	narrow west of site 6	no	grey	wet semi-solid	+			
98	572875	8415102	30.10.10	site 6 near drums	no	grey	wet semi-solid crumbling with gravel chippings	+			
99	572967	8415114	30.10.10	site 6 barrack	no	grey	wet semi-solid crumbling with gravel chippings	+			
100	572746	8415055	30.10.10	narrow west of site 6	no	grey	wet semi-solid crumbling with small gravel chippings	+			

** coordinate system:*
Kotelny Island - UTM 53N

Table 5.6 – Register of technical liquid samples

No. of sample	Sample date	Coordinates*		Sampling point	Identification of liquid	Parameters to be determined	
		x	y			PCB	HM
10	30.10.10	572435	8415013	accumulation of drums downslope, site 5	+		
11	30.10.10	572566	8414902	drums, site 5	+		
12	30.10.10	572377	8415005	accumulation of drums, site 5	+	+	+
13	30.10.10	572844	8415021	accumulation of drums, site 6	+	+	+
15	30.10.10	572886	8415034	drum in Diesel station building, site 6	+		
16	30.10.10	570836	8411301	TEMP, accumulation of drums	+		
17	30.10.10	572845	8415019	container, site 6	+	+	+
18	30.10.10	572364	8415423	drum in Diesel station building, site 4	+	+	+
19	30.10.10	572364	8415431	accumulation of drums, site 4	+		

20	30.10.10	572369	8415397	accumulation of drums, site 5	+	+	+

** coordinate system Bolshoy Lyakhovsky - UTM 54N*

Table 5.7 – Content in soil of PH, mg/kg

No. of	PH content	No. of	PH content	No. of	PH content	No. of	PH content
41	523000	56	4200	71	23000	86	172
42	123	57	1220	72	37000	87	1280
43	1070	58	3240	73	78000	88	9000
44	21000	59	470	74	53000	89	2220
45	37000	60	114	75	86	90	2260
46	25900	61	540	76	1760	91	33
47	13100	62	8400	77	1060	92	860
48	4400	63	sample lost	78	8300	93	890
49	4200	64	11200	79	32600	94	187
50	490	65	9500	80	13000	95	360
51	4200	66	76000	81	13100	96	182
52	5000	67	48000	82	37700	97	288
53	4700	68	1540	83	366	98	305
54	3110	69	76	84	330	99	238
55	109	70	32	85	148	100	221

Table 5.8 – Content of polycyclic aromatic hydrocarbons in soil, mg/kg (lower value of the operating range <0.0012)

Parameter to be determined	No. of sample											
	Temp		air-defense base									
	43	46	49	55	57	59	61	62	64	65	67	68
Naphthalene	0,6347	0,4569	0,3275	0,0214	0,2167	0,0281	0,0258	0,4241	0,0275	0,0240	0,2689	0,0223
Benzo(a)pyrene	<0.0012	<0.0012	0,0369	0,0074	0,0008	0,0068	0,0061	0,0013	0,0076	0,0068	0,0016	0,0074
Acenaphthylene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	0,0103	<0.0012
Acenaphthene	0,0124	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	< 0.0012	<0.0012
Fluoranthene	<0.0012	0,0129	<0.0012	0,0658	0,0036	0,0497	0,0497	<0.0012	0,0679	0,0616	< 0.0012	0,0518
Fluorene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	0,0412	<0.0012	<0.0012	0,0271	<0.0012
Phenanthrene	0,3182	0,0826	<0.0012	0,0454	<0.0012	0,0481	0,0492	0,1889	0,0379	0,0395	0,1162	0,0449
Anthracene	0,4545	0,0270	<0.0012	0,0151	0,0009	0,0153	0,0169	0,0064	0,0190	0,0155	< 0.0012	0,0192
Pyrene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	< 0.0012	<0.0012
Benzo(a)anthracene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	< 0.0012	<0.0012
Chrysene	<0.0012	<0.0012	<0.0012	<0.0012	0,0032	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	< 0.0012	<0.0012
Benzo(b)fluoranthene	0,0400	<0.0012	0,1218	0,0257	0,0023	0,0345	0,0261	0,0096	0,0290	0,0330	0,0032	0,0334
Benzo(k)fluoranthene	<0.0012	<0.0012	0,0355	0,0071	0,0005	0,0064	0,0065	0,0005	0,0075	0,0057	< 0.0012	0,0066
Dibenzo(a,h)anthracene	<0.0012	<0.0012	0,4175	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	< 0.0012	<0.0012
Indeno(1,2,3-c,d)-pyrene	<0.0012	<0.0012	0,1542	<0.0012	0,0050	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	< 0.0012	<0.0012
Benzo(g,h,i)perylene	<0.0012	<0.0012	0,0277	<0.0012	0,0007	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	< 0.0012	<0.0012

Continuation of Table5.8

Parameter to be determined	No. of sample								
	air-defense base								
	70	72	74	77	78	79	83	85	94
Naphthalene	0.0220	0.0272	<0.0012	0.5738	0.0258	0.0220	0.1422	0.0249	0.0323
Benzo(a)pyrene	0.0069	0.0069	<0.0012	<0.0012	0.0062	0.0064	<0.0012	0.0079	0.0012
Acenaphthylene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Acenaphthene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Fluoranthene	0.0602	0.0525	<0.0012	0.0077	0.0574	0.0616	<0.0012	0.0665	<0.0012
Fluorene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Phenanthrene	0.0417	0.0502	<0.0012	<0.0012	0.0497	0.0454	0.0599	0.0374	0.0579
Anthracene	0.0200	0.0145	<0.0012	<0.0012	0.0196	0.0157	<0.0012	0.0198	<0.0012
Pyrene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Benzo(a)anthracene	<0.0012	<0.0012	<0.0012	0.1382	<0.0012	<0.0012	<0.0012	<0.0012	0.0027
Chrysene	<0.0012	<0.0012	<0.0012	0.0011	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Benzo(b)fluoranthene	0.0319	0.0301	<0.0012	<0.0012	0.0349	0.0349	<0.0012	0.0345	0.0041
Benzo(k)fluoranthene	0.0056	0.0065	<0.0012	0.0039	0.0067	0.0078	0.0019	0.0068	0.0014
Dibenzo(a,h)anthracene	<0.0012	<0.0012	<0.0012	0.0036	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Indeno(1,2,3-c,d)pyrene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Benzo(g,h,i) perylene	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Total PAH	0.1883	0.1879	<0.0012	0.7284	0.2003	0.1938	0.2040	0.1979	0.0997

Table 5.9 – Content of heavy metals and PCB in baseline and main soils samples

parameter to be controlled	unit of measurement	lower value of operating range	background	Temp	air-defense base									
				number of sample										
				43	49	51	53	57	62	67	74	77	83	94
Mercury	mg/kg	< 0.005	0.015	0.385	0.011	0.009	0.004	0.008	0.001	0.015	0.019	0.013	0.005	0.006
Lead	mg/kg	< 0.20	19.40	12.31	113.58	62.48	28.96	52.42	34.78	13460.25	371.43	327.01	16.92	36.34
Cadmium	mg/kg	< 0.010	0.018	<0.01	0.069	1.556	0.049	0.191	0.0.043	1.476	1.980	0.203	0.960	0.017
Cobalt	mg/kg	< 0.20	13.73	5.14	13.69	4.94	7.67	6.72	6.20	4.85	4.51	11.74	11.10	4.83
Nickel	mg/kg	< 0.30	17.63	7.67	41.18	15.72	324.44	29.51	32.62	25.94	27.68	32.61	37.34	28.17
Copper	mg/kg	< 0.20	15.59	8.93	30.56	27.81	12.62	25.03	17.39	70.98	64.66	32.78	19.09	15.67
Zinc	mg/kg	< 1.0	62.1	35.1	181.4	142.6	69.5	69.9	65.7	201.6	962.5	178.0	81.8	62.2
Manganese	mg/kg	< 0.20	275.73	179.32	609.81	505.07	268.11	626.71	478.01	313.34	356.27	534.11	496.95	487.73
Chrome total	mg/kg	< 0.50	31.60	7.42	35.52	13.36	24.89	24.88	22.67	15.90	32.18	29.36	32.34	19.98
Tin	mg/kg	< 0.50	1.01	<0.50	1.99	56.33	5.31	21.86	0.64	6.99	6.93	2.07	1.60	9.22
#28	mg/kg	< 0.000050		0.001152	0.001228			0.001575	0.001159	0.000724	0.000636	0.001507	0.001199	0.001258
#31	mg/kg	< 0.000050		0.002629	0.001449			0.002177	0.001081	0.000066	0.000093	0.001039	0.000969	0.001547
#52	mg/kg	< 0.000050		0.002114	0.003682			0.001882	0.002192	<0.000050	<0.000050	0.002333	0.001850	0.001734
#99	mg/kg	< 0.000050		0.000403	0.001686			0.000497	0.000534	0.009290	0.009883	0.001089	0.000270	0.000234
#101	mg/kg	< 0.000050		0.000861	0.003408			0.000831	0.000971	0.000708	0.016003	0.001957	0.000514	0.000494
#105	mg/kg	< 0.000050		0.000672	0.002058			0.000843	0.000735	0.006435	0.010401	0.001177	0.000401	0.000367
#118	mg/kg	< 0.000050		0.000442	0.001890			0.000722	0.000451	0.000296	0.006683	0.000958	0.000206	0.000243
#128	mg/kg	< 0.000050		0.000190	0.001023			0.000626	0.000294	0.004748	0.004083	0.000956	0.000101	0.000180
#138	mg/kg	< 0.000050		0.001801	0.003365			0.001508	0.000870	0.015197	0.015412	0.002474	0.000278	0.000398
#153	mg/kg	< 0.000050		0.001444	0.002919			0.001360	0.000764	<0.000050	0.015762	0.002467	0.000262	0.000388
#156	mg/kg	< 0.000050		0.000179	0.000590			0.000267	0.000121	0.002598	0.001505	0.000283	<0.000050	0.000055
#170	mg/kg	< 0.000050		0.000332	0.000364			0.000297	0.000055	0.000823	0.001018	0.000298	<0.000050	<0.000050
#180	mg/kg	< 0.000050		0.000437	0.000453			0.000332	0.000075	0.001438	0.000938	0.000268	<0.000050	<0.000050
#183	mg/kg	< 0.000050		0.000082	0.000140			0.000065	<0.000050	<0.000050	0.000944	0.000096	<0.000050	<0.000050
#187	mg/kg	< 0.000050		0.000191	0.000194			0.000136	<0.000050	0.000057	0.000540	0.000075	<0.000050	<0.000050
#209	mg/kg	< 0.000050		<0.000050	<0.000050			<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Total 7 PCB*	mg/kg	< 0.000050		0.008250	0.016946			0.008211	0.006482	0.018364	0.055434	0.011964	0.004309	0.004515
Total 9 PCB*	mg/kg	< 0.000050		0.009101	0.019594			0.009321	0.007338	0.027397	0.067340	0.013424	0.004710	0.004937
Total 15 PCB*	mg/kg	< 0.000050		0.012736	0.024255			0.012983	0.009301	0.042324	0.083360	0.016901	0.006050	0.006898

Table 5.10 - Results of identification of technical liquids with conclusion

Parameter to be controlled	number of sample									
	10	11	12	13	15	16	17	18	19	20
Density at 20° C, kg/m³	869.3	807.1	869.6	856.6	822.7	852.5	856.2	889.1	-	860.60
Density at 15° C, kg/m³	872.7	810.6	873.0	860.0	826.2	856.0	859.6	892.5	-	864.0
Viscosity at 20° C, centistokes	5.33	2.37	5.52	7.74	2.12	7.01	7.78	-	-	7.51
Viscosity at 40° C, centistokes	3.42	-	3.52	4.70	-	4.32	4.72	55.43	-	4.58
Viscosity at 50° C, centistokes	-	-	-	-	-	-	-	-	-	-
Viscosity at 100° C, centistokes	-	-	-	-	-	-	-	12.51	-	-
Viscosity index	-	-	-	-	-	-	-	232	-	-
Fractional composition (50%),° C	264.8	198.7	269.8	269.1	220.4	270.8	269.3	-	-	267.8
Fractional composition (end boiling point),° C	350.0	261.2	352.1	353.0	294.0	356.7	354.1	-	-	351.2
Flash and ignition points in open crucible, ° C	104	-	108	104	-	118	106	246	-	110
Flash and ignition points in closed crucible, ° C	41	55	42	68	68	85	69	-	-	77
Pour point, ° C	<-40	<-40	<-40	<-40	<-40	<-40	<-40	-26.9	-	<-40
Cloud point, ° C	<-30	<-30	<-30	<-30	<-30	<-30	<-30	-	-	<-30
Leak-off coefficient	2.95	1.09	3.15	2.20	1.11	2.35	3.10	-	-	3.10
Sulphur, %	0.215	0.195	0.232	0.443	0.132	0.105	0.396	-	-	0.443
Sulphurated hydrogen, ppm	-	abs.	-	-	abs.	-	-	-	-	-
Water, %	abs.	0.576	abs.	abs.	abs.	abs.	abs.	0.284	99.982	abs.
Mechanical admixtures, %	abs.	0.0345	abs.	abs.	abs.	abs.	abs.	0.0663	-	abs.
Sulphated ash, %	-	-	-	-	-	-	-	0.54	-	-
Ash content, %	0.055	0.044	0.083	0.079	0.039	0.075	0.068	-	-	0.085
Alkali neutralization number, mg KOH/g	1.53	-	-	0.90	-	-	-	7.93	-	0.55
Acid number, mg KOH/g	-	-	-	-	-	-	-	-	-	-
Acidity, mg KOH/100 g	3.380	3.115	3.560	2.330	2.956	10.300	2.250	-	-	2.930
Iodine number, g I/100 g	1.8	1.2	0.9	1.3	1.3	0.8	1.1	-	-	1.3
Presence of water-soluble acids and alkalis	-	abs.	-	-	abs.	-	-	-	-	-
Conclusion	Motor oil for Diesels M-14V	Winter Diesel fuel	Winter Diesel fuel with PPD	Winter Diesel fuel with PPD	Winter Diesel fuel	Winter Diesel fuel with PPD	Winter Diesel fuel with PPD	Motor oil for Diesels M-14V2	water	Winter Diesel fuel with PPD

Table 5.11 – Content of HM and PCB in technical liquids

		Kotelny Island, area of decommissioned milatary site				
		No. of sample				
Parameter to be controlled	Lower value of operating range	12	13	17	18	20
		Winter Diesel fuel with PPD	Winter Diesel fuel with PPD	Winter Diesel fuel with PPD	Motor oil for Diesels M-14V	Winter Diesel fuel with PPD
Lead	< 0.20	29.35	51.39	38.82	< 0.20	6.45
Cadmium	< 0.010	0.253	0.384	0.384	0.016	0.100
Cobalt	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	< 0.30	43.18	< 0.30	< 0.30	< 0.30	74.66
Copper	< 0.20	22.55	7.39	7.10	0.20	25.13
Zinc	< 1.0	111.55	47.38	45.48	627.23	93.51
Manganese	< 0.20	1.19	0.27	0.26	0.27	1.14
Chrome	< 0.50	1,77	< 0.50	< 0.50	< 0.50	< 0.50
Tin	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
#28	< 0.000050	0,012712	0,021161	0,016212	0,016717	0,021688
#31	< 0.000050	0,064679	0,040217	0,029683	0,029891	0,048317
#52	< 0.000050	0,000832	0,002231	0,000188	0,000989	0,000307
#99	< 0.000050	0,000239	0,000349	0,000166	0,000398	0,000338
#101	< 0.000050	0,000598	0,000753	0,000352	0,000850	0,000305
#105	< 0.000050	0,000972	0,003327	0,000793	0,006470	0,001491
#118	< 0.000050	0,000241	0,000473	0,000438	0,000355	0,000241
#128	< 0.000050	0,000385	< 0.000050	< 0.000050	0,000812	< 0.000050
#138	< 0.000050	0,001142	0,001963	0,001104	0,001406	0,001391
#153	< 0.000050	0,000713	0,001143	0,000551	0,000851	0,000743
#156	< 0.000050	0,000055	0,000322	0,000154	0,000554	0,000160
#170	< 0.000050	< 0.000050	0,000150	0,000325	0,000336	0,000210
#180	< 0.000050	0,000185	0,000366	0,000127	0,000396	0,000129
#183	< 0.000050	< 0.000050	< 0.000050	< 0.000050	0,000217	0,000064
#187	< 0.000050	< 0.000050	< 0.000050	< 0.000050	0,000217	0,000096
#209	< 0.000050	< 0.000050	< 0.000050	< 0.000050	0,000474	< 0.000050
Total 7 PCB*	< 0.000050	0,016423	0,028090	0,018971	0,021564	0,024805

Table 5.12 – Results of chemical analysis of water sample* (creek infall, drining the site areas)

No.	Parameter to be controlled	Unit of measurement	Lower value of operating range	sample 14
1	Dichromate value	mg/dm^3	< 5.0	437
2	Petroleum hydrocarbons	mg/dm^3	< 0.005	1.82
3	Benzo(a)pyrene	mg/dm^3	< 0.0000005	< 0.0000005
4	Lead	mg/dm^3	< 0.0020	0.086
5	Cadmium		< 0.00010	<0.00010
6	Cobalt		< 0.002	0.0024
7	Nickel		< 0.002	0.031
8	Copper		< 0.0010	0.014
9	Zinc		< 0.04	<0.04
10	Manganese		< 0.10	0.841
11	Chrome		< 0.002	<0.002
12	Tin		< 0.005	0.0098
13	#28		< 0.00030	< 0.000030
14	#31		< 0.00030	< 0.000030
15	#52		< 0.00020	< 0.000020
16	#99		< 0.00020	< 0.000020
17	#101		< 0.00020	< 0.000020
18	#105		< 0.00020	< 0.000020
19	#118		< 0.00020	< 0.000020
20	#128		< 0.00020	< 0.000020
21	#138		< 0.00020	< 0.000020
22	#153		< 0.00020	< 0.000020
23	#156		< 0.00020	< 0.000020
24	#170		< 0.00020	< 0.000020
25	#180		< 0.00010	< 0.000010
26	#183		< 0.00010	< 0.000010
27	#187		< 0.00010	< 0.000010
28	#209		< 0.00010	< 0.000010
29	Total 7 PCB*		< 0.00010	< 0.000010
30	Total 9 PCB*		< 0.00010	< 0.000010
31	Total 15 PCB*		< 0.00010	< 0.000010

**** sample coordinates X-572751; Y-8414989***

5.3 Inventory of pollution sources at the decommissioned Ministry of Defense site

The object is the former radar station.

The inventory of the main pollution sources is shown on a schematic map given in chart 7.

5.3.1 Site No. 4

Panoramic image of the site is given on **photo 5.1**. The main site's infrastructure facilities and pollution sources are as follows: air-defense radar station, Diesel station (photo **5.2**), crane for fuel and lubricant distribution (**photo 5.3)**.

In south part of the study area, a storage area of empty drums laid horizontally is located (**photo 5.4**). The drums of different degree of fullness are located along the site's north side. Technical liquid sample No. 20 was taken from this area.

Diesel plant is located in the site's central part (**photo 5.2).** Inside the plant, two full drums were found, from one of technical liquid sample No. 18 was taken (**photo 5.5**). The drums of different degree of fullness are scattered south and west of Diesel station, where technical liquid sample No. 19 was taken.

40 m east of the Diesel station building, there are 5 empty cisterns **(photo 5.3)**, behind which there is an accumulation of drums with different degree of fullness. The state of the drums is satisfactory, but some local accumulations of damaged drums exist with a lot of leaks from them **(photo 5.7-.5.9**).

25 m north-west of the cisterns a transformer was found that could contain PCB **(photo 5.3, 5.6)**.

The site is littered with metal scrap.

Pollutants mainly migrate through no-name creek No.4 running into the Pshenitsyna Lagoon (**see the study area map**).

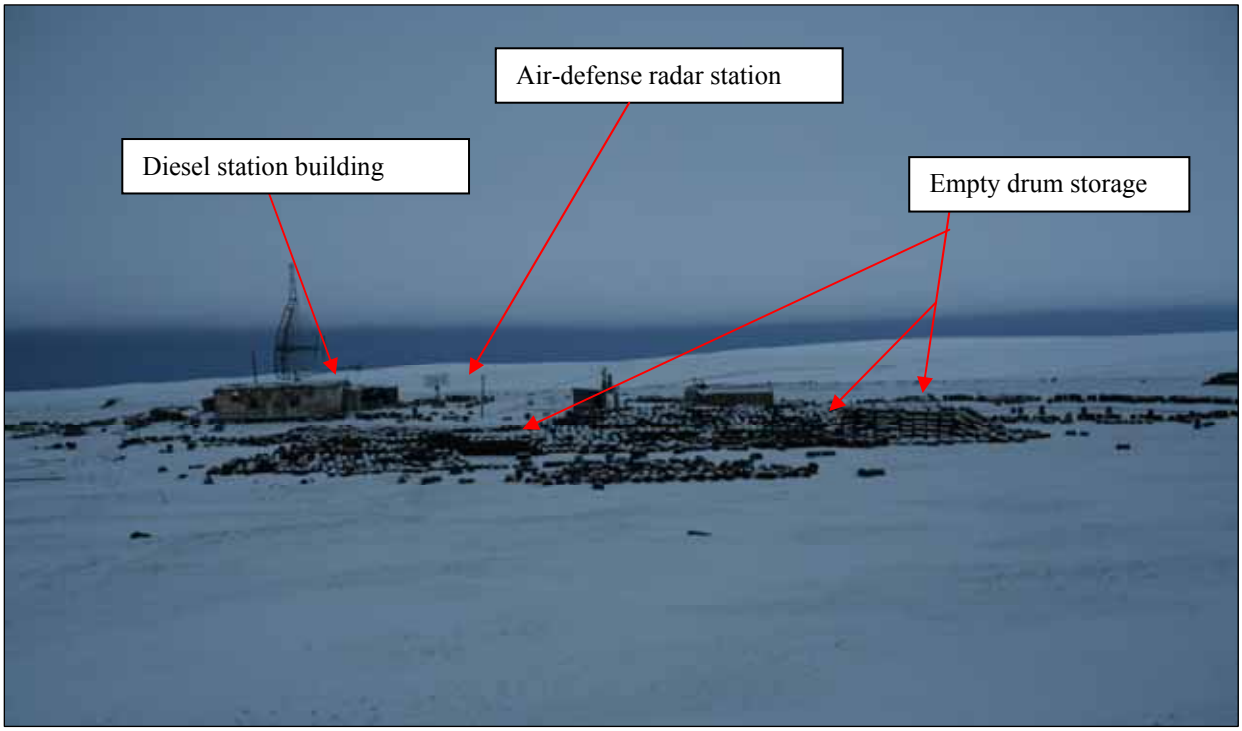


Photo 5.1 Panoramic image of site No. 4

Photo 5.2 Diesel plant building

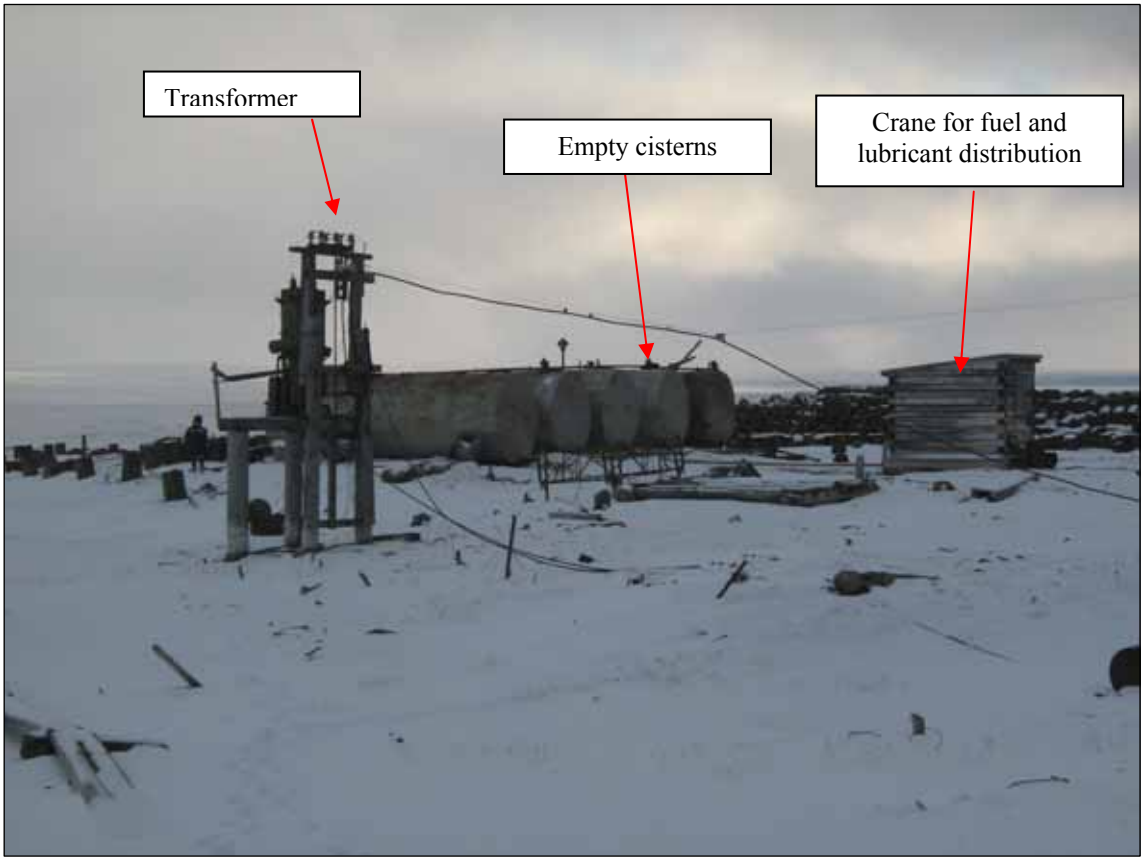


Photo 5.3 Panoramic image of site No. 4

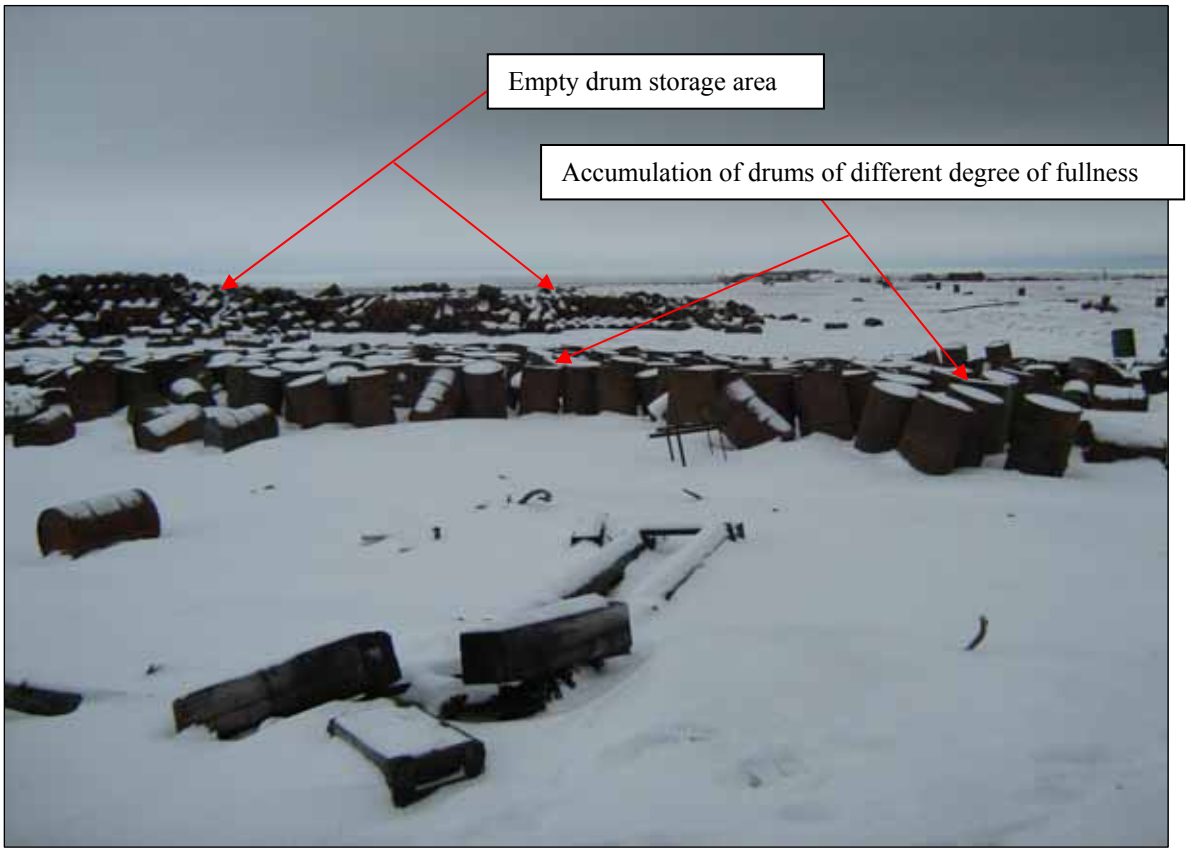


Photo 5.4 Accumulation of drums in the site’s south part

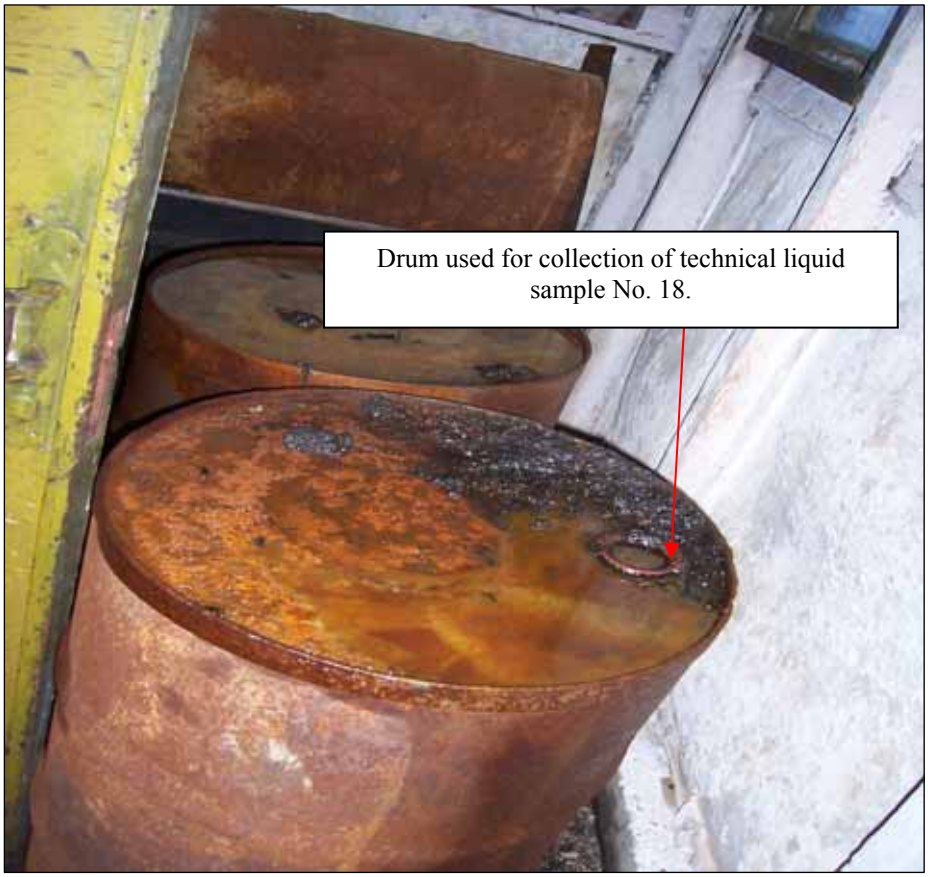


Photo 5.5 Inside the Diesel plant building

Photo 5.6 Tablet on transformer

Photo 5.7 Leak of fuel and lubricants north of the empty drum storage area

Photo 5.8 Leak of fuel and lubricants near the Diesel plant building

Photo 5.9 Leak of fuel and lubricants on the west side of the Diesel plant building

Table 5.13 shows the results of approximate calculation of the number of drums stored at the main and adjacent area of site No.4.

Table 5.13 - Results of approximate calculation of the number of drums stored at site No.4

Area occupied by drums, m^2	Number, pcs	Characteristics
101	70	mainly empty
179	140	-«-
65	120	with different degree of fullness
47	50	-«-
61	800	-«-
158	300	-«-
1823	9000-10000	mainly empty
134	600	-«-
122	500	with different degree of fullness
840	4600	mainly empty
895	5000	mainly empty
175	150	with different degree of fullness
TOTAL: ~4700	**~22300**	

5.3.2 Site No. 5

Panoramic image of the site is given on **photo 5.10**.

The following infrastructure facilities are located at the site: garage, gantry, empty cisterns, air-defense mobile control centers, dumps and accumulations of drums.

During the survey, all stored and chaotically scattered containers were empty besides the technical liquid sampling points No. 10, 11 and 12 **(photo 5.10, 5.12**).

A garage for vehicles is situated at the center of the site **(photo 5.10, 5.11).** There is a repair area there. No equipment was found in the garage.

A structure made of empty drums is located to the north-east **(photo 5.10**). A similar structure is located 50 m south-west **(photo 5.10, 5.11**).

Across the site territory, a pathway made of empty drums directed to the barrack.

Three empty cisterns are found 35 m west of the garage **(photo 5.13**).

Empty drums are scattered below along the slope.

Pollutants migrate along the slope into no-name creek No.4 (**panoramic photo 5.10**). There is an empty fuel truck in the creek **(photo 5.14**).

Transformers, condensers and other PCB-containing equipment are not found at the site.

The area is littered with metal scrap. There are three Diesel generators among other waste (**photo 5.11, 5.15**).

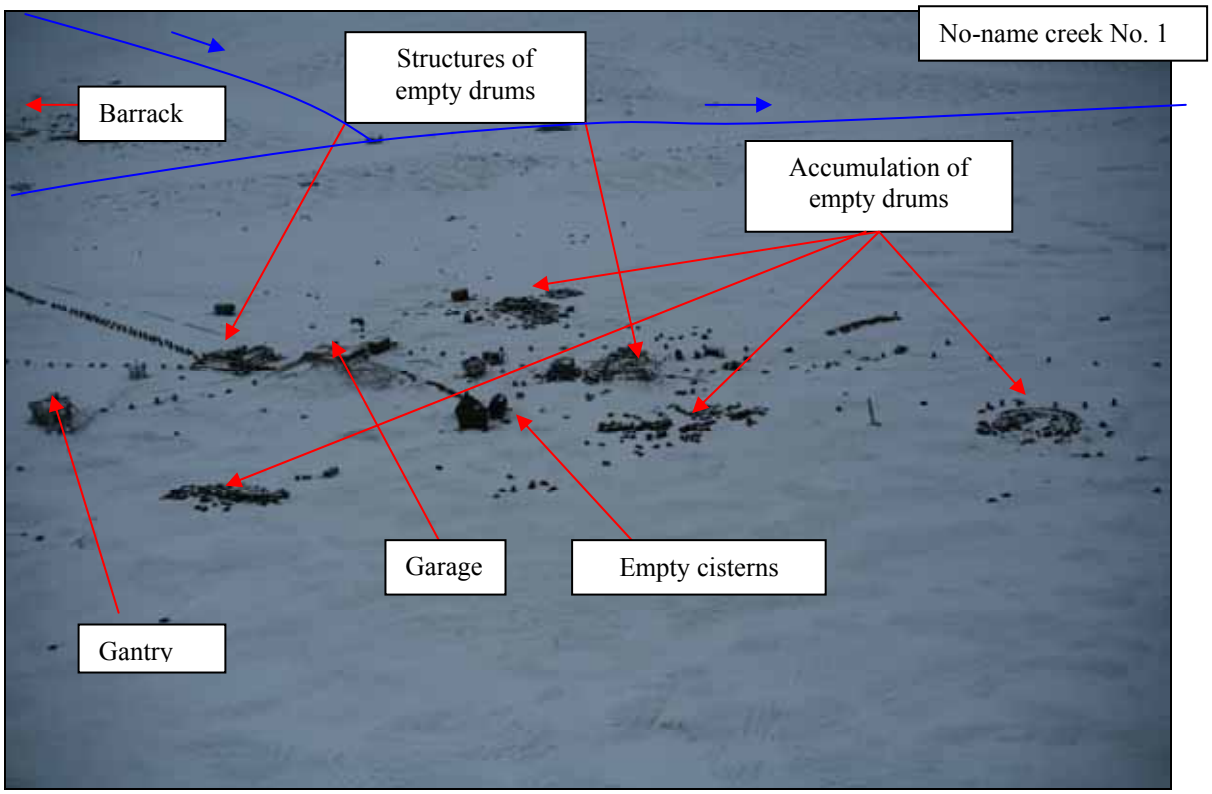


Photo 5.10 Panoramic image of site No. 5

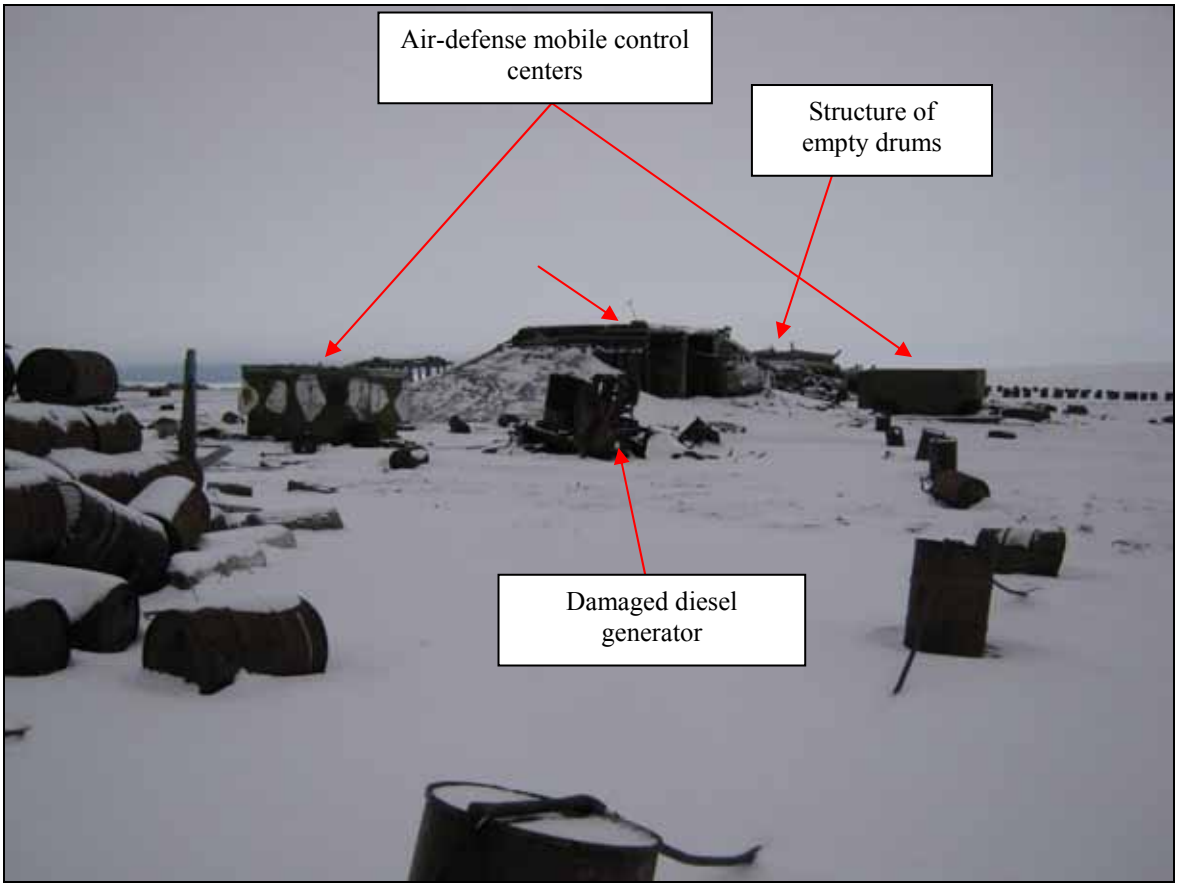


Photo 5.11 View of garage from south-west

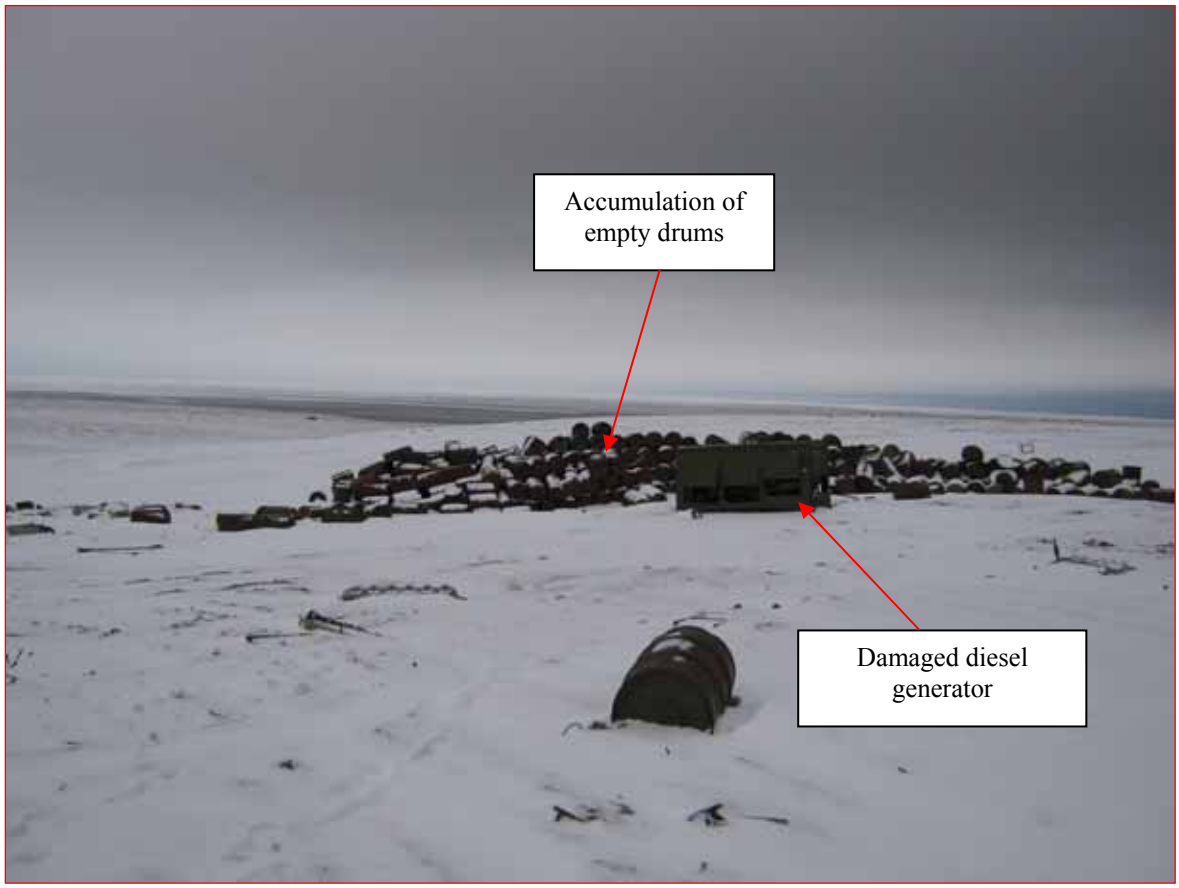


Photo 5.12 On the site's south-east part

Photo 5.13 View of empty cisterns from north-east part

Photo 5.14 Empty fuel truck located at no-name creeks crossing No. 1, 2.

Photo 5.15 Two damaged Diesel generators

Table 5.14 shows the results of approximate calculation of the number of drums stored at the main and adjacent area of site No. 5.

Table 5.14 results of approximate calculation of drums stored at site No. 5

Area occupied by drums, m^2	Number, pcs	Characteristics
115	150	mainly empty
125	400	-«-
144	300	-«-
119	300	-«-
63	100	-«-
58	80	with different degree of fullness
220	750	-«-
32	60	with different degree of fullness
150	500	mainly empty
TOTAL: ~ 1020 m^2	**~2650**	

5.3.3 Site No. 6

Panoramic images of the site are given on photos **5.16 - 5.19**.

The following infrastructure facilities: barrack, several domestic premises, two Diesel plants, boiler-house and repair area. The area is enclosed with empty drums. Pathways between the buildings are also made of empty drums.

On the left no-name creek bank No.4, there is an empty drum storage area and several empty cisterns **(photo 5.16-5.18**). North of the cisterns, drums of different degree of fullness are scattered, from two of which technical liquid samples No.13, 17 were taken **(photo 5.20**).

North-east of the cisterns, the Diesel plant building is located. Inside the building, technical liquid sample No.15 was taken **(photo 5.22**). The soil under the building is strongly polluted by oil products.

North and south of the the Diesel plant, empty drums are stored **(photo 5.17**).

Higher on the terrain, near the barrack a similar Diesel generator and boiler-house are located (**see photo 5.22**). Steam heating was used coming from the boiler-house to domestic premises.

There are 16 empty cisterns at the site dispersed across the area.

Transformers, condensers and other PCB-containing equipment are not found at the site.

Pollutants migrate from the site through no-name creeks No.4, 5 running into the Pshenitsyna Lagoon **(photo 5.16, 5.17**).

Water sample No.14 was taken from no-name creek No.4.

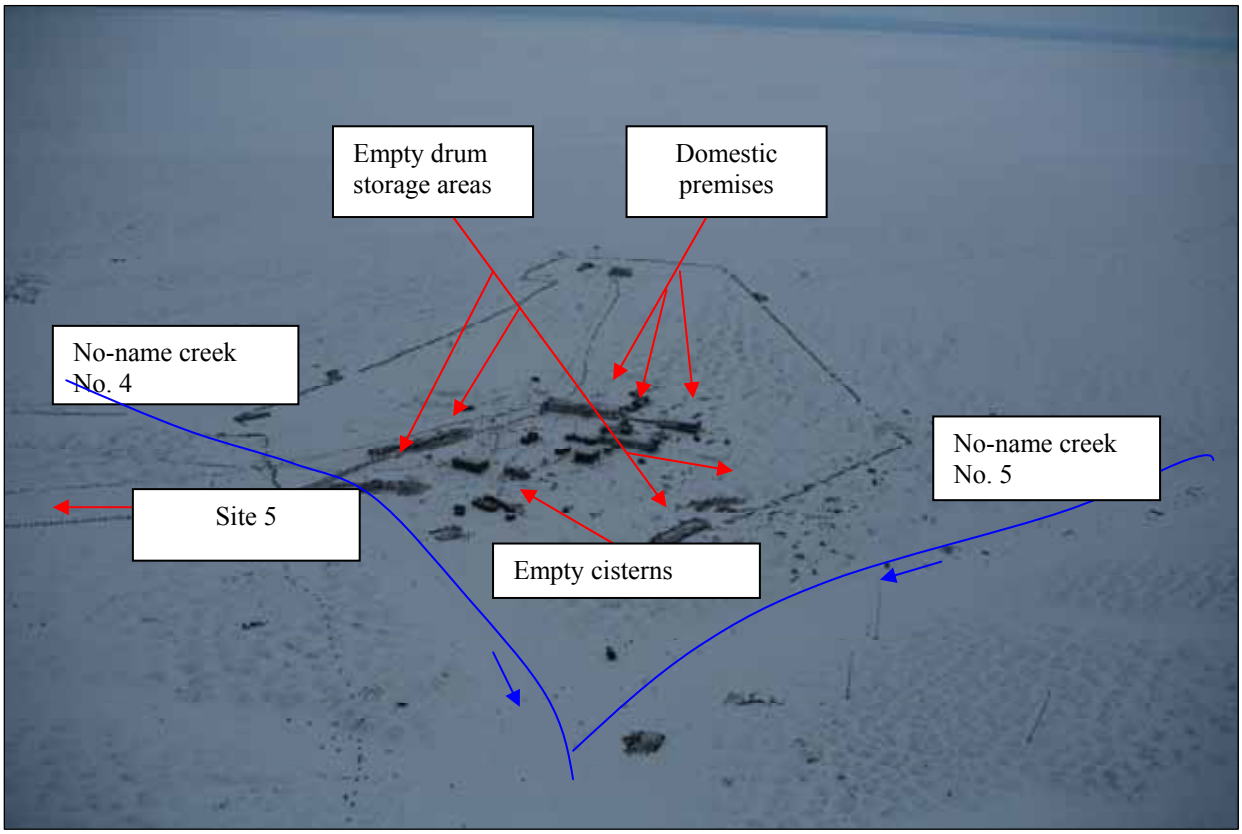


Photo 5.16 Panoramic image of site No. 6

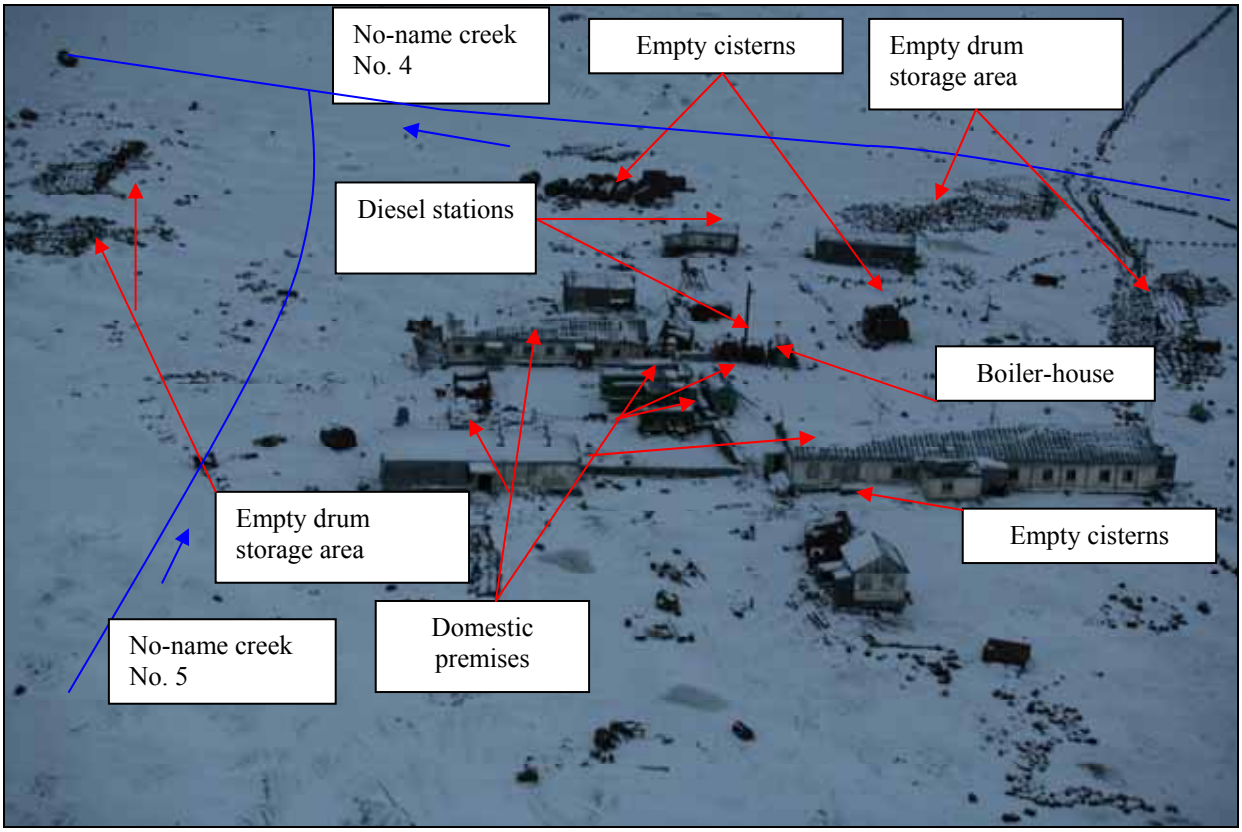


Photo 5.17 Panoramic image of site No. 6

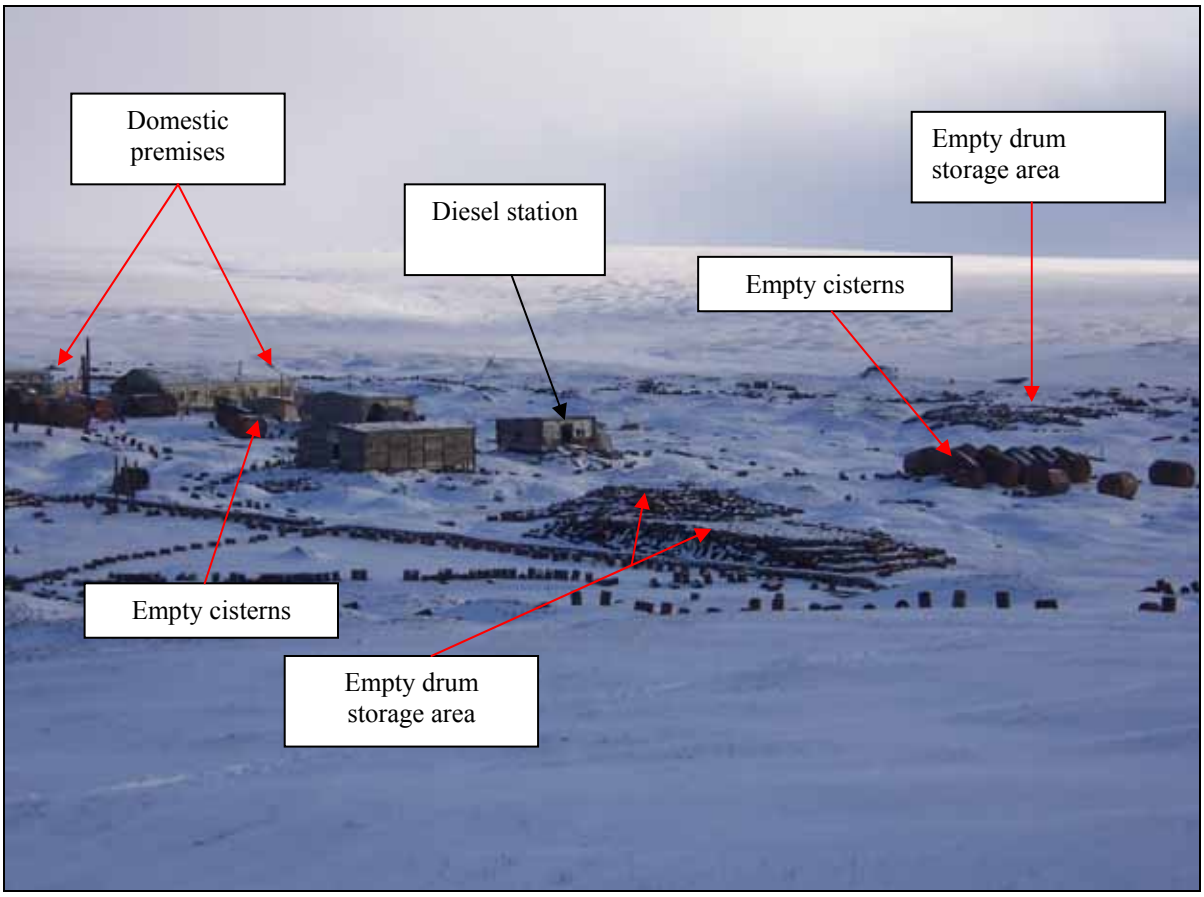


Photo 5.18 View of site No. 6 from site No.4

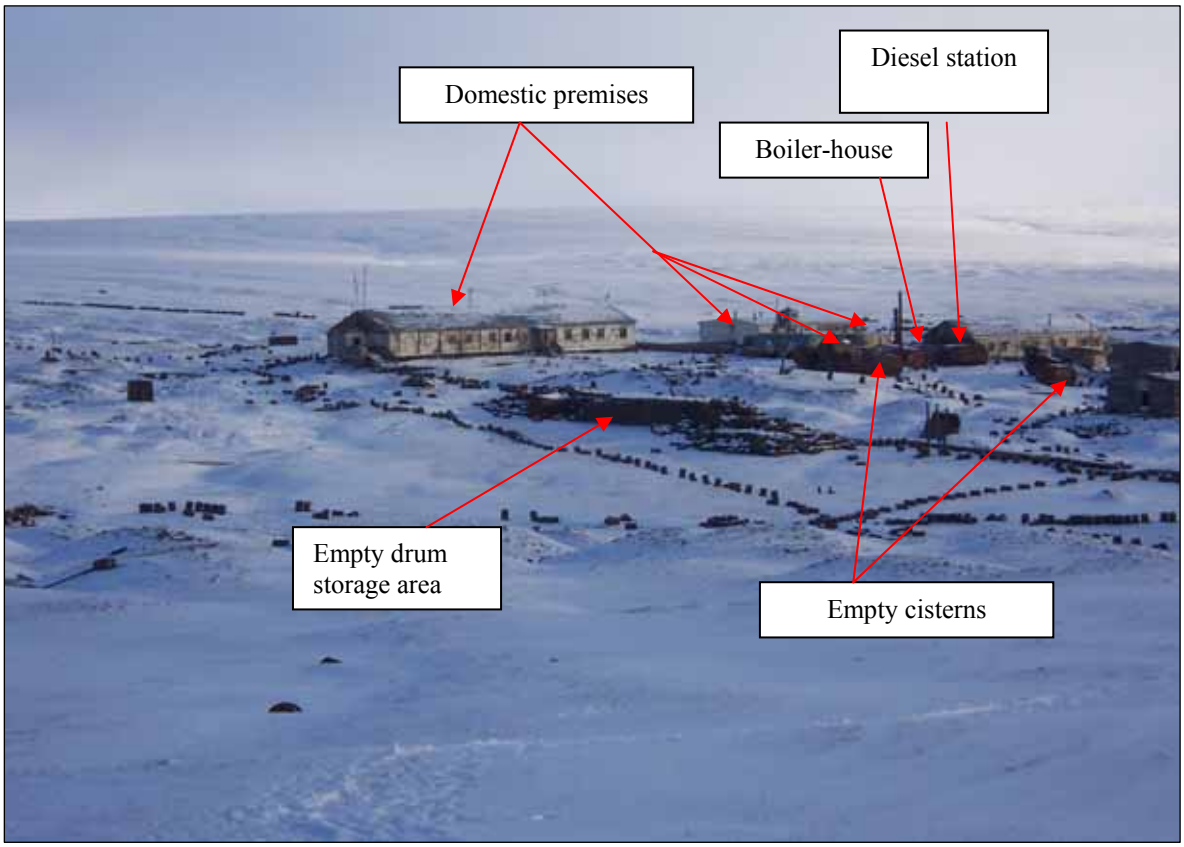


Photo 5.19 View of site No. 6 from site No.4

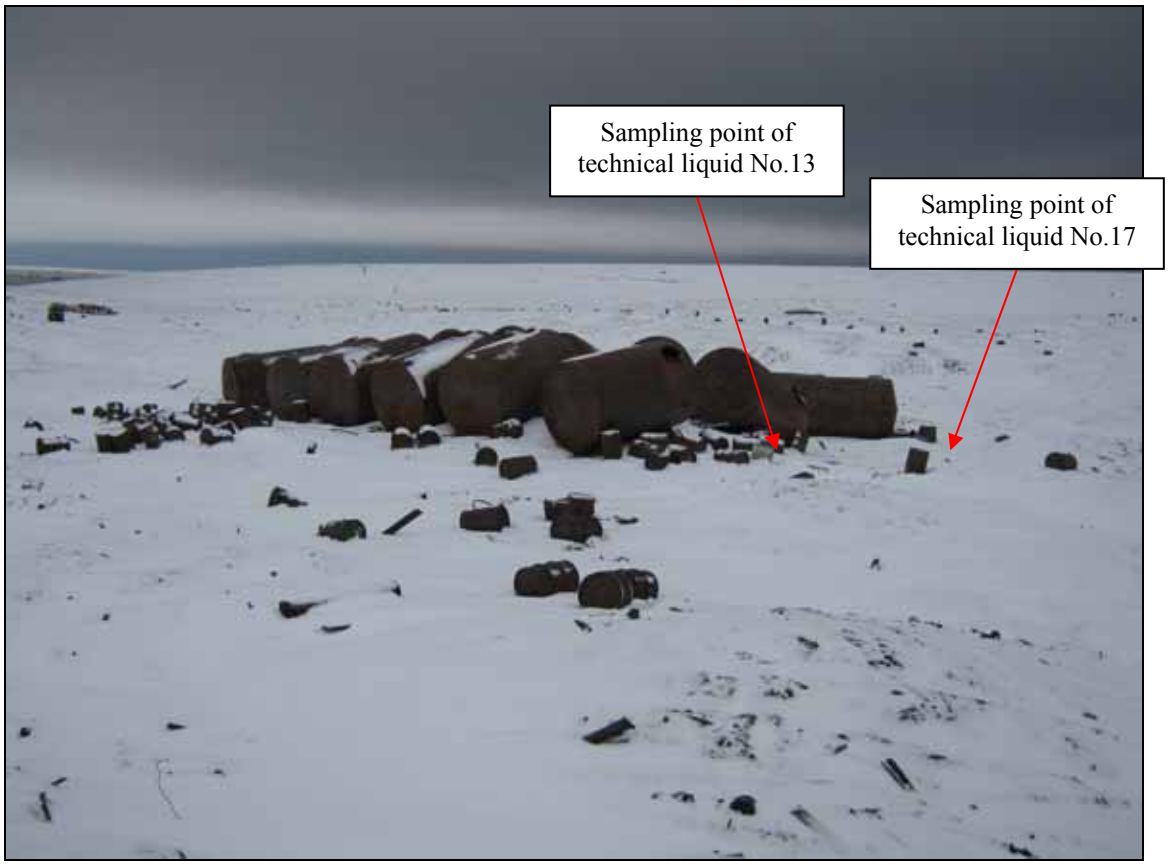


Photo 5.20 Empty cisterns and drums scattered around them, located on the left bank of no-name creek No.4

Photo 5.21 Drum in the Diesel station building

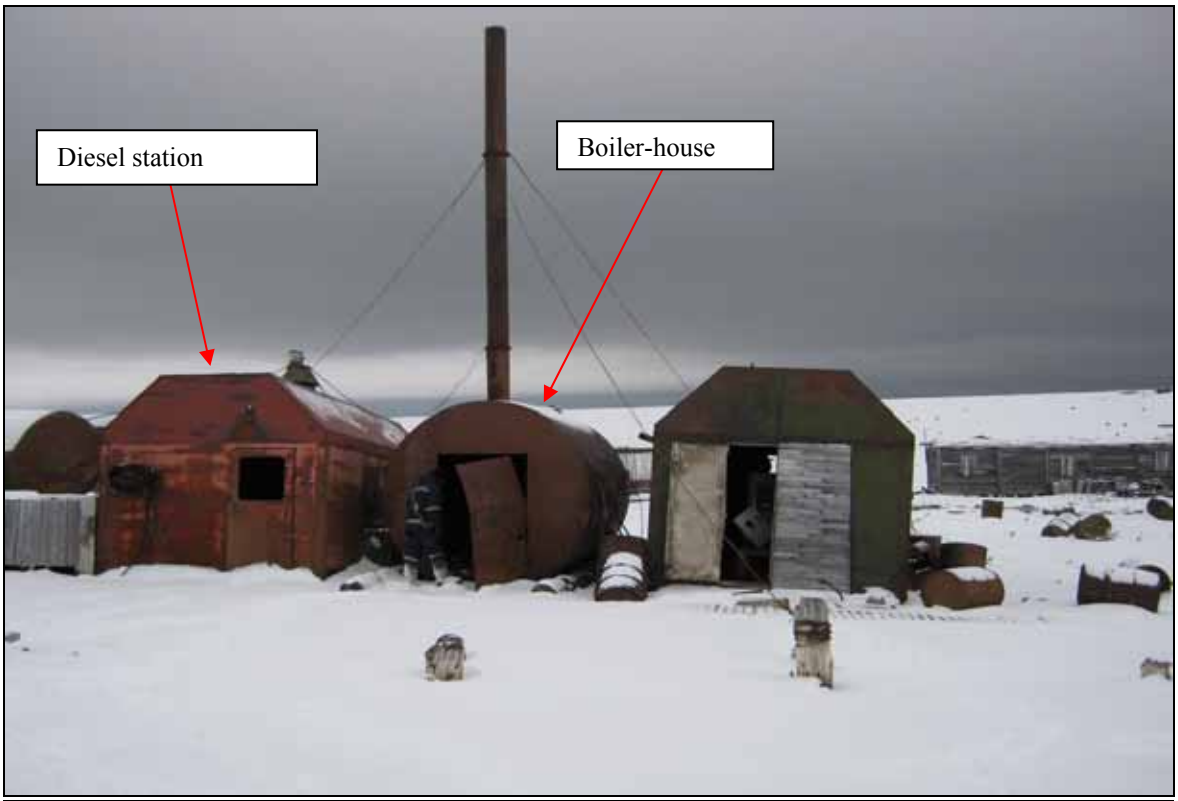


Photo 5.22 Diesel plant and boiler-house near the barrack

Table 5.14 shows the results of approximate calculation of the number of drums stored at the main and adjacent area of site No.6.

In this Table, the calculation of the number of drums is also given for the entire study area that are aligned in line contouring the sites and the results of approximate calculation of the number of drums connecting the sites to each other (chart 7).

Table 5.15 - Results of approximate calculation of the number of drums stored at site No. 6 and aligned in line (all over the site)

Area occupied by drums, m^2	Number, pcs	Characteristics
Are of site No. 6		
547	3200	mainly empty
310	2800	-«-
142	1100	-«-
65	700	with different degree of fullness
87	800	-«-
1195	7000	mainly empty
825	4500	-«-
63	100	with different degree of fullness
80	200	-«-
178	900	-«-
194	1100	mainly empty
175	900	-«-
Pathways of drums outlining sites 4-6 and connecting them to each other		
	3500	empty
TOTAL: area ~ 3900	26800	

5.3.4 Register of infrastructure facilities and pollution sources at the area of the former air-defense base

The register of infrastructure facilities and main pollution sources at the former air-defense base with indication of the coordinates of the centers composed based on the schematic map presented in chart 7 is shown in summary Table.

Table 5.16 – register of infrastructure facilities and main pollution sources at the former air-defense base **Kotelny Island** *(coordinate system UTM 53N)*

No. on map	Name of object	Coordinates center	
		X	Y
1	**2**	**3**	**4**
1	Accumulation of drums	572358.58	8415521.04
2	Accumulation of drums (strip of about 105 m)	572409.20	8415477.32
3	Radar station	572352.00	8415477.89
4	Radar	572342.08	8415473.76
5	Transformer	572392.27	8415452.84
6	Diesel plant	572354.98	8415424.82
7	Crane for fuel and lubricant distribution	572390.94	8415420.29
8	Cisterns 5 pcs	572405.93	8415420.77
9	Accumulation of drums	572413.73	8415421.50
10	- « -	572412.75	8415406.76
11	- « -	572488.75	8415475.61
12	Accumulation of drums (strip of about 35 m)	572461.60	8415423.08
13	Accumulation of drums (strip of about 63 m)	572440.37	8415387.19
14	Large accumulation of drums	572420.45	8415369.25
15	Small accumulation of drums	572377.99	8415341.67
16	- « -	572398.76	8415318.38
17	Accumulation of drums	572282.75	8415292.95
18	- « -	572252.50	8415253.18
19	- « -	572245.21	8415206.69
20	Small accumulation of drums	572319.67	8415077.28
21	Gantry	572374.55	8415086.25
22	Cistern	572318.37	8415061.46
23	3 cisterns	572324.96	8415032.99
24	Accumulation of drums	572300.16	8415011.11
25	- « -	572324.59	8415000.57
26	Damaged Diesel generator	572335.27	8415011.02
27	- « -	572355.05	8415014.68
28	- « -	572384.12	8415000.52
29	Garage	572367.02	8415038.12
30	Accumulation of drums	572383.38	8415051.80
31	Mobile air-defense center	572374.35	5415024.20
32	Small accumulation of drums	572379.23	8415024.94
33	Small structure	572434.19	8415031.53

Continuation of Table5.16

1	2	3	4
34	Small accumulation of drums	572410.25	8414987.09
35	Accumulation of drums	572382.41	8414986.11
36	- « -	572393.64	8414971.70
37	- « -	572323.30	8414954.36
38	- « -	572266.79	8414972.69
39	- « -	572882.08	8414921.53
40	Small accumulation of drums	572922.94	8414933.69
41	- « -	572922.45	8414951.26
42	- « -	572795.49	8414976.40
43	- « -	572799.46	8414984.78
44	Cistern	572831.27	8414983.72
45	Accumulation of 11 cisterns	572834.45	8415002.81
46	2 cisterns	572817.70	8415005.35
47	Large accumulation of drums	572797.13	8415060.96
48	Storage area	572858.22	8415059.90
49	Diesel plant	572869.88	8415036.78
50	Large accumulation of drums	572862.29	8415108.60
51	4 cisterns	572917.25	8415082.48
52	2 cisterns	572912.23	8415056.01
53	2 cisterns	572931.96	8415060.85
54	Storage area	572915.07	8415041.47
55	Small structure	572932.12	8415045.31
56	- « -	572939.14	8415048.32
57	Large domestic premise	572946.83	8415048.65
58	Abandoned equipment	572937.97	8415023.58
59	2 cisterns	572964.22	8415047.48
60	1 cistern	572989.50	8415043.31
61	Abandoned equipment	572992.51	8415035.95
62	Small accumulation of drums (strip of 20 m)	573016.58	8415077.40
63	Domestic premise	572995.35	8415066.71
64	Group of 5 domestic premise	572954.72	8415071.58
65	Diesel plant	572933.99	8415069.07
66	Boiler-house	572932.49	8415072.24
67	Storage area	572929.48	8415075.25
68	Large domestic premise	572965.43	8415116.41
69	Accumulation of 5 cisterns	572998.52	8415109.06
70	Domestic premise	573008.05	8415117.58
71	Small accumulation of drums	573035.53	8415141.51
72	Small structure	572921.58	8415162.15
73	Small accumulation of drums	572813.77	8415213.90
74	- « -	572898.93	8415273.05
75	Small structure	572990.91	8415194.78
76	Small accumulation of drums	573257.90	84152094.87
77	Small structure	573224.36	8415413.25
78	Abandoned equipment (5 pieces)	573225.05	8415456.35

5.3.5 Pollution sources outside the air-defense base

1.4 km south-west of site No. 5 along the coast of the Stakhanovtsev Arktiki Bay a large accumulation of stacked and dumped drums (**panoramic photos 5.23, 5.24)**, cisterns and abandoned military equipment. Besides the areas of compact storage, a large number of drums are chaotically scattered across the entire area, some of them are located immediately ashore.
No terrestrial survey and aerial photography on the coastal area were done.

The total number of stored drums accumulated at the area is estimated at 20600 pieces. Scattered drums amount to several hundreds.

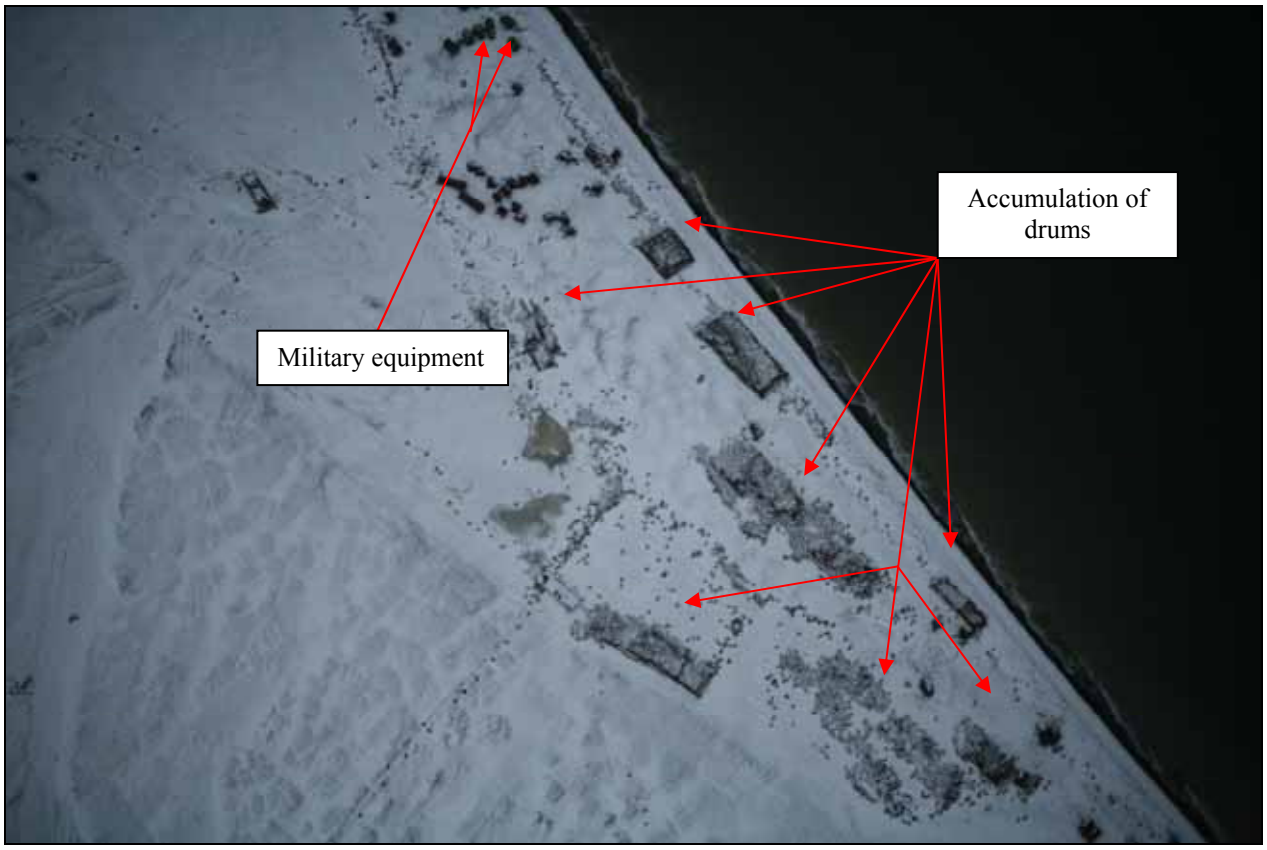


Photo 5.23 Coast of Stakhanovtsev Arktiki Bay 1.4 km south-west of site No. 5

Photo 5.24 Coast of Stakhanovtsev Arktiki Bay 1.4 km south-west of site No. 5

Photo 5.25 South part of the Stakhanovtsev Arktiki Bay coast.

5.4 Assessment of pollution level of the air-defense base area

The level of soil cover pollution at the area of air-defense station on Kotelny Island was assessed by 4 parameters: PH, PAH, PCB and HM.

PH. The main pollutants are petroleum hydrocarbons. Only 3.8% out of 52 samples taken in sites No. 4-6 and adjacent areas have PH content less than PC (50 mg/kg), 67.3% fall into PC-IL range, 28,8% exceed IL (5000 mg/kg). Pollution has an areal character. Figure 5.3 shows the distribution of samples by a range of PH concentrations (mg/kg).

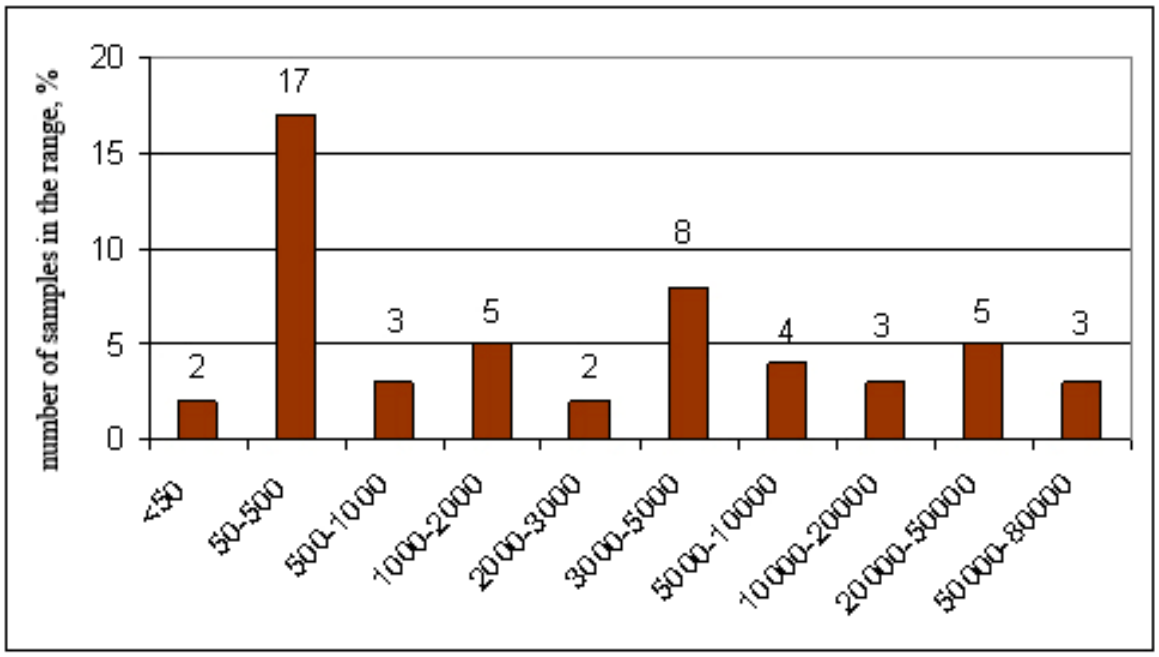


Figure 5.3 – Distribution of samples by a range of PH concentrations

Table 5.17 shows the main results of statistical processing of chemical analysis data.

Table 5.17 – Average and maximum content of petroleum hydrocarbons in soils in fractions of the intervention level (5000 mg/kg)

Excess	site 4	site 5	site 6
av.	3.4	0.6	3.1
max.	15.6	1.0	9.6

PH spatial distribution in the study area soils is shown in **chart 8**. Contour lines show the areas with PH concentration of 3000 and 5000 mg/kg, where 3000 – PC (Brandenburgische Liste) and 5000 – IL. Pollution level higher than PC equal to 50 mg/kg (Neue Niederlandische Liste) takes place practically across the entire study area.

The highest pollution level is observed at proper sites. Their territory is found inside a contour line equal to 5000 mg/kg. Sites No. 4 and 5 are found inside a common contour of 3000 and 5000 mg/kg.

The area, within which the level of pollution with petroleum hydrocarbons exceeds the intervention level is equal to:

- site No. 4 and 5 – 3.30 ha
- site No. 6 – 3.13 ha

total for the site – 6.43 ha

The total area occupied by accumulations of drums at the same territory is equal to ~ 0.96 ha.

The map of soil pollution with the substances of **PAH and PCB** groups is given in **chart 4**.

PAH. Total PAH exceeds PC (1 mg/kg) by 1.1 times in one sample only out of 19. An average content for the site is 0.31 mg/kg. The following substances are present in the site's soil: naphthalene, benzo(a)pyrene, fluoranthene, phenanthrene, anthracene, benzo(b)fluoranthene benzo(k)fluoranthene. Other components were detected in single samples.

An average content of benzo(a)pyrene is 0.0074 mg/kg (0.37 MPC). MPC (0.02 mg/kg) excess is detected in a single sample (by 1.8 times).

The level of the site pollution with PAH is permissible (classification - Table 3.5)

PCB. This pollutant group was determined in 8 samples. An average concentration of total PCB is 0,025 mg/kg (at a level of PC=0.02 mg/kg). 3 samples out of 8 (37.5%) exceeded the permissible level by 21.2; 2.1 and 4.2 times (concentration - 0.024, 0.042 and 0.083 mg/kg, respectively).

Among the congeners to be determined the following ones have the highest concentration: #52, #99, #101, #105, #128, #138, #153 (average concentrations 0.0023; 0.0029; 0.0031; 0.0028; 0.0015; 0.0049; 0.0034, respectively). The highest concentration is: 101- 0.016; #153-0.016; #138 – 0. 05 mg/kg.

The results obtained make it possible classify PCB as priority pollutants for the study area, the level of pollution is hazardous (Table 3.5).

HM. The level of soil pollution with heavy metals is given in Tables 5.18 and 5.19.

The map showing their distribution across the area is given in **chart 10**.

Table 5.18 – Association of the main HM with the level of accumulation $C_i > 2{,}5\ C_b$

No. of sample	Concentration factor C_i						Zc
	Lead	Cadmium	Nickel	Copper	Zinc	Tin	
49	5.9	3.8	2.3	2.0	2.9	2.0	15
51	3.2	86.4	0.9	1.8	2.3	55.8	145
53	1.5	2.7	18.4	0.8	1.1	5.3	23
57	2.7	10.6	1.7	1.6	1.1	21.6	34
62	1.8	2.4	1.9	1.1	1.1	0.6	3
67	694	82.0	1.5	4.6	3.2	6.9	786
74	19.1	110.0	1.6	4.1	15.5	6.9	152
77	16.9	11.3	1.8	2.1	2.9	2.0	33
83	0.9	53.3	2.1	1.2	1.3	1.6	55
94	1.9	0.9	1.6	1.0	1.0	9.1	10
Ci max	694	110	18	5	15	56	
range of accumulations: Pb; Cd; Sn; Ni; Zn; Cu							

Table 5.19 – Excess of MPC and APC of the main HM in soil (MPC, APC – in mg/kg)

No. of sample	Lead MPC= 32	Lead APC= 65	Cadmium APC=1	Nickel APC=40	Copper APC=66	Zinc APC=110
49	3.5	1.7		1.0		1.6
51	2.0	1.0	1.6			1.3
53				8.1		

57	1.6					
62	1.1					
67	421	207	1.5		1.1	1.8
74	11.6	5.7	2.0	0.7	1.0	8.8
77	10.2	5.0				1.6
83			1.0			
94	1.1					

The total number of samples for HM is 10. In 3 samples of 10 the pollution level is determined as hazardous, in 3 – as extremely hazardous. The highest HM concentrations are detected in sites No. 1 and 3 soils. The elements of toxic group I (cadmium, lead) are presented in the association due to their anomalously high concentrations.

Summary Table 5.20 shows the results of sampling data processing for all components to be determined.

Pollution of surface waters. Water sample 14 was taken to assess pollutant migration with surface runoff in creek crossing run off from sites 6 and 4 (Kotelny Island). The parameter characterizing the total content of organic substances in water (chemical oxygen demand – COD) is an integral and the most informative characteristic for man-made water pollution. According the COD value (437 mg O_2/dm^3) the creek water is waste water. According to Appendix J to SNiP 11-102-97, the situation with COD>80 mg O_2/dm^3 is regarded as an environmental disaster. PH concentration in water amountd to 1.82 mg/dm^3 (36.5 MPC); concentration of copper and lead is 14 MPC. PAH and PCB are in concentration below the detection limit. The results obtained show the informativeness of this kind of study to obtain an integral characteristic of the pollution level of the area especially when pollution is of local character.

Technical liquids. The winter Diesel fuel was detected in 8 out of 10 containers, including 6 with PPD. Besides that one sample was identified as motor oil and one with water polluted with oil products.

There were detected in large amounts lead, zinc, copper and nickel. The prevailing PCB congeners in the liquids are #28 b#31 (average concentrations are 0.018 and 0.043 mg/dm^3, maximum – 0.022 and 0.065 mg/dm^3, respectively). An average content of total PCB is 0.068 mg/dm^3; the maximum one is 0.083 mg/dm^3.

The state of containers identified based on the terrestrial survey results indicates the presence of a potential hazard of soil pollution with metals and PCB due to the penetration of their content into the environment.

Table 5.20 – Content of pollutants in soils of the former Ministry of defence site on Kotelny Island

No. of sample	Soil sampling point	PH content			average for the area			heavy metals			total 15 PCB		benzo(a)pyrene		total PAH	
		concentration mg/kg	in PC fractions 50 mg/kg	in IL fractions 5000 mg/kg	concentration mg/kg	PC Excess 50 mg/kg	IL excess 5000 mg/kg	total pollution index. Zc	Pollution category *	Rxcess of Background by main HM: Ci=K/Kb	Concentration mg/kg	PC excess 0,02 mg/kg	Concentration mg/kg	MPC excess 0,02 mg/kg	Concentration mg/kg	PC excess 1 mg/kg
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
48	site 4 dish near west edge	4400	88.0	0.88	**17123**	**342**	**3.4**			Pb - 19 Cd - 110 Cu - 4 Zn - 16 Sn - 7						
49	site 4 dish near west edge	4200	84.0	0.84				15	permiss.		**0.0243**	**1.22**	**0.0369**	**1.85**	**1.1212**	**1.12**
71	site 4 crane near cisterns	23000	460	4.60												
72	site 4 Diesel station	37000	740	7.40									0.0069	0.35	0.1879	0.19
73	site 4 drums near building	78000	1560	15.60					extrem. hazardous							
74	site 4 drums near building	53000	1060	10.60				**152**			**0.0834**	**4.17**	<0.0012		<0.0012	
75	site 4 radar station	86	1.7	0.02												
76	site 4 separate drums	1760	35.2	0.35												
77	site 4 accumulation of drums	1060	21.2	0.21				**33**	hazardous		0.0169	0.85	<0.0012		0.7284	0.73
78	site 4 drum storage area	8300	166	1.66									0.0062	0.31	0.2003	0.20
79	site 4 drum storage area	32600	652	6.52									0.0064	0.32	0.1938	0.19
80	site 4 drum storage area	13000	260	2.60												
81	site 4 drum storage area	13100	262	2.62												
82	site 4 drums near cisterns	37700	754	7.54												
83	site 4 drum storage area	366	7.3	0.07				**55**	hazardous		0.0061	0.31	<0.0012		0.204	0.20

	site’s south part													
	site 4 drum storage area													
84	site’s south part	330	6.6	0.07										
	site 4 dish near													
85	site’s south edge	148	3.0	0.03								0.0079	0.40	0.1979	0.20
	site 4 drums in													
86	site’s south-west corner	172	3.4	0.03										
87	below site (between site 4 and 5)	1280	25.6	0.26		25.6	0.26							
	site 5 accumulation of drums site’s													
50	north-west part	490	9.8	0.10					extrem. hazardous					
	site 5 gantry in													
51	site’s north-east corner	4200	84.0	0.84	2879	57.6	0.6	**145**		Pb - 3 Cd - 86 Ni - 18 Sn - 56				
	site 5 cisterns with fuel and													
52	lubricant	5000	100	1.00										
	site 5 drum													
53	storage area	4700	94.0	0.94				23	moderat. hazardous					
54	site 5 drums	3110	62.2	0.62										

Continuation of Table5.20

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
55	site 5 generator	109	2.2	0.02									0.0074	0.37	0.1879	0.19
56	site 5 tractor	4200	84.0	0.84												
57	site 5 slope under drums, structures	1220	24.4	0.24				**34**	hazardous		0.013	0.65	0.0008	0.04	0.2338	0.23
58	below site 5 drums on slope	3240	64.8	0.65												
59	below site 5 creek on slope	470	9.4	0.09	1275	25.5	0.3						0.0068	0.34	0.1889	0.19
60	below site 5 creeks crossing	114	2.3	0.02												
62	site 6 dish near drums	8400	168	1.68				3	permiss.		0.0093	0.47	0.0013	0.07	0.672	0.67
64	site 6 boiler-house	11200	224	2.24									0.0076	0.38	0.1964	0.20
65	site 6 Diesel station	9500	190	1.90									0.0068	0.34	0.1861	0.19
66	site 6 cisterns fuel and lubricant	76000	1520	15.20						Pb - 694						
67	site 6 Diesel station 2	48000	960	9.60					extrem.	Cd - 82						
68	site 6 drums in south part	1540	30.8	0.31	**15573**	**311.5**	**3.1**	**786**	hazardous	Cu - 5	0.0423	**2.12**	0.0016	0.08	0.4273	0.43
95	site 6 north part	360	7.2	0.07						Zn - 3			0.0074	0.37	0.1856	0.19
96	site 6 north of barrack	182	3.6	0.04						Sn - 7						
98	site 6 near drums	305	6.1	0.06												
99	site 6 barrack	238	4.8	0.05												
69	south of site 6 near MAZ	76	1.5	0.02	54	1.1	0.0									
70	south of site 6 under gantry	32	0.6	0.01									0.0069	0.35	0.1883	0.19
88	narrow between site 4 and site 6	9000	180	1.80												
89	narrow between site 4 and site 6	2220	44.4	0.44	4493	89.9	0.9									
90	narrow between site 4 and site 6	2260	45.2	0.45												
94	dish site near site's 6 north-west corner	187	3.7	0.04				10	permiss.		0.0069	0.35	0.0012	0.06	0.0997	0.10
92	narrow between site 4 and site 6	860	17.2	0.17												
91	dish between site 4 and site 6	33	0.7	0.01	452	9.0	0.1									
93	hollow west of site 6	890	17.8	0.18												
97	narrow west of site 6	288	5.8	0.06												
100	narrow west of site 6	221	4.4	0.04	381	7.6	0.1									
61	creek on base site 6	540	10.8	0.11									0.0061	0.31	0.1803	0.18

5.5 Inventory of pollution sources at the former Temp Airport

The civil Temp Airport is located 4 km south-west of the former military site (sites No.4-6) on a pebbled bar. An operational polar station is also located there. The orthophoto map is given in **chart 11**. Coordinates of reference points are given in Table 5.21.

Table 5.21 – Coordinates of reference points *(coordinate system UTM 53N)*

No. of point	Coordinates			No. of point	Coordinates			No. of point	Coordinates		
	X	Y	H		X	Y	H		X	Y	H
1_1	571221.399	8411434.771	1.763	1_3	571098.793	8411184.874	1.369	1_5	571053.135	8410947.856	0.715
1_2	571169.055	8411264.287	0.826	1_4	571140.245	8410981.792	0.453				

The general view of the airport is given in panoramic **photo 5.26 and 5.27**. The site has several wooden structures (**photo 5.28, 5.29**), steel beams, numerous accumulations of drums (**photo 5.30**), cisterns (**photo 5.31**), abandoned equipment (**photo 5.32**), barge (**photo 5.33**). A landing strip is located between them.

The main pollution sources are accumulations of drums to the left of the landing strip. A large number of drums is scattered in the coastal area (**photo 5.34**). The state of containers is unsatisfactory. They have fallen into disrepair; many of them have traces of corrosion (**photo 5.35**); there are a lot of fuel and lubricant leaks (**photo 5.36**). Also there is a boiler-house in the vicinity of which a soil sample for analysis was taken, and a dump where in addition to empty drums there are a lot of damaged mechanisms, technological equipment and metal scrap (**photo 5.38**).

Photo 5.26 – Wooden structures to the right of the landing strip

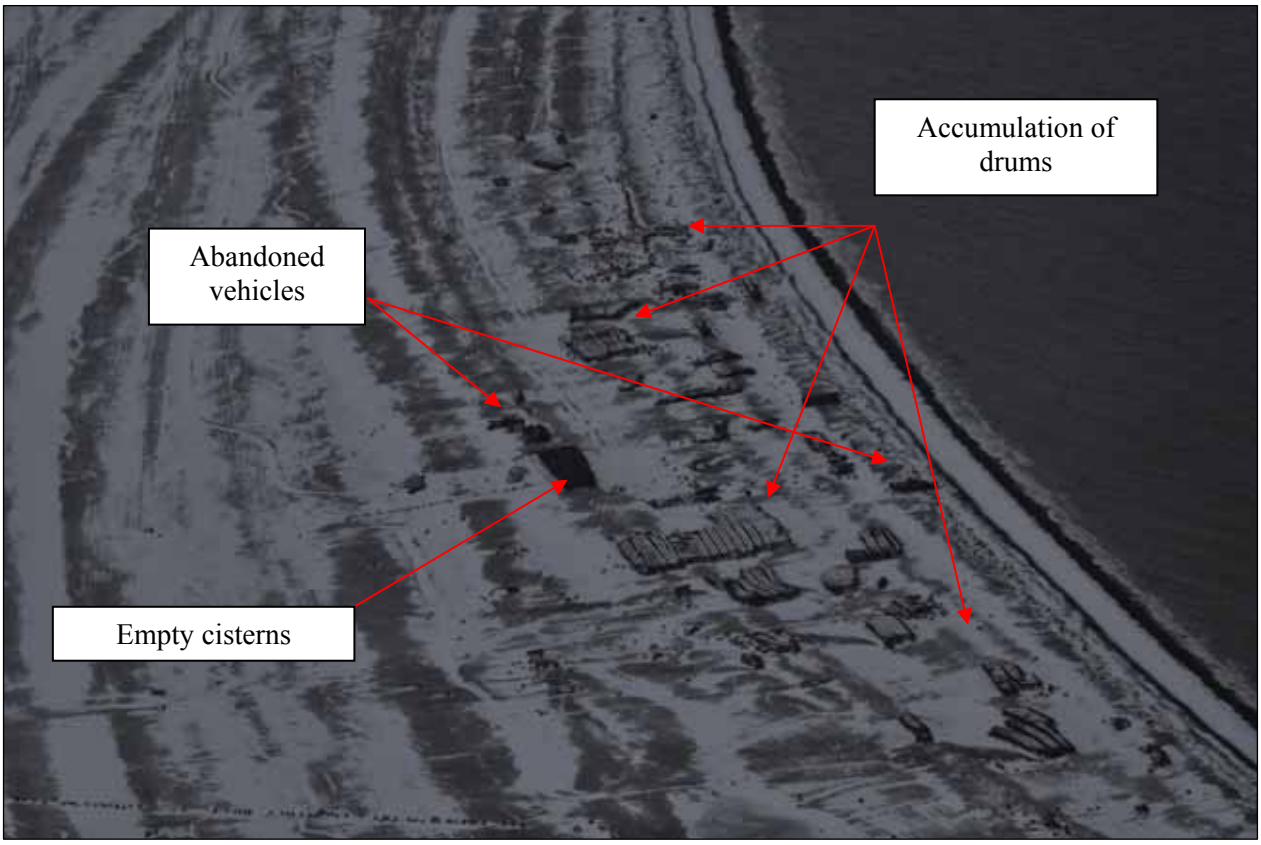


Photo 5.27 Accumulation of drums, cisterns and abandoned equipment to the left of the landing strip

Photo 5.28 Airport

Photo 5.29 Central built-up part

Photo 5.30 Accumulations of drums

Photo 5.31 Empty cisterns

Photo 5.32 Abandoned equipment

Photo 5.33 – Abandoned equipment, drums, barge on the coast

Photo 5.34 – Drums located on the coastal area

Photo 5.35 Leaks from drums

Photo 5.36 Soil contaminated with oil products

Photo 5.37 Boiler-house

Photo 5.38 Dump

The state of the structures is unsatisfactory. The marauding traces are visible everywhere. There are destroyed buildings there (**photo 5.39, 5.40**).

In the Pshenitsyna Lagoon coastal strip, drums of different degree of fullness are scattered, some of which drift in the lagoon (photo **5.41**).

Photo 5.39 Destroyed building

Photo 5.40 Deteriorated structures

Photo 5.41 Drifting drums in the lagoon

An old disassembled transformer is found on the landing strip. The tap is on top but not fixed (**photo 5.42, 5.43**).
No label was found. Supposedly, there is sovtol diluted by melting and rain water inside.

Photo 5.42 Transformer (top view)

Photo 5.43 Transformer

The results of calculation of the number of drums at the Temp Airport are given in Table 5.22. The total number of drums is about **25600** pieces.

Table 5.22 – Approximate calculation of the number of drums at the Temp Airport

No. of site	Area m^2	Number of drums, pcs	No. of site	Area m^2	Number of drums, pcs
1	68.91	292	18	73,21	159
2	11.71	30	19	203,89	975
3	165.85	842	20	64,82	274
4	450.56	2289	21	99,16	420
5	66.39	337	22	85,6	260
6	60.08	305	23	48,2	259
7	61.26	311	24	754,45	3607
8	56.31	286	25	372,15	1890
9	1826.29	8731	26	57,21	129
10	218.05	814	27	48,14	104
11	53.98	183	28	33,36	78
12	47.42	161	29	48,28	245
13	107.87	548	30	330,93	425
14	49.96	254	31	59,86	92
15	32.47	165	32	37,32	190
16	47.13	239	33	62,22	90
17	55.7	100	Separate drums		500

5.6 The level of pollution of Temp Airport area

The airport area survey to assess the level of soil pollution was diagnostic. The total number of samples for different types of pollutants was as follows: 7 – PH, 2 – PAH (composition), 1 – PCB, 1 – HM.

Physical and geological map and content of pollutants in the airport soil are given in **chart 11**.

Tables 5.23 and 5.24 contain the results of processing of chemical analysis data.

Table 5.23 – Characteristics of the airport soil pollution with oil products

No. of sample	Sampling point	PH content			average for the area		
		concentration mg/kg	in fractions of PC 50 mg/kg	in fractions of IL 5000 mg/kg	concentration mg/kg	excess of PC 50 mg/kg	excess of IL 5000 mg/kg
41	under cistern	523000	**10460**	**105**			
42	airport midpoint	123	2	0.02			
43	airdrome boiler-house	1070	21	0.2			
44	drums along the coast	21000	420	4.2	**88742**	**1775**	**18**
45	leaks from drums	37000	740	7.4			
46	coast near the barge	25900	518	5.2			
47	drums on the coast	13100	262	2.6			

Table 5.24 – Characteristics of the airport soil pollution with with PAH, PCB and heavy metals

No of sample	heavy metals			total 15 PCB		benzo(a)pyrene		total PAH	
	total pollution index Zc	pollution class	backgr. excess by main HM Ci=K/Kb	concentration mg/kg	PC excess 0,02 mg/kg	concentration mg/kg	MPC excess 0,02 mg/kg	concentration mg/kg	PC excess 1 mg/kg
41									
42									
43	**21**	moderat. hazardous	**Hg - 25**	0.01274	0.64	<0.0012		**1.4599**	**1.46**
44									
45									
46						<0.0012		0.5794	0.60
47									

The sampling results show a high level of soil pollution with oil products. In sample 41, PH mass fraction exceeds 50%. An average level of IL excess is 18, maximum (sample 41) – 105.

Taking into account that the number of areas container storage interpreted from the aerial photographs amounts to 33 and their total area is almost 1 ha, PH can be identified as priority pollutants for the airport area. Like the air-defense base sites (the area of PH accumulation >IL exceeds the area occupied by drums by 4-8 times) the area of pollution at the Temp Airport is equal to several hectares (from 3 to 5).

A single sample for HM showed a result different from the others. Cadmium having the highest content in the range of accumulations is present in the area in concentrations below the detection limit. The content of other HM is close to the background, except for mercury whose content exceeds the background by a factor of 25. At the same time, this anomalous concentration is 20% only of health standards (2.1 mg/kg). So the level of pollution with heavy metals is classified as moderately hazardous.

Soil pollution with the substances of PAH and PCB groups does not exceed the permissible level (Table 3.5).

A technical liquid taken from one of containers is identified as winter Diesel fuel with PPD. No determination of PCB and HM was done.

6. CONCLUSION FOLLOWING THE SURVEY RESULTS

Within the framework of the pilot project aerial photography and terrestrial survey of the former military sites were carried out on Bolshoy Lyakhovsky and Kotelny Islands. The survey area amounted to 25 and 65 ha respectively. In addition, the area of the civil Temp Airport was surveyed. The survey area is 40 ha.

100 soil samples for PH, 39 samples for PAH (composition) 17 samples for PCB and 19 samples for HM were collected to assess the level of site pollution.

The main pollution source is the leaks from deteriorating containers for storing Diesel fuel, spent oils and other technical liquids. 19 samples were collected to identify the liquids accumulated at the sites. 10 of them contained HM and PCB.

The creek water draining Kotelny Island air-defense base sites No. 4 and 6 was sampled to study the characteristics of pollutant migration.

Following the orthophoto map and terrestrial survey date, the number of containers stored at the above sites was approximately calculated. Using panoramic images an analogical assessment was carried out for adjacent areas (see ii.4.3.5 and 5.3.5) located outside the survey area.

The calculation results are given in Table 6.1

Table 6.1 – Rough estimate of the number of drums stored at the surveyed sites

Site	Rough estimate of the number of drums, pcs
Bolshoy Lyakhovsky Island, air-defense base	30000
Bolshoy Lyakhovsky Island, Malakatyn Bay coast and Malakatyn-Chokur Mountain	5800
TOTAL:	**35800**
Kotelny Island, air-defense base	51700
Kotelny Island, Stakhanovtsev Arktiki Bay coast	20600
Kotelny Island, Temp Airport	25600
TOTAL:	**97900**

During the calculation, separate drums scattered across the territory whose number can amount to several percent of those given in Table 6.1 were not accounted for.

A high level of pollution with petroleum hydrocarbons is observed at all sites. Pollution has an areal character. An IL-exceeding level takes place at the areas of former military sites in 22.5% (Bolshoy Lyakhovsky Island) and 28.8 % (Kotelny Island) of samples. In the Temp Airport, IL is exceeded in 5 samples out of 7. Table 6.2 shows average and maximum excess levels at the sites.

Table 6.2 - Average and maximum content of petroleum hydrocarbons in fractions of IL (5000 mg/kg)

Excess	Bolshoy Lyakhovsky Island			Kotelny Island, air-defense base			Temp Airport
	site 1	site 2	site 3	site 4	site 5	site 6	
aver.	2.7	12.6	2.7	3.4	0.6	3.1	18
max.	13.4	20.4	7.9	15.6	1.0	9.6	105

The area where the soil pollution exceeds IL is:

- air-defense base on Bolshoy Lyakhovsky Island – 4,6 ha;
- air-defense base on Kotelny Island – 6,4 ha;
- Temp Airport – 3-5 ha.

The sources of pollution are fuel and lubricant leaks from deteriorated drums exposed to corrosion. Not only filled drums but also empty ones contribute to the pollution. Particularly, 2 samples taken from the drums contained water polluted with PH flowing there with melt and drain water. Water washes out PH residues from the drum bottom and walls and facilitates the corrosion process leading to the penetration of contaminated water into the soil.

The survey results do prove the areal pollution with heavy metals of both former military sites temselves and adjacent areas. The level of pollution is hazardous and extremely hazardous (a value of the total pollution index of the sites on Bolshoy Lyakhovsky Island amounts to 149-193; on Kotelny Island – 145-152). The anomalies have polyelemental composition. The association of elements includes cadmium, lead, copper, nickel, zinc and tin. Single samples contain very high levels of pollution with hazard class 1. Particularly, a sample taken from site 6 on Kotelny Island shows 700-fold excess of lead level comparing to the background and 25-fold excess of mercury in the Temp Airport.

PCB pollution is local taking into account the character of release of those substances into the environment. Nevertheless, a random sampling revealed an excess of PCB permissible concentration (0.02 mg/kg) by a factor of 2.3 on Bolshoy Lyakhovsky Island; and 1.2 and 4.2 on Kotelny Island. It is enough to classify PCB as priority pollutants on the islands. The level of pollution (from 2 to 5 MPC) is hazardous.

The main source of release of polycyclic aromatic hydrocarbons into the environment is fuel combustion. During almost 20-year period of inoperation of the former Ministry of Defense sites, in spite of slowed destruction of organic pollutants in the Arctic, their concentration in soil has decreased. Only 10% of samples on Bolshoy Lyakhovsky and Kotelny Island contained benzo(a)pyrene (no standards exist for other substances) in an amount equal to 2 MPC. All they are associated with negative land forms (dishes, narrows) located outside the mian sites. In wet shadowed soils organic pollutants are destroyed slower than at the other territory. Also the total PAH PC (1 mg/kg) was insignificantly exceeded (1.12 - 1.46 times) in songle samples (3 out of 40). The results obtained show that this type of pollutants is present at the surveyed sites but the level of pollution is permissible (up to 2 MPC) and has a tendency to decrease.

As a result of the terrestrial survey transformers were revealed at the air-defense and Temp Airport on Kotelny Island. They are opened taps are not fixed; however, the state of cases is visually assessed as satisfactory. A filling level is high enough. No samples were taken immediately from

PCB-containing equipment due to safety requirements. Supposedly, the transformers contain sovtol diluted by water from atmospheric precipitation.

19 samples for identification of technical liquids were taken from numerous partiall filled containers concentrated at the sites. Winter Diesel fuel is prevailing mostly with PPD. Also summer Diesel fuel, motor oils and mixtures of spent oils were also detected. The state of containers at all surveyed sites is unsatisfactory. There are corrosion seats and a lot of leaks. 2 samples contained water.

Water washes out fuel and lubricant residues from the drum bottom and walls and facilitates the corrosion process leading to the penetration of water into the soil causing its pollution.

Water sample 14 was taken to assess pollutant migration with surface runoff in creek crossing run off from sites 6 and 4 (Kotelny Island). The parameter characterizing the total content of organic substances in water (chemical oxygen demand – COD) is an integral and the most informative characteristic for man-made water pollution. According the COD value (437 mg O_2/dm^3) the creek water is waste water. According to Appendix J to SNiP 11-102-97, the situation with COD>80 mg O_2/dm^3 is regarded as an environmental disaster. PH concentration in water amounts to 1.82 mg/dm^3 (36.5 MPC); concentration of copper and lead is 14 MPC. A high level of water pollution integrally characterizes the level of pollution accumulation in soil. This assessment is especially informative under the conditions of local pollution.

7. PROPOSALS FOR THE REMOVAL OF POLLUTION SOURCES AND REMEDIATION OF CONTAMINATED SOILS ON THE SURVEYED TERRITORY OF NEW SIBERIAN ISLANDS.

A general approach to the development of the measures for the removal of pollution sources and further remediation of contaminated lands in high-latitude Arctic was proposed during the implementation of the demonstration project "Environmental Remediation of the Decommissioned Military Base on Franz Josef Land Archipelago" in 2007.

Reconnaissance of the present environmental state of the areas of surveyed site on B. Lyakhovsky and Kotelny Islands showed a significant similarity of the character and degree of the decommissioned sites of the Russian Federation Ministry of Defense on Franz Josef Land and New Siberian Islands archipelagos.

Man-made degradation of the territory is also represented by the following types:

- organized (stored) and non-organized accumulation of drums and cisterns (empty and full of oil and lubricants).
- abandoned military, transport and other equipment.
- infrastructure facilities such as different pipelines, cables, transformers and diesel generators.
- permanent structures of different levels of destruction.
- abandoned electronic equipment including radar stations, aerodrome equipment, etc.

The level of pollution at most surveyed sites can be regarded as hazardous and in some places as extra-hazardous.

The survey results allow to determine in simplified form a list of main works on the integrated site treatment. First, it is necessary to perform detailed pre-design prospecting work to specify the scope of work for the land cleaning:

- detection of the areas having hazardous and extra-hazardous degree of pollution of soil with oil products specifying earthing areas, volumes of removed and buried grounds;
- determination of the whole area to be cleaned;
- specification of the parameters and structural components of building structures to be demounted;
- specification of the total number of containers and drums for fuel and lubricant in storage areas; number and type of unaccounted oil product and other technical liquid residuals to removed or disposed of on-site;
- specification of the volume of industrial garbage, industrial waste, domestic waste, ferrous and nonferrous metal scrap, used drums located within the territory and produced during the disassembly of technological and domestic facilities;
- determination of work for cleaning of the surveyed site areas;
- engineering survey at the sites of auxiliary facilities location needed to perform the complex cleaning of the sites.

Following the survey results, a design assignment estimated costs of the project are developed. At the same time, it is necessary to solve legal problems related to the ownership of the facilities and legal succession after the completion of the remediation of polluted areas.

The development and implementation of the project for the removal of pollutions and remediation of contaminated lands in the Russian Arctic zone is a rather expensive activity and cannot be implemented without appropriate funding from the federal budget and the determination of customer. In this case, it could be the Russian Federation Ministry of Natural Resources with involvement of the Government of Republic of Sakha (Yakutia) and the Ministry of Defense experts.

It is likely that the project will be developed and implemented by organizations winning respective tenders for public contracts. It is expedient to take into account existing experience in planning and implementing similar demonstration and pilot projects, particularly, those implemented within the framework of UNEP/GEF Project “Support to the National Program of Action (NPA) for the Protection of the Arctic Marine Environment”

REGULATORY DOCUMENTS AND SCIENTIFIC-METHODOLOGICAL LITERATURE

Regulatory documents regulating the organization of observation of environmental component quality, composition of the parameters to be controlled and criteria of environmental assessment

1. The Provision for Submitting Information on the Environmental State, its Contamination and Human-Induced Emergencies that Negatively Influenced, Influence or Can Influence the Environment. Approved by the Russian Federation Decree No. 128 of 14.02.00.
2. GOST 17.4.3.04-85 Nature Protection. Soils. General Requirements for Pollution Control and Protection.
3. GOST 17.4.1.02-83 Nature Protection. Soils. Classification of Chemicals for Pollution Control.
4. GOST 17.4.3.06-86 Nature protection. Soils. General Requirements for the Classification of Soils by the Impact of Chemical Pollutants on them.
5. SanPiN 2.1.7.1287-03 Sanitary and Epidemiological Soil-Quality Requirements.
6. Health Standard 2.1.7.2041-06 Maximum Permissible Concentration (MPC) of chemicals in soil.
7. Health Standard 2.1.7.2511-09 Approximate Permissible Concentration) of chemicals in soil.
8. MG 2.1.7.730-99 Methodological Guidelines. Sanitary Evaluation of Soil Quality in Residential Areas. Moscow, RF Ministry of Health, 1999.
9. Methodological Guidelines for Assessment of the Level of Hazard of Soil Pollution with Chemicals. Moscow, USSR Ministry of Health, 1987.
10. RD 52.44.2-94 Methodological Guidelines. Nature Protection. Integrated Monitoring of Environmental Media of Industrial Regions under Intensive Anthropogenic Pressure.
11. Criteria of Assessment of Environmental Situation at the Areas for Discovering the Zones of Environmental Emergency and Zones of Environmental Disaster. Approved by the Ministry of Natural Resources on November 30, 1992.
12. Building Regulations 11-102-97 Engineering Environmental Site Investigations for Construction.
13. Federal Waste Classification Catalog (as amended by the Ministry of Natural Resources Order No.663 of 30.07.2003).
14. Regulations for Operation of Oil Plants (approved by Order No. 232 of the RF Ministry of Energy 19.06.).

Regulatory documents regulating the realization of topographical work

1. Instruction for Photogrammetric Work for the Creation of Digital Topographical Maps and Plans. GKINP (GNTA) – 02-036-02. Moscow, TsNIIGAiK, 2002.
2. Satellite Technology for Geodetic Work. Moscow, TsNIIGAiK, 2001.
3. Instruction for Topographical in Scales 1:5000, 1:2000, 1:1000 and 1:500. Nedra.
4. Map symbol for Topographical Plans in Scales 1:5000, 1:2000, 1:1000 and 1:500. M.: FSUE "Kartgeotsentr", 2005.

Regulatory documents regulating the requirements for collection, storage, transport and processing of samples

1. GOST 2517-85 Oil and Oil Products. Methods of Sampling.
2. GOST 17.4.3.01-83 Nature Protection. Soils. General Requirements for Sampling.
3. GOST 17.4.4.02-84 Nature protection. Soils. Methods for Sampling and Preparation of Soil for Chemical, Bacteriological and Helminthological Analysis.
4. GOST 28168-89 Soils. Sampling.
5. GOST 12071-2000 Soils. Collection, Packing, Transport and Storage of Samples.
6. PND F 12.1:2:2.2:2.32-03 Guidelines "Sampling of Soils, Grounds, Sediments of the Biological Treatment Plants, Industrial Sewage Muds, Bottom Sediments of Artificial Reservoirs, Containment Pond and Hydraulic Structures".

GRAPHIC ANNEXES

No. of drawing	Name of drawing	Sheet
1	New Siberian Islands archipelago Bolshoy Lyakhovsky Island Physical and geological map	1
2	New Siberian Islands archipelago Bolshoy Lyakhovsky Island Map of infrastructure facilities and pollution sources	2
3	New Siberian Islands archipelago Bolshoy Lyakhovsky Island Pollution of soils with petroleum hydrocarbons mg/kg	3
4	New Siberian Islands archipelago Bolshoy Lyakhovsky Island Content of benzo(a)pyrene, PAH and PCB in soils	4
5	New Siberian Islands archipelago Bolshoy Lyakhovsky Island Content of heavy metals in soils. Total soil pollution index	5
6	New Siberian Islands archipelago Kotelny, air-defense base Physical and geological map	6
7	New Siberian Islands archipelago Kotelny, air-defense base Map of infrastructure facilities and pollution sources	7
8	New Siberian Islands archipelago Kotelny, air-defense base Pollution of soils with petroleum hydrocarbons mg/kg	8
9	New Siberian Islands archipelago Kotelny, air-defense base Content of benzo(a)pyrene, PAH and PCB	9
10	New Siberian Islands archipelago Kotelny, air-defense base Content of heavy metals in soils. Total soil pollution index	10
11	New Siberian Islands archipelago Kotelny Map of Temp Airport with the results of random soil sampling	11

площадка 1

площадка 2

площадка 3

Условные обозначения

- 1 Пробы почвы (НУВ)
- 7 Пробы почвы (НУВ и ПАУ)
- 9 Пробы почвы (НУВ, ПАУ, ПХБ, ТМ)
- 3 Пробы жидкости (идентификация)
- 2 Пробы жидкости (идентификация, ПХБ, ТМ)
- 4 ТОЧКИ ПРИВЯЗКИ

Горизонтали проведены через 2 метра

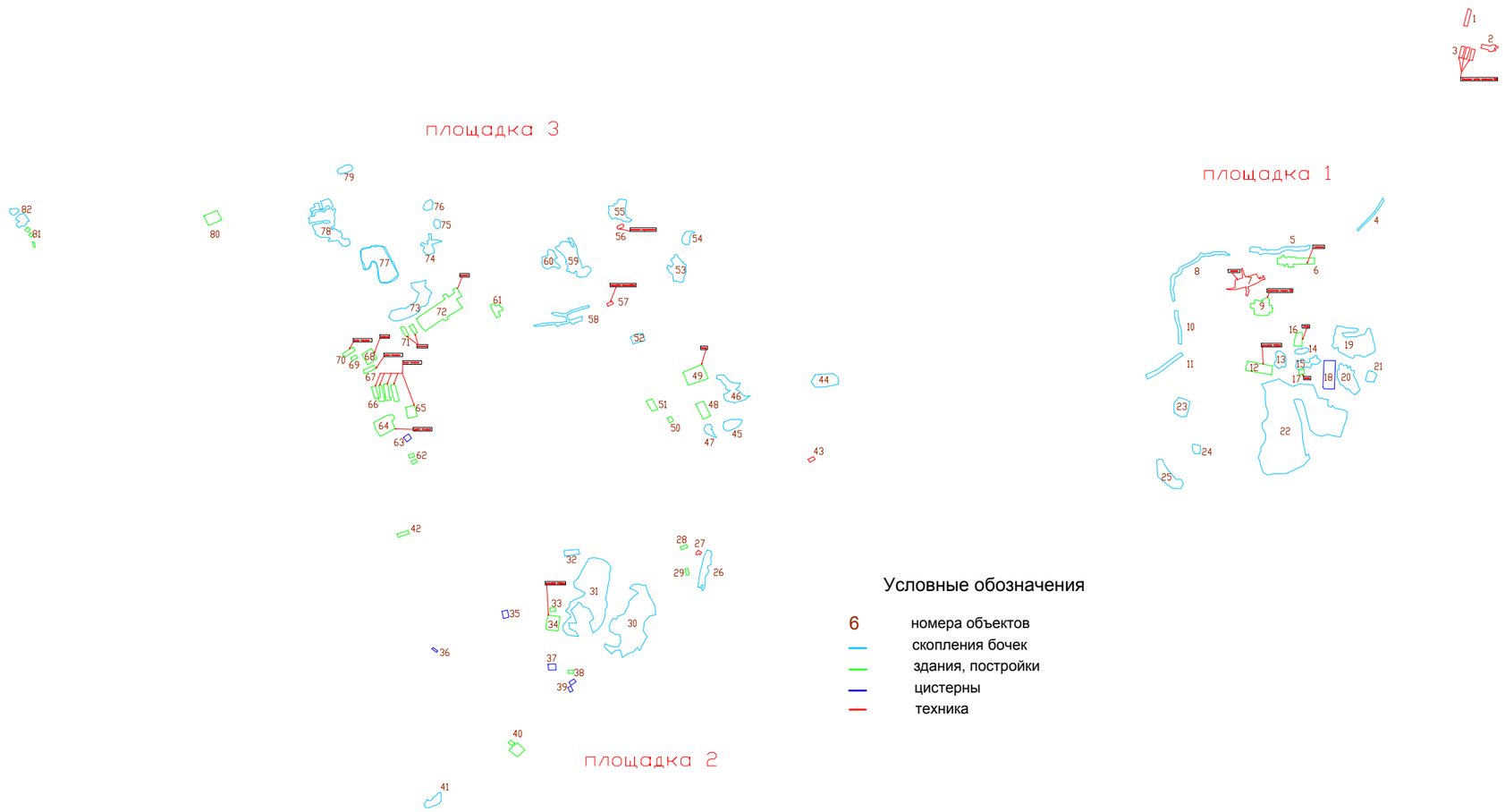
1:1000

Архипелаг Новосибирские острова
о. Большой Ляховский
Карта фактического материала

Стадия | Лист | Листов
1

Копировал

Инв.№подл. | Подп. и дата | Взам.инв.№



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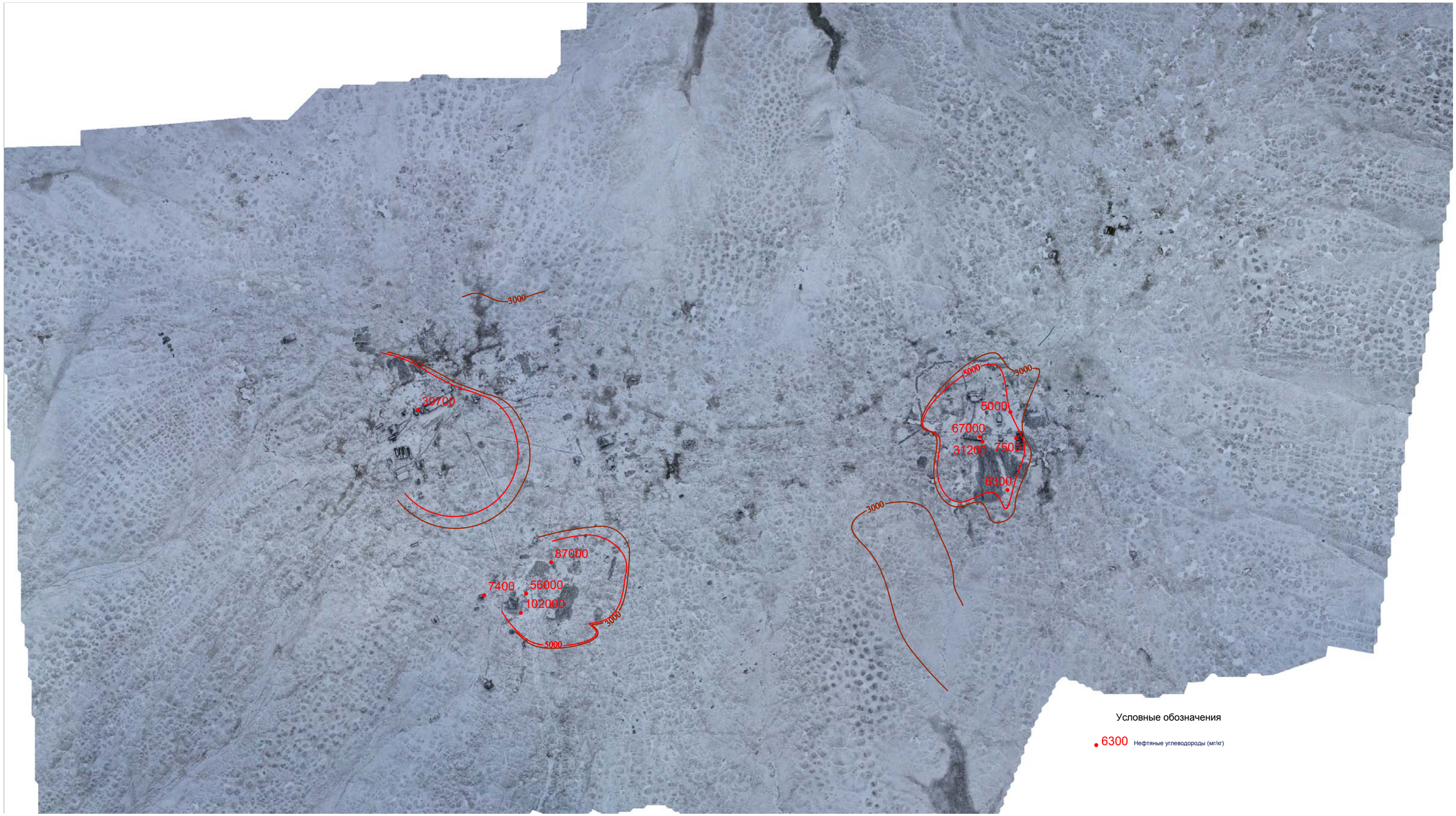
Архипская Новосибирская острова о. Б. Ляховский
Карта-схема объектов инфраструктуры и источников загрязнения

Изм.	Кол.уч.	Лист	№ док.	Подп.	Дата
Гл. гл. гл.		Тарлин С.Н.			
Нач. отр.					
Гл. спец.		Ермолов С.С.			
Гл. спец.		Ермолов В.В.			
Н. контр.					
Инженер		Гилев Е.С.			

Стадия	Лист	Листов
	2	

Копировал



Условные обозначения

6300 Нефтяные углеводороды (мг/кг)

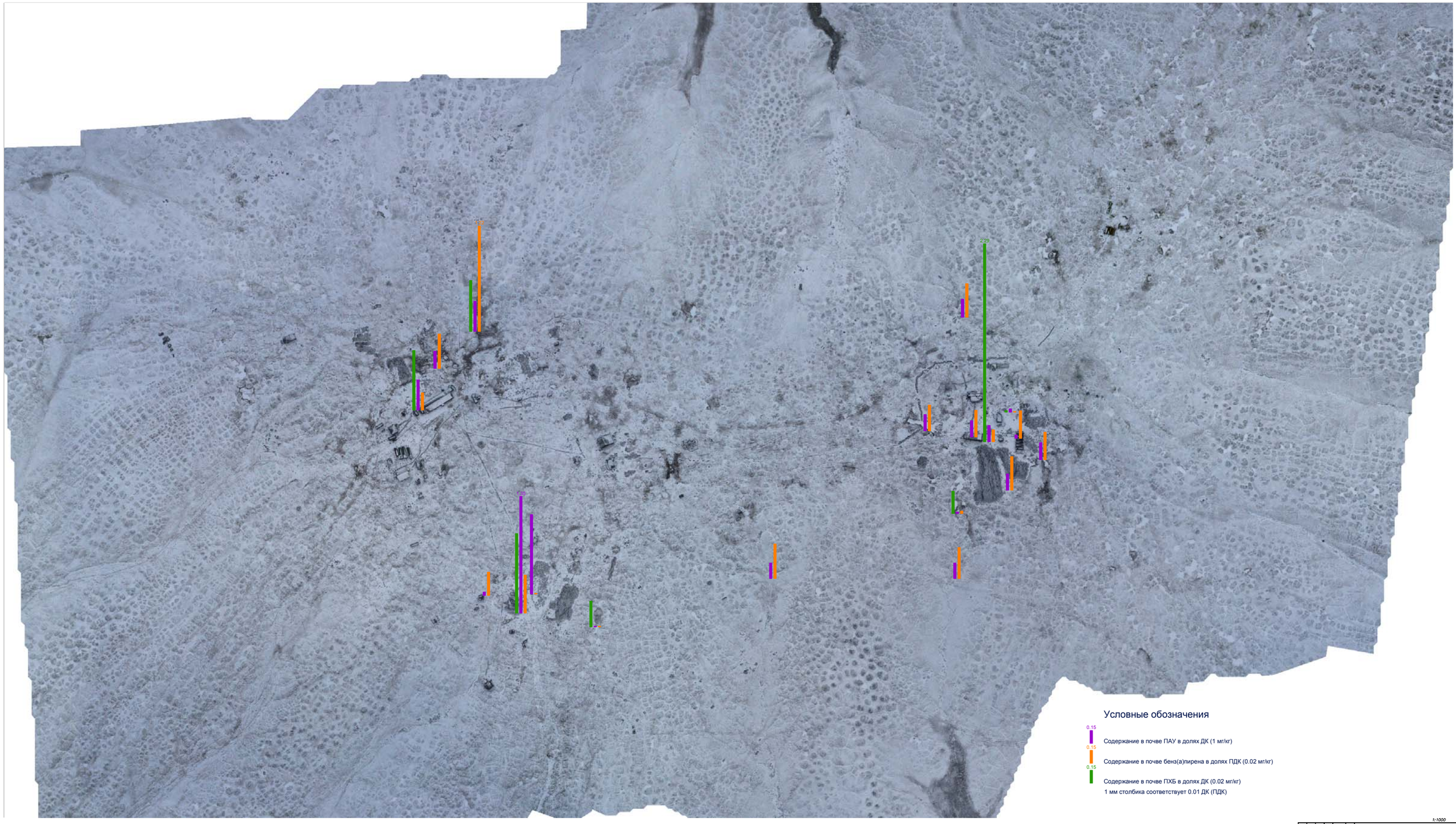
1:1000

Изм.	Кол.уч.	Лист	№док.	Подп.	Дата	Архипелаг Новосибирские острова, о. Б. Ляховский Загрязнение почвенного покрова нефтяными углеводородами, мг/кг		
Г. И. П.		Чепик С.В.					Стадия	Лист	Листов
Нач. отр.									
Г.в отряд.		Хрячий С.Г.						3	
Г.в отряд.		Цветов Е.В.							
Н.контр.									
Руководитель		Гилев Е.С.							

Копировал

Формат А3

Инв.№подл. | Подп. и дата | Взам.инв.№



Условные обозначения

0.15 — Содержание в почве ПАУ в долях ДК (1 мг/кг)

0.15 — Содержание в почве бенз(а)пирена в долях ПДК (0.02 мг/кг)

0.15 — Содержание в почве ПХБ в долях ДК (0.02 мг/кг)

1 мм столбика соответствует 0.01 ДК (ПДК)

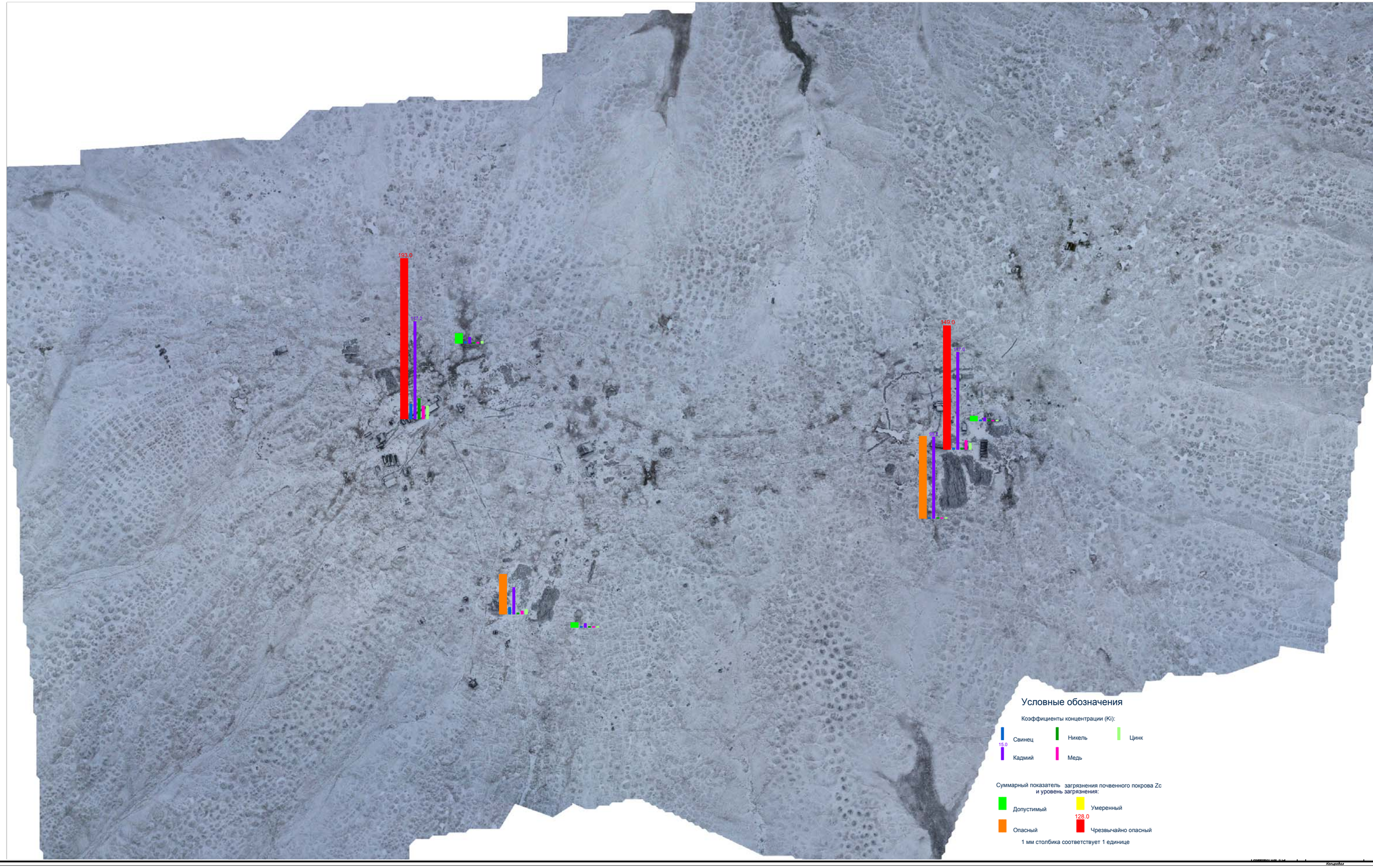
1:1000

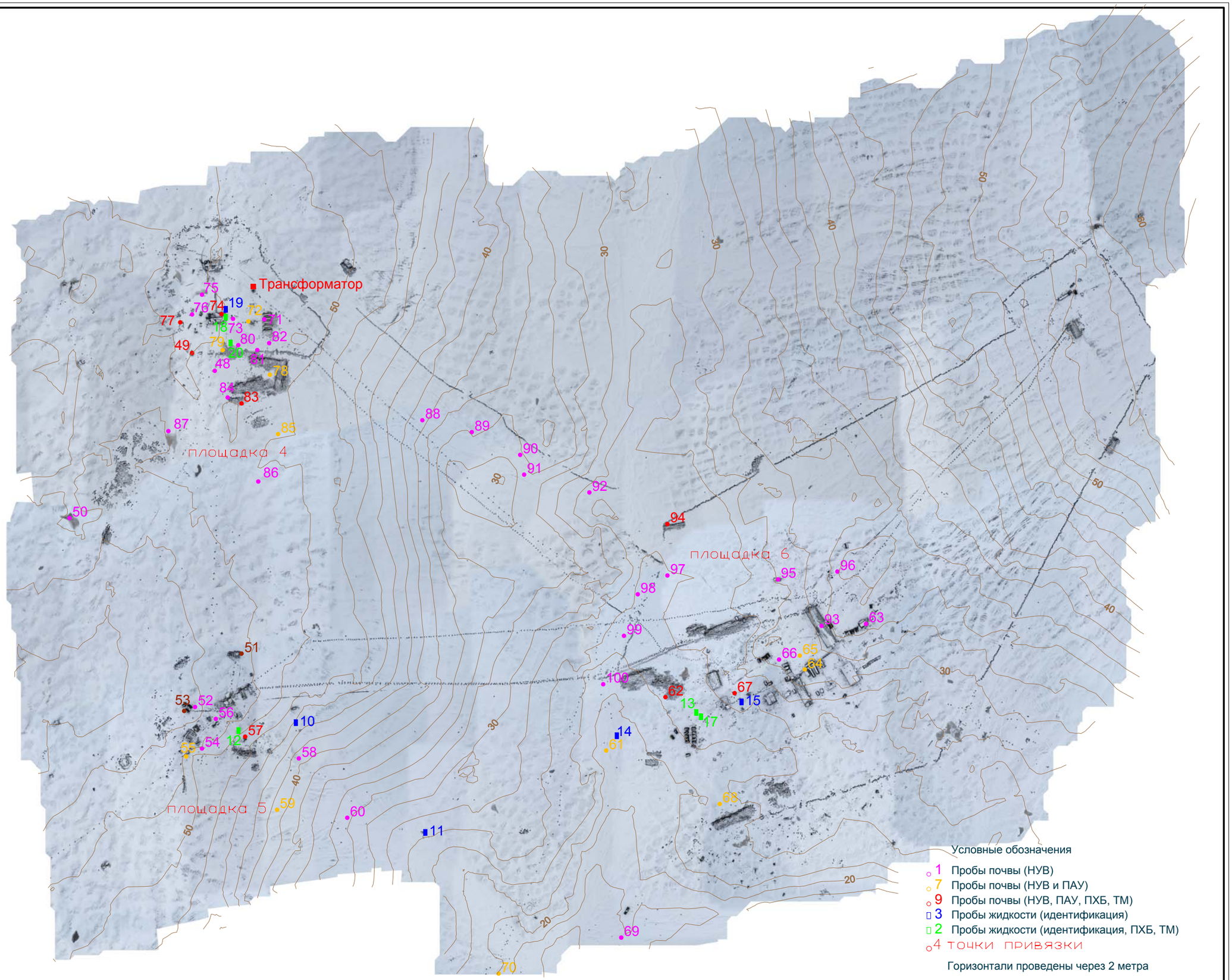
							Архипелаг Новосибирские острова о. Б. Ляховский Содержание в почвах бенз(а)пирена, ПАУ и ПХБ
Изм.	Кол.уч.	Лист	№док.	Подп.	Дата		
Г. И. П.		Таран С.В.				Стадия	Лист	Листов
Нач.отд.								
Гл.спец.		Тимофеев С.Г.					4	
Гл.спец.		Ермаков В.В.						
Н.контр.								
Инженер		Гилев Е.С.						

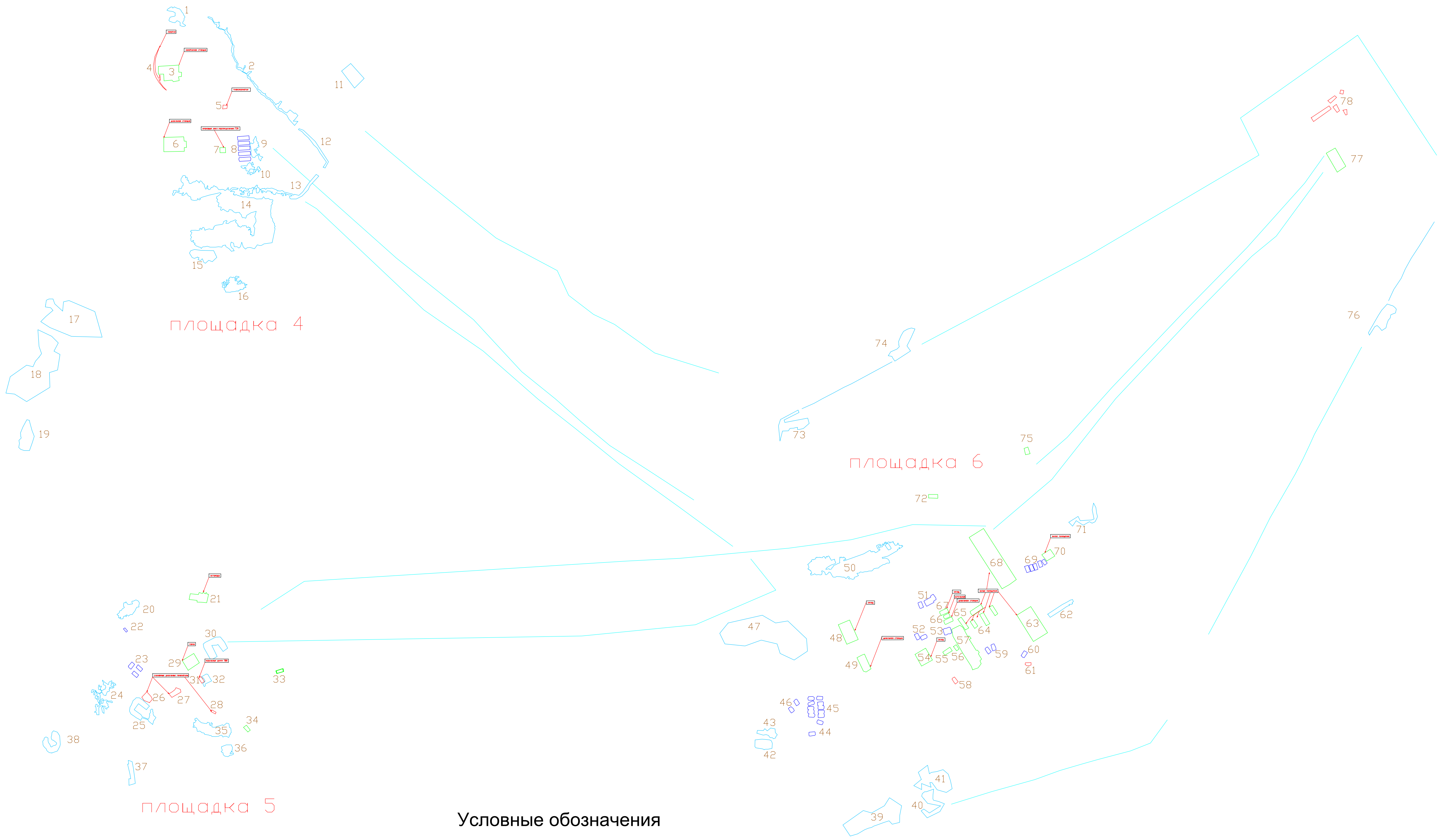
Копировал

Формат А1

Согласовано Инв.№ подл. | Подпись и дата | Взам.инв.№


193.0
149.0
Условные обозначения
Коэффициенты концентрации (Ki):
Свинец
Никель
Цинк
15.0
Кадмий
Медь
Суммарный показатель загрязнения почвенного покрова Zc
и уровень загрязнения:
Допустимый
Умеренный
128.0
Опасный
Чрезвычайно опасный
1 мм столбика соответствует 1 единице


Трансформатор
площадка 4
площадка 5
площадка 6
Условные обозначения
1 Пробы почвы (НУВ)
7 Пробы почвы (НУВ и ПАУ)
9 Пробы почвы (НУВ, ПАУ, ПХБ, ТМ)
3 Пробы жидкости (идентификация)
2 Пробы жидкости (идентификация, ПХБ, ТМ)
4 точки привязки
Горизонтали проведены через 2 метра
1:1000
Архипелаг Новосибирские острова
о. Котельный. База ГБО
Карта фактического материала



Условные обозначения

6	номера объектов
—	скопления бочек
—	здания, постройки
—	цистерны
—	техника

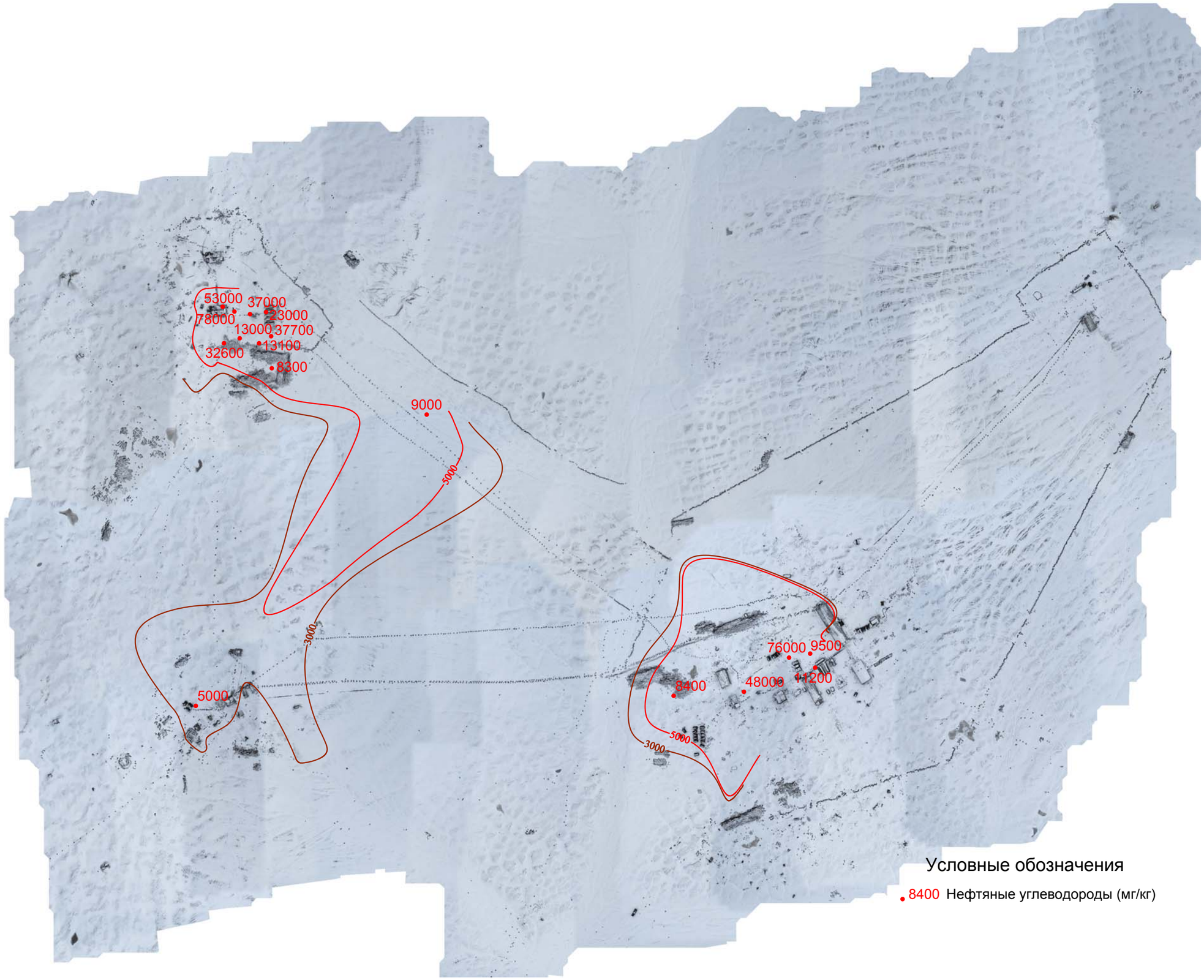
1:1000

Арх. Новосибирские острова, о. Котельный, База ПВО
Карта–схема обьектов инфраструктуры
и источников загрязнения

Изм.	Кол.уч.	Лист	N° док.	Подп.	Дата
Г И П		Тюрин С.В.			
Нач. отд.		Ефремова Л. В.			
Гл. спец.		Тихонов С.Г.			
Гл. спец.					
Н. контр.					
Инженер		Гиль Е.С.			

Стадия	Лист	Листов
	7	

Копировал



Условные обозначения

8400 Нефтяные углеводороды (мг/кг)

1:1000

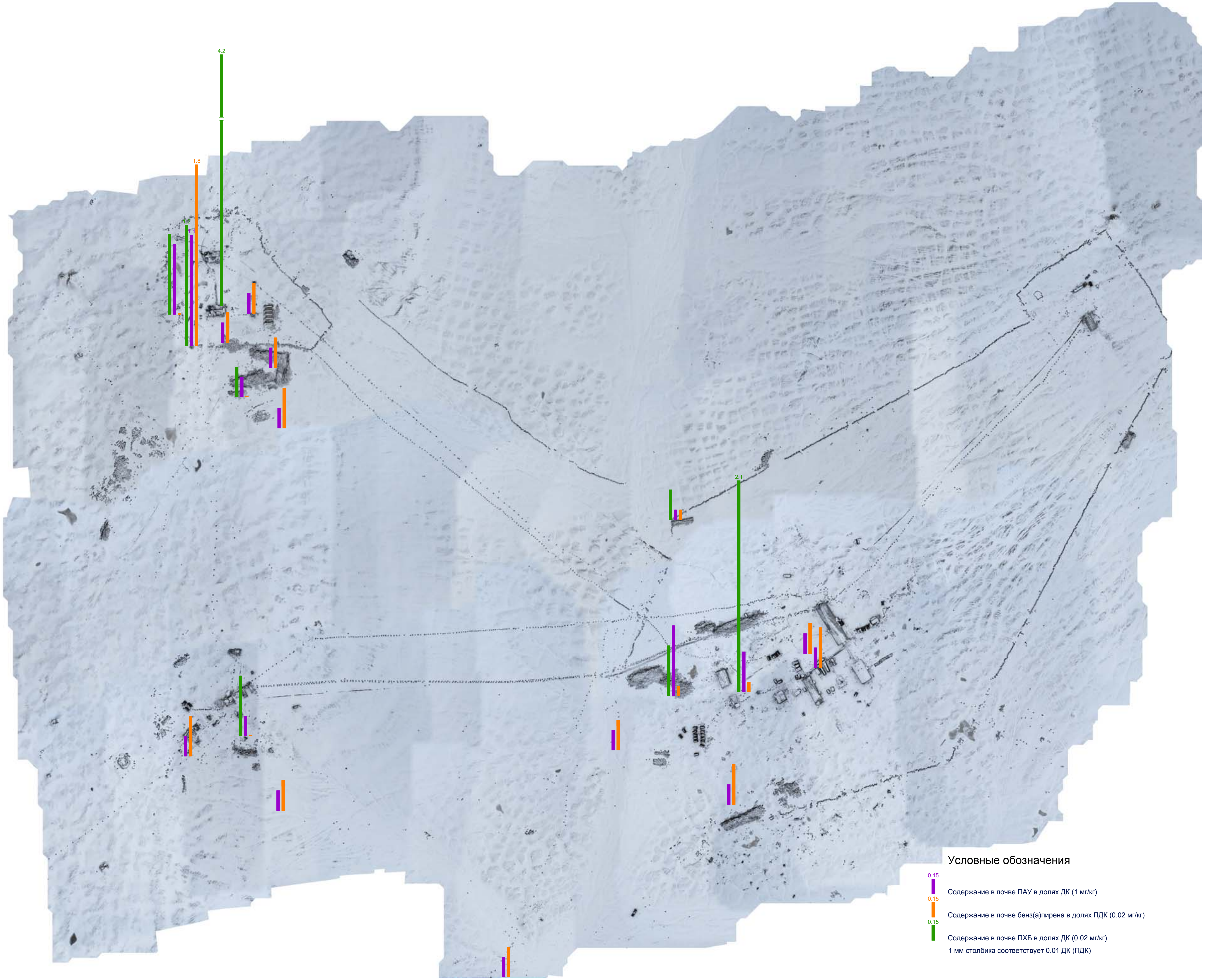
Арх. Новосибирские острова, о. Котельный, База ПВО
Загрязнение почвенного покрова нефтяными углеводородами, мг/кг

Изм.	Кол.	Лист	№ док.	Подп.	Дата
Т. Н. П.		Терин С.В.			
Нач. отд.		Ермаков Е.В.			
Гл. спец.		Тимофеев С.Г.			
Гл. спец.					
Н. контр.					
Инженер		Гудов Е.С.			

Стадия: В | Лист | Листов

Копировал

Формат А4 | Подпись и дата | Инв. № подл. | 26.11.2015

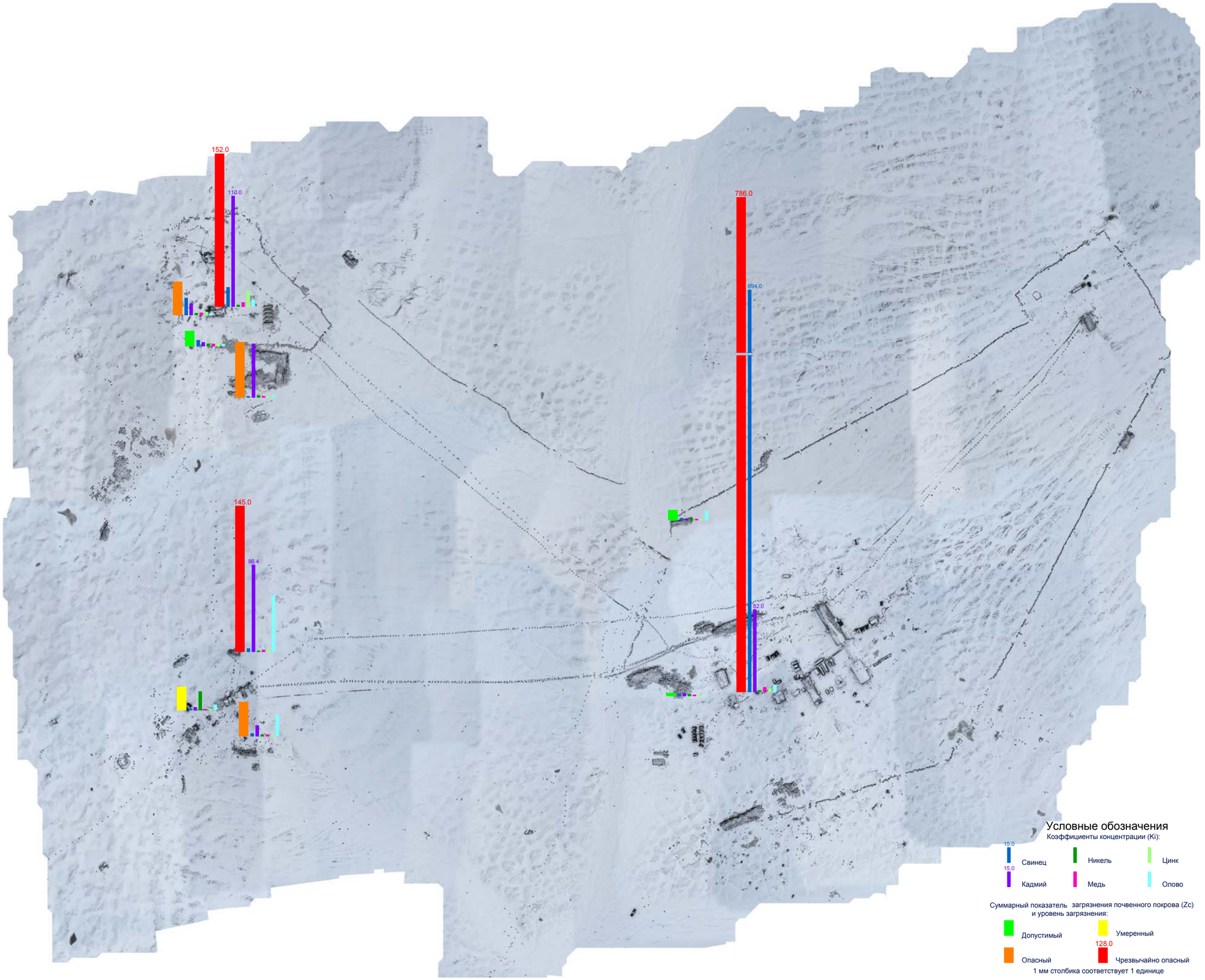


1:1000

Изм.	Кол.уч.	Лист	N° док.	Подп.	Дата	Архипелаг Новосибирские острова о. Котельный, база ПВО Содержание в почвах бенз(а)пирена, ПАУ и ПХБ
Г И П		Тюрин С.В.				Стадия / Лист 9 / Листов
Нач. отд.						
Гл. спец.		Тихонов С.Г.				
Гл. спец.		Ефремова Л. В.				
Н. контр.						
Инженер		Гиль Е.С.				

Копировал

Инв.N° подл.	Подпись и дата	Взам. инв.N°
	26.11.2010	



Условные обозначения

Коэффициенты концентрации (Ki):

15.0 Свинец

Никель

Цинк

15.0 Кадмий

Медь

Олово

Суммарный показатель загрязнения почвенного покрова (Zc) и уровень загрязнения:

Допустимый

Умеренный

Опасный

128.0 Чрезвычайно опасный

1 мм столбика соответствует 1 единице

1:1000

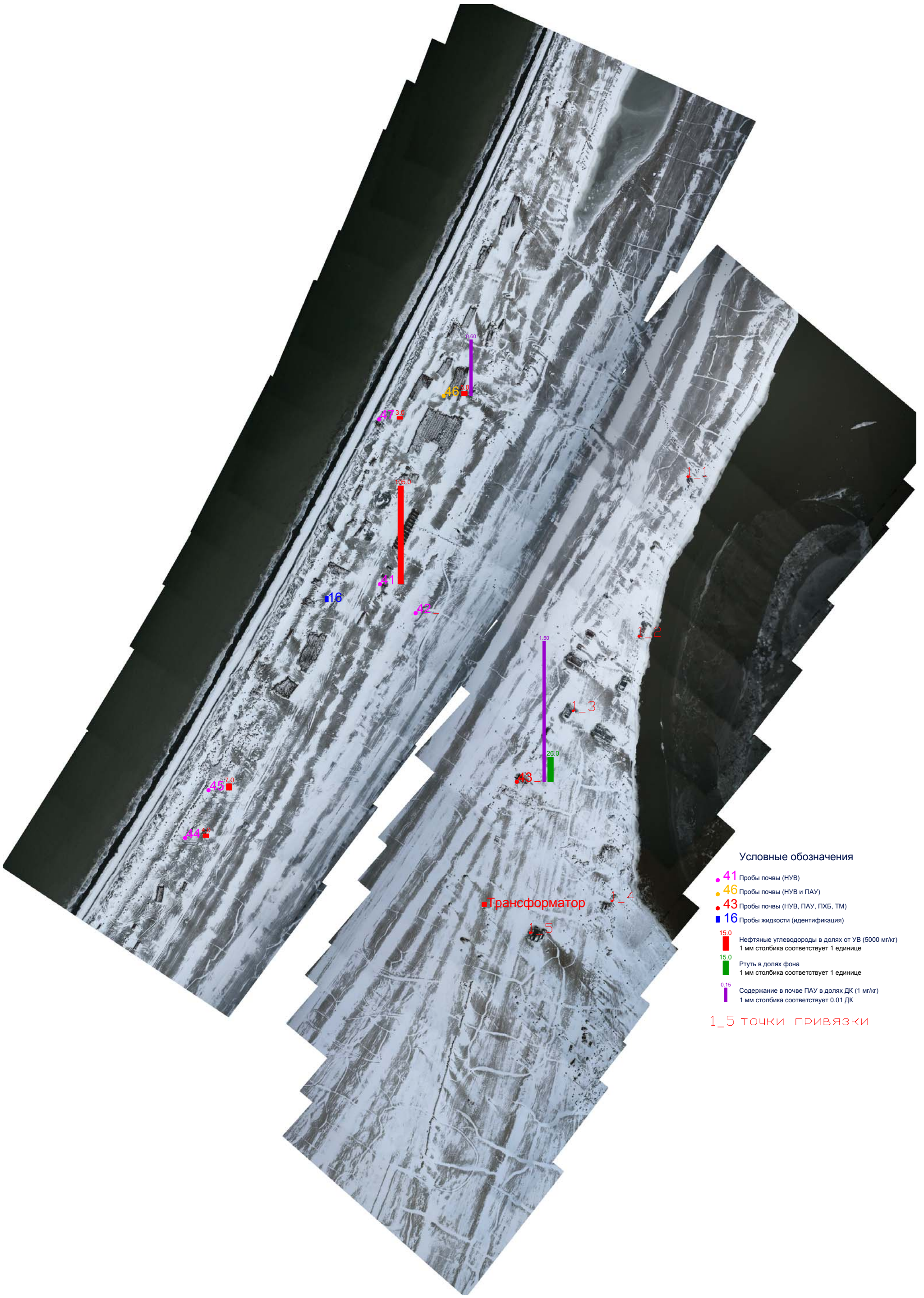
Изм.	Кол.уч.	Лист	№док.	Подп.	Дата		
Г. И. П.		Терин. С.В.					
Нач.отд.							
Гл.спец.		Тимной С.Г.					
Гл.спец.		Ермель Е.В.					
Н.контр.							
Инженер		Гиль. Е.С.					

Арх. Новосибирские острова, а.Котельный. База ПВО
Содержание в почвенном покрове тяжелых металлов
Суммарный показатель загрязнения почвенного покрова

Стадия	Лист	Листов
	10	

Копировал

Инв.№ подл. | Подпись и дата | Взам.инв.№
26.11.2010



Условные обозначения

- 41 Пробы почвы (НУВ)
- 46 Пробы почвы (НУВ и ПАУ)
- 43 Пробы почвы (НУВ, ПАУ, ПХБ, ТМ)
- 16 Пробы жидкости (идентификация)

15.0 Нефтяные углеводороды в долях от УВ (5000 мг/кг)
1 мм столбика соответствует 1 единице

15.0 Ртуть в долях фона
1 мм столбика соответствует 1 единице

0.15 Содержание в почве ПАУ в долях ДК (1 мг/кг)
1 мм столбика соответствует 0.01 ДК

1_5 точки привязки

1:1000

Архипелаг Новосибирские острова, о. Котельный
Карта аэропорта Темп с результатами
выборочного опробования почвенного покрова

Изм.	Кол.уч.	Лист	№док.	Подп.	Дата
Г. Н. П.		Керин С.В.			
Нач.отд.					
Гл.спец.		Тихонов О.Г.			
Гл. спец.		Ермаков А.В.			
Н.контр.					
Инженер		Силь Е.С.			

Стадия | Лист | Листов
— | 11 |

Копировал

Инв.№ подл. | Подпись и дата | Взам.инв.№
26.11.2010