

Public Environmental Monitoring of the Quality of Water Bodies in Norilsk and Taimyr

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Received November 27, 2020; Revised December 24, 2020; Accepted February 2, 2021

Cite This Paper in the following Citation Styles

(a): [1] Natalia V. Karmanovskaya, Olga V. Nosova, Victoria V. Galishevskaya, "Public Environmental Monitoring of the Quality of Water Bodies in Norilsk and Taimyr," *Environment and Ecology Research*, Vol. 9, No.2, pp. 45 - 63, 2021. DOI: 10.13189/eer.2021.090202.

(b): Natalia V. Karmanovskaya, Olga V. Nosova, Victoria V. Galishevskaya (2021). *Public Environmental Monitoring of the Quality of Water Bodies in Norilsk and Taimyr*. *Environment and Ecology Research*, 9(2), 45 - 63. DOI: 10.13189/eer.2021.090202.

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Abstract The problem of environmental pollution and degradation of all elements of ecosystems is becoming more and more urgent. Therefore, the main purpose of the work is to monitor the quality of water bodies. The objects of the research were Norilsk, Kayerkan, Talnakh, Dudinka, and Lama Lake. The study was conducted in August-September 2019. The work investigated the organoleptic characteristics of water bodies: smell, color, turbidity, salt content, pH, alkalinity, hardness, SO_4^{2-} , COD. Organoleptic, visual, potentiometric, titrimetric methods were used as research methods. The work identified the causes of odor, turbidity, the color of the water; an evaluation scale for determining organoleptic indicators is given. The color of the water was determined by comparing samples of the test liquid with solutions that imitate the color of natural water. The categories of water salinity are revealed. It was found that the hardness and odor of the water samples did not exceed the norm. The acidic pH is highest on the Ambarnaya River at two sampling points and also on the Daldykan River. It was concluded that the ecological situation in the region requires the adoption of serious measures since the level of pollution of water bodies in many respects exceeds the norm.

Keywords Organoleptic Characteristics, Oxidizability, Titrated Solution, Indicator, Snellen Scale

1. Introduction

Norilsk is the northernmost city in Russia with a population of over 150 thousand people. Norilsk has an extremely harsh subarctic climate, just like the city of Taimyr. It is one of the coldest cities in the world, much colder than Murmansk, which is located at almost the same latitude. Norilsk is a very polluted city, since the industry is represented by non-ferrous metallurgy. Water bodies are a fairly polluted ecosystem, both in Norilsk and in Taimyr. Although environmental activities are constantly being carried out in cities, environmental pollution remains quite high. The problem of environmental pollution and degradation of ecosystems is becoming more and more urgent. Therefore, the work studied the organoleptic characteristics of water from the Norilsk and Taimyr reservoirs. The analysis of the indicators is presented below.

Color is a natural property of melt water due to the presence of humic substances that are formed during the destruction of organic compounds in the soil, are washed out of it, enter open water bodies and give them a yellowish to brown color. Therefore, the color is inherent in the melt water of open reservoirs and increases sharply during the flood period. The color of the melt water can be imparted by iron compounds (yellow-greenish coloration), flowering algae, suspended solids, sewage pollution, etc. The color of the melt water is determined photometrically, it should not be higher than 20° , then the water is considered colorless. The hygienic value of chromaticity is

that when the chromaticity is above 35°, water consumption is limited; an increase or decrease in the color of groundwater indicates their pollution; chromaticity is a measure of the effectiveness of water discoloration in waterworks.

The smell of water of natural origin is usually associated with the presence of phytoplankton and with the activity of bacteria that decompose organic matter. Therefore, the water of springs, springs, artesian wells is usually odorless. More than 200 substances are known that are secreted only by algae of various species that can be perceived by olfactory receptors, but in reality the problems of the appearance of the emerging odors of tap water are associated only with some of them: 2-methylisoborneol (MIB), geosmin, mercaptans, dimethyl disulfide, dimethyl sulfide, 2,4-heptadienal, 2,6-nonadienal [1]. The number of different types of smells is quite large. The most common odors of surface water bodies are: putrid, herbaceous, earthy, dung. Certain types of algae produce specific odors. For example, from the group of diatoms, odorizing substances are produced by representatives of the genera *Asterionella* (geraniums and fish), *Cycotella* (herbaceous, geranium, fish), *Tabellaria* (herbaceous, geranium, musty). Representatives of the genera of golden algae (chrysophytes) *Synura*, *Dinobryon*, *Uroglenopsis* are capable of imparting a strong fishy smell to the water. This smell, as in the case of diatoms, has aldehydes and ketones, which are formed as a result of enzymatic conversion of unsaturated fatty acids during cell death. The main causes of groundwater odors are hydrogen sulfide and iron compounds. Hydrogen sulfide appears as a result of the action of anaerobic reducing sulfur bacteria on organic and elemental sulfur, sulfates and sulfites. In low concentrations, it can produce a swampy, musty odor [2].

Often water from wells smells like iron – the most common pollutant, which, when interacting with oxygen in the air, turns into a trivalent form. Therefore, the water just extracted from the well looks clean and only then acquires a brown color and an unpleasant metallic, ferrous smell and taste. High-quality water, centralized water supply, can be considered only one that, according to consumers, has no smell, taste or taste. Usually people do not smell, taste and taste with an intensity of 0 and 1 point on a five-point scale. Only some consumers (up to 10% of the population) feel a

smell with an intensity of 2 points, and only if you pay their attention to it. As the intensity increases, the odor becomes perceptible to all consumers without any warning.

Therefore, the intensity of the smell of drinking tap water should not exceed two points. In addition, it should be borne in mind that the water is heated to prepare hot drinks and first courses, and this can lead to an increase in its smell. That is why drinking water, as a rule, should not have an odor of more than two points at a temperature of both 20°C and 60°C [1]. Smells of natural origin are caused by organisms living and dying in the water, the influence of the banks, bottom, soil, ground, etc. So, the presence of plant residues in the water gives it an earthy, muddy or swampy smell; when blooming, the water has an aromatic smell; the presence of hydrogen sulfide gives the water the smell of rotten eggs; when organic matter decays or is contaminated with sewage, a putrid, hydrogen sulfide or fecal odor occurs.

The main causes of odor and taste in water are:

- Rotting plants. Algae and aquatic plants in the process of decay can cause fishy, herbal, putrid water smell and a similar unpleasant taste.
- Fungi and mold. These microorganisms cause moldy, earthy or musty odors and lead to off-tastes. The tendency for the reproduction of these microorganisms occurs in places of stagnant water and there, where the water can be heated (for example, in the water supply systems of large buildings with storage tanks).
- Glandular and sulfur bacteria. Both types of bacteria release waste products, which, when decomposed, create a sharply unpleasant odor.
- Compounds of heavy metals, especially corrosion products of iron, manganese, copper, which cause a slight smell of water, insufficiently distinct metallic taste.
- Odors of artificial origin occur when water is polluted by industrial and other wastewater (phenolic, camphor, pharmacy, chlorine, metal, gasoline, etc.).

The intensity of water smell is assessed using a 5-point system, presented in Table 1. The odor of water should not exceed 2 points when used for drinking.

Table 1. Assessment of Smell Intensity

Smell Intensity	The Nature of the Manifestation of the Smell	Smell Intensity, Points
No	The smell is not felt	0
Very weak	The smell is not felt by the consumer, but is detected during laboratory research	1
Weak	The smell is noticed by the consumer if his attention is paid to it	2
Notable	The smell is easily noticed and leads to disapproval of the water	3
Distinct	The smell attracts attention and makes you refrain from drinking	4
Very strong	The smell is so strong that it makes the water unusable	5

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Hydrogen sulfide appears as a result of the action of anaerobic reducing sulfur bacteria on organic and elemental sulfur, sulfates and sulfites. In low concentrations, it can produce a swampy, musty odor. Often water from wells smells like iron – the most common pollutant, which, when interacting with oxygen in the air, turns into a trivalent form. Therefore, the water just produced from the well looks clean and only then acquires a brown color and an unpleasant metallic, ferrous odor and taste [5,6,7]. Turbidity of water is an indicator characterizing a decrease in water transparency due to the presence of inorganic and organic finely dispersed suspensions, as well as the development of planktonic organisms. Turbidity of water can be caused by the presence of clay, inorganic compounds (aluminum hydroxide, carbonates of various metals), as well as organic impurities or cake organisms, for example, bacteria, phyto- or zooplankton.

Also, the reason may be the oxidation of iron and manganese compounds by atmospheric oxygen, which leads to the formation of colloids. The turbidity of water in rivers and coastal areas of water bodies increases with rains, floods, and glaciers melting. As a rule, in winter, the level of turbidity in water bodies is lowest, highest in spring and during summer rains. Turbidity of drinking water is normalized mainly due to the fact that turbid water protects microorganisms during ultraviolet disinfection and facilitates the growth of bacteria, as well as for aesthetic reasons [1].

2. Features of Determining the Organoleptic Characteristics of Drinking Water

Turbidity depends on the presence of suspended particles of mineral or organic origin in the water. Increased turbidity limits water consumption and indicates pollution of natural waters. Turbidity is an indicator of the efficiency of the water clarification process at a wastewater treatment plant. Organoleptic characteristics of drinking water must comply with the standards

presented in Table 2.

Table 2. Organoleptic Characteristics of Drinking Water

Indicators	Units	Standards (no more)
Smell	Points	2
Flavor	Points	2
Chromaticity	Degrees	20(35)
Turbidity	TUF (turbidity units for formazin) or mg/l (for kaolin)	2.6(3.5), 1.5(2)

Note: The value indicated in brackets can be set based on the sanitary and epidemiological situation.

Chemicals that can impair the organoleptic properties of water include natural mineral elements (chlorides, sulfates, iron, copper, zinc, calcium and magnesium salts), as well as some chemicals added to water during its processing (aluminum compounds, polyacrylamides, etc.), therefore, limit standards for the content of such substances have been established. A change in the organoleptic characteristics of water has an adverse effect on humans and can lead to a deterioration in the sanitary state of water (for example, an increase in water turbidity reduces the bactericidal effect of chlorination).

Transparency is a technological indicator of water quality that allows you to simply and quickly control the content of suspended solids and colloidal impurities in it. The measure of transparency is the height of the water column through which the control object can still be observed. Depending on the type of this object, it is customary to distinguish between several types of transparency. When observing a white (usually porcelain) board or disc with a diameter of 20 cm, the “transparency over the disc” is determined. This value is measured only for surface water bodies (rivers, lakes, reservoirs). Transparency (turbidity) depends on the presence of suspended particles of mineral or organic origin in the melt water, increased turbidity indicates its contamination with solid particles from the air. Turbidity of water is an indicator characterizing a decrease in water transparency due to the presence of inorganic and organic finely dispersed suspensions, as well as the development of planktonic organisms. Turbidity of water can be caused by the presence of clay, inorganic compounds (aluminum hydroxide, carbonates of various metals), as well as organic impurities or cake organisms, for example, bacteria, phyto- or zooplankton. Also, the reason may be the oxidation of iron and manganese compounds by atmospheric oxygen, which leads to the formation of colloids. The turbidity of water in rivers and coastal areas of water bodies increases with rains, floods, and glaciers melting. As a rule, in winter, the level of turbidity in water bodies is lowest, highest in spring and during summer rains. Turbidity of drinking water is normalized mainly due to the fact that turbid water protects microorganisms during ultraviolet disinfection and facilitates the growth of bacteria, as well as for aesthetic reasons [1].

The water contains suspended substances that reduce its transparency. The clarity of water depends on the amount of suspended solids and chemical impurities contained in it. Turbid water is always suspicious of epizootic and sanitary conditions. There are several methods for determining the clarity of water.

On the Secchi disc. To measure the transparency of river water, a Secchi disc with a diameter of 30 cm is used, which is lowered on a rope into the water, attaching a weight to it so that the disc goes vertically downward. Instead of a Secchi disc, you can use a plate, lid, bowl, put in a grid. The disc is lowered until it is visible. The depth to which you lowered the disc will be an indicator of the transparency of the water.

By cross. Find the limiting height of the water column through which the drawing of a black cross on a white background with a line thickness of 1 mm and four black circles with a diameter of 1 mm is visible. The height of the cylinder, in which the determination is carried out, must be at least 350 cm. At the bottom there is a porcelain plate with a cross. The bottom of the cylinder should be

illuminated with a 300 W lamp.

By font. A standard font is placed under a cylinder 60 cm high and 3-3.5 cm in diameter at a distance of 4 cm from the bottom, the test sample is poured into the cylinder so that the font can be read, and the maximum height of the water column is determined. The method for quantitative determination of transparency is based on determining the height of the water column, at which it is still possible to visually distinguish (read) a black font with a height of 3.5 mm and a line width of 0.35 mm on a white background or see an alignment mark (for example, a black cross on white paper). The method used is unified and complies with ISO 7027. The classification of water by transparency is shown in Table 3.

There is a relationship between the transparency along the cross, the transparency in the font and the content of suspended solids, which is shown in Table 4. However, the content of suspended solids by the transparency value can be estimated rather approximately, since the latter also depends on the color of substances dissolved in water.

Table 3. Assessment of Water Transparency

Transparency Assessment	Transparency by Font, cm	Suspended Matter Content, mg/dm ³
Transparent	More than 30	Less than 3÷4
Low-Turbid	25÷30	Less than 5÷6
Medium-Turbid	20÷25	6÷10
Muddy	10÷20	10÷30
Very Turbid	Less than 10	More than 30

Table 4. Conversion of Transparency, Determined by Various Methods, From One to Another and Assessment of the Content of Suspended Solids

Transparency, cm		Suspended Substances, mg/dm ³	Transparency, cm		Suspended Substances, mg/dm ³
By Cross	By Font		By Cross	By Font	
0.5	5	160÷300	16	160	9÷14
2	20	40÷120	17	170	8÷12
3	30	30÷90	18	180	7÷10
5	50	16÷75	19	190	6÷9
6	60	14÷52	21	210	5÷8
8	80	11÷40	23	230	4÷6
9.5	95	10÷33	25	250	3÷6
11	110	10÷27	26	260	3÷6
12.5	125	10÷20	28	280	3÷6
14	140	10÷17	30	300	3÷6

Table 5. Groups of Natural Waters Depending on the pH Value

Group	pH	Note
Strongly Acidic Waters	<3	The result of hydrolysis of salts of heavy metals (mine and mine waters)
Acidic Waters	3-5	Intake of carbonic acid, fulvic acids and other organic acids into water as a result of decomposition of organic substances
Weakly Acidic Waters	5-6.5	The presence of humic acids in the soil in bog waters (waters of the forest zone)
Neutral Waters	6.5-7.5	Presence in waters of Ca(HCO ₃) ₂ , Mg(HCO ₃) ₂
Weakly Alkaline Waters	7.5-8.5	Presence in waters of Ca(HCO ₃) ₂ , Mg(HCO ₃) ₂
Alkaline Water	8.5-9.5	Presence of Na ₂ CO ₃ Na or NaHCO ₃
Strongly Alkaline Waters	9.5	Presence of Na ₂ CO ₃ Na or NaHCO ₃

The determination of the hydrogen index (pH) is based on the use of the electromotive force of the electrochemical (potentiometric) cell on the concentration (activity) of the analyte in the analyzed solution. The simplest potentiometric cell contains two electrodes; the potential of one of them directly or indirectly depends on the concentration of the analyte – it is called an indicator (ion-selective) electrode; and a second electrode with respect to which the potential of the indicator electrode is measured, called a reference electrode.

Potentiometric analysis allows direct and selective determination of different elements and different ionic forms of the same element (NH₄⁺, NO₂⁻, NO₃⁻, S²⁻, SO₄²⁻, Cl⁻), which is of particular importance for environmental analysis. The advantages of the method are simplicity, speed, low cost of equipment, the ability to conduct analysis in turbid and colored media. Hydrogen index (pH) – characterizes the concentration of free hydrogen ions in water and expresses the degree of acidity or alkalinity of water (the ratio of ions in water H⁺ and OH⁻ formed during the dissociation of water) and is quantitatively determined by the concentration of hydrogen ions $\text{pH} = -\lg [\text{H}^+]$. The pH value in river waters usually varies within 6.5-8.5, in atmospheric precipitation 4.6-6.1, in swamps 5.5-6.0, in sea waters 7.9-8.3. In accordance with the requirements for the composition and properties of water in reservoirs near drinking water use points, water in water bodies in recreation areas, as well as water in fishery water bodies, the pH value should not go beyond the range of 6.5-8.5. Natural waters are rationally divided into seven groups depending on the pH value (Table 5).

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the pH value should not go beyond the range of 6.5-8.5. It is rational to divide natural waters into seven groups depending on the pH value [8].

Salinity (total mineralization) is a quantitative indicator of the content of substances dissolved in water. It is also called total salt content, since the substances dissolved in water are in the form of salts. The most common inorganic salts (bicarbonates, chlorides and sulfates of calcium, magnesium, potassium and sodium) and a small amount of organic matter soluble in water. The total mineralization is confused with the dry residue. In fact, these parameters are very close, but the methods for determining them are different. When determining the dry residue, more volatile organic compounds dissolved in water are not taken into account. As a result, the total salinity and dry matter may differ by the amount of these volatile compounds (usually no more than 10%). The level of salinity in drinking water is due to the quality of water in natural sources (which vary significantly in different geological regions due to the different solubility of minerals) (Table 6). In addition to factors caused by nature, a person has a great influence on the general mineralization of water: industrial wastewater, city storm water (Salt is used in winter as an anti-icer), etc. According to the World Health Organization (WHO), there is no reliable information on the health effects of increased salt content.

Table 6. Categories of Water Salinity

Water Category	Mineralization, G/Dm ³
Pickles	> 35
High Salinity Waters	10-35
Salty	3-10
Brackish	1.0-3.0
Waters With Relatively High Mineralization	0.5-1.0
Fresh	0.2-0.5
Ultrafresh	< 0.2

For medical reasons, WHO does not impose restrictions. As a rule, the taste of water is considered normal with a total mineralization of up to 600 mg/l, with a salt content

of more than 1000-1200 mg/l, water can cause complaints from consumers. In this regard, WHO recommends for organoleptic indications a limit for total mineralization of 1000 mg/l. This level may vary depending on prevailing habits and local conditions. Today, in developed countries, people consume water with low salt content – water purified by reverse osmosis technology. Such water is the purest and most harmless, it is widely used in the food industry, the manufacture of bottled water, etc. Read more about minerals and water in the article: Water and Minerals. A separate topic is the value of mineralization during the deposition of scale and precipitation in the boiler room, boiler and plumbing equipment. In this case, special requirements apply to the water, and the lower the level of mineralization (especially the content of hardness salts), the better [1].

Determination of water salinity is carried out by calculation method as the total concentration of anions, cations and non-dissociated inorganic substances in water, expressed in g/dm^3 (Table 7) [1]. Conductivity is used to estimate the total dissolved solids in water. Such a method of analytical chemistry as conductometry is based on the numerical indicator of this physical quantity. Considering specifically water, which is a solution of a mixture of strong and weak electrolytes: the mineral part of water is made up of sodium, potassium, calcium, chlorine, sulfate (SO_4^{2-}), bicarbonate ions, we can conclude that it is these ions that determine the electrical conductivity of water.

The presence of such ions as ferrous and trivalent iron, manganese, aluminum, nitrate, etc. does not have any serious effect on electrical conductivity (unless, of course, these ions are contained in water in significant quantities). Electrical conductivity is not standardized, but a value of $2000\mu\text{S/cm}$ roughly corresponds to a total mineralization of 1000 mg/l. As already noted, electrical conductivity

changes with temperature, which often leads to measurement errors. With the help of electrical conductivity, it is possible to indirectly estimate the electrochemical composition of water and compare it with the parameters of the environment favorable for the development of living organisms. Conductivity meters are devices for measuring resistivity or conductivity that are used to monitor the quality of water, condensate or steam. The main purpose of conductometers is to analyze the properties and quality of water, and its suitability for economic use.

Titrimetric analysis is a method for determining the amount of a substance by accurately measuring the volume of solutions of substances that react with each other. The main task of titrimetric analysis is not only to use a solution of precisely known concentration (fixed channel), but also to correctly determine the equivalence point [9,10].

Rigidity. The different total level of calcium Ca and magnesium Mg salts dissolved in water characterizes the so-called total water hardness. Magnesium and potassium bicarbonates form carbonate (temporary) hardness, which is completely eliminated by prolonged boiling of water, but turns into an insoluble precipitate with the release of carbon dioxide. The property of water to wash surfaces without leaving a deposit is well known in everyday life. Soft water lathers well, and after it only the natural layer of fat, secreted by the surface layer of the skin, remains. In hard water, there is a feeling of some additional unnatural cover. Water hardness is one of the main indicators characterizing the use of water in various industries. Water hardness is a set of properties due to the content of alkaline earth elements in it, mainly calcium and magnesium ions.

Table 7. Classification of Mineral Waters by Salinity

Classification Of Mineral Waters By Salinity	Water Mineralization rates	Appointment
Fresh	Up to 1 g/dm^3 incl.	Table Water, Medicinal Table Water, Medicinal Water
Slightly Mineralized	St. 1 to 2 g/dm^3 incl.	Medicinal Table Water, Medicinal Water
Low Mineralized	St. 2 up to 5 g/dm^3 incl.	
Medium Mineralized	St. 5 to 10 g/dm^3 incl.	
Highly Mineralized	St. 10 to 15 g/dm^3 incl.	Medicinal Water

Table 8. Non-Systemic Hardness Units

Degree	Designation	Definition	Value	
			$^{\circ}\text{S}$	mmol/l
German	$^{\circ}\text{dH}$ (Deutsche Härte) $^{\circ}\text{dGH}$ (Degrees of General Hardness) $^{\circ}\text{dKH}$ (for Carbonate Hardness)	1 Part of Calcium Oxide (CaO) or 0.719 Parts of Magnesium Oxide (MgO) Per 100 000 Parts of Water	0.3566	0.1783
English	$^{\circ}\text{e}$	1 Grain of CaCO_3 per English Gallon of Water	0.2848	0.1424
French	$^{\circ}\text{TH}$	1 Part of CaCO_3 per 100 000 Parts of Water	0.1998	0.0999
American	ppm	1 Part of CaCO_3 per 100 000 000 Parts of Water	0.0200	0.01100

In complexometric (titrimetric) determination of hardness, ions of aluminum, cadmium, lead, iron, cobalt, copper, manganese, tin and zinc affect the establishment of the equivalent point and interfere with the determination. Orthophosphate and carbonate ions can precipitate calcium under titration conditions. Certain organic matter can also interfere with the determination. If the interfering influence cannot be eliminated, it is recommended to determine the hardness by atomic spectrometry methods [11]. In different countries, various non-systemic units were used (sometimes still used) – degrees of hardness. The relationships between the units of water hardness are taken as follows: 1 dH = 17.8 ppm; 1 f = 10 ppm; 1 A = 50.05 ppm; 1 mEq/L = 50.05 ppm (Table 8).

By the value of the total hardness, water is distinguished: up to 4 mEq/L water is soft; from 4 to 8 mEq/L – medium hardness; from 8 to 12 mEq/L – hard; over 12 mEq/L – particularly hard. The water hardness of surface sources varies significantly throughout the year; it is maximal at the end of winter, and minimal during flood periods. In groundwater, the hardness is usually higher (up to 8-10, less often up to 15-20°S) and changes less during the [12].

Alkalinity is equal to the sum of the concentrations of anions (negative ions) of bicarbonates, carbonates and hydroxides: HCO_3^- , CO_3^{2-} and OH^- . Often the total alkalinity is simply equal to the hydrocarbonate content, because there are many more of them than the rest of the anions. It is measured, as well as hardness, in units of milligram-equivalent per liter. The alkalinity of water is determined by the presence of compounds interacting with strong acids. These can be free hydroxides (in industrial wastewater) or salts formed with weak acids and strong bases (for example, bicarbonates, carbonates, silicates, sulfides, alkali metal acetates). Alkalinity due to the presence of soluble hydroxides (OH^- ions) is called hydration alkalinity. In natural waters, alkalinity is usually caused by hydrocarbons. HCO_3^- (hydrocarbonate), in alkaline waters – also carbonates CO_3^{2-} (carbonate). The alkalinity of water is characterized by the amount of acid required to neutralize 1 liter of water. It is expressed in mEq/L. Distinguish between free and total alkalinity of water. If the pH of the test water is more than 8.3, then it is considered that the water has free alkalinity. Its value is determined by the amount of acid required to neutralize the alkalinity components (OH^- , SiO_3^{2-} , CO_3^{2-}) until the pH of the test water reaches 4.5 (or according to the color change of methyl orange). If the pH of the water is less

than 4.5, then the alkalinity of the water is taken to be zero. It is believed that waters with a pH value of 8.3 do not contain free alkalinity.

Permanganate oxidizability is a value that characterizes the content of organic and mineral substances in water, oxidized (under certain conditions) by one of the strong chemical oxidants. This indicator reflects the total concentration of organic matter in the water. The nature of organic matter can be very different – humic acids of soils, and complex organics of plants, and chemical compounds of anthropogenic origin. Other methods are used to identify specific compounds. Permanganate oxidizability is expressed in milligrams of oxygen consumed for the oxidation of these substances contained in 1 dm³ of water. There are several types of water oxidizability: permanganate, bichromate, iodate. The highest oxidation state is achieved by the dichromate method. In the practice of water purification, permanganate oxidizability is determined for natural low-contaminated waters, and in more polluted waters, as a rule, bichromate oxidizability (COC – “chemical oxygen consumption”).

The oxidizability of natural waters can vary widely from fractions of milligrams to tens of milligrams of O_2 per liter of water. Surface waters have a higher oxidizability compared to groundwater. This is understandable – organic matter from the soil and plant litter more easily gets into surface waters than into ground waters, most often limited by clay seals. The water of lowland rivers, as a rule, has an oxidizability of 5-12 mg O_2/dm^3 , rivers with swamp feeding – tens of milligrams per 1 dm³. Groundwater has an average oxidizability of from hundredths to tenths of a milligram O_2/dm^3 . Although groundwater in areas of oil and gas fields, and peat bogs can have a very high oxidizability. COC of drinking water for permanganate oxidizability according to SanPiN 2.1.4.1175-02 “Hygienic requirements for the quality of water in non-centralized water supply. Sanitary protection of sources” is 5.0-7.0 mg/dm³.

Qualitative reactions are reactions that make it possible to prove the presence of a particular substance (ion) in the medium or the presence of a functional group in a substance (Table 9). Analyzed substances can be in various states of aggregation (solid, liquid and gaseous). From the point of view of the observed effects, all detection reactions can be divided into several groups: formation of characteristic precipitation; dissolution of a substance; appearance (change) of color; evolution of gases; change in smell; coloring the flame.

Table 9. Qualitative Reactions

White Sediment Insoluble in Acids	$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4 \downarrow$ Qualitative Reaction to Sulfate ions;
Blue Sediment Formed by Interaction with a Solution of Red Blood and Yellow Blood Salt	$3Fe^{2+} + 2[Fe(CN)_6]^{3-} \rightarrow Fe_3[Fe(CN)_6]_2 \downarrow$ a Qualitative Reaction to Iron (II) salts – With Red Blood Salt;
Black Sediment Formed by Interaction with Sulfates or with H_2S	$Pb^{2+} + S^{2-} \rightarrow PbS \downarrow$
Blood Red Sediment Formed by Interaction with Rodanide ion SCN^-	$Fe^{3+} + 3SCN^- \rightarrow Fe(SCN)_3$ the Appearance of Intense Red (Blood Red) Staining;
Blood Red Sediment Formed by Interaction with Dimethylglyoxime (Chugaev's reagent) (pH = 6-9)	$Ni^{2+} + 2 \begin{array}{c} H_3C-C=N-OH \\ \\ H_3C-C=N-OH \end{array} \rightarrow \begin{array}{c} O \cdots \cdots H-O \\ \quad \quad \quad \\ H_3C-C=N \quad \quad \quad N=C-CH_3 \\ \quad \quad \quad \quad \quad \quad \\ H_3C-C=N \quad \quad \quad N=C-CH_3 \\ \quad \quad \quad \\ O-H \cdots \cdots O \end{array} + 2H^+$ <p>*Here The Dots Denote Hydrogen Bonds $O \cdots H$</p>

Table 10. Chromaticity

Solution N 1, cm	0	1	2	3	4	5	6	8	10	12	14
Solution N 2, cm	100	99	98	97	96	95	94	92	90	88	85
Degrees of Chromaticity	0	5	10	15	20	25	30	40	50	60	70

3. Characterization of the Data Required for the Experiment

The color of water is determined photometrically – by testing the test liquids with solutions that imitate the color of natural water. The following equipment, materials, reagents are used for testing: photoelectric colorimeter (PEC) with a blue light filter (413 nm); cuvettes with a depth of the light-absorbing layer of 5-10 cm; volumetric flasks according to GOST 1770, with a capacity of 1000 cm^3 ; measuring pipettes in accordance with GOST 29227, with a capacity of 1, 5, 10 cm with divisions of 0.1 cm; Nessler cylinders 100 cm; potassium dichromate according to GOST 4220; cobalt sulfate according to GOST 4462; sulfuric acid according to GOST 4204, with a density of 1.84 g/cm; distilled water in accordance with GOST 6709; membrane filters N 4.

All reagents used in the analysis must be of the “analytical grade” qualification. Preparation of the basic standard solution (solution N 1) 0.0875 g of potassium dichromate ($K_2Cr_2O_7$), 2.0 g of cobalt sulfate ($CoSO_4 \cdot 7H_2O$) and 1 cm^3 of sulfuric acid (density 1.84 g/cm) are dissolved in distilled water and bring the solution to 1 dm. The solution corresponds to a color of 500°. Preparation of a dilute sulfuric acid solution (N 2 solution): 1 cm^3 of concentrated sulfuric acid with a density of 1.84 g/cm³ is brought to 1 dm³ distilled. To prepare the color scale, use a set of Nessler cylinders with a capacity of 100 ml. In each cylinder, mix solution N 1 and solution N 2 in the message indicated on the color scale (Table 10). The solution in each cylinder corresponds to a certain degree of color. The chromaticity scale is stored in a dark place. It is replaced every 2-3 months.

The calibration graph is plotted on the chromaticity scale. The obtained values of optical densities and the corresponding degrees of chromaticity are plotted on the graph. In a Nessler cylinder, measure 100 cm of the test water filtered through a membrane filter and compare it with the color scale, viewing from above on a white background. If the test water sample has a color of more than 70°, the sample should be diluted with distilled water in a certain ratio until the color of the test water is comparable to the color of the color scale. The result obtained is multiplied by the number corresponding to the dilution. When determining the chromaticity using an electrophoto colorimeter, cuvettes with a thickness of the light-absorbing layer of 5-10 cm are used. The control liquid is distilled water, from which suspended substances are removed by filtration through membrane filters N 4. The optical density of the filtrate of the test water sample is measured in the blue part of the spectrum with a light filter at = 413 nm. Chromaticity is determined by a grading schedule and is expressed in degrees of chromaticity.

The color of water is determined photometrically – by comparing samples of the test liquid with solutions that imitate the color of natural water. The following equipment, materials, reagents are used for testing: photoelectric colorimeter (PEC) with a blue light filter (413 nm); cuvettes with a thickness of the light-absorbing layer of 5-10 cm; volumetric flasks in accordance with GOST 1770, with a capacity of 1000 cm^3 ; measuring pipettes according to GOST 29227, with a capacity of 1, 5, 10 cm with divisions of 0.1 cm; Nessler's cylinders 100 cm; potassium dichromate according to GOST 4220; cobalt sulfate according to GOST 4462; sulfuric acid

according to GOST 4204, with a density of 1.84 g/cm^3 ; distilled water in accordance with GOST 6709; membrane filters N 4. All reagents used in the analysis must be of the "analytical grade" qualification.

The solution in each cylinder corresponds to a certain degree of color. The chromaticity scale is stored in a dark place. It is replaced every 2-3 months. Organoleptic methods determine the nature and intensity of the smell. The nature of the smell of water is determined by the realization of the perceived smell. Determination of odor at 20°C : measure 100 cm^3 of test water with a temperature of 20°C into a flask with a ground stopper with a capacity of $250\text{-}350 \text{ cm}^3$. The flask is closed with a stopper, the contents of the flask are stirred several times with rotary movements, after which the flask is opened and the nature and intensity of the smell is determined. Determination of odor at 60°C : measure 100 cm^3 of test water into a flask. The neck of the flask is closed with a watch glass and heated in a water bath to $50\text{-}60^\circ\text{C}$. The contents of the flask are mixed several times with rotary movements. Moving the glass to the side, we quickly determine the nature and intensity of the smell. The intensity of the odor of water is determined at 20 and 60°C and is assessed using a five-point system. For example: at 20°C 1 crane (Volga river) – no – 0. At 60°C 1 crane (Volga river) is earthy-1. 2 tap (RFC) – chlorine-1. 2 tap (RFC) – chlorine-2.

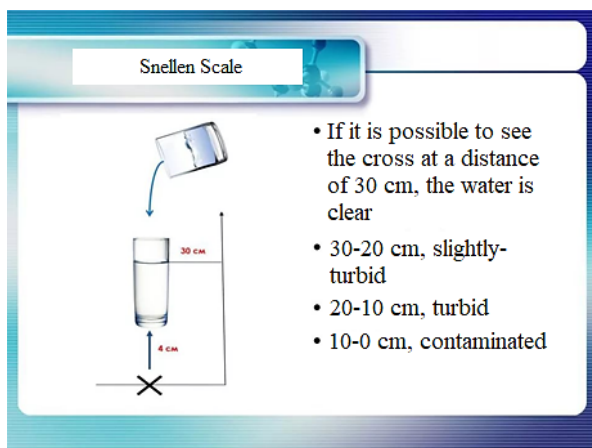


Figure 1. Snellen Scale

The transparency of the waste water by the Font, according to the method [1], is determined in the Snellen cylinder. The test water is thoroughly mixed (shaken) and poured into a cylinder, under which a text printed on white paper in Snellen font is placed under it from the bottom of the cylinder at a distance of 4 cm (Figure 1). They read the font by looking at it through a column of water. Excess water is drained off with a tap or hose while stirring continuously with a glass rod until the text can be read. The height of the liquid column is read off the scale applied to the cylinder with an accuracy of 0.5 cm. Scientific sanitary assessment of water is one of the most difficult problems of sanitary examination 5 4 1 7 8 3 0 9.

The result is expressed in centimeters, as the arithmetic mean of two determinations. The "cross transparency" is determined using a white plate with two crossed black lines 1 mm thick. This method is used to control the operation of treatment facilities. In thermal power engineering, the most often used is "font transparency (according to Snellen)", equal to the height of a column of water through which a standard typographic font with a letter height of 3.5 mm can still be read.

Methods for determining the pH value. There are several methods for determining the pH value of solutions. The pH value is approximately estimated using indicators, accurately measured with a pH meter, or determined analytically, by conducting an acid-base titration.

For a rough estimate of the concentration of hydrogen ions, acid-base indicators are often used organic dye substances, the color of which depends on the pH of the medium. The most popular indicators: litmus, phenolphthalein, methyl orange (methyl orange), etc. Indicators can be in 2 differently colored forms – either in acidic or basic. The color change of all indicators occurs in their acidity range, often 1-2 units.

To increase the working range of pH measurement, a universal indicator is used, which is a mixture of several indicators. The universal indicator sequentially changes color from red through yellow, green, blue to violet when passing from an acidic region to an alkaline one. Determination of pH by the indicator method is difficult for turbid or colored solutions.

The use of a special device – a pH meter – makes it possible to measure pH in a wider range and more accurately (up to 0.01 pH units) than using indicators. The ionometric method for determining pH is based on the measurement of the electromotive force of a galvanic circuit, which includes a glass electrode, the potential of which depends on the concentration of H^+ ions in the surrounding solution, with a millivoltmeter-ionometer. The method has high accuracy and convenience, especially after calibration of the indicator electrode in the selected pH range, which makes it possible to measure the pH of opaque and colored solutions and therefore is often used.

The analytical volumetric method – acid-base titration – also gives accurate results in determining the acidity of solutions. A solution of known concentration (titrant) is added dropwise to the solution to be investigated. When they are mixed, a chemical reaction occurs. The equivalence point – the moment when the titrant is exactly enough for the complete completion of the reaction is fixed using an indicator. After that, if the concentration and volume of the added titrant solution are known, the acidity of the solution is determined.

Effect of temperature on pH values

0.001 mol/L HCl at 20°C has $\text{pH} = 3$, at 30°C $\text{pH} = 3$;

0.001 mol/L NaOH at 20°C has pH = 11.73, at 30°C pH = 10.83.

The effect of temperature on pH values is explained by different dissociation of hydrogen ions (H⁺) and is not an experimental error. The temperature effect cannot be compensated for by the electronics of the pH meter [13]. Universal indicator paper (pH 1-10), tweezers, scissors, 50 ml porcelain cup. A small amount of the sample is placed in a porcelain dish, a strip of litmus paper is cut off, which is immersed in the test liquid, and the resulting color is immediately compared with the scale. Depending on the pH value, conclusions are drawn about the suitability of water for human consumption.

Determination of total mineralization (total salt content). The electrometric method for determining salinity is based on measuring the relative electrical conductivity of water using a special device – a conductometer, which makes it possible to accelerate and, in principle, increase the accuracy of its determination in comparison with other methods (Figure 2). The principle of operation of the conductometer is based on the direct dependence of the electrical conductivity of water (current strength in a constant electric field created by the electrodes of the device) on the number of compounds dissolved in water. A wide range of relevant equipment now allows you to measure the conductivity of almost any water, from ultrapure (very low conductivity) to saturated with chemical compounds (high conductivity) [1].



Figure 2. Conductivity Meter “T.D.S Hold”

Conductivity meter “T.D.S hold”, beaker with a capacity of 25 cm³. The switched on conductometer is placed in the glass with the test sample.

Definition of general cruelty. Burette 25 cm³, rack, ammonium buffer (NH₄OH + NH₄Cl) with pH 8-9, complexone III (Trilon B) 0.1 N, eriochrome black indicator (sugar mixture 1 g indicator + 99 g sodium chloride), conical flasks with a capacity of 250 cm³, measuring cylinders for 100 cm³, 10 cm³. Place a sample of 100 cm³ in a conical flask, add 10 cm³ of an ammonium buffer mixture, 10-20 mg of an indicator with a small

cylinder, mix and titrate with a solution of Trilon B until the color of the solution changes from wine-red to blue. The total hardness is calculated by the formula (Eq. 1):

$$S = \frac{V \times C \times 1000}{W} \text{ mmol} - \frac{eq}{dm^3}, \quad (1)$$

where: V is the volume of 0.1 Trilon B solution used for titration, C is the concentration of Trilon B solution, W is the aliquot part of the sample.

Determination of total alkalinity is carried out in one of the following ways:

Method 1. Determination of total alkalinity by titration with hydrochloric acid solution (direct titration). 0.1 cm³ of methyl red is added to the solution used to determine free alkalinity. Continue to titrate with an appropriate hydrochloric acid solution until the blue-green color changes to gray. Record the volume of hydrochloric acid solution consumed for titration

Method 2. Determination of total alkalinity by titration with sodium tetraborate solution (back titration). Add 10 drops of a mixture of methyl red and methylene blue indicators to a flask with a solution used to determine free alkalinity and continue titration with a solution of hydrochloric acid with a molar concentration of 0.02 mol/dm³ until a raspberry color appears. After the appearance of a raspberry color, another 2.00-5.00 ml of a solution of hydrochloric acid of the appropriate concentration is added and the total volume of the solution of hydrochloric acid used in the titration is recorded. At least two titrations are carried out, while the discrepancy between the values of the total volumes of hydrochloric acid consumed for the titration should not exceed 0.05 cm. If the discrepancy exceeds the specified value, then the titration is repeated until an acceptable discrepancy is obtained. If the determination of free alkalinity is not required, then during titration with visual fixation of the titration endpoint, a mixed indicator is immediately added to the analyzed water sample, and during potentiometric titration, only one titration endpoint is recorded at pH 4.5.

Determination of COC:

1. Place an adsorbent of a given mass in a beaker with a prepared sample.
2. Mix thoroughly and place in a centrifuge to separate the phases (solid-liquid).

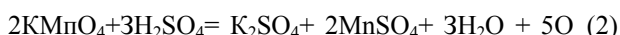
Determination of the concentration of oil products after adsorption:

1. Place the liquid phase in a separation column.
2. Allow to settle, pour the lower layer into a 200 ml glass, and drain the upper organic layer into a pre-weighed 50 ml glass.
3. Determine the mass of the glass with the organic layer.
4. Calculate the concentration of organic matter.

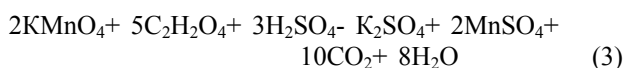
Determination of water oxidizability by permanganate method (COD). Depending on the oxidizing agent used, a distinction is made between permanganate (oxidizing agent

KMnO₄) and chromate or dichromate (oxidizing agent K₂Cr₂O₇ in sulfuric acid) oxidizability. The permanganate method for determining oxidizability is the most widespread, especially in fish farming, because of its simplicity, the dichromate method requires more time and labor. Comparing the values of dichromate and permanganate oxidizability, one can judge the quantitative composition of organic matter in water.

Determination principle. Oxidation is carried out by boiling the water under investigation for exactly 10 minutes with a potassium permanganate solution added to the sample. During boiling, atomic oxygen is released from KMnO₄ and easily oxidized organic substances are oxidized with this oxygen. This process can take place in both acidic and alkaline environments. Usually, in fresh waters, oxidation is carried out in an acidic medium, in sea water – in an alkaline one (Eq. 2):



For better oxidation, it is necessary to add a solution of potassium permanganate to the sample in excess, that is, so that after boiling the sample remains pink. If, when boiling with KMnO₄, the color of the sample becomes brownish, the oxidation should be repeated first, diluting the test water 2.5 or 10 times. Permanganate that did not go into the oxidation of organic matter is reduced with a solution of oxalic acid added to the sample in an amount equivalent to the amount of potassium permanganate solution poured into the water sample before boiling it (Eq. 3):



The amount of oxalic acid remaining in the sample, after reducing the excess of KMnO₄, is titrated with a solution of potassium permanganate. By the amount of potassium permanganate solution used for titration, the oxidizability of water is judged, and 1 ml of a 0.01 N KMnO₄ solution is equivalent to 0.08 mg of atomic oxygen that went into the oxidation of organic matter in the sample. In a conical flask, take 100 ml of the test water, add 5 ml of a 25% sulfuric acid solution and heat to boiling. At the very beginning of boiling, 10 ml of 0.01 N KMnO₄ solution is added to the sample, and then the sample is boiled for exactly 10 minutes (it is advisable to time the time by a clock with a second hand or a stopwatch). Care must be taken to ensure that the boil is even and not very violent. For this purpose, before heating the flask with the sample, glass beads or capillaries, well washed with distilled water and dried, are placed on the bottom of this flask. If a brown tint appears during boiling, the sample should be done as indicated in the principle of determining oxidizability by this method. At the end of boiling, 10 ml of a 0.01 N solution of oxalic acid is introduced into the flask with a sample, its contents are stirred and the discolored liquid is titrated with 0.01 N solution of KMnO₄ until a stable slightly pink color appears.

To determine the correction factor for the normality of

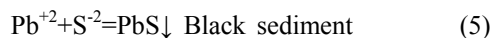
the KMnO₄ solution, add 10 ml of exactly 0.01 N oxalic acid solution to the freshly titrated, not yet cooled down sample and titrate with 0.01 N potassium permanganate solution. The correction factor is calculated by the formula: $K = 10/n(*)$, where n is the number of ml of potassium permanganate solution that went into titration of 10 ml of exactly 0.01 N solution of oxalic acid. In the process of defining, records should be kept in the table. The oxidizability is calculated by the formula (Eq. 4):

$$O = \frac{[(A_1 + A_2)K - B] \cdot 0.08 \cdot 1000}{V} \text{ mg/l}, \quad (4)$$

where: A_1 is the amount of KMnO₄ solution added to the sample at the beginning of boiling ml; A_2 is amount of KMnO₄ solution used for sample titration, ml; K is correction factor to the titer of potassium permanganate solution; B is the amount of exactly 0.01 N oxalic acid solution added to the sample after its oxidation, ml; 0.08 is the amount of oxygen equivalent to 1 ml of 0.01 N KMnO₄, ml; V is the volume of the sample taken for analysis, ml. The calculation results should be rounded to the nearest 0.01 mg/l.

4. Analysis of Qualitative Reactions to Determine Organoleptic Characteristics

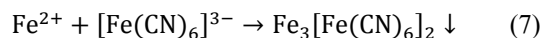
Determination of ions Pb²⁺: Place the investigated melt water into a test tube at a height of 1-2 cm add 1 cm³ of sodium sulfide solution (Na₂S) concentration (Eq. 5):



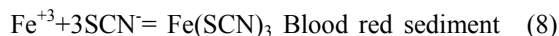
Determination of ions Fe⁺² (Eq. 6):



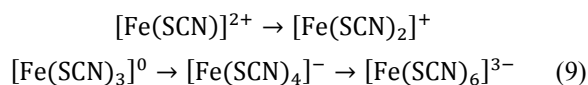
Iron cation reactions (II) Fe²⁺: Salt solutions Fe²⁺ painted in pale green. Potassium hexacyanoferrate (III) K₃[Fe(CN)₆] gives with ion Fe²⁺ dark blue sediment of the so-called turnbull blue (Eq. 7):



Add 1-2 drops of solution K₃[Fe(CN)₆] to 2-3 drops of salt solution Fe²⁺. The reaction is sensitive and is most often used to detect Fe²⁺. Determination of ions Fe⁺³: ammonium thiocyanates NH₄SCN or potassium KSCN form with Fe³⁺ thiocyanate complex [Fe(SCN)]²⁺, blood red staining solution (Eq. 8):



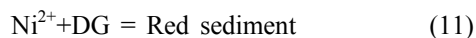
With an excess of reagent, the equilibrium of this reversible reaction shifts to the right and the color of the solution increases. Along with this, as A.K. Babko, a number of complex ions colored in the same color are formed (Eq. 9):



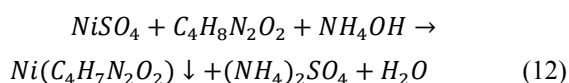
The reaction is carried out either in a test tube or by the drop method. Determination of ions SO_4^{2-} (Eq. 10):



Determination of ions Ni^{2+} (with dimethylglyoxime) (Eq. 11):



L.A. Chugaev's reaction: Dimethylglyoxime $[\text{CH}_3\text{CNOH}]_2$ separates Ni^{2+} from solutions in the form of a crystalline scarlet-red precipitate of the intracomplex salt. Add 3-5 drops of NH_4OH and 2-3 drops of a 1% alcohol solution of dimethylglyoxime to 2-3 drops of a solution of nickel salt Ni^{2+} , a pink-red precipitate of the complex precipitates (Eq. 12):



This is the most characteristic and sensitive reaction to the Ni^{2+} ion. All solutions except dimethylglyoxime should

be taken 2H. The reaction can be carried out by the drop method on filter paper. To do this, a drop of nickel (II) salt solution is applied to a sheet of filter paper, then a drop of an alcohol solution of dimethylglyoxime. The paper is held over a bottle with a concentrated ammonia solution (in ammonia vapor) until a pink-red spot appears.

Research object: water sampled from different areas of the NDP: Central District (Norilsk), Kayerkan, Talnakh, Dudinka, Lama Lake in the period August-September 2019 (Figures A, B, C, D, E). Water samples were taken in order to test the hypothesis about the influence of the enterprises of the Polar Division of PJSC MMC Norilsk Nickel on the water quality of open reservoirs located in the immediate vicinity of the metallurgical, processing and mining enterprises of the Polar Division. Organoleptic indicators were determined in water samples: smell, color, turbidity (transparency), as well as pH, salt content, alkalinity, hardness, permanganate oxidizability, the presence of nickel, iron, lead and sulfate ions (Tables 11, 12) (Figures 3-7).

Table 11. Experimental Indicators of Smell, Color, Turbidity

Place of selection	Smell	Chromaticity	Turbidity (transparency), TUF (turbidity units according to Formazin)
Norilsk			
Dolgoye lake	2	<30	1.8
Gorodskoye lake	2	<30	1.8
Kayerkan			
Amarnaya river (p. No. 1)	2	<30	1.7
Amarnaya river (p. No. 2)	2	<30	1.6
Daldykan river	2	<30	1.7
Kupets river	2	<30	1.8
Untitled lake	2	<30	1.8
Talnakh			
Levy Mukulay river	1	<30	1.6
Mukulay river	2	<30	1.6
Haraelach river	0	<30	1.6
Pyasino lake	1	<30	1.8
Rotten stream	2	<30	1.6
Dudinka			
Yenisey river	1	<30	1.8
Sukhoy Log river	1	<30	1.6
Lama			
Nerelach river	1	<30	
Kurolakh river	1	<30	
Isthmus	3	<30	
Lama stream	1	<30	
Nikita	1	<30	
Bunisyaka	2	<30	
Kygan	0	<30	
Skala	2	<30	

Table 12. Organoleptic Indicators in Water Samples

Place of selection	Salinity	pH	Alkalinity	Hardness	SO ₄ ²⁻	COC
	Mg/l	Unit pH	Mmol/l	Mmol/l	<0.1	Mg O ₂ /l
Norilsk						
Dolgoye lake	112.0	7.95	0.46	1.16	-	2.24
Gorodskoye lake	155.5	7.8	0.665	3.175	+	5.04
Kayerkan						
Ambarneya river (p. No. 1)	172.5	8.3	0.85	2.18	-	2.04
Ambarneya river (p. No. 2)	180.5	8.2	0.68	2.24	-	2.92
Daldykan river	179.0	8.15	0.63	2.28	-	3.44
Kupets river	59.75	7.65	1.48	8	+	4.12
Untitled lake	97.65	7.75	0.625	1.23	-	3.6
Talnakh						
Levy Mukulay river	90.15	6.6	0.595	0.81	-	2.32
Mukulay river	97.15	6.9	0.65	2.09	-	2.48
Haraelach river	69.9	7.8	0.96	0.09	-	2.16
Pyasino lake	77.55	7.2	0.74	0.08	-	5.68
Rotten stream	113.5	7.8	1.11	0.95	-	3.4
Dudinka						
Yenisey river	110.5	8	1.325	0.55	-	7.72
Sukhoy Log river	36.05	7.2	0.535	0.33	-	-
Lama						
Nerelach river	30.4	7.55	0.33	0	-	4.84
Kurolakh river	57.9	6.75	0.49	0	-	5.68
Isthmus	89.5	7.85	0.39	0	-	3.4
Lama stream	39.5	7.6	0.47	0	-	1.56
Nikita	25.7	7.5	0.46	0.31	-	3.84
Bunisyaka	42.4	6.15	0.42	1.2	-	4.28
Kygan	35.3	6.75	0.37	0	+	2.92
Skala	44.8	7.6	0.245	0.53	-	-

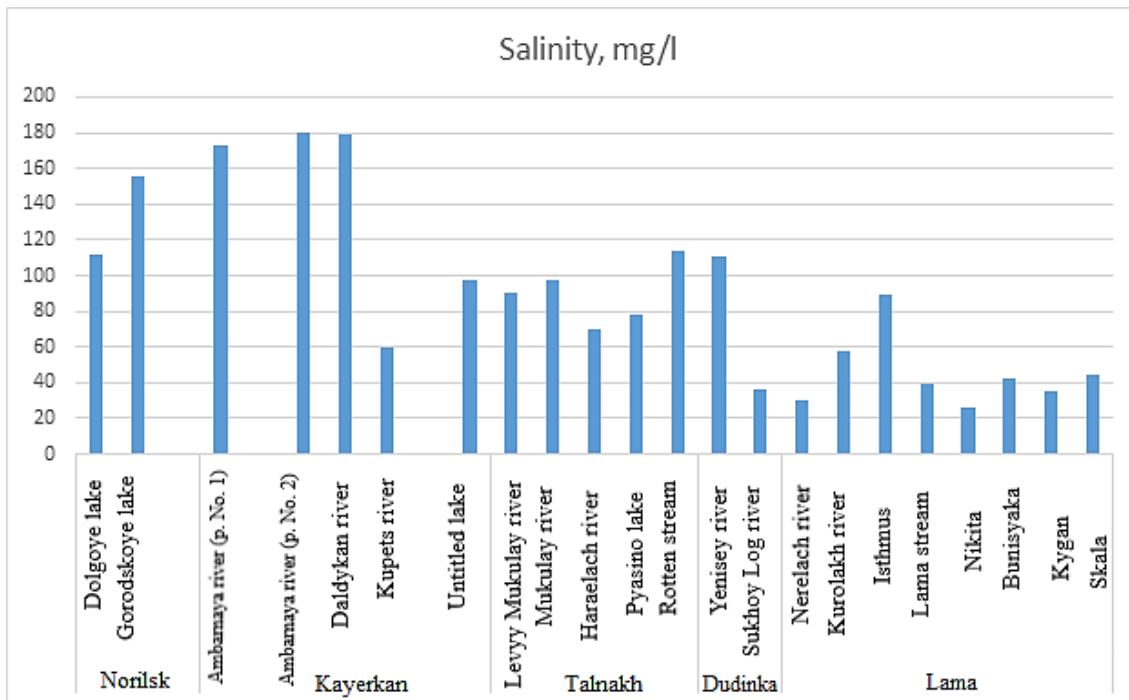


Figure 3. Indicators of Salinity in Water Bodies, mg/l

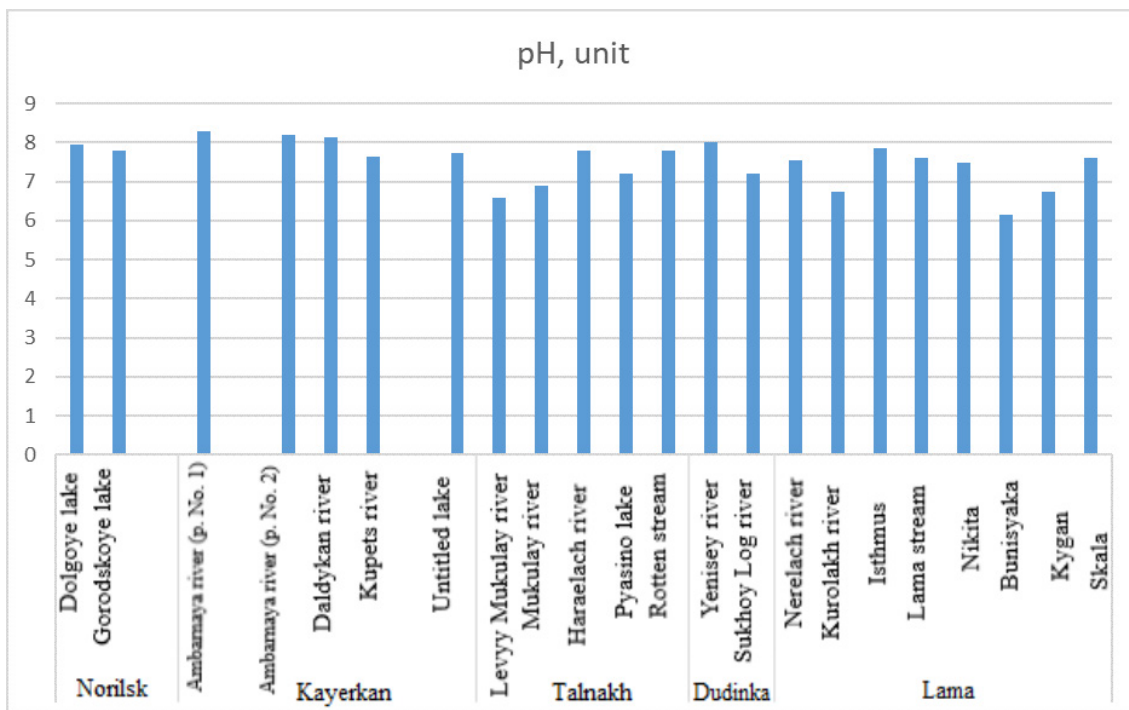


Figure 4. Indicators of pH in Water Bodies, Units

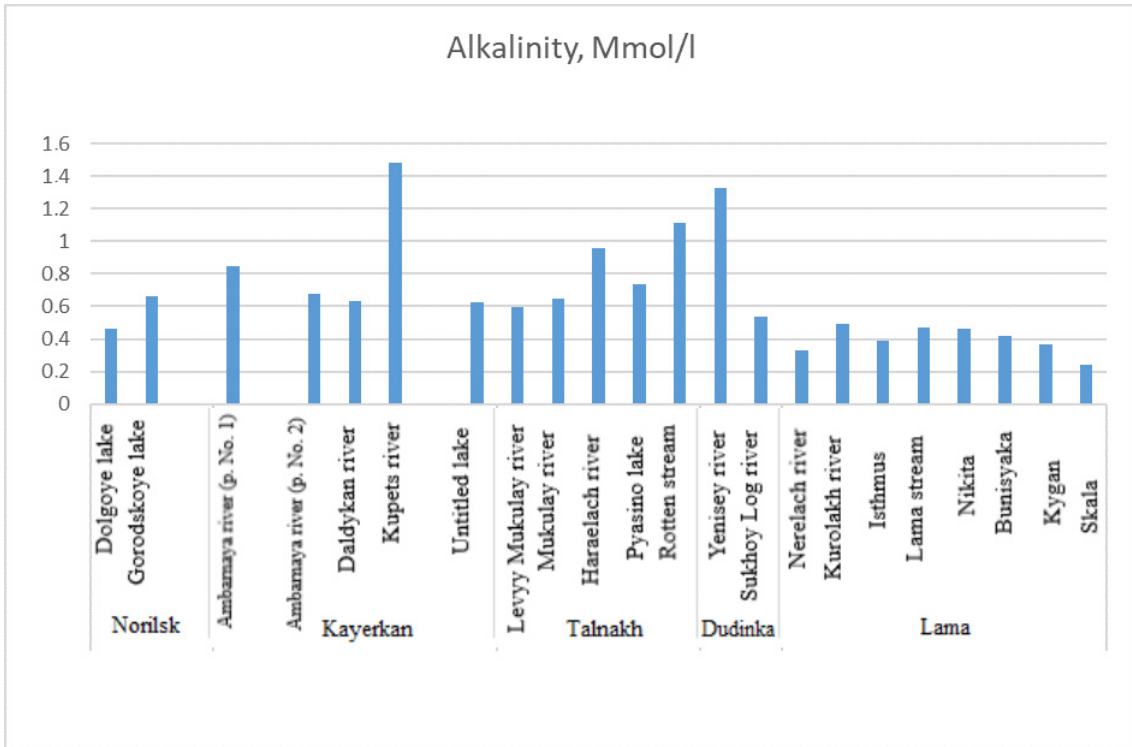


Figure 5. Indicators of Alkalinity in Water Bodies, mg/l

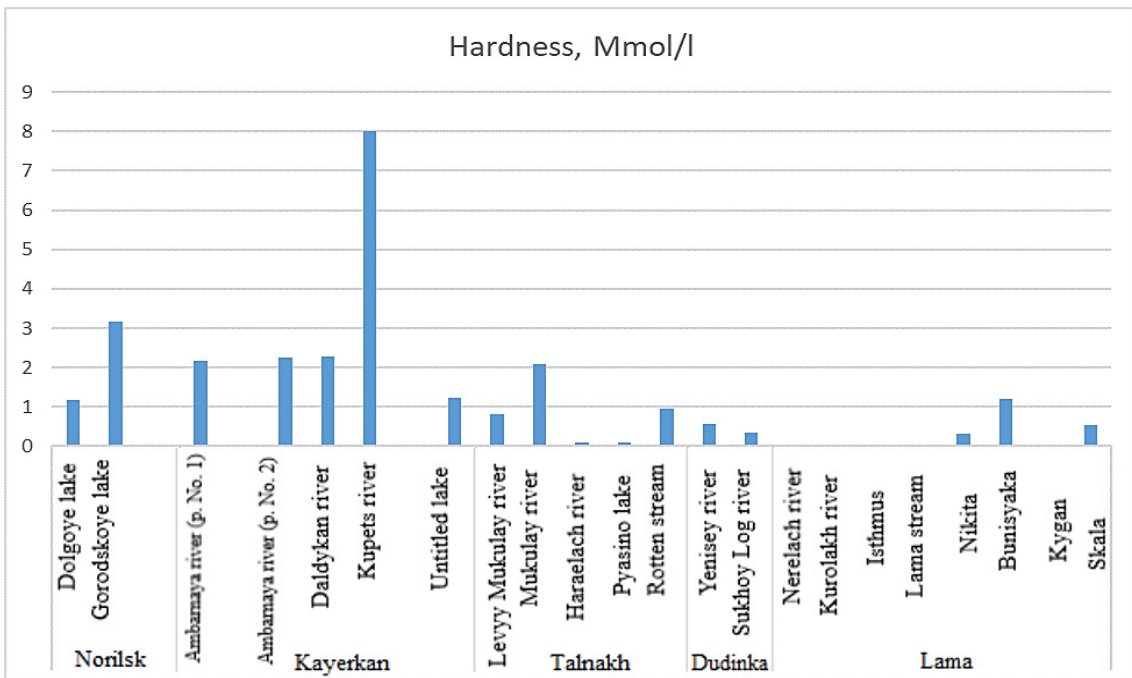


Figure 6. Indicators of Hardness in Water Bodies, Mmol/l

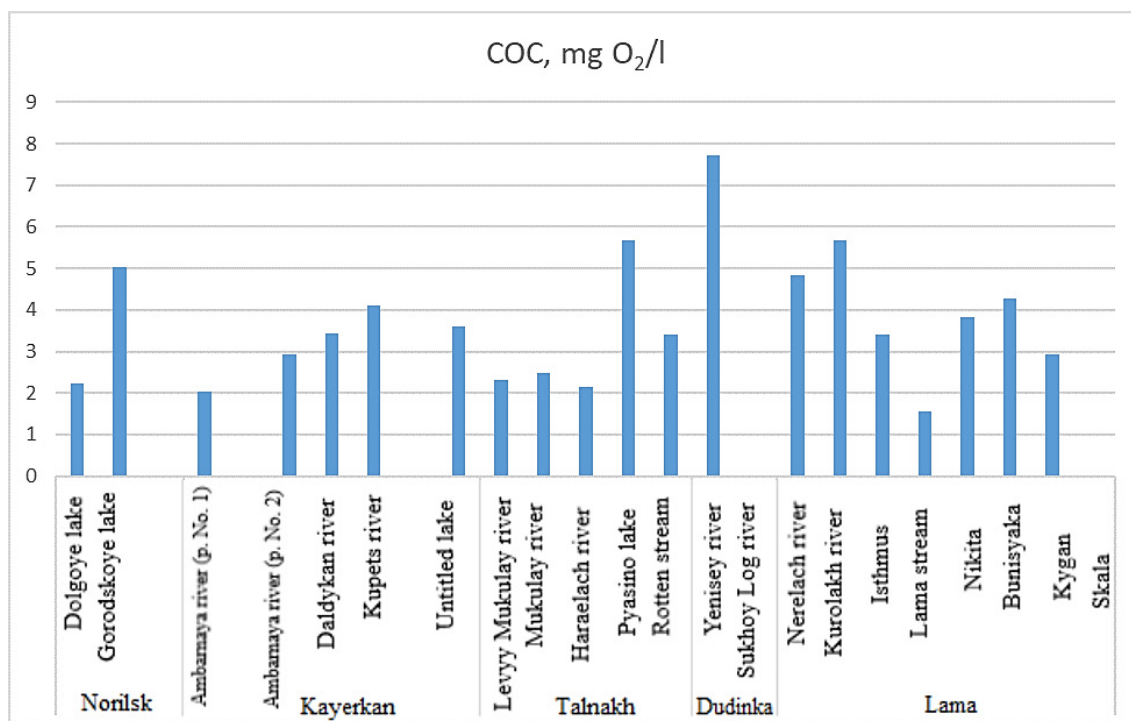


Figure 7. COC Indicators in Water Bodies, mg O₂/l

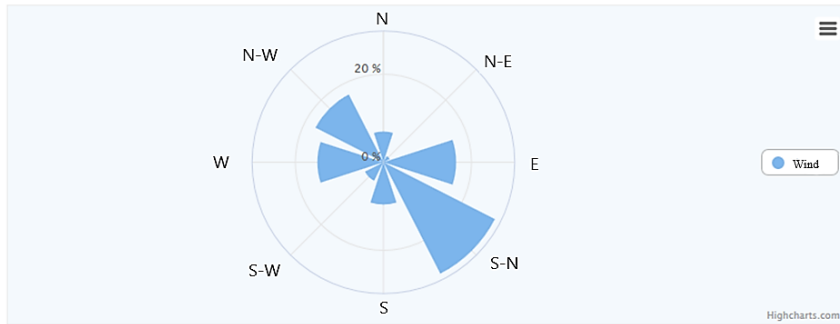
5. Conclusions

The paper studies the issues of environmental monitoring of water bodies in Norilsk and Taimyr. In water bodies, organoleptic indicators were determined: odor, color, turbidity (transparency), pH, salt content, alkalinity, hardness, permanganate oxidizability, the presence of nickel, iron, lead and sulfate ions. During the study, the most common odors of water in surface water bodies were determined: putrid, herbaceous, earthy, and dung. In the introductory part of the article, the standard norms of organoleptic indicators are presented. For example, the intensity of the scent should not exceed 2 points. And in the course of the research, it turned out that this indicator

corresponds to the norm.

The color of the water was determined photometrically – by comparing samples of the test liquid with solutions that imitate the color of natural water. On the Snellen scale, water turbidity is contaminated at all sites. SO₄²⁻ exceeds the norm in the reservoirs Gorodskoe, Kupets, Kygan. Hardness values are the highest, which were taken from water samples Gorodskoe lake (3.175 Mmol/l); Daldykan river (2.28 Mmol/l); Ambarnaya river, point N 2 (2.24 Mmol/l). In general, the ecological situation in the region requires the adoption of serious measures, since the level of pollution of water bodies in many respects exceeds the norm.

Appendix



Wind graph (direction – where the wind is blowing from) in Norilsk, with averaged values according to our data

N Northern	N-E Northeast	E Eastern	S-N Southeastern	S Southern	S-W Southwestern	W Western	N-W Northwestern
7%	1.6%	16.5%	28.4%	9.6%	4.7%	15%	17.3%

Figure A. Wind Rose in Norilsk

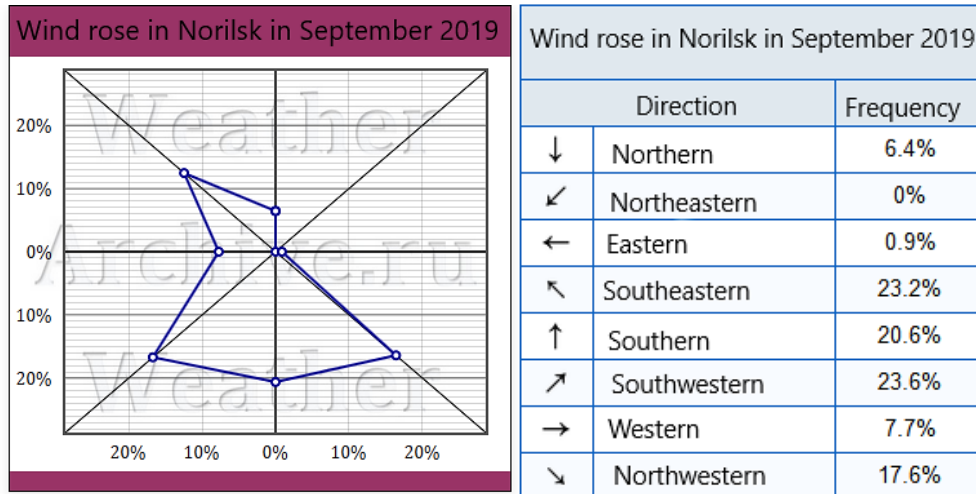


Figure B. Wind Rose in Norilsk, September 2019 (Rivers)

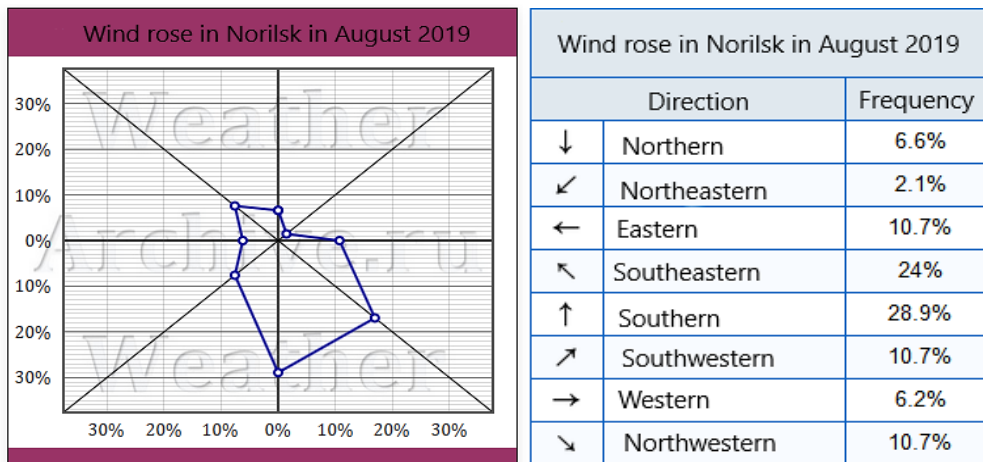


Figure C. Wind Rose in Norilsk, August 2019 (Rivers)

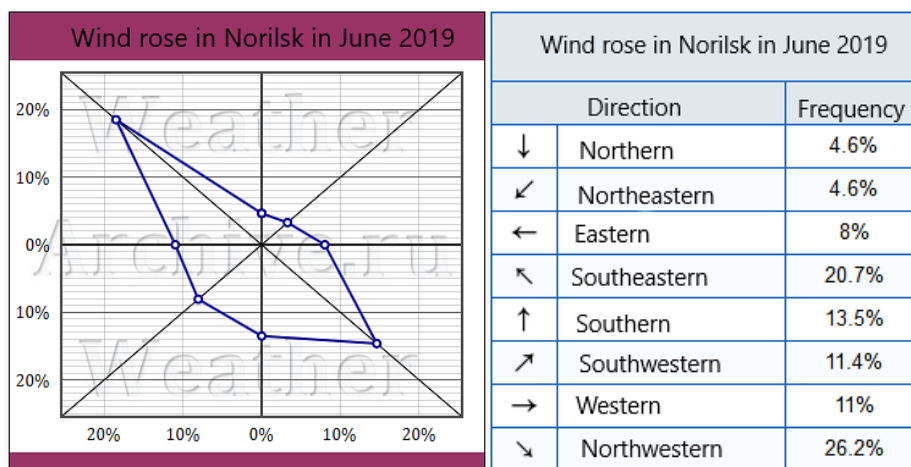


Figure D. Wind Rose in Norilsk, June 2019 (Lakes)

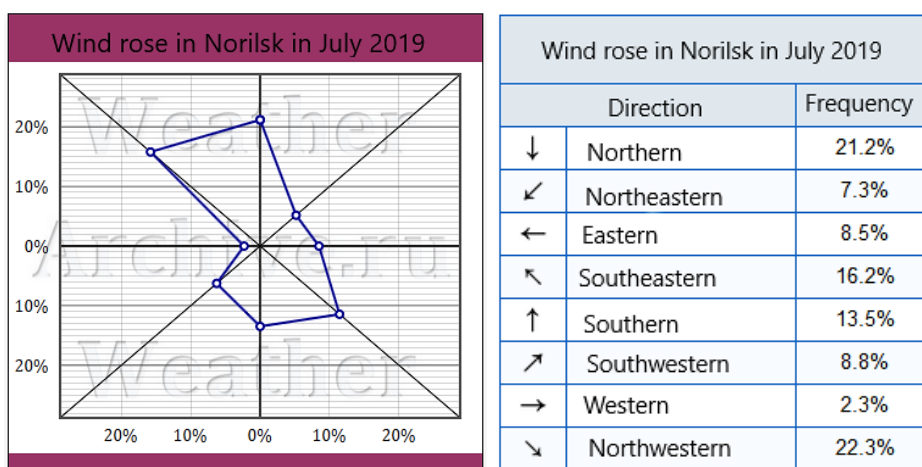


Figure E. Wind Rose in Norilsk, July 2019

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