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## Introduction

The purpose of the work is to assess the environmental impact by the construction of the 220/500kV remote-mounted SWYD at the Navoi TPP JSC.

The Navoi TPP JSC is one of the largest power plants of the Republic of Uzbekistan and is part of the Central Asian united energy system providing electricity to the Navoi, Samarkand and Bukhara regions and heat to the Navoi region and the city of Navoi.

The construction was started in 1960. The launch of the first turbogenerator VPT–25–4 with the boiler TGM – 151 was carried out in February 1963. The construction of the plant was finished in December 1981, while the capacity of the Navoi TPP was 1,250 MW.

In the early 2000s, there was a need to modernize the worn-out equipment of the plant. The lifetime of the 12 existing power plants was 20 - 35 years, which was the cause of the continuing deterioration of the technical condition of the equipment, reduction of its reliability, and as a result, low technical and economic indicators and an increase in the probability of accidents with possible negative consequences for the environment. In connection with the then current situation, a course was set for the introduction of new equipment with the use of advanced fuel combustion technologies – combined-cycle plants.

In February 2013, the first combined-cycle gas turbine unit with a capacity of 478 MW was commissioned, while the installed capacity of the plant reached 1,728 MW.

In 2014, TG-1, 2 with a capacity of 25 MW each and TG-6 with a capacity of 60 MW were decommissioned. At the end of 2014, the installed capacity of the plant was 1,618 MW.

In 2011, another 450 MW CCGT Unit was designed, the construction of which was supported by the State Ecological Expertise of the State Ecology Committee of the Republic of Uzbekistan (Conclusion No. 18/147z dated 21.02. 2012), which commissioning was supposed to decommission Boilers No. 3 and 8. Construction of CCGT Unit No.2 is being completed now.

At the end of 2018, the installed capacity of the Navoi TPP was 1,618 MW.

Construction of more technologically advanced and modern J class CCGT Units No. 3, 4 in this project will allow increasing the total capacity of the Navoi Thermal Power Plant by another 1,300 MW.

The Draft EIA for the construction of two J class combined-cycle plants (CCGT Units No. 3, 4) with a total capacity of 1,300 MW at the Navoi TPP JSC had been developed earlier and positive opinion of the State Ecological Expertise No. 01-01/10-08-818 dated 03.05.2019 (Appendix 1) was obtained.

Construction of a 220/500 kV remote-mounted SWYD at the Navoi Thermal Power Plant JSC will serve to supply power from CCGT Units No. 3, 4.

The designed facility belongs to the **IInd category of environmental impact** in accordance with Resolution of the Cabinet of Ministers No. 949 dated 22.11.2018 (medium risk, clause 10).

The main objectives in the draft EIA development were:

- to assess the degree of negative environmental impact of the designed facility;

- to make an environmental analysis of the design solution, determining the types, objects and nature of the impact;

- to make an analysis of emergency risks after putting the construction project into operation;

- to make a predictive assessment of the environmental impact of the construction project after the project implementation;

- to develop a program of actions to reduce the negative impact on the environment during the construction period and at the stage of operation of the remote-mounted SWYD after the project implementation.

The environmental impact assessment of the construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP was based on an analysis of the current state of the environment, the designed process equipment, and identification of sources of emissions, discharges and waste during the construction phase and the stage of operation of the designed facility.

The level of air pollution by emissions from the operation of the designed facility, during all types of construction works (excavation, painting and welding) in the construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP was calculated and its compliance with the requirements of the State Ecology Committee of the Republic of Uzbekistan was determined.

When performing the work, they were guided by the "Regulations on State Ecological Expertise" approved by Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 949 dated 22.11.2018 determining the composition and volume of the presented section of the environmental impact assessment.

# 1 Characteristics of the current state of the environment in the area of location of the construction project

## *1.1 Physical-geographical, and climatic conditions*

Construction of the 220/500 kV remote-mounted SWYD is planned in the Novbakhor district of the Navoi region (Appendix 2).

The closest distance from the site of CCGT Units No. 3.4 to the site for the construction of the remote-mounted SWYD is 1.875 km to the north.

For the construction of the 220/500 kV remote-mounted SWYD, it is expected to allocate agricultural lands with a total area of 25 hectares.

The boundaries of the construction site are wheat and cotton planted agricultural lands on all sides.

The closest distance to residential development of the settlement of Urgench (to the south-west from the territory of the designed remote-mounted SWYD) is 330 m, which meets the regulatory requirements in terms of establishment of sanitary - protective gaps for newly designed OHL according to clause 23.23.4 of SanPiN № 0350 - 17 “Sanitary norms and rules for the protection of atmospheric air in populated areas of the Republic of Uzbekistan”.

The distance to residential development of Pakhtakor settlement located to the east is 490 m, and it is 810 m to the village of Metan located to the south-west.

During the implementation of the project demolition of residential buildings is not expected.

There are no tree plantations and surface watercourses on the territory of the construction site.

The location of the studied area deep in the continent determines its climate: sharply continental, warm, very dry in summer and humid, relatively cold in winter, as well as significant annual and daily variations in air temperature.

The mountain systems limiting the studied area from the north, east, and south affect the air currents and determine local climate features, and, in particular, the wind regime.

In the annual wind rose, the eastern direction prevails.

The analysis of climatic characteristics of the area where the designed facility located was made according to observations of Uzgidromet under the Ministry of Emergency Situations of the Republic of Uzbekistan at a meteorological station of the city of Navoi (Table 1.1., Fig. 1.1). Climatic indicators were selected from tables of meteorological observations (TMO) for 2018.

The average annual temperature is + 15.9 °C.

The average monthly temperature of the coldest month (January) is plus 3.0 °C, the average temperature of the hottest month (July) is plus 30.9 °C.

The average minimum temperature for a year is plus 9.2 °C, the average maximum temperature is plus 22.8 °C.

The maximum temperature for a year is plus 40.0 °C, the minimum is minus 13.4 °C.

**Table 1.1 Main climatic characteristics**

| **Characteristics** | **Unit of measurement** | **Value** |
|---|---|---|
| Coefficient A depending on the temperature stratification of the atmosphere | | 200 |
| Average annual temperature | °C | + 15,9 |
| Average maximum temperature | °C | + 22,8 |
| Maximum temperature | °C | + 40,0 |
| Average minimum temperature | °C | + 9,2 |
| Minimum temperature | °C | - 13,0 |
| Average air temperature in January | °C | + 3,0 |
| Average air temperature in July | °C | + 30,9 |
| Average soil surface temperature | °C | + 18,0 |
| Minimum soil surface temperature | °C | - 5,0 |
| Maximum soil surface temperature | °C | + 69 |
| Precipitation | mm | 180,54 |

| Characteristics | Unit of measurement | Value |
|---|---|---|
| Average annual frequency of wind directions by rhumb lines | % | N-3,4<br>NNE-2,8<br>NE-16,8<br>ENE-0,9<br>E-23,9<br>ESE-3,25<br>SE-13,0<br>SSE-0,58<br>S-6,6<br>SSW-0,58<br>SW-6,08<br>WSW-0,5<br>W-10,5<br>WNW-0,75<br>NW-8,9<br>NNW-1,08<br>lull – 11,8 |
| Number of cases according to grades, % | m/s | |
| | 0-1 | 41,8 |
| | 2-3 | 27 |
| | 4-5 | 10,9 |
| | 6-7 | 8,5 |
| | 8-9 | 4,6 |
| | 10-11 | 0,16 |
| | 12-13 | 4,8 |
| | >15 | 0,64 |
| Average wind speed | m/s | 3,6 |
| The highest wind speed which exceeds 5% | m/s | u*=7,0 |

Precipitation in Navoi falls all year round, the average annual precipitation is 180.54 mm.

Monthly maximum precipitation occurs in February, the minimum falls in July.

Fogs are very rare, 10 hours a year. Most often fogs are observed during winter months, the average frequency of fogs does not exceed 0.5%.

The average monthly relative humidity during a year varies from 41 to 82%. The maximum values are observed in the winter months, the minimum - in June-July.

One of the meteorological factors determining conditions of pollutant dispersion in the atmosphere is the wind direction and speed.

During the year, eastern (23.9%) and northeast (16.8%) winds are characteristic of the area under consideration (Figure 1.1.). Lulls or still weather occur in 11.8% of cases, which contributes to the accumulation of pollutants in the surface layer of the atmosphere.

In the studied area, the average wind speeds during a year varies from 2.7 to 5.1 m/s. Their highest values fall on July, the smallest - on September, November, December. The average annual wind speed is 3.6 m/s, the maximum - 30 m/s.

The city of Navoi in general is characterized by small values of average monthly wind speeds. The recurrence of winds at a speed of 0–1 m/s is 41.8%, which contributes to the accumulation of pollutants in the surface layer of the atmosphere. Winds with a slightly higher speed (2–3 m/s with 27% frequency), serving as a cleansing factor, are most frequent from March to July. Strong winds (8–9 and 10–13 m/s) are quite rare (frequency is 4.6 and 4.96%, respectively). Even less often squall winds occur at speeds of 14–15 m/s (1.16%), 16–17 m/s (0.6%) and 18–20 m/s (0.16%).

The high repeatability of weak winds does not lead to an increase in the pollution of the atmosphere of the city because impurities mainly accumulate near the Navoi TPP. Frequently repeated increased wind speeds improve the dispersion of impurities from high hot springs, and transfer them over long distances.

From the south, the wind blows much less frequently, in winter its frequency is 8%, in summer it is 5.3%. The recurrence of the northwest wind direction blowing towards the city in winter is the smallest and amounts to 4.6%, in summer it increases to 15.6%, and the average annual rate does not exceed 8.9%.

Thus, the area of the designed route construction is characterized by a significant variability in air temperature from winter to summer, and in the summer period during the day, which is one of the main manifestations of the sharp continental climate.

The analysis of the physical-geographical and climatic features of the area where the designed facility located shows that high air temperatures, low precipitation, and increased solar radiation contribute to environmental pollution.

### *1.2. Existing sources of impacts*

The construction site of the 220/500 kV remote-mounted SWYD at the Navoi thermal power plant is located in the Novbakhor district of the Navoi region.

There are no industrial enterprises in the immediate vicinity of the designed facility.

The sources of environmental impact in the area of the 220/500 kV remote-mounted SWYD are farms, construction industry enterprises, and highways.

A significant share in the emissions from sources of the area of location of the site for the construction of the 220/500 kV remote-mounted SWYD is contributed by motor vehicles.

Freight and passenger transportation, mainly of regional significance, is carried out by automobile companies of various departmental subordination, as well as by small private enterprises and firms. Oxides of nitrogen, carbon monoxide, nitrogen dioxide, benzo(a)pyrene, and lead aerosol enter the atmosphere with exhaust gases from motor vehicles.

Automobile companies and gas stations are scattered throughout the territory of the area under consideration. Fuel combustion products and hydrocarbons enter the atmosphere from these objects.

The sources of environmental impact in the area of the 220/500 kV remote-mounted SWYD construction are also enterprises of farms, livestock complexes, dairy farms, construction, food, processing enterprises, gas stations and car repair enterprises, local boiler houses.

The emissions of these enterprises contain dust, nitrogen oxides, sulfur dioxide, hydrocarbons, soot, aldehydes, benzo(a)pyrene.

Highways of regional significance are characterized by low traffic intensity and are sources of dusting and vehicle emissions of carbon oxides, nitrogen, hydrocarbons, benzo(a)pyrene, soot, sulfur dioxide and lead compounds.

The maximum concentrations of pollutants created by motor vehicle emissions on highways exceed the sanitary standards for nitrogen dioxide and benzo(a)pyrene by 1.5–2 times in 100 m from the roads. The content of soot, carbon monoxide, hydrocarbons and sulfur dioxide is lower than the MPC.

Natural sources of air pollution, soil and vegetation at elevated wind speeds include a dry underlying surface, especially plowed agricultural land. During the period of treatment of fields with defoliants, the soil, air, groundwater and surface water are regularly polluted with defoliants.

The nearest large enterprises are located in the city of Navoi.

The main source of environmental pollution in the area under consideration is the Navoi TPP JSC, located on the northern outskirts of the Navoi industrial zone.

In the industrial zone, which occupies the territory from the western, southwestern and southern sides of the city of Navoi, all industrial giant enterprises are concentrated, which are the main sources of air pollution: enterprises of Uzzstroymaterialy Uzbekistan State Concern (Kyzylkumtsement OJSC), Uzbekenergo JSC (Navoi TPP JSC), Uzkhimprom Association

(Navoi-Azot Production Association, Navoi Electrochemical Plant), Kyzylkumredredmetzoloto concern (Navoi Mining and Metallurgical Complex), Uzgkhlopkopromsbyt (cotton gin plant).

**Annual Wind Rose of the city of Navoi**

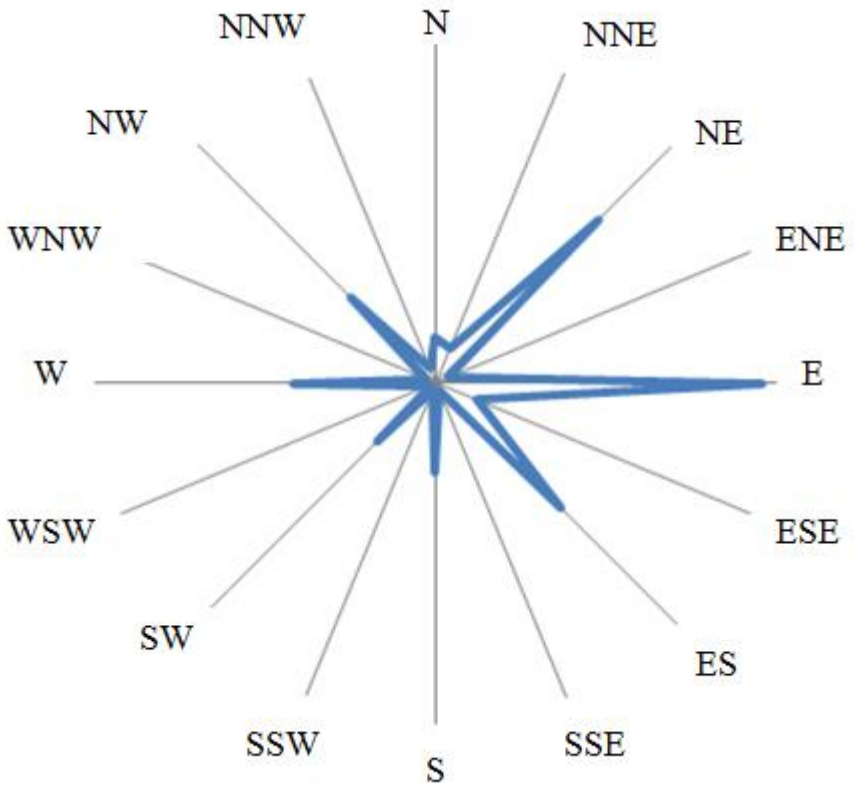


**Figure 1.1**

Along with large-scale production facilities, there are less powerful enterprises in the industrial zone such as: a tank farm, automobile companies, concrete products, repair, construction and installation department, a rock-crushing plant, ABC, meat and dairy plants, bread products, a timber trading base, a tare repairing plant, including enterprises of the Karmana district: a winery, Khleboprodukt Production Association, motor transport enterprises (ATP-22, ATP-2, car maintenance plants), construction enterprises (ELUABS, PMK-2, HRU). A total of about 19 large facilities with more than 450 stationary sources of emissions to the environment.

Emissions from stationary sources of the city, including industrial zone enterprises, according to the latest published data of Uzgidromet under the Cabinet of Ministers of the Republic of Uzbekistan, amounted to 36,261 tons of harmful substances, of which: solids – 19,802 tons, sulfur dioxide – 2,913 tons, carbon monoxide – 5,002 tons, nitrogen oxides – 2,146 tons, hydrocarbons (without VOC) – 4,522 tons, volatile organic compounds - 231 tons, other gases and liquids – 1,644 tons.

The largest share of gross emissions from all stationary sources of enterprises accounts for the Navoi TPP JSC, Kyzylkumtsement OJSC and Navoiazot PA.

In 2018, according to the station's statistical reporting, the Navoi TPP emitted 3180.0485 tons into the atmospheric air. The plant has 46 sources of pollutant emissions. 22 items of pollutants enter the atmosphere. The most powerful emission sources are pipes of boiler units, from which 99.37% of the total plant emission enters the atmosphere. The leading role among the pollutants belongs to nitrogen dioxide - 2002.99 tons (62.9%).

The main harmful substances entering the city's atmosphere from the sources of Kyzylkumtsement JSC are dust of cement, limestone and gypsum; Navoiazot PA - oxides of nitrogen, carbon, ammonium nitrate, ammonia, acrylonitrile, hydrocyanic acid, ammonium sulfate. Ore dust, ammonia, carbon oxides, nitrogen, inorganic and wood dust can be distinguished from among the emitted harmful substances of the NMMC sources.

In total, 78 various harmful substances are emitted into the atmosphere of Navoi and its environs, while carbon monoxide, nitrogen oxide, sulfur dioxide, dust, hydrocarbons, nitrogen oxide, ammonia, ammonium nitrate, acrylonitrile, hydrocyanic acid, and ammonium sulfate are large-tonnage and most characteristic for the city.

The main environmental pollution with carbon monoxide, hydrocarbons is performed by motor vehicles, all other harmful substances come mainly from sources of industrial enterprises and energy facilities.

Since in the industrial zone all large enterprises are located around the perimeter, with dominant wind directions (east and northeast), their emissions will spread in the direction opposite to the city, not reinforcing each other. With the southern wind direction, the main sources of impact in the vicinity of the Navoi TPP will be Navoiazot Production Association and NMMC. With the south-western wind direction, emissions from Kyzylkumtsement JSC and NMMC form a general field of concentrations that covers the territory of the city.

The background aggravating the state of the studied area is high and hot sources of emissions from industrial enterprises and boiler houses in the central part of the city.

The sources of impact on soil and plants in the area of the construction project are emissions of vehicles, industrial enterprises, energy facilities described above. Harmful impurities in the soil and plants come from the atmosphere with precipitation, and direct absorption.

Of all the facilities under consideration, in terms of the volume of environmental impacts, the Navoi TPP, Navoiazot Production Association, some of NMMC production facilities, and Kyzylkumtsement OJSC should be highlighted. These enterprises have powerful sources of

emissions of harmful impurities, releases of industrial effluents into surface water, and unutilized solid waste.

Thus, the state of the environment in the area of the object under consideration is determined mainly by emissions of high hot springs from the enterprises of the city of Navoi, such as Navoi TPP JSC, Kyzylkumtsentment OJSC, Navoiazot PA, NMMC, motor vehicles, and also a dusty soil surface and vehicle emissions.

The greatest anthropogenic impact on the environment in the area of the construction of the remote-mounted SWYD is exerted by the existing sources of the Navoi TPP JSC.

### *1.3 Analysis of sources of environmental impact from the Navoi TPP JSC*

#### 1.3.1 Analysis of sources of emissions of harmful substances into the atmosphere

The Navoi TPP, being one of the largest power plants in the Republic of Uzbekistan, is part of the integrated energy system of Central Asia. The Navoi TPP generates power for consumers in the Navoi, Samarkand and Bukhara regions, steam, hot water for heating the city of Navoi and adjacent villages.

The installed electric capacity of the plant at the end of 2018 was 1,618 MW.

The structure of the installed electric power is given in table 1.2, thermal power - in table 1.3.

**Table 1.2 Structure of electric power installed**

| Name of equipment | Installed power, thousand kW· h | | Power as of 31.12.2018, thousand kW· h | |
|---|---|---|---|---|
| | as of 01.01.2017 | as of 01.01.2018 | operating | available |
| 2 X P-50-130 | 100 | 100 | 72 | 72 |
| 2 X K-160-130 | 320 | 320 | 217 | 217 |
| 2 X PVK-150-130 | 300 | 300 | 201 | 201 |
| 2 X K-210-130 | 420 | 420 | 292 | 292 |
| CCGT-478 | 478 | 4478 | 385 | 385 |
| TOTAL: | 1618 | 1618 | 1167 | 1167 |

**Table 1.3 Structure of heat power installed**

| | *Installed power, Gcal/h* | | *Power as of 31.12.2018, Gcal/h* | |
|---|---|---|---|---|
| | *as of 01.01.2017* | *as of 01.01.2018* | *operating* | *available* |
| *2 X P-50-130* | *376* | *376* | *246,5* | *246,5* |
| *K-160-130* | *99* | *99* | *99* | *99* |
| *CCGT-478MW* | *43* | *43* | *43* | *43* |

In 2018:

- electricity generation amounted to 8,207.5 million kWh, compared to the plan of 8,584.1 million kWh;

- heat output amounted to 2,106.7 thousand Gcal, while the plan was 1,867 thousand Gcal.

For power generation, the plant mainly operates in the base mode.

The level of electricity generation increases slightly in winter and falls in summer due to power outages for repairs.

In 2018, the maximum power generation took place in December and amounted to 857,018.873 thousand kWh.

The maximum heat output in the amount of 307.0 thousand Gcal occurred in the month of December and the minimum of 95.3 thousand Gcal - in July.

The specific consumption of reference fuel amounted to 381.24 g/kWh for the electric power supplied and 185.84 kg/Gcal for the supply of thermal energy, respectively, against 379.8 g/kWh and 165.1 kg/Gcal on average for the power system.

The main technical and economic performance indicators of the Navoi TPP for 2018 are given in Table 1.4.

**Table 1.4 Main technical and economic performance indicators of the Navoi TPP JSC for 2018**

| *Item No.* | *Indicators* | *Units of measurement* | *2018* | | | *2017* |
|---|---|---|---|---|---|---|
| | | | *As planned* | *In fact* | *%* | |
| *1* | *Operating power* | *MW* | *1026,7* | *1012,9* | *98,7* | *1176,1* |
| *2* | *Efficiency ratio of* | | | | | |
| | *- electric power* | *%* | *61,2* | *57,9* | *94,6* | *59,9* |
| | *- heat energy* | | *40,8* | *46,4* | *113,7* | *40,8* |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***3*** | ***Generation of electric power*** | ***million kWh*** | ***8584,1*** | ***8207,5*** | ***96,6*** | ***8499,5*** |
| ***4*** | ***Heat energy supply*** | ***Thousand Gcal*** | ***1867*** | ***2106,7*** | ***112,8*** | ***1849,1*** |
| ***5*** | ***Sale of heat energy***<br>***- implementation of measures on liquidation of receivables*** | ***million UZS number of measures*** | | ***192719,2*** | | ***45471,5*** |
| ***6*** | ***Specific consumption of reference fuel: (normative)***<br>***- for power supply***<br>***- for heat supply*** | ***g/kWh n/f***<br>***kg/Gcal n/f*** | ***376,00***<br>***185,84*** | ***381,24***<br>***185,84*** | | ***369,61***<br>***186,86*** |
| ***7*** | ***Consumption of power for own needs (normative)***<br>***- for power generation***<br>***- for heat supply*** | ***%***<br>***kWh/Gcal*** | ***5,78***<br>***45,0*** | ***6,04***<br>***45,0*** | | ***5,73***<br>***45,0*** |
| ***8*** | ***Listed number of personnel*** | ***Person*** | ***1530*** | ***1532*** | ***98,9*** | ***1503*** |

The sources of harmful emissions in the production of heat and electricity are the main and auxiliary process equipment of the TPP.

The plant consists of cogeneration and condensation parts. The condensation part works according to the block principle.

The Navoi TPP has two power units of 210 MW each, two power units of 150 MW each, two power units of 160 MW each, TPP - 140 with a capacity of 100 MW, a combined-cycle plant CCGT Unit-478 MW.

Characteristics of TPP boilers, their main indicators are given in Table 1.5.

**Table 1.5 Characteristics of boilers of the Navoi TPP at rated load**

| Plant boiler No. | Boiler type | Rated steaming capacity, t/h | Fuel consumption, tut/h | Heat capacity, Gcal/h | Time of commissioning |
|---|---|---|---|---|---|
| 1 | TGM-151 | 220 | 21,7 | 151,9 | 02.1963 |
| 2 | TGM-151 | 220 | 21,2 | 148,4 | 05.1963 |
| 3 | TGM-94 | 500 | 62,5 | 437,5 | 10.1964 |
| 4 | TGM-94 | 500 | 62,7 | 438,9 | 10.1965 |
| 5 | TGM-84 | 420 | 41,2 | 288,4 | 09.1966 |
| 6 | TGM-84 | 420 | 41,4 | 289,8 | 05.1967 |
| 7 | TGM-84 | 420 | 41,5 | 290,5 | 09.1967 |
| 8 | TGM-94 | 500 | 62,5 | 437,5 | 07.1968 |
| 9 | TGM-94 | 500 | 62,5 | 437,5 | 07.1968 |
| 10 | TGM-84 | 420 | 41,2 | 288,4 | 03.1972 |
| 11 | TGME-206 | 670 | 71,7 | 501,9 | 06.1980 |
| 12 | TGME-206 | 670 | 71,7 | 501,9 | 07.1981 |
| TOTAL | | 5460 | 601,8 | 4212,6 | |

Gas-oil burners of a vortex type TKZ are installed on all boilers of the TPP. On boilers of plants No 11, 12 the burners are installed in two tiers on the rear wall of the combustion chamber - six burners in each tier.

On the remaining boilers (plants No. 3–10), the burners are located along the front wall of the furnace evenly in three tiers. The flue gas recirculation scheme incorporated in the projects of block boilers TGME-206, TGM-94, is periodically restored by performance and commissioning works carried out by Uzenergosozlash UE.

The Navoi TPP uses gas from the Zevardy and Kultak fields with a calorific value of 8150 Gcal/nm³ and below as the main fuel, with a hydrogen sulfide content of 0.06 to 0.1 vol.%. Fuel oil is used as emergency fuel.

In 2018, gas consumption at the TPP amounted to 2,830,665.482 thousand nm3.

According to TPP data, CCGT Unit-478 burns sulfur-free gas.

Gas is supplied to the TPP through three pipelines, two of them have a diameter of 700 mm, one - 500 mm.

The presence of gas condensate in the fuel leads to a significant distortion of the true gas flow. In addition, the combustion of this gas causes corrosion and contamination of the cold layer of RAH stuffing, low-temperature sections of gas ducts, clogging of gas distributing burner nozzles, which causes worsening of technical and economic indicators, stopping for preventive measures to clean the heating surfaces and restore corroded elements.

M-100 grade fuel oil is mainly supplied with a sulfur content of 2.5% and a lower working combustion heat of 9,365 kcal/kg.

Nitrogen dioxide, nitrous oxide, sulfur dioxide, carbon monoxide, benzo(a)pyrene, the main of which are nitrogen oxides, come to the atmosphere during the operation of the equipment at the plant, and additional fuel oil ash is burned when fuel oil is burned.

Currently, flue gases from the existing boilers are emitted into the atmosphere through four chimneys from the five existing pipes. Boilers № 3-10 are connected to three pipes of 56 m high, № 11, 12 - to the pipe of 180 m high, CCGT Unit № 1 - to the pipe 60 m high.

Characteristics of chimneys at rated operation of boilers are given in table 1.6.

**Table 1.6 Characteristics of chimneys for rated boiler operation**

| No. of emission source | Height, m | Diameter, m | Plant No. of boilers | t of exhaust gases, °C | Air excess ratio, αex |
|---|---|---|---|---|---|
| 2 | 56 | 9,18 | 3, 4 | 149 | 1,55 |
| 3 | 56 | 9,18 | 5, 6, 7 | 117 | 1,63 |
| 4 | 56 | 9,18 | 8, 9, 10 | 140 | 1,55 |
| 5 | 180 | 6 | 11, 12 | 154 | 1,47 |
| 44 | 60 | 8,5 | CCGT Unit-478 | 126 | 2,0 |

Flue gas cleaning at the Navoi TPP is not provided. On all TPP boilers, according to the Atmosphere NIPTI's project, the technology of staged gas combustion was introduced through its redistribution among burner tiers, which shall ensure a reduction in nitrogen oxide emissions for up to 30 percent or more. However, the design effect of reducing emissions of nitrogen oxides is not achieved.

The amount of power output for each boiler depends on the amount and type of fuel used, the design of the boiler, the state of the boiler equipment.

In addition to the main sources of emissions into the atmosphere, at the TPP there are emissions from the operation of auxiliary units and equipment.

On the territory of the TPP in the repair departments there are two forge furnaces connected to two pipes. Furnaces operate on gaseous fuel, while they emit nitrogen dioxide, carbon monoxide.

Emissions of fuel oil facilities are carried out through the breathing valves of the tanks for long-term storage of fuel oil, consumable tanks and receiving trays. The fuel facilities of the TPP include four tanks of 3,750 m³ and three of 15,000 m³ each. The receiving-drain device of liquid fuel is designed to receive rail tank cars with a capacity of 120 tons. The maximum number of discharge tanks is 21 with 60 tons of the average amount of fuel oil in 1 tank. Marginal and aromatic hydrocarbons, hydrogen sulfide are emitted into the atmosphere.

When storing fuels and lubricants in a TPP garage in the amount of 164 tons/year (125 tons - gasoline, 25 tons - diesel fuel and 14.4 tons - engine oil) through the breathing valves of eight tanks (3×25 m³ - for gasoline, 1×25 m³3 , 1×60 m³ - for diesel fuel, 1×3.5 m³, 1×5 m³ - for engine oil), as well as when storing turbine (118 tons/year) and transformer (228 m³) oils in ground metal tanks (9 pcs.) hydrocarbon vapors are emitted at the oil facilities of the electrical workshop.

Unorganized emissions of pollutants include:

- emissions during unloading-loading and storage in storage facilities of table salt, anthracite, lime, cement, inorganic dust, quicklime, sulfuric acid, caustic soda, hydrazine hydrate, sulfur dioxide, polyacrylamide, anion and cation resin, ammonia, used as reagents in the chemical workshop;

- emissions from the production of electric welding and gas welding operations. Nitrogen dioxide, carbon monoxide, welding fumes, iron oxides, manganese, fluoride compounds come to the atmosphere. There are 57 mobile and stationary welding stations at the plant, but their simultaneous operation is excluded. The ratio of simultaneity is 0.3-0.4. The consumption of electrodes at the station is 15 tons.

During gas pipeline purging before firing boilers, salvo emissions of natural gas through purge plugs take place. The duration of purging is 10 minutes.

The characteristics and parameters of the sources of atmospheric pollution of the Navoi TPP JSC for the existing situation are given in Table 3.1 of Appendix 3.

The gross emission of pollutants in 2018 according to the statistics of the TPP amounted to 3,180.8893 tons, including:

- nitrogen dioxide - 2002.99 tons;

- carbon monoxide - 748.20 tons;

- carbon monoxide - 325.349 tons.

### 1.3.2 Water consumption and waste disposal

Water at the Navoi Thermal Power Plant is used for technical and utility purposes.

Water for technical and utility purposes is used for drinking and for feeding the heating network, and is fed to the TPP from the city pipeline.

For the production needs of the plant water is taken from the river Zeravshan and is spent on:

- cooling of turbine condensers;

- cooling of auxiliary equipment of turbines and power units;

- needs of a water treatment plant (own needs and make-up of steam cycle boilers);

- production needs (irrigation of the territory, fire-fighting water supply pipeline, washing of industrial premises, etc.);

- supply of steam to industrial consumers;

- condensate return.

The scheme of cooling water supply to plants № 11, 12 is reverse block-type. The design capacity of the circulating water supply is 335,456.0 thousand m³ per year, in fact, the circulating water supply was 193031.0 thousand m³ per year.

According to the project, the capacity of cooling towers No. 1, 2 is 48,968.0 m³/h, through cooling tower No. 1, water consumption was 26,875.70 thousand m³/year, through cooling tower No. 2 – 86,307.19 thousand m³/year.

In 2018 for industrial needs 577,868,644 thousand m³ was collected from the river Zeravshan. The water use limit is 860.0 million m³. There was no over-limited water consumption in 2018.

The design capacity of the repeated water supply (mix channel) is 28,500.0 thousand m³/year. The actual capacity of the repeated water supply is 1,452.60 thousand m³/year.

The main source of pollution of surface watercourses is the equipment of water treatment plants.

Water treatment and chemical regime

Replenishment of steam and water losses in the plant cycle is provided by the distillate of the evaporators and desalinated water from the ion exchange unit equipped with pre-treatment.

The feed water of the evaporators is produced by the ion-exchange softening unit also with pre-treatment in clarifiers. A small part of the softened water with a lack of desalted water and distillate is sent to the steam generator deaerators.

The source water for the water treatment plant is taken from the Zarafshan River and is characterized by high mineralization, the presence of seasonal fluctuations and tendencies for the steady growth of the qualitative characteristics of the chemical composition.

1. Desalting unit.

Design capacity - 600 m³/h.

The actual capacity is 660 t/h due to the lack of filtering materials.

Since May 1997, the desalting unit has been working on a mixture of waters: from the Zeravshan River and the waters of the Damkhoja water conduit.

The average annual amount of strong acid anions in the source water of the Zeravshan River was 12.43 mg-eq/dm³, in a mixture of water - 5.188 mg-eq/dm³.

Produced over a year – 3,739,742 m³ (426.9 m³/h) of desalinated water.

2. Sodium hydroxide treatment scheme.

Design capacity is 300 m³/h, actual - 250 m³/h.

The decrease in the capacity of the plant is due to the deterioration of the water quality of the Zerafshan River with regard to the designed by 2 times due to the physical deterioration of equipment that has developed an estimated service life, part of which has been dismantled.

Produced over a year – 1,537,217 m³ (175.48 m³/h) of Na-cationized water.

3. Condensate purification scheme.

Design capacity is 250 m³/h, the actual capacity is 250 m³/h, due to the physical wear of the equipment and the replacement of stage II filters with filters of a smaller diameter.

Purified over a year - 1,135,614 m³ (129.64 m³/h).

4. Installation of water treatment for feeding heating networks at water purification plants-1, 2.

Design capacity is 570 m³/h.

The actual capacity is up to 700 m³/h due to an increase in the number of filters and calcinators.

Due to equipment aging, a large number of defects are formed on the connection and in the filter housings.

The actual output per year at water purification plants-1, 2, 3 is 8,675,191 m³ (990.32 m³/h) of softened water to feed the heating network.

In 2018, 20 pieces of filters were repaired. At all water treatment plants for feeding the heating network in the filters, there is underload of filtering material (sulfo coal) due to non-delivery, which leads to a decrease in plant performance, its reliability and efficiency.

Due to the periodic absence of chemical reagents of hydrazine hydrate and trisodium phosphate, ulcer and oxygen corrosion and scale deposits appear in the composition in which calcium and magnesium deposits are present.

The decrease in the performance of the existing listed water treatment plants compared to the designed one is explained by the following reasons: deterioration of the water quality of the Zerafshan River, physical deterioration of equipment that has developed an estimated service life (the main defects of water treatment plants are corrosive wear of N-cationite filters, a large number of defects on filter connection, mass violation chemical protection).

The operation of ion-exchange plants with the use of water of increased mineralization requires a large amount of reagents, which in the form of used regenerative and washed streams flow into surface water. Due to the non-delivery of filtering materials, the lack of reagent dosing at the automation station, disruptions in the operation of dosing pumps, there are deviations in pH, the content of iron oxides, copper, hydrazine in the feeding water. At the same time, with increased salinity of the source water, underload of filter materials leads to a decrease in the performance of the water treatment plant.

The consumption of reagents at the station is: $H_2SO_4$ - 27.5 tons/day, caustic - 12.5 tons/day, lime - 13.0 tons/day, table salt - 9.0 tons/day, coagulant - 0.165 tons/day. Wastewater of treatment installations is contaminated with salts, bases and acids.

There are also industrial waste streams polluted with oil products, wastewater from water-chemical flushing of boilers and equipment conservation, effluents from RAH washing (acid and alkaline), from cooling tower blowing, industrial drains at the TPP. Household discharges are sent to wastewater treatment plants of the city sewage system, industrial effluents through certain outlets are sent to the river Zeravshan and “Sanitary” collector.

According to the project, the complex of treatment facilities for industrial effluents of the TPP (CTIE) includes:

- a building with a cleaning installation (neutralization, sedimentation) of waste water from flushing boilers and RAH;

- a filter room of the plant for cleaning oiled and fuel oiled waste and condensate purification;

- pretreatment of oiled and fuel oiled waste, which includes receiving tanks, an oil trap, floaters, an oil and sludge pumping station;

- the room of the settling tanks for condensate purification;

- pumping station for sewage pumping;

- pipeline racks: from the main building, reagent warehouse to hydraulic structures;

- hydraulic structures - sludge dumps, evaporator pond, pumping stations.

Out of CTIE installations the following ones operate:

UOZZS is an installation for cleaning oiled and fuel oiled waste with a capacity of 100 $m^3/h$ with an oil product content of not more than 100 $mg/dm^3$ in the incoming water.

UOZK is a purification plant for fuel oiled condensate with a capacity of 45 $m^3/h$ with an oil product content in the incoming condensate of not more than 10 $mg/dm^3$. The circuit is in reserve due to the absence of fuel oiled condensate.

UOVK and RAH is an installation for purification of wastewater from washing of boilers and RAH with evaporation ponds of neutralized effluents with an area of 18,050 $m^2$.

The volume of normatively treated effluents at the treatment plants, after which the effluents are discharged into the Zeravshan River, amounted to 2,182 thousand $m^3$ for 2018, of which:

- physical and chemical treatment - 1,832.0 thousand $m^3$ per year (sludge disposal tank of the CTIE);

- mechanical treatment - 350.4 thousand $m^3$ per year (oil trap No. 1, 2).

The volume of normatively treated effluents received by the river Zerafshan in 2018 without purification amounted to 577,868,644 thousand $m^3$.

There are seven wastewater discharges at the plant, the characteristics of which are given below.

Discharge № 1. The warmed (heated) waters after cooling of condensers and coolers of auxiliary mechanisms. Discharge to the river Zerafshan. Actual consumption: 67360.927 $m^3/h$, approved flow rate – 106,365 $m^3/h$. Waters are normatively treated. The salt composition of the waste water does not differ from the initial one, the temperature increase is due to reheating in I-II turn heat exchangers of the TPP, operating on a direct-flow system of water supply.

Discharge № 2. Waste water drain, drainage from blocks 8-12 through oil trap No. 2 into the river Zerafshan. Discharges are polluted with oil products, suspended particles, high mineralization. The actual discharge is at the approved level and is 35 $m^3/h$.

Discharge № 3. Blowdown water from cooling towers is regulatory clean. The content of calcium and magnesium salts is increased. Discharge is into the "Sanitary" collector. The actual discharge is at the approved level and is 254.5 m³/h.

Discharge № 4. Industrial drainage, main building, drainage from units of plants No. 1-7. Discharge into the river Zerafshan after settling in the well. The drains are normatively purified. Approved and actual discharge - 5.0 m³/h.

Discharge № 5. Discharge of regulatory purified effluents into the river Zerafshan after the integrated treatment of industrial wastewater (from the sludge collector of effluents from all water treatment plants, purification of contaminated condensates associated with ion exchange, where, after exchange reactions, the hardness salts to be removed from the make-up water accumulate in the filtering material. In the process of recovery of ion-exchange filters, the trapped ions pass into the waste water, contaminating them with hardness salts, iron impurities, silicic acid, sulfates, chlorides, etc.). The amount of actually discharged water is 209.13 m³/h, the approved wastewater flow is 344.0 m³/h.

Discharge № 6. Discharge of regulatory clean water from the pumping station for interception of water treatment plant drains in case of failure of pumps for sewage pumping interception (regeneration, washing of filters) onto the terrain. The actual discharge is at the approved level and is 785 m³/h.

In 2018, a discharge was made only into discharges No. 1, 2.4.5.

Table 1.7 provides the quantitative and qualitative characteristics of each discharge in comparison with the allowed and maximum allowable concentrations for fishery watercourses, table 1.8 - according to the measurements of the plant compared to MACf.w.

The background concentrations in the source water exceed the standards in terms of the content of suspended substances, salts, sulfates, nitrite nitrogen, iron and petroleum products. A similar excess for the listed pollutants is available in the case of discharge No. 1. Iron salts, in the case of other discharges, except discharge No. 1, are not detected.

For all the discharges, the concentration of salts introduced into the surface watercourse with wastewater is 1.4 - 1.7 times higher than the standard values for water reservoirs of fishery importance, mainly due to sulphates and hardness salts accumulated in chemical filters.

The main source of the river Zeravshan pollution with salts is discharge No. 5 - wastewater after water treatment plants, including those settled in a sludge collector.

For discharge No. 4, the excesses in suspended substances and oil products can be observed, the content of other pollutants has not been identified.

Thus, chemical pollution of the river Zerafshan is mainly caused by the existing condition of the water treatment plant equipment, in which the plant's production effluents exceed the permitted and standard values of pollutant concentrations for fishery watercourses.

**Table 1.7 Permissible concentrations of pollutants**

**in waste waters of the Navoi TPP, mg/dm³**

| No. | Indicator | MACf.w. | Discharge 1 | Discharge 2 | Discharge 3 | Discharge 4 | Discharge 5 | Discharge 6 |
|---|---|---|---|---|---|---|---|---|
| 1 | Suspended substances | 15 | 487 | 487 | 487 | 487 | 487 | 487 |
| 2 | Mineralization | 1000 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 |
| 3 | Nitrites | 0,08 | 3,3 | 3,3 | 3,3 | 3,3 | 3,3 | 3,3 |
| 4 | Nitrates | 40 | 45 | 45 | 45 | 45 | 45 | 45 |
| 5 | Sulphates | 100 | 500 | 500 | 500 | 500 | 1000 | 1000 |
| 6 | Chlorides | 300 | 350 | 350 | 350 | 350 | 350 | 350 |
| 7 | Calcium | 190 | 280,5 | 280,5 | 280,5 | 280,5 | 280,5 | 280,5 |
| 8 | Magnesium | 40 | 170,1 | 170,1 | 170,1 | 170,1 | 170,1 | 170,1 |
| 9 | Oil products | 0,05 | 0,234 | 0,1 | 0,1 | 0,1 | | |
| 10 | Total iron | 0,05 | 4,62 | 4,62 | 4,62 | 4,62 | 4,62 | 4,62 |

**Table 1.8 Composition of discharge water of the Navoi TPP JSC, mg/dm³**

| No. | Indicator | Feed Channel (Background) | Discharge No.1 | Discharge No.2 | Discharge No.4 | Discharge No.5 | MACf.w. |
|---|---|---|---|---|---|---|---|
| 1 | Suspended substances | 791 | 759 | 192 | 181 | 183 | 15 |
| 2 | Mineralization | 1516 | 1516 | 1410 | abs | 1671 | 1000 |
| 3 | Chlorides | 91 | 90,3 | 86 | abs | 94,2 | 300 |
| 4 | Sulphates | 545 | 545 | 496 | abs | 634 | 100 |
| 5 | Oil products | 0,24 | 0,24 | 0,29 | abs | abs | 0,05 |
| 6 | Nitrite nitrogen | 0,156 | 0,186 | 0,124 | abs | abs | 0,02 |
| 7 | Nitrate nitrogen | 7,6 | 7,8 | 6,25 | abs | abs | 9,1 |
| 8 | Iron | 5,0 | 5,1 | | 0,27 | abs | 0,05 |
| 9 | pH | 8,25 | 8,23 | 8,1 | 7,9 | 8,15 | 6,5-8,5 |
| 10 | Temperature, °C | 19,0 | 20,0 | 21,1 | 17,3 | 20,3 | Not more than by 3°C |

### 1.3.3 Solid waste generation and storage

Waste generated at the TPP differs in morphology, genesis, and hazard class.

Some types of waste are generated continuously, the generation of others is periodic.

Production wastes are generated at the TPP during the operation of the chemical, electrical, boiler-turbine, fuel and transport workshops, an auto garage, and the repair and construction site.

When preparing feed water for power boilers in a desalting plant, during the process of coagulation with iron sulfate and filtration, mechanical sludge is formed on the mechanical

filters, which is sent to the sludge dumps and contains 85% of suspended substances, 13% of iron hydroxide, and 2% of silicic acid.

When cleaning water for making up the heating network, on cationic filters of the water treatment plant, when they are restored, sodium chloride is used, which comes as solid waste to the sludge collectors.

Liquid sludge, in addition to industrial wastewater treatment effluents, contains boiler equipment acid cleaning mud, drains after cooling of auxiliary equipment of power units and stormwater drainage. For the purpose of sedimentation of a solid phase, liquid sludge enters 5 sludge collecting sedimentation tanks:

A two-section sludge dump for wastewater of water purification plant and lime green coke with sludge pipelines and discharge ports for clarified runoff into the river Zerafshan;

The sludge dump for fuel oiled sludge and sediment with sludge pipelines and reverse water conduit for clarified water and a pump station for clarified water;

Evaporation ponds for acidic water washing of boiler equipment and washing water of the RAH.

The two-section sludge dump of wastewater of the water purification plant was designed as unfiltered, the building height is 4.5 m, the slope ratio is m = 2.5.

The area along the bottom of one section is 11,800 m² (sludge dump No. 1), of the other one - 8,000 m² (sludge dump No. 2). The sludge dump is designed for a volume of 83,000 m³ of solid sediment. The water clarified in the sludge collector enters the mine water intake wells, the height of which is increased by installing dam beams as the sludge dump is filled with solid fractions. From the water intake wells, water flows by gravity through a pipe with a diameter of 350 mm into the discharge channel. At the moment, both sections are on the verge of exhaustion. The discharge technology is often violated. In view of the failure of the integrated treatment of industrial wastewater (neutralization device of the water purification plant), alkaline and acid waste flows separately into the dump. The environment is aggressive. There is an uneven interaction reaction at the discharge sites with a negative effect on the impervious screen. Actually, the sludge dump is partially filtered. In the asphalt concrete surface there are cracks and breaks. Section cladding does not meet specifications. The dam coating is destroyed, it is cobbled with lime green coke discharges after the clarifiers.

Periodically, work is performed on scooping up the sludge and shipping it to the sites allocated in the area of city dumps. For the full disposal of the water purification plant waste, allocation of about 40,000 m² of space is required. Given the presence of chemicals in the

composition of waste, their migration into soils and groundwater is possible. Periodically, settlers No. 1, 2 are cleaned from reeds and plants. Currently, sludge dump No. 1 is closed for sludge cleaning, 20% of the total sludge has been removed. 50% filled sludge dump No. 2 is in progress.

Condensed waste enters the sludge dump for fuel oiled mud and sediment after the installation of cleaning oiled and fuel oiled wastewater. The sludge dump is designed to be unfiltered with two sections. The height is 14.5 m, the area of each section is 1000 m2. The accommodating volume is 9600 m³. At the moment, the filling of the sludge collector is about 70%.

According to the project, the impervious screen of the ZIO sludge dumper is made of fine-grained asphalt concrete. The surface of the bottom and slopes of the evaporation pond before facing with asphalt concrete is treated with long-acting herbicides (douran, monuran) in order to avoid germination of vegetation. The solid fraction is to be incinerated in the boiler furnaces. The water clarified in the sludge dump enters the mine water intake wells, the height of which increases as the sludge dump is filled with solid fractions. From there, through the overflow pipe with a diameter of 200 mm, the clarified water returns to the integrated treatment of industrial wastewater cycle through the pumping station.

Sludge containing metals (iron, nickel, copper, chromium, vanadium), as well as sulfuric, hydrochloric acids, ammonium compounds, which are formed periodically during chemical cleaning of heating equipment (steam generators) and cleaning of RAH surfaces.

Under the project two sections of the evaporation pond are provided unfiltered with a design similar to the sludge dump for fuel oiled sludge. The evaporation ponds are located on the site, which has a slope to the floodplain of the river Zerafshan. The area of one section is 11000 m², the other one - trapezoidal - 6000 m². The building height is 1.5 m. The sections of the pond fit into the terraced terrain with 1.5 m elevation of the bottom of one section below the other one. According to the project, flushing water to be collected in acid washing tanks to neutralize acidic and alkaline drains. At the end of neutralization, to precipitate heavy metal ions, decompose hydrazine, ammonium compounds, the solution shall be treated with lime cream, and then discharged into the pond. Due to the toxicity of the sludge, the water component is subject to complete evaporation (estimated at 101 cm per year), the sludge is deposited and compressed.

The estimated amount of washing water is ≈43000 m³/year. Of these, the solid component is ≈2000 tons/year.

The water purification plant sludge is characterized by increased mineralization of aqueous solution of the water purification plant sludge, total salt content is about 6000 mg/dm³, pH - 7.8, sulfates (3939.759 mg/dm³) prevail among anions, magnesium (657.598 mg/dm³) prevails among cations.

The sludge from the evaporation pond after chemical cleaning of the equipment contains less soluble substances. The total mineralization of the aqueous extract is in the range of 300-2500 mg/dm³, pH - 7.8, sulfates prevail among anions, their content is 5 times less than in the sludge from the settling tanks of the water purification plant (783.750 mg/dm³), among cations - magnesium cations (141.866 mg/dm³).

The spectral analysis showed an increased content of magnesium, calcium, iron, sodium, and potassium in the sludge from the water purification plant ponds. Iron, copper, vanadium, chromium, and zinc dominate in the sediment of evaporation ponds.

Thus, the analyses confirm the addition of salts and metals generated in the process of water softening and chemical equipment cleaning.

Solid waste is also generated during the regeneration of waste (transformer, turbine and other) oils.

The waste oils are cleaned at the plant's oil facilities. Contaminated oil is collected in a special tank with up to 30 ton volume.

Regeneration is performed by passing the oil through a centrifuge and silica gel filters. Refined oil is collected in another tank and returned to the process cycle. After the centrifuge, the dirt is collected in a bucket and manually transported to the fuel oil facilities, from there all the waste goes to the integrated treatment of industrial wastewater with fuel oiled drains.

The used silica gel is folded in a bucket, it is dried in an oven, and then returned to the process.

Non-ferrous metal wastes are generated in the electrical shop, auto garage, while repairing turbine and electrical equipment. The total amount of waste of non-ferrous scrap reaches 3 tons/year.

The used fluorescent lamps are generated as waste from production workshops and office premises in the amount of up to 500 pieces/year, they are stored locked up in corrugated boxes, and as they accumulate, they are transferred to a specialized organization for de-mercuration.

Waste ferrous metals are generated during the repair and maintenance of vehicles, during the repair of the plant (replacement of sections of screen tubes, superheaters, water economizers

as a result of corrosion), their amount is estimated at 513 tons/year, ferrous scrap is delivered to Vtorchermet.

When carrying out welding, residues of electrodes are formed.

In the garage, used tires, used brake pads, waste batteries and electrolyte are generated.

At all production sites, oiled rags generated as a result of cleaning equipment and hands of personnel are formed as waste.

During construction, construction waste is generated as solid waste. Construction waste is transported to designated areas of the household waste landfill, allocated by sanitary and epidemiological authorities.

Waste from the dining room is food waste, which is temporarily stored in a metal container and then given as feed to personnel pets.

The TPP has a first-aid post which waste is: waste dressings, used medical syringes and needles from them.

The TPP also has its own ancillary farm, the waste of which is manure as the product of animal life.

Household waste is generated in all divisions of the TPP and consists of 47% paper, 1% wood, 1.8% leather and rubber, 0.5% bones, 4.5% metal, 29% food waste, 5% textiles, 4.9% glass and stones, 2% plastics. Household waste is transported to the city landfill in coordination with the Central State Sanitary Epidemiological Service.

A total of 37 items of waste are generated at the TPP. Temporary storage facilities are provided for all wastes.

Some of these wastes are regenerated or reused at the enterprise, some are exported under contracts to specialized organizations for recycling and disposal.

Information on production and consumption waste of the Navoi TPP JSC is given in table 1.9.

**Table 1.9 Information on production and consumption waste**

| No. | Waste description | Amount of waste, t/year | | Hazard class |
|---|---|---|---|---|
| | | Norm | Limit | |
| 1. | Oiled rugs | 0,097686 | 0,048 | 3 |
| 2. | Waste paper | 1,5 | 0,74 | 4 |
| 3. | Ferrous metal scrap | 513,05 | 253 | 4 |
| 4. | Remains of welding electrodes | 2,795 | 1,378 | 5 |
| 5. | Non-ferrous metal scrap | 3,0 | 1,479 | 3 |

| | | | | |
|---|---|---|---|---|
| 6. | Oil sludge | 0,1006 | 0,1006 0,0496 | 3 |
| 7. | Lead waste batteries | 0,374 | 0,184 | 1 |
| 8. | Electrolyte | 0,144 | 0,071 | 2 |
| 9. | Used plastic battery boxes | 0,057 | 0,028 | 4 |
| 10. | Used PPE | 10,716 | 5,284 | 4 |
| 11. | Used fluorescent lamps | 6,829055 | 5,5926 | 1 |
| 12. | Used turbine oil | 1,556 | 0,767 | 2 |
| 13. | Used tires | 3,52 | 1,736 | 4 |
| 14. | Used oiled filters | 0,057 | 0,028 | 4 |
| 15. | Used brake pads | 0,09 | 0,044 | 5 |
| 16. | Metal shavings | 18,0 | 8,877 | 5 |
| 17. | Used lining material | 119,0 | 58,685 | 4 |
| 18. | Construction waste | 257,4375 | 126,956 | 5 |
| 19. | Containers from under paints and varnishes | 16,0 | 7,89 | 3 |
| 20. | Used dressings of medical station | 0,05 | 0,025 | 4 |
| 21. | Used medical syringes | 0,0336 | 0,017 | 4 |
| 22. | Used medical syringe needles | 0,0044 | 0,002 | 4 |
| 23. | Used transformer oil | 45,0 | 22,192 | 2 |
| 24. | Waste of thermal insulation materials | 21,9 | 10,8 | 3 |
| 25. | Fuel oiled mud | 21,75 | 10,726 | 3 |
| 26. | Turbine oil cleaning sludge | 12,85 | 6,337 | 3 |
| 27. | Oiled waste sludge | 1,4016 | 0,691 | 3 |
| 28. | Sludge from wastewater treatment plant (WTP) | 5002,244 | 2466,86 | 3 |
| 29. | Sludge from raw water pre-treatment | 4264,508 | 2103,045 | 3 |
| 30. | Mud from river water clarification | 4500 | 2219,1781 | 4 |
| 31. | Sediment from chemical cleaning of condensers and tubes of the screen system | 18,0 | 8,877 | 3 |
| 32. | Used lime | 667,8 | 329,326 | 5 |
| 33. | Technical salt waste | 89,84 | 44,305 | 4 |
| 34. | Isolator crushing | 0,1 | 0,049 | 4 |
| 35. | Manure | 2299,5 | 1134 | 4 |
| 36. | Food waste | 56,43 | | 5 |
| 37. | Household waste | 265,75 | | 5 |
| | TOTAL | 18221,4854 | 8827,0547 | |

Total 1 hazard class waste generation is 7.203055 tons/year, 2 hazard class - 46.7 tons/year, 3 hazard class - 9361.90889 tons/year, 4 hazard class - 7,537.371 tons/year, 5 hazard class 5 - 1268.3025 tons/year.

Thus, in the production of power and heat, thermal power plant has sources of pollutants entering the environment in the form of emissions, discharges and solid waste.

***1.4 Atmospheric air condition***

The state of the atmospheric air in the area where the business object located is determined by emissions of the sources listed in section 1.2 and depends on the conditions of their dispersion.

In the area under consideration, stationary observations of the state of atmospheric air are not performed.

The qualitative and quantitative addition of polluting chemicals entering the atmosphere along with the flue gases of the Navoi TPP depends on the type of fuel used. When hydrogen-containing gas is burned, nitrogen oxide and dioxide, sulfur dioxide, carbon monoxide, benzo(a)pyrene enter the atmosphere. Fuel oil ash is added during fuel oil burning.

The gross emission of pollutants during the operation of TPP equipment at maximum load, according to the calculations, is 4976.6268 tons/year. The main air pollutants are nitrogen dioxide (3483.5658 tons/year), accounting for 70.0% of the total emissions into the atmosphere, carbon oxide (874.4503 tons/year) - 17.57% and nitrogen oxide (577.9607 tons/year) - 11.61%. The share of other 19 pollutants is 0.82%.

The list of substances polluting the atmosphere with emissions from the Navoi TPP in accordance with the current state is given below in Table 1.10.

The air pollution analysis in the studied area showed that the highest concentrations outside the industrial site of the Navoi TPP JSC had been formed by nitrogen dioxide emissions and amounted to 1.03 MPC, which exceeded the quota permitted by the State Ecology Committee of Uzbekistan for 2 hazard class substances and enterprises located in the Navoi region by 4.12 times.

**Table 1.10 List of substances polluting the atmosphere with emissions from the Navoi TPP JSC (current state)**

| No. | Pollutant | MAC or SRLI, | Hazard class (SRLI) | Established quota (MAC | Maximum concentration in MAC | Compliance with the established | Pollutant emission, tons/year | % |
|---|---|---|---|---|---|---|---|---|

| | | mg/m3 | | shares) | shares | quota (+,-) | | |
|---|---|---|---|---|---|---|---|---|
| 1 | Ammonia | 0,2 | 4 | 0,5 | 0,004 | + | 0,1490 | 0,003 |
| 2 | Oil aerosol | 0,05 | 4 | 0,5 | 0,04 | | 0,0002 | 0,000004 |
| 3 | Sulfuric acid aerosol | 0,3 | 2 | 0,25 | 0,16 | | 9,9944 | 0,20 |
| 4 | Alkali aerosol | 0,01 | 3 | 0,33 | 0,01 | | 0,0081 | 0,0002 |
| 5 | Benz(a)pyrene | 0,000001 | 1 | 0,2 | 0,14 | | 0,0393 | 0,0008 |
| 6 | Nitrogen dioxide | 0,085 | 2 | 0,25 | 1,03 | - | 3483,5658 | 70,00 |
| 7 | Sulphur dioxide | 0,5 | 3 | 0,33 | 0,01 | | 21,1547 | 0,43 |
| 8 | Limestone | 0,03 | 3 | 0,33 | 0,24 | | 0,0142 | 0,0003 |
| 9 | Fuel oil ash | 0,002 | 2 | 0,25 | Cm<0,1* | | 0,0031 | 0,0001 |
| 10 | Manganese and compounds | 0,005 | 2 | 0,25 | 0,05 | | 0,0075 | 0,0002 |
| 11 | Nitrogen oxide | 0,6 | 3 | 0,33 | 0,03 | | 577,9607 | 11,61 |
| 12 | Iron oxide | 0,2 | 3 | 0,33 | 0,03 | | 0,1583 | 0,003 |
| 13 | Silicon oxide | 0,02 | 3 | 0,33 | 0,01 | | 0,0196 | 0,0004 |
| 14 | Carbon monoxide | 5 | 4 | 0,5 | 0,005 | | 874,4503 | 17,57 |
| 15 | Gasoline vapor | 5 | 4 | 0,5 | 0,13 | | 1,0347 | 0,02 |
| 16 | Abrasive dust | 0,04 | 3 | 0,33 | 0,08 | | 0,0007 | 0,00001 |
| 17 | Metal dust | 0,2 | 3 | 0,33 | 0,23 | | 0,0011 | 0,00002 |
| 18 | Hydrocarbons | 1 | 4 | 0,5 | 0,13 | | 5,9609 | 0,12 |
| 19 | Fluorides | 0,2 | 2 | 0,25 | 0,001 | | 0,0196 | 0,0004 |
| 20 | Hydrogen fluoride | 0,012 | 3 | 0,33 | 0,02 | | 0,0140 | 0,0003 |
| 21 | Hydrogen chloride | 0,2 | 2 | 0,25 | 0,04 | | 2,0563 | 0,04 |
| 22 | Sodium chloride | 0,5 | 3 | 0,33 | 0,02 | | 0,0142 | 0,0003 |
| | **Total** | | | | | | **4976,6268** | **100,00** |
| *- The total maximum concentration created by the emissions of this substance is less than the coefficient of expediency of calculations E3 = 0.1 (no emission calculation was made for this substance) | | | | | | | | |

Concentrations of all other pollutants meet the established requirements for the level of air pollution and do not exceed the quotas for pollutants of the relevant hazard class and enterprises located in the Navoi region.

Thus, the state of the atmospheric air in the zone of influence of the Navoi TPP JSC in accordance with the "Methodological guidelines on ecological and hygienic zoning of the territory of the Republic of Uzbekistan by the degree of hazard to public health" should be classified as moderately polluted, causing concern for public health.

The gross emission of pollutants during the operation of TPP equipment at maximum load, according to the previously performed calculations, is 4976.6268 tons/year. The main air pollutants are nitrogen dioxide (3483.5658 tons/year), accounting for 70.0% of the total emissions into the atmosphere, carbon oxide (874.4503 tons/year) - 17.57%, and nitrogen oxide (577.9607 tons/year) - 11.61%. The share of other 19 pollutants is 0.82%.

The list of substances polluting the atmosphere with emissions from the Navoi TPP in accordance with the current state is given below in Table 1.4.1.

To study the state of the atmospheric air, to identify the contribution by the Navoi TPP to the level of atmospheric pollution in the current state, the concentrations of pollutants produced by the enterprise emissions were calculated.

The calculation made out according to the program "Ecologist" on the area of 8×5 km with a step of 0.5 km, taking into account parameters of the sources of emissions of harmful substances, meteorological characteristics and coefficients determining the pollutant dispersion conditions and described in section 1.1.

The analysis of air pollution in the studied area showed that the highest concentrations outside the industrial site of Navoi TPP JSC had been formed by nitrogen dioxide emissions and amounted to 1.03 MPC, which exceeded the quota for 2 hazard class substances and enterprises located in the Navoi region by 4.12 times.

Concentrations of all other pollutants meet the established requirements for the level of air pollution and do not exceed the quotas for pollutants of the corresponding hazard class and enterprises located in the Navoi region.

Thus, the state of atmospheric air in the zone of influence of Navoi TPP JSC in accordance with the "Methodological guidelines on ecological and hygienic zoning of the territory of the Republic of Uzbekistan by the degree of hazard to public health" shall be classified as moderately polluted, causing concern for public health.

### *1.5 Surface water*

There are no surface watercourses in close proximity to the construction site of the 220/500 kV remote-mounted SWYD.

The hydrographic network of the area under consideration is represented by canals, small collectors, seasonal channels, and the Zerafshan River.

The distance from the construction site of the 220/500 kV remote-mounted SWYD to the Zerafshan river is 1.2 km.

The Zerafshan river is the largest surface watercourse in the area under consideration. In the past, the Zerafshan River was a tributary of the river Amu-Darya. Currently - Zerafshan is a drainless river. Its waters are used entirely for people's household needs.

In the area of Duguli village, the river overlooks a desert-sandy plain. Water collection of the mountainous part of the river is 11722 km².

The Zerafshan River basin extends in the latitudinal direction from east to west and is bounded by the Turkestan and Zerafshan ranges. The river has a length of 750 km.

After leaving the mountains, the river is divided into two branches: the northern - Akdarya and the southern - Karadarya. When entering the Zerafshan valley, the branches again merge into one channel, 60 km downstream from the confluence of the branches, the water intake of the Navoi TPP is located.

The Zerafshan River is fed by glaciers and snow. It is formed by the confluence of the rivers Matchi and Fandarya.

The waters of the Zerafshan River are used entirely to irrigate the land of Tajikistan, and Samarkand and Bukhara regions of Uzbekistan.

The flow of the Zerafshan River is largely regulated by the Katta-Kurgan Reservoir, built in 1947, with a capacity of 500 million m³.

Four irrigation canals take water from the Zarafshan River in the section from Zaatdin village to Navoi city: Kanimekh, Kalkon-Ata, Kasoba and Khanym with a maximum total withdrawal of up to 20 m³/h. The residual flow of the river of Zaravshan is used to fill the Kuymazar reservoir located below the thermal power plant. In its lower reaches the Zerafshan river belongs to low rivers. Throughout the length of the river to the city of Navoi, an intensive water intake takes place. The river flow, as in all glacier-fed rivers, depends on the season. Low flow (minimum flow) occurs from October to May. In June and July there is a flood, and in August-September there is a slow decline in the water level.

To date, the river's water balance in the annual course of time is close to long-term observations, and specifically depends on the amount of precipitation during a year.

There is a tendency to a decrease in the value of the minimum flow, which is associated with increased water intake for agricultural needs during the low-flow periods.

The chemical composition of Zerafshan river water is formed under the influence of pollutants coming with sewage water from industrial enterprises of the cities of Samarkand, Kattakurgan, Navoi and farmland. The qualitative composition of surface water also depends on the meteorological, hydrogeological and morphological characteristics of water. In recent decades, the intensive growth of industry in the region of the Zerafshan river valley, the development of desert lands has led to a change in the flow of the river. Long-term observations of the chemical composition of river water indicate a tendency to increase mineralization (the content of sulphates, chlorides, hardness salts), which contributes to the development of salt-like organisms in aquatic biocenoses that affect the periphyton values.

The analysis of the state of water in the Zerafshan river before wastewater discharges in the city of Navoi and after industrial discharges of the city's enterprises showed the following.

The maximum water flow occurs in July - August. The maximum temperature of 24°C at the approach to the city was observed in June, July. The minimum flow of water is observed in November, December, and October. The minimum water temperature falls in January, February. With a decrease in the flow of the river, the mineralization and, accordingly, the content of sulphates, chlorides, carbonates, the content of hardness salts (magnesium, calcium, sodium) increase sharply. Chemical pollution of water increases in the autumn-winter period. When approaching the city, water contains above the permissible values of ions of magnesium, calcium, sulfates, phenol, chromates, and iron. In some months, there is an increase in nitrites, metals (copper, zinc, etc.).

A water quality criterion is the water pollution index (WPI). When the WPI value is up to 1.0, water is considered clean. With 4>WPI> 2.5, water belongs to moderately polluted water of the third class of quality. At the gauging station before the city of Navoi, WPI is 8.5. This is due to the industrial indicators of industrial enterprises. Despite the pollution, water of the river Zerafshan is used for potable purposes of the city of Navoi and the region, since the quality of groundwater does not meet the potable water standards. Water quality after the city of Navoi is deteriorating. The concentration of suspended solids, magnesium, chlorides, sulphates, total hardness, total nitrogen increases, the content of oil products, iron, copper, zinc, chromium, surfactants, phenols increases slightly, the water temperature increases by 2-4°C with an average and maximum drain and up to 8 -9°C with a minimum flow (table 1.11).

**Table 1.11 Chemical composition of the river Zerafshan**

| Indicators | Unit of measurement | Section above Navoiazot | Section lower Navoiazot |
|---|---|---|---|
| Oxygen | mgO2/dm3 | 10,2 | 10,55 |
| BOD | mgO2/dm3 | 1,86 | 2,36 |
| COD | mgO2/dm3 | 12,59 | 14,32 |
| Ammonia nitrogen | mg/dm3 | 0,05 | 0,14 |
| Nitrite nitrogen | mg/dm3 | 0,019 | 0,037 |
| Nitrate nitrogen | mg/dm3 | 1,9 | 2,1 |
| Iron | mg/dm3 | 0,02 | 0,04 |
| Copper | mkg/dm3 | 1,1 | 1,0 |
| Zinc | mkg/dm3 | 1,6 | 2,2 |
| Chrome VI | mkg/dm3 | 1,0 | 1,0 |
| Phenols | mg/dm3 | 0,004 | 0,004 |
| Oil products | mg/dm3 | 0,02 | 0,02 |
| Synthetic surfactants | mg/dm3 | 0,0 | 0,0 |
| Suspended solids | mg/dm3 | 388,5 | 325,4 |
| Mineralization | mg/dm3 | 1234,5 | 1234,5 |
| * According to the Surface Water Quality Yearbook on the territory of Uzgidromet activities. | | | |

In their lower course, the waters of the Zerafshan River are characterized by a high content of suspended solids, especially during the flood period, a large mass of garbage passes along the river, the formation of which occurs due to rainwater flushing of rhizomes of cotton, bushes and other garbage from ploughed up river slopes developed for agricultural fields.

The highest turbidity reaches 11,000 to 13,000 g/m³ in the spring and summer period. The smallest is 32 g/m³ in the autumn-winter period.

Thus, the quality of the water flow of the Zerafshan river indicates a change in its chemical composition, temperature and hydrological regimes under the influence of effluents from industrial enterprises. The river waters in the area of the city of Navoi in terms of the content of petroleum products, phenol, heavy metal elements, and nitrites exceed the MAC. The salt content increases from year to year. The temperature rises and water flow somewhat

decreases. The Navoi TPP is one of the main contributors to chemical pollution, the temperature and hydrological characteristics of the Zerafshan river.

***1.6 Ground, groundwater***

Geomorphologically, the described area is located on the right bank of the Zeravshan river. This is a flat plain with a slight bias towards the river, refers to the Golodnostep sedimentation cycle.

Along the axial part the widespread valley of the river Zerafshan is cut by a modern riverbed which banks are morphologically well expressed by the ledges of the first and third above flood-plain terraces.

Absolute elevations range from 328.27 to 335.0. The height of the terrace ledge above the low-water horizon in the river is 6–7 m.

Within the area from the surface, a stratum of quaternary deposits is developed, underlain everywhere by continental tertiary deposits — a layer of interbedded sand, argillite clay, sandstones, and conglomerates. More ancient Paleozoic and Cretaceous rocks spread far beyond the industrial site.

Quaternary deposits of the Golodnostep complex are represented by alluvial-proluvial loams and sandy-brownish sandy loams, moist, dense, plastic, macroporous, imbedding as a layer with a thickness of 5-6 to 10 m and more, which decreases with distance from the river. Sandy cobbles with gravel and clay filler, with interlayers and lenses of sand, rotted rock and less often conglomerates, lie below. Pebbles are small, mostly flat, from shale, sandstone, limestone, etc. The gravel-pebble layer reaches 20-25 m and more.

Soil mineralization on average is 0.12 - 0.22%, in horizons of high salinity - 0.5 - 0.6% of dry matter.

From the surface, the relief of the site is complicated by ground dumps crossed by small sprinklers, and excavations for various hydraulic structures (settlers for various purposes).

The analysis of archive materials on the chemical composition of water extracts of soils has not revealed sharp fluctuations in their pH values (7.4-7.6), the total content of easily and moderately soluble salts in the hydrochloric acid extract ranges from 1.461 to 3.3%, gypsum - from 1,401 to 2,799%, therefore the soils are non-saline.

Hydrogeological conditions of the area are complex due to geological, climatic and agricultural factors.

The water-bearing complex of Cretaceous-Paleogene (Upper Cretaceous-Paleocene) sediments is represented by sandstones and limestones with clay and siltstone interlayers. The

group of streams of proluvial-alluvial deposits of foothill plains with a depression curve of a structural-lithological backwater. The area is with a positive salt balance.

Hydrogeological conditions are characterized by the development of groundwater, confined to the quaternary sediments of the Zerafshan river valley. Within the study area, the type of feeding is snow and rain, and in addition, groundwater receives additional feeding due to infiltration of irrigation water. A genetic type of groundwater regime is irrigation-hydrological, riverine, and drainage.

Since the area of the plant is in the field of intensive development for irrigated agriculture, the fluctuation of the groundwater level is seasonal and depends on the frequency of irrigation of agricultural crops. The maximum level is observed in the summer period and is 3–5 m, being increased as it approaches the river.

Groundwater salinity is increased and varies from 3.4 to 9.2 g/dm³. The type of mineralization is sodium sulphate.

The filtration ratio of clay rocks varies from 0.0045 to 0.2 m/day, for pebble rocks - from 1.09 to 6.84 m/day.

The surface of the groundwater mirror has slight slopes, and is generally identical with the general slope of the relief. During the period of intensive irrigation, the groundwater level rises, water flows into the river and are drained everywhere in the riverbed. When the groundwater level drops, the reverse process takes place, so groundwater in the study area has a hydraulic connection with the surface water of the river, the groundwater flow varies depending on seasonal conditions, or it pinches into the river or is fed from it.

The lithological structure of the plant area is as follows: bulk soil with a thickness of 1 to 7 m lies on the surface and represents a disorderly mixture of loam, pebble, construction debris. Bulk soils are underlain by loams with rare inclusions of sand lenses with fragments of rotted rock. The thickness of the layer ranges from 4 to 9 m. In this layer there are also sandy loam and sands with rare inclusions of gravel. Clay soils, as a rule, lie above the groundwater level.

They are underlain by gravel-pebble sediments that form the aquifer. The revealed thickness of these deposits varies from 1.9 to 9 m. This layer contains conglomerate lenses.

The groundwater in the area of the plant has a high salinity. Dense residue ranges from 1190 to 2808 mg/dm³, rarely 3602 mg/dm³. The type of mineralization is sulphate-sodium with $SO_4^{2-}$ content of up to 2164 mg/dm³. The depth of groundwater varies depending on the nature of the relief and the season of the year.

The chemical composition of groundwater indicates its high mineralization and its classification as sulphate.

***1.7 Soil, vegetation and wildlife***

The construction site of the 220/500 kV remote-mounted SWYD at the Navoi TPP is located on light sierozem soils and sierozem on loess loams. Sierozem soils are gypsum-bearing, as they develop on the gypsum-bearing weathering crust. The soils of the study area are characterized by a neutral and slightly alkaline medium with a pH value of 7.1–7.6, and a low content of humus (1–2%).

Soil solutions are characterized by an excess of calcium ions, sulfates and carbonates, the latter accumulate in the long dry season and increase due to emissions and discharges of enterprises of the Navoi industrial zone. In the elemental composition of the soil, not only an increased content of calcium, sulfur, but also iron is found. These elements can bind toxic substances present in the emissions of enterprises.

In the soils of the study area, there is a high content of calcium, sulfur, iron, arsenic, lead, strontium and barium in comparison with the regional background - the Central Asian sierozems.

The geochemical anomalous nature of the listed microelements is confirmed by an increase in concentrations with depth and not towards the surface, as happens in the case of man-made pollution. In addition, the increased content of strontium and barium (from 330 to 1300 mg/kg) go along with an increase in calcium content in the horizons enriched with carbonates and sulphates at a depth of 10-30 and 20-50 cm. Thus, the concentration of many elements can be associated with a carbonate alkaline barrier.

The phosphorus content in soils is low (0.15 - 0.2%), moreover, due to the high carbonate content, it is contained mainly in the form of sparingly soluble and insoluble calcium phosphates. In the soil there is a lack of nitrogen (0.02 -0.07%). But the gross amount of calcium in irrigated sierozem reaches significant values - 2% or more. The main part of it is silicates, and exchangeable and water-soluble potassium is less than 1%. The upper soil layers are enriched with water-soluble calcium and magnesium salts.

In the study area there is no clear distinction between soil horizons due to the frequent displacement of the upper horizons during planning operations in the construction of communications and roads.

The mechanical impact on the soil cover in the study area is expressed in shallow recesses, which either overgrow or serve as a waste deposit for various garbage. The greatest

deformation of the soil cover is observed on unorganized crossings, which contributes to the violation of integrity and dusting of the underlying surface.

The vegetation cover at the construction site of the 220/500 kV remote-mounted SWYD is represented by wheat and cotton plantings, around the territory of the designed SWYD there are ephemeroid and wormwood communities, as well as agricultural crops along roads and canals in the territory of residential settlements.

Natural full-member communities of ephemeroid-absinthic communities with significant participation of bluegrass, awn, annual astragalus, foxtail, and iris are preserved in the areas near roads. However, being used for unorganized grazing of livestock, they are largely enriched with weed species: harmel peganum, cousinia, and saltworts.

Halophytic and meadow coenoses with tamarisk and alhagi are noted in the depressions; and single reeds can be met. The rest of the space is occupied by a rarefied group of annual saltworts, indicating superficial salinization of the soil.

Plantings of mulberry, poplars, and plane trees are observed along roads and canals, along numerous fields.

Among the tree species located at a distance of 330 to 815 m from the construction site of Urgench, Metan and Pakhtakor villages there is a variety of gas-resistant species: white mulberry, Siberian elm, Bollé poplar and Canadian poplar, oleaster. From among the mid-gas-resistant ones, box-elder and white willow are planted, from gas-resistant ones - Pennsylvanian ash, sycamore tree, English oak, and stone fruit trees - peaches, cherry, apricot. In addition, there are artificial plantings of grapes, roses and other decorative flowers. Regular watering and care favorably affect the condition of the plants, although, according to evidence of archive materials, insignificant focal necrosis was found on the leaves of trees growing on the territory of the TPP in visual inspection, and considerable amount of necrotic sites indicating exposure to atmospheric pollutants was found in plant samples selected near the Navoi TPP.

The most significant violations of the leaf surface were observed in ash, sycamore, acacia in artificial plantings in close proximity to the TPP. The detected areas of destruction of cell walls on both sides of the epidermis of the leaves, gray granules between the cells indicate the effect of gas and dust pollution on the morphological and anatomical structure of leaves of trees, shrubs and herbs.

The analysis of archive materials also revealed in the samples of plants taken from four sides of the TPP near the territory (200–300 m) and at a distance of 1 km, and studied using the spectral analysis method in the vegetative part of such species as annual saltwort and harmel

peganum, the increased Cr concentration compared with the regional level by 10 times or more, and the maximum allowable – by 40 or more times. Significant Cu and Ni increased concentrations were also detected (by 2-4 times higher than permitted).

When analyzing the samples, the following pattern was revealed: from the north and east of the TPP, the metal content in plant samples is much higher near the territory than at a distance, and in the southern and western directions, on the contrary, the concentration of metals near the territory is lower than at a distance. The analysis performed allows us qualifying the state of the soil and vegetation around the TPP as characteristic of the zone with a tense environmental situation.

There are no species of plants listed in the Red Book, either on the territory of the site for the construction of the 220/500 kV remote-mounted SWYD or close to it.

There are no lands for environmental protection or any nature reserve fund near the construction site.

Among the animals settling in the study area characterized by significant dust and noise levels, only those groups can be mentioned that can hide from the noise impact of the Navoi TPP and vehicles. In the soil, they are insects (winter-annual and cotton budworm, beet borer, red spider) and reptiles (desert lidless skink, rapid french-toed lizard, water snake, Central Asian tortoise), or the species that can quickly leave unfavorable areas, such as birds (tree sparrow, laughing dove, common starling, barn swallow, red-rumped swallow, black swift, mynah, magpie). In the areas with stagnant or running water, such amphibians as toads and frogs settle. From among the mammals, there are house mouse, mole lemming, common bat, tamarisk gerbil, eared hedgehog, and scilly shrew.

The modern composition of ichthyofauna of the river Zerafshan is represented by 30 species belonging to seven bloodlines, of which cyprinoid fishes are most widely represented one (19 species). Six species of loaches were found, and one species of catfish, livebearers, snakehead, darters and poachers. The ichthyofauna is represented mainly by local commercial species, however, there are also acclimatized commercial (white and black amur, tench, eastern bream, goldfish, silver and big-head carp, pike-perch) and accidentally imported non-commercial species (rhinogobius, Balkhash perch, Triplophysa strauchii, Korean and common sawbelly).

Thus, soil pollution in the area under consideration is moderate, flora and fauna are permissible.

## 2 Socio-economic conditions

At present, the Navoi TPP JSC provides electricity and heat to consumers in the Navoi, Bukhara and Samarkand regions and the population of the city of Navoi.

To ensure reliable and continuous electricity and heat supply to enterprises, as well as to improve the environmental situation in the zone of influence of the Navoi TPP, it is necessary to create their own sources of power control. This problem can be solved by building the third and fourth J class combined-cycle gas turbine plant with a total capacity of 1,300 MW.

To supply power from CCGT Units No. 3,4, it is planned to build a 220 kV overhead line to the projected 220/500 kV remote-mounted SWYD at the Navoi TPP.

The work on implementation of the project for construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP will partially solve the problem of employment of the population, including unskilled labor, and workers, dispatchers, drivers, etc. from among the local population, in particular.

Employment under the project is not limited to the direct presentation of jobs. There will also be indirect incomes and employment of the population associated with the purchase of goods by the contractors and payment for services. There will also be employment created by personal expenses of the project staff, but its scale will be insignificant. The other side of the emergence of opportunities for significant local purchases and businesses based on the implementation of this project is the influx of people from other parts of the region, which can provide a noticeable development of the local economy.

Thus, the main part of the socio-economic impacts associated with the construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP will be positive.

Mitigation measures shall be taken to reduce negative impacts to a minimum, and the positive effects need to be extended. To this end, the following measures will be taken:

- construction operations will be managed so as to minimize the inevitable and short-term effects (smoke, noise, vibration, dust, dirt, delays, accidents) of construction operations on local residents and other road users;

- operations will be managed so as to minimize the impact on the local residents, in particular, time limits for noisy work during the daytime hours will be introduced and a schedule of delivery of materials will be made in order to avoid traffic violations;

- local employees will be given the opportunity to learn and master new technologies;

- deliveries of the main equipment will be made from abroad.

Resettlement due to the planned construction is not expected.

Implementation of this project in conjunction with the scheduled construction of the 220 kV overhead transmission line in the region (in 500 kV dimensions) to the Besopan Substation and the construction of the 500 kV Muruntau Substation will provide a reliable source of power for the NMMC in full, will give a great socio-economic effect for the NMMC, whish is a large industrial enterprise, for Uchkuduk - Zerafshan energy unit, and for the whole republic, it will allow reducing the power deficit in the Republic of Karakalpakstan, Khorezm, Bukhara and Navoi regions.

# 3 Environmental analysis of the design solution

## *3.1. Characteristics of technical solutions*

The construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP is necessary to generate power from the proposed newly constructed CCGT Units No. 3.4 and to connect the designed 220 kV transmission line from CCGT Units No. 3.4 to the 220/500 kV remote-mounted SWYD at the Navoi TPP.

All the technical solutions described below for the construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP are preliminary and will be refined during further design.

On the territory of the 220/500 kV remote-mounted SWYD, the following buildings and structures are envisaged:

- 500kV SWYD;
- 200kV SWYD;
- substation control house;
- autotransformer 167000/500/220-U1 - 6 pieces;
- reactor RODC 60000/500-U1 - 3 pcs;
- closed switchgear – 10kV with reactor chambers - 2 pcs;
- ZVN – 3 pcs;
- room 05;
- closed warehouse;
- control room of oil facilities – 4 pcs;
- open oil storage;
- fire fighting pumping station;
- 2x100 m3 water storage tanks;
- pumping station above the well;
- water tower;
- valve switching chamber;
- corridor;
- oil collector with a capacity of 200 m3;
- oil collector with a capacity of 100 m3;
- diesel-engine building;
- antenna support;
- cesspool with a capacity of 18$m^3$;
- outhouse for one point;

- free standing lightning rods;
- observation tower (4 pcs);
- mushroom knob (11 pcs);
- dead-end support for 500 kV transmission line;
- dead-end support for 200 kV transmission line.

Equipment of the 500 kV SWYD with 5 cells:

- 500kV circuit breakers;
- 500kV disconnecting devices;
- current transformers (CT) 500 kV - 15 pcs;
- voltage transformers (VT) 500 kV - 3 pcs;
- surge arresters 500 kV;
- coupling capacitors and HF barriers 500 kV.

Equipment of the 220 kV SWYD with 14 cells includes:

- 220kV circuit breakers;
- 220kV disconnecting devices;
- current transformers (CT) 220 kV - 36 pcs;
- voltage transformers (VT) 220 kV - 3 pcs;
- surge arresters 220 kV;
- coupling capacitors and HF barriers 220 kV.

The following is also envisaged:

1. Security lighting and alarm around the perimeter of the territory;
2. Working light;
3. Lightning protection and grounding;
4. Arrangement of highways;
5. Construction of cable channels and oil drains;
6. Measures to protect operational personnel from electric field effects (bioprotection).

For the reactors installed, it is required to arrange an automatic fire extinguishing system with the construction of a free-standing chamber for switching valves and a wiring network.

PET installation for heating the relay room is envisaged.

In accordance with modern requirements for the storage of tanks (cylinders) with SF6 gas in the territory of the substation, an auxiliary 6×6 m building with exhaust ventilation is provided.

The project provides for modern floodlighting taking into account the required standards of illumination.

Relay protection. Protection and automation of equipment of the 220/500 kV remote-mounted SWYD is performed in accordance with the Electrical Installation Code.

There are protection and devices performed in cabinets using microprocessor equipment, namely:

- phase comparison protection with a set of stepped protection devices and one-phase automatic reclose;

- a set of step protection devices: additional current cut-off, three-stage remote directional protection and four-stage current directional protection against earth faults with the function of remote acceleration and remote disconnection through command transmission equipment (UPASK) and one-phase automatic reclose;

- Breakers Control Automation (BCA) and breaker failure protection (BFP);

- fault locator;

The followings are provided to protect a 500 kV shunt reactor:

- longitudinal and transverse differential current protection;

- gas protection;

- BCA;

- BFP;

- input insulation testing (IIT);

- reactor automatic fire extinguishing;

- reactor circulating cooling.

Also, a 220 kV overhead line and reactor control panel, a 220 kV overhead line VT cabinet, and a power cabinet with operating current are provided for.

Automatic protective devices. The following devices are provided:

To control the amount of active power flow in the pre-emergency mode, a previous mode controlling device is provided for at the 220/500 kV SWYD.

To select control actions, there is an automatic action adjustment device (AAA) to select the necessary control actions (CA) upon the emergency shutdown of the 220 kV overhead line from the PMC. CA is selected based on the PMC.

To prevent and eliminate the increase in voltage that occurs when the line is disconnected unilaterally, it is necessary to install automatic surge protection devices (ASPD). The devices must act to turn on the linear reactors and, if the voltage is still high, to turn off the overhead transmission line with a remote disconnection signal transmitted to the opposite end of the line.

To monitor, accumulate and present information about the process of occurrence, development and liquidation of emergency situations on electrical equipment of the 220/500 kV SWYD, installation of an electrical event recorder (EER) is provided.

Automated information and measuring system of commercial energy metering. In accordance with Guidance Document RD RUz34-351-661-2010 "Energy accounting in its production, transmission and distribution in the Uzbek power system" the designed automated information and measuring system of commercial energy metering should include electricity meters.

Remote control engineering of the 220/500 kV SWYD is provided for process supervisory control. The required amount of telecommunication information is determined in accordance with the methodological guidelines named “Choosing information volumes, designing information collection and transmission systems in a uniform electric power system” RH 34-115-138: 2011.

Remote control engineering is carried out with the help of a modern software and hardware complex (SHC) based on an industrial telemechanic controller, with a set of digital multifunctional measuring transducers PM130P/PM175, in industrial rack cabinets NKU IP54. The project outlines the organization of communication channels, relay protection and emergency control automation.

Power supply to Dispatch Telecontrol System (DTS). The reliability and quality of power supply to the DTS modern equipment which uses digital signal processing technologies, are subject to specific requirements, due to the fact that the presence of sharp or short-term voltage drops lasting more than 100 ms causes the transfer system to fail for the time of the self-test (1 to 3 minutes) or “freeze”. In addition, fluctuations with a significant supply voltage increase in emergency situations disable the static power supply units which fact requires significant costs to restore the equipment in general.

In world practice, UPS devices are used to eliminate the effect of poor-quality power supplies on equipment.

The use of SF6 circuit breakers on the 220/500 kV remote-mounted SWYD instead of oil and air switches widely used on the existing substations will allow eliminating emissions of nitrogen dioxide and oil vapors from the switches.

The SF6 circuit breakers, in comparison with air circuit breakers, offer a number of advantages: the ability to be applied to all classes of voltages over 1 kV, high disconnecting ability, low wear of arcing contacts, the ability to create series with unified nodes, reliable

disconnection of small inductive and capacitive currents when the current passes zero without a cutoff and occurrence of overvoltages. No less important indicators are relatively small dimensions and weight, fire and explosion safety, as well as suitability for outdoor and indoor installation, the absence of emissions into the atmosphere, speed of action and silent operation.

Maintenance of SF6 circuit breakers, compared to air circuit breakers, is much easier. Air circuit breakers require great attention such as regular removal of condensate that has accumulated in them, strict control over temperature conditions, purging of the air distribution network with compressed air of working pressure, testing for shutdown and switching on at nominal and minimum allowable pressure, air cleaning from mechanical impurities. After the project is implemented, personnel will have to monitor the SF6 pressure in the switch tanks to prevent SF6 excessive leaks and reduction of electric strength of the insulating gaps possible in these cases. Pressure is controlled according to pressure gauge readings. A special alarm device will immediately alert the staff about a sudden appearance of SF6 leaks.

SF6 circuit breakers have a longer service life and a longer turnaround time.

In the SF6 circuit breakers installed, SF6 is used in arc control devices as an insulating medium - an electrical gas which is sulfur hexafluoride SF6.

At operating pressures and ordinary temperature, SF6 gas is a colorless gas, odorless, non-toxic, non-flammable, 5 times heavier than air (density is 6.7 vs 1.29 for air), the molecular weight is also 5 times greater than that of air.

SF6 does not age, that is, it does not change its properties over time, it disintegrates during electric discharge, but quickly recombines, restoring the original dielectric strength.

At temperatures of up to 1000 K, SF6 gas is inert and heat-resistant, at temperatures of about up to 500 K it is chemically inactive and not aggressive with respect to the metals used in the construction of SF6 switchgears. Chemically, SF6 gas is also inactive with respect to other substances, as well as nitrogen.

In an electric field, SF6 has the ability to capture electrons which leads to high electrical strength of SF6 gas. Capturing the electrons SF6 gas forms sluggish ions which slowly disperse in the electric field.

The high dielectric strength of SF6 gas allows reducing insulation distances with a small working gas pressure, as a result of which the weight and dimensions of the electrical equipment are reduced. This, in turn, makes it possible to reduce dimensions of GIS cells.

The high dielectric strength of SF6 gas provides a high degree of insulation with minimal dimensions and distances, and good arc blowout ability and cooling capacity of SF6 gas increase the switching capacity of switching devices and reduce heating of current-carrying parts.

All other things being equal, the use of SF6 allows increasing the current load by 25% and the permissible temperature of copper contacts up to 90°C (75°C in the air) due to chemical resistance, incombustibility, fire safety and greater cooling capacity of SF6 gas.

In its natural state, SF6 gas is supplied and stored in pressure tanks (cylinders or spherical containers) under a pressure of approximately 20 bar at 20°C (in a liquefied state) and complies with IEC 376.

Modern SF6 circuit breakers are equipped with instruments that control SF6 leakage which volume is insignificant (the average leakage value is about 1% of gas volume per year).

During service life of the SF6 circuit breakers, SF6 gas can be observed not only in clean but also in contaminated state:

- the use of new SF6 gas for fueling or refueling switches;
- leakage under normal operating conditions;
- maintenance including opening of switches containing old gas (decomposition products);
- abnormal situations (internal arcing ground leading to protection destruction);
- switch dismantling the end of its service life.

Under normal operating conditions, gas leaks are very insignificant and non-essential, even if the gas contains impurities (due to regenerating filters installed in the switch).

The SF6 gas decomposition products during arc blowout $S_2F_{10}$ (solid fluorides) are trapped by special absorption filters installed in the switch chambers. Therefore, the impact of the SF6 decomposition products on the environment is excluded.

It should be noted that despite belonging to fluorides, SF6 gas is not included in the list of substances to be banned or restricted in use. In addition, the total contribution of SF6 gas to the greenhouse effect of the atmosphere does not exceed 0.2% (the share of SF6 gas of electrical equipment is much smaller).

The switchgear equipment is a source of noise and electromagnetic effects on the environment.

To reduce the noise level generated by transformers, the construction of noise protection screens is not foreseen due to the remote location of the remote-mounted switchyard territory from the residential development. There are no permanent jobs on the territory of the switchyard, except for the checkpoint, where, due to the distance from the transformers, the noise level will

meet the standards established in the territory of Uzbekistan and will not exceed 80 dBA according to San PiN №0325-16 “Sanitary norms of permissible noise levels at workplaces”.

During the operation of SF6 circuit breakers, a lower level of acoustic noise is expected compared to air circuit breakers due to a small number of moving elements available.

The control of 500, 220 kV switches and 10 kV main switches is provided from the control panel located in the substation control building (SCB).

Relay protection and automation of elements of the remote-mounted switchgear is performed in accordance with the Electrical Installation Code.

To ensure security measures within the SWYD territory, a free strip of 5.0 m wide is provided along the perimeter of the external fence.

Removal of surface water is designed as an open system with the release of storm water outside the fence onto lowered relief areas. The project provides for a small irrigation network with reinforced concrete trays.

Intra-site roads and paved sites are designed at the site of the remote-mounted SWYD. The width of the roadway is 3.5-4.5 m.

The remote-mounted SWYD area free from construction is filled with rubble.

The source of water supply to the switchyard is its own well. Water is supplied for household purposes and for replenishment of the fire fighting reservoirs by separate inputs.

Considering 5 people of staff and 25 l/day as a rate of consumption per worker in accordance with clause 31 of Appendix 3 to KMK 2.04.01 - 98 "Internal water supply and sewerage of buildings", water consumption for household purposes will be: 5x25 = 125 l/day, 0.125 m3/day, 0.0052 m3/h, 45.625 m3/year.

Water consumption for shower will be: 500 l/day for 1 shower head per shift in accordance with clause 29 of Appendix 3 to KMK 2.04.01 - 98, for three-shift operation: 0.5 m3 x3 = 1.5 m3/day, 547.5 m3/year.

The total consumption of artesian water on the territory of the switchyard will be: 45,625 + 547.5 = 593.125 m3/year, 1.625 m3/day.

Fire extinguishing is performed with two D 320 pumps located at the fire extinguishing pumping station, by taking water from two fire fighting water tanks and feeding it into the fire-fighting network of the switchgear site.

Fire extinguishing of transformers is automatic with the arrangement of valve switching chambers and piping around transformers.

Fire extinguishing of transformers is performed in 30 minutes by triple switching on. Irrigation intensity is 0.2 l / cm2.

The minimum water reserve in two tanks is 200 m3.

The volume of wastewater from sanitary facilities and showers is 593.125 m3/year, 1.625 m3/day. Wastewater is discharged into a cesspit of 18 m3 through a gravity network followed by removal of household wastewater to the district treatment facilities under an agreement with the Central State Sanitary Epidemiological Service.

To prevent oil spreading and fire spread in case of an accident there are oil outlets from the oil-filled equipment.

Oil and water are discharged through the oil outlets into two tanks for emergency oil discharge (200 and 100 m3 in volume), which are designed for the full volume of oil of the most capacious autotransformer and 80% of the water volume from the automatic fire extinguishing installation. The oil outlets are made from asbestos-cement pressure pipes.

In the buildings located at the SWYD site the heating is electric. Electric furnaces are used as heating devices.

Automobile entry and driveways are provided on the territory of the remote-mounted SWYD, ensuring the access for fire engines to any structure.

An entrance with a platform is arranged to the water tanks used for fire extinguishing. The buildings and structures have access to fire engines. Roads and entrances to buildings and structures are designed with carriageways 3.5 and 4.5 m wide.

Electrical safety on the territory of the switchyard is provided by:

- protective grounding;
- breaks to current-carrying parts;
- locking of device safety;
- protective fencing;
- insulation control;
- warning alarm;
- inscriptions and posters;
- individual and group protective equipment.

Stage of construction. Excavation of pits is carried out by an excavator with a bulldozer moving the soil. When cleaning the foundation pits, part of the soil is left on the edge, and then used for backfilling. Excess soil is carried from the site to the dump.

Prior to the commencement of works on the construction of buildings and structures, excavating operations should be completed, passages and engineering communications necessary for the construction period should be organized and laid.

The construction of the 220/500 kV remote-mounted SWYD does not have volumes with untapped job practices and does not require special equipment and appliances.

All building, installation and special operations for the construction of the 220/500 kV remote-mounted SWYD should be carried out according to the standard planning sheets and rules applicable in electrical grid construction, in accordance with KMK 3.01.02-00 "Safety engineering in construction", "Instructions for designing fire protection of energy enterprises" and other regulatory documents.

***3.3. Identification of sources of environmental impacts***

Stage of operation. The analysis of design solutions showed that the sources of pollutant emissions into the atmosphere during the operation of the 220/500 kV SWYD equipment were oil-filled equipment (autotransformers, reactors, current and voltage transformers), through which leakages oil hydrocarbons were emitted, as well as during discharge/filling of transformer oil during its replacement, performed once in 18 - 20 years. In addition, when carrying out repair operations on the territory of the switchgear, electric welding operations were carried out using one electric welding apparatus. When conducting electric welding operations, iron oxide and manganese compounds will be emitted into the atmosphere.

Emissions of pollutants on the territory of the 220/500 kV switchgear are unorganized.

Parameters of emission sources on the territory of the 220/500 kV switchgear are given in Appendix 3 (Table 3.1).

The 220/500 kV switchgear equipment is also a source of noise and electromagnetic effects on the environment.

Stage of construction. During construction works, the environmental impact is determined by:

- air pollution by exhaust gases of motor vehicles and construction equipment used in the delivery of equipment and building materials, during construction and installation operations on the construction of foundations and installation of equipment; inorganic dust during excavating operations; iron oxide, manganese compounds during welding; vapors of organic solvents, aerosols of paints and varnishes when carrying out painting operations; nitrogen oxides, soot, sulfur dioxide, carbon monoxide during diesel generator’s operation. I.e. emissions mainly come

from mobile vehicles and unorganized sources. The parameters of emission sources are given in Table 3.2 (Appendix 3). There are no stationary organized emission sources;

- noise and vibration effects of building mechanisms;

- seizure of land resources for temporary use to accommodate building structures, platforms for storing building materials and waste generated during construction operations;

According to the list of main motor vehicles and mechanisms used in the construction of the 220/500 kV switchgear (table 3.1), 11 diesel and gasoline-operated units of the main motor vehicles and building mechanisms of various capacity and power will be used to carry out construction operations related to the emission of air pollutants.

**Table 3.1 List of main motor vehicles and mechanisms used in the construction of the 220kV transmission line at the 220/500 kV switchgear at the Navoi TPP**

| Item No. | Name of motor vehicle (mechanism) | Type of fuel | Carrying capacity (power) |
|---|---|---|---|
| 1. | Automobile KRAZ, 1 pc. | diesel fuel | 7 tons |
| 2. | Forklift truck, 1 pc. | diesel fuel | 5 tons |
| 3. | Bulldozer, T-100, 1 pc. | diesel fuel | 79kW |
| 4. | Mobile compressor, ZIF-55, 1pc. | diesel fuel | 35kW |
| 5. | Truck-mounted crane, KS-4501, 1 pc. | diesel fuel | 10 tons |
| 6. | Crawler crane, 1pc. | diesel fuel | 16 tons |
| 7. | Watering and cleaning truck, 1 pc. | gasoline | 6000l |
| 8. | Drilling machine MRK-750, 1pc. | diesel fuel | 79kW |
| 9. | Tractor truck, 1 pc. | diesel fuel | 15 tons |
| 10. | One-bucket crawler excavator, 1 pc. | diesel fuel | 0.5m3 |
| 11. | Mobile power station, 1 pc. | diesel fuel | |

The list of raw and other materials which use of during construction operations will lead to the emissions of pollutants into the atmosphere is presented in Table 3.2.

**Table 3.2 List of raw and other materials used in the construction of the 220kV transmission line at the 220/500 kV switchgear at the Navoi TPP**

| Item | Name | Unit of | Quantity |
|---|---|---|---|

| No. | | measurement | |
|---|---|---|---|
| | **Painting operations** | | |
| 1. | R60 Solvent | t | 0.018 |
| 2. | Mastic compound | t | 1.2 |
| 3. | Enamel PF-115 | t | 0.03 |
| 4. | Paint BT-117, silver | t | 0.182 |
| 5. | Oil-based paint, nitroenamel | t | 0.021 |
| | **Installation of supports** | | |
| 6. | Heave concrete | m3 | 4.2 |
| 7. | Sand | m3 | 45 |
| 8. | Rubble | m3 | 122.5 |
| 9. | Sand and gravel mixture | m3 | 58.8 |

In total, during the construction of the overhead transmission line, 13 types of pollutants will enter the atmosphere, as listed in Table 3.1 of Appendix 3.

During construction operations, 7 types of waste are generated, including:

III hazard class - 1;

IV hazard class – 5.

Sources of waste are:

- construction operations;

- cleaning of temporary premises and construction sites.

Waste generated during construction works are waste of metal, concrete, reinforced concrete (IV hazard class), waste paint, cleaning materials contaminated with oils (oil content less than 15%, III hazard class), waste of mixtures of heterogeneous hardened plastics (container from paint, IV), SMW (unsorted garbage from temporary household premises, excluding large-sized, IV).

Waste generation norms are determined on actual basis. Specially arranged places and tanks are provided for the collection and temporary storage of waste.

The building contractor-organization collects and temporarily stores SMW and industrial waste generated during construction works in specially equipped places with subsequent removal for disposal by specialized organizations in accordance with the concluded agreements. The

contractor-organization being a general contractor is fully responsible to the customer and the inspecting authorities for the sanitary-epidemiological and environmental situation.

The impact on the environment with the application of measures to organize the collection and disposal of waste during construction works will have a small probability.

## 4 Analysis of impacts on the environment

### *4.1. Addition of pollutants*

Stage of operation. During the electrical equipment operation on the territory of the 220/500 kV remote-mounted SWYD at the Navoi TPP, the emission of oil hydrocarbons from non-densities occurs during operation of the oil-filled equipment (autotransformers, current transformers, voltage transformers, reactors).

Oil is topped up to compensate for the loss of oil hydrocarbons due to evaporation from non-densities. The emission of hydrocarbons into the atmosphere is not organized.

The amount of emissions in the evaporation from the oil-filled equipment in accordance with [6] was calculated by the formula:

$$П_р = 4{,}46 V_{ж^р} P_{S(38)} M_n (K_{5x} + K_{5T}) (K_6 K_7 (1 - \eta) \cdot 10^{-9},$$

where:

$V_{ж^р}$ - annual volume of liquid poured (m³/year);

$P_{S(38)}$ - vapor pressure of liquid at a temperature of 38°C (hPa);.

$M_n$ - molecular weight of liquid vapor;

$K_6$ - coefficient depending on the pressure of saturated vapor and climatic zone;

$K_7$ - coefficient depending on the technical equipment and mode of operation;

$P_{S(38)}$ determination

The value of the saturated vapor pressure $P_{S(38)}$ for multicomponent liquids (oil and oil products) is taken depending on the values of the equivalent initial boiling point of the liquid ($t_{eq}$, °C), is determined by the formula:

$$t_{eq} = t_{nk} + (t_{kk} - t_{nk})/8{,}8,$$

where:

$t_{nk}$ and $t_{kk}$ – temperature of the beginning and end of boiling of multicomponent liquid (°C) respectively

Oil:

$t_{nk}$ – 300 °C
$t_{kk}$ – 400 °C
$t_{eq}$ = 300+(400-300)/8,8 =311 °C,

that complies with $P_{S(38)}$ - 0,0023 hPa

Molecular weight of oil products $M_n$

For oil products, the average molecular weight of vapor is taken depending on the initial boiling point of this mixture.

Oil

$t_{nk}$ – 300 °C

$M_n$ – 237,5 g/mol

Determination of $K_5$ coefficient

For ground metal unheated tanks, the temperature for the six coldest months is determined by the formula:

$t_{г.х}^{р} = K_{1х} + K_{2х}t_{ах} + K_{3}t_{жх}^{р}$ ,

and for the six warmest months, according to the formula:

$t_{г.х}^{р} = K_4(K_{1т}+K_{2т}t_{ат} + K_{3}t_{жх}^{р}$, where:

$t_{ах}$ and $t_{ат}$ - arithmetic average values of the temperature of atmospheric air for the six coldest and six warmest months of the year (°C) respectively;

$K_{1т}$, $K_{2т}$, $K_{3т}$, and $K_{1х}$, $K_{2х}$, $K_{3х}$ are coefficients for 6 warm and cold months;

$K_4$ - for ground metal unheated tanks is taken depending on the color of the tank surface and the climatic zone;

$t_{жт}^{р}$, $t_{жх}^{р}$ - the average temperature of oil products in six warm and six cold months.

Oil temperature at systematic loads - 105°C.

$K_5$ coefficient

Oil

$K_{5х}$ – 412,1
$K_{5т}$ – 412,1

Determination of $K_7$ coefficient

The tank is equipped with a breathing valve - 1 unit.

Oil density - 0,8413 t/m³

| | | |
|---|---|---|
| Oil consumption after project implementation | t/year | m3/year |
| | 270,0 | 320,932 |
| storage time | 8760 | h/year |
| | 0,00090 | kg/h |
| Emissions after project implementation | g/s | kg/h |

| | | |
|---|---|---|
| Hydrocarbons | 0,00025 | 0,0078 |

I.e. emissions of pollutants from the main equipment of the 220/500 kV SWYD are insignificant.

The emission of pollutants on the territory of the 220/500 kV SWYD also occurs as a result of the operation of the electric welding machine.

Manual electric arc welding station ensures the implementation of current and capital repairs of machinery and equipment. The welding machine consumes 50 kg per year of ANO-4 electrodes on average.

On average, 0.3 kg of electrodes are burned in one hour of operation. The duration of welding operations is 200 hours per year.

According to table 1.12.1 [5], specific emissions from electric arc welding are: iron oxide - 5.41 g/kg, manganese dioxide - 0.59 g/kg.

Emissions from the welding station are:

Iron oxide = 5.41 × 0.3/3600 = 0.0005 g/s or 0.0003 t/year;

Manganese dioxide = 0.59 × 0.3/3600 = 0.00005 g/s or 0.00003 t/year.

Emission source is non-organized:

H = 2.0 m; D = 0.56 m; V = 1.8 m/s; Q = 0.443 m³/s; T = 24°C.

The gross emission of pollutants from sources of the 220/500 kV remote-mounted SWYD at the Navoi TPP will be 0.0081 t/year.

To determine the level of impact of 220/500 kV SWYD emissions on the atmospheric air, pollutant concentrations were calculated using the “Ecologist” program on an area of 1.8 × 1.8 km with a step of 0.1 km. Technical data of emission sources, meteorological characteristics and coefficients that determine the nature of dispersion of chemicals in the atmosphere of the area of the 220/500 kV SWYD were used as initial data.

The analysis of the dispersion calculations showed that the maximum concentrations of hydrocarbons, iron oxide and manganese compounds created by emissions of 220/500 kV SWYD sources made up trace amounts and did not exceed the quotas approved by the State Ecology Committee of Uzbekistan (table 4.1).

**Table 4.1 Characteristics of air pollutants during operation of the 220/500 kV SWYD and air pollution levels**

| No. | Name of pollutants | MAC, mg/m3 | Hazard class | Quota | MAX concentration, MAC share | Compliance with quota (+/-) | After project implementation | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | t/y | % |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | Hydrocarbons | 1 | 4 | 0.5 | Cm<0.01* | + | 0.0078 | 96.32 |
| | Iron oxide | 0.2 | 3 | 0.33 | Cm<0.01 | + | 0.0003 | 3.32 |
| | Manganese compounds | 0.005 | 2 | 0.25 | Cm<0.01 | + | 0.00003 | 0.36 |
| | **Total** | | | | | | **0.0081** | **100.0** |

*Cm<0.01 - the total maximum concentration created by emissions of the 220/500 kV SWYD equipment is less than the coefficient of expediency of calculations E3 = 0.01 MPC, for this substance the concentration fields were not calculated.

Stage of construction

The calculation of emissions of pollutants during the construction (excavation, installation, waterproofing, painting) is given in Appendix 3.

In total, during the construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP, 5.7530 t/year of 13 types of pollutants will enter the atmosphere.

The greatest contribution to the addition of pollutants during construction operations is made by: oil solvent (2.00 t/year, 34.78% of the total mass of emissions), carbon monoxide - 1.4976 t/year, 26.03%, nitrogen dioxide – 0.5136 t/year, 8.93%, hydrocarbons - 0.4485 t/year, 7.8%). The addition of the remaining nine ingredients is 22.46% of the total mass of emissions.

To determine the level of impact of emissions during the construction of the 220/500 kV SWYD on the atmospheric air, pollutant concentrations were calculated using the "Ecologist" program on an area of 1.8 × 1.8 km with a step of 0.1 km. The technical characteristics of emission sources, meteorological characteristics and coefficients that determine the nature of dispersion of chemicals in the atmosphere of the SS expansion area were used as initial data.

The results of the calculation of the dispersion of pollutant emissions in the atmosphere during the construction of the 220/500 kV remote-mounted SWYD in the form of dispersal maps are shown in Fig. 4.1 - 4.15 (Appendix 4).

The analysis of dispersion calculations showed that the greatest contribution into the atmospheric pollution was made by nitrogen dioxide and xylene emissions, which maximum concentrations did not exceed the quotas approved by the State Ecology Committee of the Republic of Uzbekistan (table 4.2).

| | | | | | | | t/year | % | t/year | % | t/year | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Nitrogen dioxide | 0,085 | 2 | 0,25 | 0,23/0,03 | + | 0,4608 | 15,54 | 0,0528 | 1,89 | 0,5136 | 8,93 |
| 2 | Sulphur dioxide | 0,5 | 3 | 0,33 | 0,02/0,001 | + | 0,2880 | 9,71 | 0,0173 | 0,62 | 0,3053 | 5,31 |
| 3 | Xylene | 0,2 | 3 | 0,33 | -/0,14 | + | - | - | 0,3617 | 12,97 | 0,3617 | 6,29 |
| 4 | Oil solvent | 1,5 | 4 | 0,50 | -/0,02 | + | - | - | 2,0007 | 71,75 | 2,0007 | 34,78 |
| 5 | Nitrogen monoxide | 0,6 | 3 | 0,33 | 0,01/0,001 | + | 0,0749 | 2,53 | 0,0086 | 0,31 | 0,0835 | 1,45 |
| 6 | Iron oxide | 0,2 | 3 | 0,33 | -/0,001 | + | - | - | 0,0007 | 0,02 | 0,0007 | 0,01 |
| 7 | Carbon oxide | 0,005 | 4 | 0,50 | 0,01/0,005 | + | 1,4400 | 48,57 | 0,0576 | 2,07 | 1,4976 | 26,03 |
| 8 | Inorganic dust | 0,3 | 3 | 0,33 | 0,01/- | + | 0,0026 | 0,09 | - | - | 0,0026 | 0,04 |
| 9 | Soot | 0,15 | 3 | 0,33 | 0,06/0,001 | + | 0,2304 | 7,77 | 0,0033 | 0,12 | 0,2337 | 4,06 |
| 10 | Manganese compounds | 0,005 | 2 | 0,25 | -/0,004 | + | - | - | 0,0001 | 0,003 | 0,0001 | 0,001 |
| 11 | White spirit | 1 | 4 | 0,50 | -/0,02 | + | - | - | 0,2685 | 9,63 | 0,2685 | 4,67 |
| 12 | Hydrocarbons | 1 | 4 | 0,50 | 0,02/0,001 | + | 0,4320 | 14,57 | 0,0165 | 0,59 | 0,4485 | 7,80 |
| 13 | Formaldehyde | 0,035 | 2 | 0,25 | 0,04/0,001 | + | 0,0360 | 1,21 | 0,0007 | 0,02 | 0,0367 | 0,64 |
| | **Total** | | | | | | **2,9647** | **100** | **2,7884** | **100,00** | **5,7530** | 100 |

**Table 4.2 Characteristics of air pollutants during construction operations on the expansion of the Surkhan Substation and the level of atmospheric pollution**

In the numerator there are values of the concentrations created by emissions during excavation, and in the denominator - installation work, waterproofing, painting.

The maximum concentrations of all other pollutants generated by emissions during the construction of the 220/500 kV SWYD do not exceed the quotas allowed by the State Ecology Committee of the Republic of Uzbekistan for corresponding hazard class pollutants and enterprises located in the Navoi region and practically make up trace amounts.

### *4.2 Addition of acoustic noise and vibrations*

The noise exposure will not exceed normative values: 45 dBA at night and 55 dBA during the day time in a residential development according to KMK 2.01.08-96 and 80 dBA at permanent workplaces during construction and preventive repair operations when operating the 220/500 kV SWYD equipment according to SanPiN No. 0325-16 "Sanitary norms of permissible noise levels at workplaces".

No noise protection measures are required because noise level at the border of the nearest residential buildings does not exceed the permissible value according to KMK 2.01.08-96.

Noise impacts during construction operations will take place at three stages:

- when mixing concrete mixtures;
- when installing foundations and equipment.

Typical levels of expected noise at a distance of 15 m from construction equipment during the construction stage are shown in table 4.4.

**Table 4.3 Typical noise exposure during construction**

| Equipment | Maximum level of expected noise |
|---|---|

| | at a distance of 15 m (dBA) |
|---|---|
| Concrete mixers | 87 |
| Cranes | 86 |
| Paint sprayers | 89 |
| Excavators | 90 |
| Welding machines | 73 |
| Dump trucks | 87 |

All the most noisy construction operations on installation of supports near residential buildings, in particular, all work on the movement of soil are limited to daytime hours.

Thus, noise associated with construction activities will be temporary and periodic, and will not exceed noise standards.

Exposure to vibrations is expected:

- when tamping soil and road surfaces;
- during operation of jackhammers;
- when compacting concrete mixtures;
- during operation of conveyors to move bulk materials, such as sand.

Vibrations associated with construction operations will be temporary and periodic in nature; vibration impacts will not extend beyond the boundaries of the working site.

## 5 Assessment of impact types determined by the extraction of natural resources from the environment

The commissioning of the 220/500 kV remote-mounted SWYD at the Navoi TPP will be accompanied by withdrawal of land resources, water, and natural raw materials in the form of construction materials supplied in quantities from 4.2 to 122.5 m3 according to Table 3.2, as well as oil products in the form of diesel fuel and gasoline for the operation of the motor vehicles and construction mechanisms.

The agricultural land alienated for the designed 220/500 kV SWYD is 25 ha.

The removal of artesian water for potable needs of the staff will be 593.125 m3/year.

At the stage of construction operations, the withdrawal of natural resources used as construction materials (gravel, sand, pebble) is expected. The consumption of construction materials is given in table 3.2.

Delivery of gravel, sand, and pebble is assumed to be by road, mainly when purchased from trade organizations.

# 6 Design solution alternatives

"Zero option". The refusal to implement the design solution was considered as a "zero option". This excludes:

- power output from SSGT Units No. 3, 4;

- the possibility to create a reliable power supply for NMMC loads in full in combination with the planned construction of 220 kV overhead lines in the region (in 500 kV dimensions) to the Besopan Substation, the construction of the 500 kV Muruntau substation and the 500 kV Navoi substation;

- obtaining a large socio-economic effect both for a large industrial enterprise - NMMC, for Uchkuduk - Zerafshan generation center, and for the whole republic;

- the possibility of reducing the shortage of electricity in the Republic of Karakalpakistan, Khorezm, Bukhara and Navoi regions.

Alternative choices of circuit breakers.

The choice of circuit breakers in favor of SF6 ones meets the advanced tendencies of switching equipment. The choice of air circuit breakers instead of SF6 ones under the project will lead to lower technical and economic indicators and an increase in emergency risks. The costs of current and capital repairs of air circuit breakers, their maintenance, as well as maintenance of compressors to provide air circuit breakers with compressed air will increase even more, and power consumption for compressor operation and heating of air circuit breakers and air collectors, consumption of compressor oil will further increase.

The choice in favor of SF6 switches also confirms their compliance with the requirements of modern power engineering in terms of switching capacity and reliability, in connection with the use of arc-extinguishing media, which is more effective than air and oil. An intensive introduction of SF6 equipment along with vacuum equipment is due to the fact that no effective arc-extinguishing methods have been found that can compete with arc-extinguishing in SF6 gas or vacuum. No new types of dielectrics surpassing SF6 or vacuum in terms of electrical insulating, arc-extinguishing and operational properties have been obtained yet.

The main advantages of SF6 equipment are determined by unique physicochemical properties of SF6 gas. With proper operation, SF6 gas does not age and does not require such careful self-care as oil.

SF6 circuit breakers have been intensively developed since 1980 and have great prospects at voltages of 110...1150 kV and cut-off currents of up to 80 kA. In technically developed countries, high and extra high voltage (110-1150 kV) SF6 circuit breakers have practically supplanted all other types of apparatuses. Also, the leading foreign companies have almost

completely switched to the production of complete switchgears with SF6 gas insulation and SF6 circuit breakers for open switchgears for 110 kV voltage classes and above.

Thus, the option of installing SF6 circuit breakers at the 220/500 kV SWYD at the Navoi TPP proposed for implementation by the technical project is optimal.

## 7 Assessment of environmental impact f possible emergencies

Emergency risks during the operation of the 220/500 kV remote-mounted SWYD at the Navoi TPP are mainly related to oil spillages with subsequent combustion, as well as fires in case of transformer damage and short-circuit cable currents in the integrated cable system.

The fire safety of the 220/500 kV SWYD is ensured by the use of the following design solutions provided for in accordance with the design instructions for the fire protection of energy companies (RD 153-34.0-49.101-2003):

1. Removal of oil from the transformer to the closed oil collector to prevent oil spreading and spread of fire in case of damage to the oil-filled transformers.

2. Lightning protection for switchyard structures.

3. Observance of fire breaks between structures and oil-filled equipment.

4. Cables are laid in above-ground reinforced concrete trays and trenches with observance of requirements and recommendations of chapter 2.3 of the Electrical Installation Code providing fire safety in the integrated cable system.

5. A set of primary fire extinguishing agents purchased through the funds allocated by the Directorate is provided for: powder and carbon dioxide fire extinguisher, boxes with sand of 0.5 $m^3$ capacity, fire fighting equipment (shovels, pickaxes, bar).

For removal of life-threatening industrial frequency currents flowing through the coupling capacitors, the bottom plates of the capacitors are grounded through the coupling filter coil.

The distance from the coupling capacitor to the coupling filter is not more than 1.5 m.

In the event of a breakdown on the coupling capacitor, the bottom plate of the latter is tightly grounded by the disconnector.

In accordance with the operating circular, all power cables provided for in the project are checked for non-ignition under the action of short circuit currents.

In accordance with the Fire Safety Regulations for energy companies, all cables provided for in the project are accepted with insulation that does not propagate burning. In the integrated cable system of the switchyard there are fireproof seals of cable lines.

The project takes into account requirements of the “Guidelines for the protection of secondary circuits of power plants and substations from impulse noise” for the laying of cables and the implementation of substation grounding.

The 220/500 kV remote-mounted SWYD at the Navoi TPP does not belong to the category of explosive hazardous installations, therefore the project does not provide for special explosion hazard measures.

To prevent contamination of the soil, surface and underground waters with oil and water contaminated with oil during accidents and fire extinguishing, the oil drainage from the transformers in accordance with the requirements of the Electrical Installation Code in the territory of the remote-mounted switchyard includes:

- arrangement of closed oil pipeline;
- oil collector bunding.

The capacity of the oil collector is designed to retain the full volume of transformer oil, based on the largest single equipment, taking into account the additional volume of water (20 m3) in accordance with the requirements of RD 153-34.0-49.101-2003 and Recommendations for the design of oil removal systems from transformers.

The project is supposed to be organized on the territory of the remote-mounted switchyard:

- control of the level of random waters in the oil collector;
- removal of accidental waters to the places approved by sanitary and epidemiological authorities at least twice a year.

The risk of accidents during the operation of SF6 circuit breakers on the territory of the remote-mounted SWYD at the Navoi TPP is low.

SF6 circuit breakers, as compared with air circuit breakers, are distinguished by a higher breaking capacity per break, lower weight and volume, and higher reliability. In such circuit breakers, many mechanical, pneumomechanical elements and air circuit breaker systems are missing, which together cause more than 40% of all accidents for mechanical reasons. For SF6 circuit breakers there is no need for a high-pressure compressor station which accident rate is 10%.

SF6 gas disadvantages include high liquefaction temperature. At a pressure of 1.5 MPa, it is only 6°C. In order to avoid SF6 gas liquefaction, automatic heaters that maintain a constant temperature of the SF6 gas are provided in circuit breakers with a high pressure of the extinguishing media.

In addition, experience and special studies have shown that under the influence of an electric arc or corona discharge (heat) decomposition of SF6 gas occurs with the formation of chemically active compounds. Gaseous decomposition products are the lower fluorides of $SF_2$, $SF_4$ media.

The composition of decomposition products (DP) depends on the intensity of the arc and on the foreign inclusions in SF6 gas: air and moisture. The analysis of SF6 gas decomposition

products is a powerful means indicating when it is necessary to repair equipment and what the most likely cause of the accident is.

The analysis scheme is the same as in the case of oil insulation: sampling of defective SF6 gas containing decomposition products from the arc heat. Investigation of defective SF6 gas includes the analysis of the SF6 gas decomposition products, the moisture content in the gas, determination of the intensity and duration of arc burning. The main instruments used in the analysis of decomposition products, is a gas chromatograph with a thermoelectronic trap and a flame emission spectrophotometer.

SF6 gas analysis should be made:

- at acceptance tests of new equipment
- at regular intervals throughout the service life of the equipment, each time comparing the results of the analysis with the original data
- after each accident before equipment repair.

SF6 molecules are thermally sufficiently stable, however, they dissociate under the influence of high arc temperature. During dissociation, a lot of energy is absorbed, as a result of which the arc stem is cooled, which contributes to its quenching. After arc extinguishing, intense recombination of ions occurs and the SF6 gas self-restores its properties, although not completely. Molecular filters or scrubbers made of activated aluminum are used to trap residual decomposition products. But these devices cannot be designed for the entire volume of decomposition products formed in emergency conditions, and sooner or later the SF6 gas must be cleaned from the decomposition products and the circuit breaker's contact system must be inspected.

Decomposition products are a recombination of lower sulfur fluorides with moisture and air located in the zone of dissociated SF6 gas. Their composition depends on many factors: the intensity and duration of the arc discharge, the material of the structural elements, the content of moisture and air in SF6 gas.

The course of reaction may be as follows: first, $SF_6$ dissociates into $SF_4$, $SF_2$, and metal fluorides. Metal fluorides are solid formations. Sulfur fluorides are gases and react with the trapped air oxygen forming $SOF_4$ and $SOF_2$. Further dissociation of gases leads to the appearance of $SO_2F_2$, SF, and $SO_2$. Other incidental decomposition products initially contain $F_2$, SF, $SF_2$. These decomposition products dissociate further. It is assumed that such course of reaction and the nature of distribution of decomposition products are manifested as a result of corona discharge, partial discharge and arc discharge, or under the influence of a rupturing arc.

The degree of decomposition will depend on the intensity and duration of these processes. SF6 circuit breakers, even after a certain number of normal switching, will have a concentration of decomposition products which may be unacceptable. Knowledge of this concentration, along with the operational history of the circuit breaker is necessary to assess the reliability of its operation.

Let's assume that a certain amount of $SOF_2$ and moisture is systematically recorded in the circuit breaker. If subsequent analyzes show a sharp decrease in moisture and an increase in the $SOF_2$ concentration, it should be assumed that the circuit breaker has been exposed to partial discharges that decompose $SF_6$, and that decomposition products are hydrolyzed.

Samples of defective SF6 gas sent to the laboratory for testing should be enclosed in stainless steel cylinders. Sampling is simplified when installing gas drawing nozzles on the equipment. The current systematic analysis of the SF6 gas will contribute to the early detection of internal equipment malfunctions, reduce accident rates, reduce repair costs and increase the reliability of the SF6 equipment.

The safety of handling defective SF6 gas is ensured by the knowledge of the composition of decomposition products and rules of handling which are as follows:

1. Treatment of solid decomposition products must be made wearing gloves.
2. Gaseous decomposition products must not be exhaled.
3. Do not determine the presence of damages by smell.

All equipment compartments containing SF6 gas must be reliably sealed.

The most common defect of gas-insulated apparatus is their insufficient gas-density manifested in an increased leakage of SF6 gas, which leads to a decrease in the SF6 gas density (or pressure at a constant temperature) and, as a consequence, a decrease in electrical strength. To eliminate this malfunction, the apparatuses are periodically replenished with SF6 gas.

During operation, there is a decrease in the quality of the SF6 gas, but if all the requirements are met when the equipment is manufactured and prepared for operation, the quality of the SF6 gas remains at an acceptable level throughout the assigned service life.

For trouble-free operation of the SF6 circuit breakers, an Automatic Control System (ACS) is provided.

ASC information channels of the gas-insulated equipment:

- apparatus temperature (E1 channel),
- gas pressure (E2channel),

- position (interlocks, disconnector, earthing switch, high-speed earthing switch contacts or a circuit breaker with the absence of E4 channel) (E3 channel),

- circuit breaker dynamics (position of contacts, speed and time of movement) (E4 channel),

-current (E5 channel),

- voltage (E6channel),

- counting functions (number of activations, interval of activations, operating time, total operating time of devices or mechanisms) (E7 channel),

- leakage current (on the support, on the input insulator) (E8 channel),

- power of auxiliary circuits (E9 channel),

- air pressure in a pneumatic actuator (E10 channel),

- integrity of the warm-up circuits (E11 channel),

- fluid level for hydraulic drive (E12 channel),

- humidity of SF6 gas or air in a pneumatic actuator (E13 channel),

- operating.

## 8 Actions to prevent adverse effects on the environment

The technical project provides for a number of measures to reduce the environmental impact of the construction project, as well as to eliminate the possibility of emergencies.

In emergency situations on the territory of the 220/500 kV SWYD (in case of emergency emission of autotransformer oil) to prevent contamination of soils, groundwater and surface water with oil, to prevent oil spread and subsequent fire, as well as fire spread in the case of damage to oil-filled power transformers, there is a building of an underground hydro-insulated oil collector with a capacity of 200 m3 and the system of oil outlets in accordance with the requirements of clause 4.2.70 of the Electrical Installation Code.

The use of SF6 circuit breakers that meet international standards will exclude emissions to the atmosphere and noise exposure during their operation.

Due to the lack of residential buildings close to the 220/500 kV SWYD under construction and the presence of permanent mechanical and aerodynamic noise sources (autotransformers) in the switchgear territory, no measures are required to reduce the noise level.

It is supposed to exercise constant control over the course of construction and installation operations in order to detect violations of the general nature protection requirements: movement of construction machines and mechanisms in unauthorized places, warehousing of structures in the areas not intended for these purposes, discharges of industrial oils and household waters in reservoirs.

In addition to the proposed technical solutions, it is necessary to provide special containers for collecting and temporarily placing waste of each type on construction sites, which is formed during the construction of the switchyard, followed by removal to specialized organizations and to landfills defined by the sanitary-epidemiological authorities.

Thus, the environmental risk during the implementation of the technical solutions and environmental protection measures laid down in the project is reduced to a minimum.

If the listed recommendations and measures are observed, there will be no negative impacts on the atmospheric air, surface and ground waters, soil, vegetation and population.

Environmental management

The project implementation for the construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP requires a preparation of an Environmental Management Plan (EMP) that will ensure environmental protection. The purpose of the EMP is to help the organization achieve its environmental goals and fulfill its obligations in maintaining the quality of the environment. The EMP describes the methods and plans used to reduce the environmental impact, and also identifies indicators that can be used to evaluate implementation of the EMP.

The proposed EMP is general in nature, although all the expected impacts are taken into account, it is not specific to certain transmission line routes (PTLs). Once the EIA is approved, the EMP will then be used as the basis for preparing a specific EMP.

Most of the impacts associated with the construction and operation of the designed remote-mounted SWYD will occur during construction. Therefore, the EMP focuses heavily on this stage of the project. However, recommendations for environmental management during operation, which are also included in the EMP, are taken into account.

The EMP serves as the basis for the implementation of mitigation measures at each stage of the project.

Implementation of the environmental management plan.

Before starting construction operations, detailed draft environmental conditions and mitigation measures must be approved and agreed upon with specialists of competent organizations.

The contractor will be primarily responsible for the proper implementation and implementation of plans, measures, controls, etc. in accordance with the terms and conditions defined in the relevant permits and environmental management and monitoring plans.

During construction, the customer and the designer (designer supervision) will monitor the implementation of the solutions defined in the project.

After commissioning, environmental monitoring and regular maintenance should be organized by the Navoi TPP JSC.

Environmental monitoring plan

The environmental monitoring plan includes a monitoring schedule and institutional arrangements. The environmental monitoring plan will show how to take precautions during and after the PTL construction so that the necessary actions can be taken to correct defects or deficiencies.

During the construction, monitoring will focus on ensuring the implementation of environmental mitigation measures, and some performance indicators will be checked to record the environmental performance of the Project and to take any remedial actions to prevent unexpected impacts. Monitoring of the actions during project operation will focus on recording environmental performance and proposing remedial measures to avoid unexpected impacts.

Institutional arrangement

The PIU of Navoi Thermal Power Plant JSC will be responsible for the overall implementation of the EMP.

The Navoi TPP JSC will enter into a contract with a third party for the construction of the switchyard. Other parties that will be involved in the implementation of the EMP are the following:

Governmental agencies: such as the State Ecology and Environmental Protection Committee of the Republic of Uzbekistan (Goskomecologiya), territorial nature conservation bodies (territorial ecology and environmental protection administration of the Navoi region), local governments and municipalities (to the extent affected by the project). As supervisory authorities, the Environmental and Environmental Protection Authorities at various levels will pursue environmental protection policies during the construction and operation under the project, and will be responsible for implementing laws, regulations, standards and applying environmental methods by all organizations within their respective jurisdictions.

In particular, the structure of the State Ecology and Environmental Protection Committee of the Republic of Uzbekistan includes a regional committee for environmental control and project administration, and their roles and responsibilities are as follows:

- supervision of the EMP implementation;
- enforcing applicable laws, regulations and standards;
- coordination of environmental protection efforts between the departments concerned;
- inspection and supervision of construction, completion and operation of environmental facilities.

Project Implementation Unit (PIU): The Navoi TPP JSC is ultimately responsible for the environmental effectiveness of the project both during construction and during operation. The PIU, being a direct management organization managing all aspects of the project preparation and construction, is responsible for environmental management, but is not limited to the following specific responsibilities:

- guaranteeing that all relevant EMP requirements (including environmental design and mitigation measures) are properly included in the bidding documents for the project;

- obtaining the necessary permits and/or approvals, as required, from the State Committee Ecology and other relevant government agencies, with the necessary observance of the condition that all necessary permits are obtained prior to the commencement of any construction operations under the project;

- ensuring that contractors understand their obligations to mitigate environmental problems related to the construction and train their personnel to implement the EMP;

- monitoring of the implementation of the EMP by the contractor in accordance with the environmental monitoring plan.

Construction Supervision Engineers (CSE)

Construction Supervision Engineers (CSE) are responsible for overseeing the construction operations under the project, and monitoring of other works and actions taken by the Contractor to ensure that the specifications and contractual requirements are met. CSE responsibilities include:

- ensuring guarantees of compliance with the technical design of the project and the EMP with respect to mitigation and protection of the environment. The construction may begin only after the CSE is satisfied with environmental protection measures;

- regular monitoring of the work of the Contractor's ecologists with verification of the monitoring methodology and its results. If the CSE believes that the Contractor's environmentalists do not fulfill their duties or do not fulfill the contractual requirements, it is necessary to instruct the Contractor(s) to replace the Contractor's environmentalists;

- instructing contractors to take corrective actions during a specific CSE period. If there is a violation of the terms of the contract or serious complaints from the public on the environmental performance of the contractor, the CSE requires the contractor to correct, change or stop the work informing the relevant agencies and the Client at the same time;

- supervision of the Contractor's activities and ensuring that the EMP requirements and technical requirements of the contract are fully met;

- instructing the Contractor to take measures to reduce the impact and comply with the required EMP procedures in case of detection of any non-compliances/unconformities;

- following complaints review procedures.

Contractor

Contractor's responsibilities include, but not limited to, the following:

- strict implementation of measures listed in the EMP;

- compliance with the requirements of the environmental legislation;

- working within the framework of contractual requirements and other bidding conditions;

- checking that all suppliers of construction materials have valid work licenses and any necessary environmental permits;

- ensuring the effective implementation of the EMP during the construction;

- in the case of non-compliance or inconsistencies regarding the EMP implementation, studying and submitting proposals for mitigation measures and implementing corrective measures.

Documentation and regulation

All environmental strategies, policies, responsibilities, and procedures will be clearly documented for each contractor.

Documentation - useful information for the management and staff, and preferable in a form that can be provided to third parties, such as regulators, interested citizens, or even shareholders of companies, as a proof of the company's environmental responsibility.

The Environmental Quality Management and Monitoring Plan is provided in Appendices 5 and 6.

## 9 Forecast of environmental changes as a result of identified impacts

The assessment of environmental changes as a result of the work performed showed the following results.

Atmospheric air. The commissioning of the 220/500 kV remote-mounted SWYD at the Navoi TPP will not lead to a change in the state of the atmospheric air. When operating the newly built switchgear, the state of the atmosphere will continue to be admissible.

Surface water. The state of surface waters will not change, the impact on surface watercourses is not expected.

Soils, vegetation. The state of the soil and vegetation after the implementation of the project will not change.

Ground and groundwater. The operation of the 220/500 kV remote-mounted SWYD at the Navoi TPP under normal conditions will not affect the quality of the ground and groundwater. The condition of groundwater will remain admissible.

The project implementation will lead to a reduction in emergency risks during operation of the designed power grid facility.

## Conclusion

The impact assessment of the construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP was carried out based on the analysis of the current state of the environment, socio-economic aspects and technical solutions.

For the construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP, intended for power output from CCGT Units No. 3,4, it is planned to allocate 25 hectares of land used in agriculture. The construction site is located in the Novbakhor district of the Navoi region, at a distance of 1.875 km north of CCGT Units No. 3, 4. In general, the territory under consideration belongs to the zone with a permissible ecological situation. Favorable conditions of the location of the construction site include the distance from the residential development (330 m to the south-west of the design object).

The paper describes the types of impact of the 220/500 kV remote-mounted SWYD during operation and construction.

It is shown that the operation of autotransformers of the 220/500 kV remote-mounted SWYD is associated with the addition of oil hydrocarbons into the atmosphere which, in the atmosphere, create concentrations much below the established quotas in terms of the level of atmospheric pollution for 4 hazard class substances and enterprises located in the Navoi region.

In addition, there is a physical impact (acoustic, electromagnetic) and emergency risk.

Due to the remoteness of the residential development, it is predicted to ensure compliance with noise standards (not more than 45 dBA at night and 55 dBA during the day time according to KMK 2.01.08-96 and not more than 80 dBA at permanent workplaces according to SanPiN No. 0325-16 “Sanitary norms of permissible noise at workplaces”).

The analysis of technical solutions showed their adequacy in preventing emergency risks by using oil outlets and two oil collectors for emergency discharge of oil from transformers, two water reservoirs for fire extinguishing, using SF6 circuit breakers, automated control system and protection, which allowed eliminating negative consequences for the environment in the case of development of the considered accident scenarios.

The impact on the atmospheric air during the construction is estimated as temporary and local. The paper provides an assessment of the pollutants’ addition to the environment during the construction, physical impact (addition of acoustic noise during the operation of construction equipment), and removal of natural resources, a forecast of environmental changes, as a result of the identified effects has been made.

The impact associated with the seizure of land resources is defined as permanent in the form of allotment of land under for the switchyard with an area of 25 hectares.

Due to their remoteness and the absence of discharges, impacts on surface waters are not expected. Household wastewaters are discharged into a hydroinsulated cesspool of 18 m3 with subsequent removal to the treatment plant upon coordination with the central wastewater treatment facilities.

On the territory of the 220/500 kV SWYD the system of organization of collection, temporary accumulation and movement of waste during the construction operations will allow eliminating their impact on the soil, ground and groundwater.

The draft EIS provides an analysis of the adequacy of environmental measures envisaged by the project that prevent negative environmental impacts, and in addition to the measures proposed in the technical project, there is a set of measures proposed to reduce the negative environmental impact of the construction of the 220/500 KV remote-mounted SWYD at the Navoi TPP.

Thus, the construction of the 220/500 kV remote-mounted SWYD at the Navoi TPP will not lead to environmental degradation and is possible subject to compliance with the environmental measures proposed in the basic project and in this paper.

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**Appendix**

**Annex No. 1**

# The Conclusion of the State Environmental Review № 01-01/10-08-818 of May 3, 2019

# THE STATE COMMITTEE FOR ECOLOGY AND ENVIRONMENT PROTECTION OF THE REPUBLIC OF UZBEKISTAN

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May 3, 2019 No. 01-01/10-08-818 Tashkent City

## CONCLUSION

Of the State Environmental Review

| | |
|---|---|
| Facilities: | Environmental impact assessment of the construction of 2 combined-cycle plants (Nos. 3,4), Class J, with a total capacity of 1,300 MW at Navoi TPP JSC, located in the Karmaninsky district of the Navoi region (Draft Environmental Impact Statement) |
| Customer: | "Navoi TPP JSC." |
| TIN: | 201169179 |
| Category: | I, p.35. Resolution of the Cabinet of Ministers RUz No.949 of 21.11.2018 |
| Developer: | «TeploElektroProekt» JSC |
| Expert: | Zhdapov A.V. |

To the Director of the Capital
Construction of «Navoi TPP" JSC
T.G. Nazarov

Copy: To the Department for Ecology
and Environmental Protection
of the Navoi Region.

The materials of the first stage of the environmental impact assessment of the construction at Navoi TPP JSC of 2 combined-cycle plants (Nos. 3, 4),class J, with a total capacity of 1,300 MW, located in the Karmaninsky District of the Navoi Region have been presented to the State Environmental Review.

The main production activity of the TPP is the generation of electric energy intended to meet the needs of the national economy of the Republic of Uzbekistan. The Navoi TPP JSC is one of the largest power plants in the Republic of Uzbekistan. It provides the Navoi, Samarkand, Bukhara regions with electricity and the Navoi region and the town of Navoi with heat, as well.

The Navoi TPP JSC was built in the period of 1960 - 1981 with a capacity of 1,250 MW.

In the early 2000s, there was a need to modernize the worn-out station equipment. The service life of Nos. 1, 2 power plants of the TPP was 20-35 years and this fact became the cause of the continuing deterioration of the technological condition of the equipment, a decrease in its reliability and, as a consequence, a deterioration of technical and economic indicators of the TPP, an increased probability of accidents with possible negative consequences for the environment.

In February 2013, the first combined-cycle gas turbine unit with a capacity of **478 MW** was commissioned, while installed power capacity of the plant reached **1,728 MW**.

In 2014, TGs-1, 2 (turbine-generators) with a capacity of 25 MW each and TG-6 with a capacity of 60 MW were decommissioned; by the end of 2014, the installed power capacity of the plant had become 1,618 MW.

In 2011, another 450 MW CCP was designed with the commission of which it was supposed to decommission boilers Nos. 3, 8. The construction of CCP No. 2 is currently being under completion.

At the end of 2018, the installed power capacity of the Navoi thermal power plant was 1,618 MW.

The construction of CCP Nos. 3, 4 of class J considered in this draft will make it possible to increase the total power capacity of the Navoi Thermal Power Plant by 1,300 MW, to reduce operating costs, to increase the energy conversion efficiency, and to increase the reliability of providing electricity to consumers, improve the environmental situation in the zone of plant influence.

650 MW CCPs of class J that are planned to introduce have a high power generation efficiency (above 60%), low specific consumption of reference fuel for electricity supply - 215g / kWh (specific fuel equivalent consumption for Navoi TPP JSC based on the operation results for 2018 was 381.24 g/kWh).

The main environmental advantage of the project, when realized, is reducing the maximum concentrations of pollutants in the atmospheric surface layer created by emissions of the Navoi TPP JSC by 4.3 times compared with the existing situation, with the achievement of the established standards for the level of air pollution. The commissioning of two CCPs, Nos. 3,4, with a total capacity of 1,300 MW in addition to the 478 MW CCP No. 1 and 450 MW CCP No. 2 which is at the completion stage of construction, with the decommissioning of obsolete process equipment (boilers TGM-94 No. 3.4; boilers TGM-84 No. 5.7; boilers TGM-94 No. 8.9; boiler TGM-84 No.10; boilers TGME-206 No.11.12; peak boiler house) will lead to an improvement in the environmental situation in the zone of influence of the plant - a reduction in gross emissions from thermal power plants by 1,070.3209 tons/year.

Navoi TPP JSC occupies an area of 100 hectares, located at the address: Navoi region, Karmaninsky district, CFI! "Yangi-arik", 6 km. north-west of the city of Navoi.

The site for the construction of 2 new power units of CCPs Nos. 3, 4 with a total capacity of 1,300 MW is scheduled in the eastern part of the Navoi TPP. Partly it will be on the sites currently occupied by hydrotechnical structures (septic tanks), partly- on the lands adjacent to the territory of the TPPs used for summer cottages and gardens, and the sites occupied by a military unit’s structures and access roads.

For the construction of 2 new CCP units Nos. 3, 4, an area of 22.9 hectares will be required, of which 8.6 hectares are located in the existing territory of the enterprise; 14 hectares are located on a separate area.

The boundaries of the site for the proposed construction shall be: in the west - the territory of the Navoi TPP, in the east - the Zeravshan River, in the north - abandoned summer cottages, in the south - auxiliary facilities of the TPP.

The distance to the residential buildings located in the southeast of the territory of the CCPs Nos. 3, 4 construction site is 400 meters, the distance from the nearest residential building to the chimneys - 550 m, which is consistent with the requirements of SanPiN No. 0350-17 "Sanitary Rules and Norms on Atmospheric Air Protection in the Settlements of the Republic of Uzbekistan."

The size of the water protection zone of the Zeravshan River in the area of construction of additional CCPs, in accordance with Resolution No. 174 of the Cabinet of Ministers of RUz of April 07, 1992. “Regulations on water protection zones of reservoirs, rivers and main canals and collectors, as well as the sources of drinking and domestic water supply, of medical and cultural and recreational purposes in the Republic of Uzbekistan”, is established 300m, based on the 162 m3/sec. water flow of the river.

The TPP territory is located in the western part of the Zeravshan valley, which is a piedmont plain, rising from west to east with a slight slope towards the Zeravshan River. The mountain systems that surrounds the area under investigation from the north, east, and south affect the air currents and determine the local climatic features, and in particular, the wind regime.

In the annual wind rose, the eastern direction is predominant, at which the emissions from the Navoi TPP and other large enterprises of the industrial zone are spreading in the direction opposite to the city that is the industrial site of the station is located in the light of the wind rose.

Navoi HPP JSC is located on the third right-bank over-flood terrace of the Zeravshan River. This flat plain with a slight slope towards the river refers to the Hungry-steppe cycle of sediment accumulation. Within the region, a stratum of quaternary deposits is developed on the surface underlain by the continental tertiary deposits.

Hydrogeological conditions are characterized by the development of groundwater, confined to the Quaternary sediments of the Zeravshan river valley. The maximum level of groundwater is observed in the summer and amounts to 3-5 m. The groundwater level increases as it approaches the river. Groundwater salinity is higher than normal and varies from 3.4 to 9.2 g/dm$^3$, the type of mineralization is sulphate-sodium. The territory of the station has a network of piezometric wells, the groundwater level and groundwater composition being monitored.

The soils of the territory of the TPP are light sierozems; they are distinguished by a weakly alkaline medium, a low content of humus, and a high content of calcium, sulfur, and iron.

The vegetational cover in the area of TPP location is represented by ephemeroid-wormwood communities and by agricultural plantings just at the territory of station. The site allocated for construction works is covered with green plantings that will be cut down during the process of preparation for the construction operations. According to a survey of the construction site, 536 trees are to be cut down (204 juniper-trees, 48 plane-trees, 60 apricot trees, 45 elm-trees, 34 poplar-trees, 4 plum-trees, 130 apple-trees, 2 mulberry-trees, 3 pomegranate and 6 purple willows).

In accordance with Resolution No. 290 of the Cabinet of Ministers "Regulation on the use of plants and the procedure for getting permissions for using plants" of October 20, 2014, in the process of further design, it is necessary to obtain a permit for the cutting of trees and shrubs that are located in the area of the facility construction.

Among the animals residing near the TPP, in the area characterized by significant dust and noise, it is possible to mention only those that are able to quickly escape the noise impact of the station. Among them are insects and reptiles that can hide in the soil and birds which can quickly leave unfavorable areas.

The installed electric power of the station at the end of 2018 is 1,618 MW.

There are five turbine generators operated at the TPP: 2X R-50-130 (installed capacity - 100 thousand kWh). 2X K-160-130 (installed capacity - 320 thousand kWh). 2X PVK-150-130 (installed capacity - 300 thousand kW h), 2X K-210-130 (installed capacity - 420 thousand kWh), CCGT unit -478 (installed capacity - 478 thousand kWh).

The station consists of a cogeneration part and a condensation part. The condensation part works according to the building-block principle.

Navoi TPP JSC has two power units of 210 MW each. Two units of 150 MW each, two power units of 160 MW each, TPS -140 with a capacity of 100 MW, a combined-cycle gas turbine unit (CCGT) with a capacity of 478 MW.

The following boilers are operated at Navoi TPP JSC: TGM*-151 (2 pcs.). TGM-94 (4 pcs). TGM-84 (4 pcs.). TGME** -206 (2 pcs.).

All boilers are equipped with gas-oil burners TKZ of the vortex type.

In 2018, electricity generation amounted to 8207.5 million kWh with the plan of 8584.1 million kWh; heat output amounted to 2106.7 thousand Gcal, while the plan was 1867 thousand Gcal.

The boilers used at the enterprise are the main sources of emission at the enterprise under consideration. When the equipment is operating on gaseous fuels, nitrogen oxides, carbon monoxide, benzapilene, sulfur dioxide are entering the atmosphere, as well as fuel oil ash when fuel oil is burned.

As a main fuel, the Navoi TPP uses gas from the Zevardy and Kultak fields with a calorific value of 8150 Gcal /nm3, hydrogen sulfide content being 0.06-0.1 vol. %; fuel oil of M-100 grade with sulfur content of 2.5% and a low calorific efficiency of 9365 kcal/kg. This fuel is used as an emergency one.

Fuel oil is delivered by rail, the fuel depot consists of four tanks of 3750$m^3$ each and three tanks of 15,000 $m^3$ each. The capacity of the oil depot is designed to store fuel reserves for 25 days.

Currently, flue gases from existing boilers are emitted into the atmosphere through four chimneys from the existing five chimneys. Boilers No. 3-10 are connected to three chimneys with a height of 56 meters each. Boilers Nos. 11, 12 are connected to a chimney with a height of 180 meters. CCP No.1 is connected to the chimney of 60m high.

* TGM - T - Taganrog factory; GM – work fuel, that is gas or residual oil

** TGME – T - Taganrog factory; GM – work fuel, namely gas or residual oil; E- natural circulation.

In all TPP boilers, according to the project of NIPTI "Atmosphere" (Research and Design Technological Institute "Atmosphere"), the technology of stepwise combustion of gas was introduced through its redistribution between burner tiers, which should ensure a reduction in emissions of nitrogen oxides to 30% and more. However, the designed effect of reducing nitrogen oxide emissions has not been achieved yet.

In addition to the main sources of emissions to the atmosphere, the TPP produces emissions from the operation of auxiliary units and equipment such as repair units, fuel oil facilities, and fuel and lubricant materials, storage units. During gas purging before firing boilers, peak emissions of natural gas through purge plugs take place, the duration of purgings constitutes 10 minutes.

At the current time, pollutants of 22 types come from 46 emission sources at the enterprise under consideration.

The gross emission of pollutants during the operation of the equipment of hydroelectric power stations at maximum load is 4,976.6268 tons/year. The main air pollutants are: nitrogen dioxide (3,483.5658 tons / year), accounting for 70.0% of the total emissions into the atmosphere; carbon monoxide (874.4503 tons / year), accounting for 17.57% of the total emissions into the atmosphere; nitric oxide (577.9607 tons / year), which is 11.61% of the total emissions to the atmosphere, the remaining pollutants account for 19 items constituting 0.82% of the total emissions of the enterprise.

The zero-dispersion model of pollutants in the atmospheric air of the plant's location shows that there are no observed concentrations exceeding emission quotas at no one source of enterprises except for nitrogen dioxide. The concentration of nitrogen dioxide outside the industrial site of the enterprise is 1.03 MPC with an emission quota of 0.25 MPC. The quota for the emission of nitrogen dioxide is exceeded by 4.4,2 times.

Water at the Navoi TPP is used for technical and household needs.

Water of drinking quality used for household and domestic needs and to feed the heating network is supplied to the TPP from the municipal water pipeline.

For the station’s production needs water is taken from the Zeravshan River. In respect of production purposes water is used for: cooling turbine condensers; cooling auxiliary equipment of turbines and power units; auxiliary needs of the water treatment plant and the feeding of steam cycle boilers; watering the territories, making up for losses in the fire-fighting reservoir, production facilities washing; steam supply to industrial enterprises.

The cooling water supply scheme is a reusing block water system. The design capacity of circulating water supply is 335,456.0 thousand $m^3$ per year, the actual circulating water supply is 193,031.0 thousand m3 per year.

In 2018, for production needs 577,868.644 thousand m3 of water was taken from the Zeravshan River (water use limit is 860.0 million $m^3$), there was not over-limit water consumption in 2018.

The design capacity of water recycling (sub-channel) is 28,500.0 thousand $m^3$/year. The actual capacity of the repeated water supply is 1,452.60 thousand m3/year.

The main source of pollution of surface watercourses is the equipment for water treatment plants.

The water treatment system includes: a desalting plant: a sodium cationization plant, a condensate purification plant, a water treatment plant for feeding thermal networks in a chemical water treatment process.

There are also industrial waste streams polluted with petroleum products, the drains from water-chemical washing of boilers and from conservation of equipment, the drains of washing RAH (regenerative air heater), the drains from cooling towers and stormwater drainage.

Domestic wastewater is directed to the sewage treatment plant of the municipal sewage system, the industrial effluents are directed to the Zeravshan River and to the collector "Sanitarnyi" through certain outlets.

The complex of sewage treatment plants for TPP production runoffs (KOPS) includes the following operating installations: UOZZS - an installation for cleaning of oiled and fuel oiled wastes with a capacity of 100 m3 / hour; UOSK – an installation for cleaning oily condensate with a capacity of 45 m3 / hour; UOVK - an installation of treatment of wastewater after washing of boilers and RAH (regenerative air heater) with ponds-evaporators of neutralized effluents with an area of 18,050 m2.

The volume of normatively treated wastewater discharged into the Zeravshan River in 2018 amounted to 2182 thousand m3.

The amount of partially clean flows coming to the Zeravshan River in 2018 without purification amounted to 577,868.644 thousand $m^3$. There are seven wastewater outlets at the station.

At the present time, 37 items of waste are generated on the territory of the TPP, temporary storage facilities are provided for all types of waste, some of the waste is regenerated or reused at the enterprise, and part of the waste is exported under contracts to special organizations for recycling.

In total, the generation of wastes of $1^{st}$ hazard class is 7.203 tons / year. $2^{nd}$ hazard classes - 46.7 tons / year, $3^{rd}$ hazard classes – 9,361.91 tons / year, $4^{th}$ hazard classes – 7,537.371 tons / year, $5^{th}$ hazard classes – 1,268.3 tons / year.

Each of the power units of the additional CCPs has a capacity of 650 MW, being a monoblock combined-cycle plant designed to produce electricity in the basic mode of operation, simultaneously covering the heat schedule of production and heating loads.

The equipment configuration of the 650 MW CCP is as follows: a gas turbine unit with an electric generator; a waste heat boiler; a steam-turbine plant with an electric generator; a deaerator; a gas-booster compressor station with three gas-booster compressors; an air compressor, a nitrogen generator, an electrolysis plant with receivers, an emergency diesel generator; an installation of chemical water treatment for recharging the unit, the heating network and circulating water supply system; an industrial wastewater treatment complex; tank facilities: cooling towers with a pumping station for water supply to the CCP; a warehouse for oil in containers.

It is assumed that additional CCPs will be operated with the use of natural gas as a fuel. Gas will be supplied to the site of 2 CCPs with a total capacity of 1,300 MW along newly constructed gas pipelines.

It is expected that the efficiency of new GT will be 42.3%. The efficiency of the CCP - 62.3%. The maximum hourly fuel consumption per CCP will be 120,323.09 m3/h.

The annual consumption of natural gas per CCP – 1,564.2 million m3/year; natural gas consumption by two CCPs will be 3128.4 million m3 / year.

The power units under design are combined-cycle power units, that is, they combine two cycles: the steam cycle and the gas cycle; thermal energy available in the gases generated during the combustion process of the fuel is used to produce steam with energy sufficient for use in a steam turbine. Each CCP consists of one gas turbine, a heat recovery boiler (HRB) and one steam turbine. The first cycle is represented by a gas turbine in which the rotor is driven by gases generated during combustion of the fuel. The electric generator of the gas turbine generates about 2/3 of the electricity. The second cycle: the gases generated in the first cycle are fed into the waste heat boiler (WHB) in which the heat energy of the flue gases is transferred to water to produce a high-pressure steam, this steam is used to drive the steam turbine. The electrical generator of the steam turbine generates about 1/3 of the electricity. The exhaust steam, immediately after expansion in the steam turbine, is directed to the condenser where a heat exchange takes place between the steam and the cooling water. The condensate is pumped out to the WHB, where it is re-converted into steam. At this point the steam cycle is closed.

The use of combined-cycle plants makes it possible to use the energy available in the gases resulting from the combustion of fuel, which significantly reduces the cost of energy and, ultimately, a negative impact on the environment.

To remove flue gases, the newly built CCPs are planned to equip with individual chimneys of 112 m. high and 0.7 m. mouth diameter.

The project implementation with complete conservation of outdated equipment (peak boiler house: boilers TGM-94 No. 3.4, TGM-84 No. 5.7. TGM-94 No. 8.9. TGM-84 No. 10. TGME-206 No. 11.12) will allow achieving annual savings of natural gas in the amount of 587 million m3 and, as a result, to reduce gross emissions of pollutants by 1070.3209 tons /year (from 4976.6268 tons / year at present situation to 3906.3059 tons / year after the project implementation), including nitrogen dioxide by 787.345 tons / year (from 3483.5658 to 2696.2208 t / year), carbon oxide by 165.5808 tons / year (from 874.4503 to 708.8695 tons / year).

Modeling of the dispersion fields of pollutants in the air showed that the highest concentrations outside the industrial site of the Navoi TPP after project realization will be observed for nitrogen dioxide - 0.24 MPC, not exceeding the established quota (0.25 MPC) for the release of this ingredient.

It should be noted that entry into the quota in terms of the level of air pollution will be achieved only if all existing worn-out boilers of the TPPs are shut off.

Water supply to the CCPs Nos. 3, 4 for drinking and production needs is planned to realize from the existing Navoi TPP's networks.

Operation of the CCPs Nos. 3, 4 will be accompanied by water withdrawal from the Zeravshan River and the use of tap water. To meet the technological needs of the CCPs, a circulating water supply system with cooling on cooling towers has been adopted. Approximate consumption of industrial water from the Zeravshan river for the needs of two units of CCPs Nos. 3.4 will be 1350 m3 h or 11705 thousand m3 /year, the expected consumption of tap water for drinking needs of two CCPs - 15.093 thousand m3 / year; the total water consumption for the needs of CCPs No. 3.4 will be 11,720,093 thousand m3 / year.

Discharge of purge water from cooling towers into the Zeravshan River is projected at the level of 501 m3 / hour (4008.0 thousand m3 / year).

The rated capacity of water treatment plants (WTP) for the Navoi TPP is sufficient to provide the station with water after the competition of new CCPs, but given their physical wear and tear, the project envisages the construction of a new WTP.

According to Law of the Republic of Uzbekistan No. 837-XII of September 6, 1993 "On Water and Water Use", a system of circulating technical water supply is provided for two additional CCP units. Fan cooling towers are planned to install for the plants, the technical characteristics of which will be refined with detailed design. Replenishment of losses in the circulating system (droplet entrainment, evaporation, purging) is provided for by supplying water from the Zeravshan River.

After construction of the CCPs Nos. 3, 4 the number of water outlets will remain the same ~ 7 outlets. The estimated additional amount of treated wastewater sent for discharge to outlet №1 will be 5 m3 / hour. The quality of the effluent from the CCP differs from the effluent of the existing power plants with a lower content of suspended solids.

A significant reduction of thermal waters discharge into the Zeravshan River through the use of recycled process water supply systems will reduce the supply of heat to the surface waters.

The commissioning of new CCP No. 3, 4 will not require the organization of additional sources of water supply - water consumption by thermal power plant from the Zeravshan River in 2018 amounted to 577868.644 thousand m3 / year with a limit of 860,000 thousand m3 / year.

Regenerated wastes from water treatment plants is planned to supply to chemical treatment water plant (CTW) and then to the KOPS installation (Integrated Treatment of Industrial Wastewaters) which includes a unit of neutralization of acid and alkaline effluents of WTP of feeding steam cycle and a unit of treatment of saline waste from WTPs. Treatment of saline waste is planned to carry out according to the following scheme: dosing of soda into averaging tanks, filtration of separated water at mechanical filters with the following treatment at a reverse osmosis unit. Saline wastes (salt liquor), after reverse osmosis treatment will be sent to the evaporation pond, the purified water will be returned to the WTP cycle to feed the circulating system and the steam-water cycle.

After commissioning 2 additional CCPs, the same types of waste will be generated at the Navoi TPP as it is at the present conditions, i.e. no additional types of waste are expected with respect to those produced at present time. The changes concern the norms of formation and the limits of disposal of all types of wastes. These values need to be clarified in the process of further environmental design.

Prior to the commissioning of the facilities in question, an environmental impact statement should be submitted for consideration in which environmental standards should be developed for all types of environmental impact of the proposed activity.

The State Committee of the Republic of Uzbekistan on Ecology and Environmental Protection shall coordinate a draft Statement on Environmental Impact on the construction of 2 combined-cycle plants (No. 3.4) of class J with a total capacity of 1,300 MW at Navoi TPP JSC located in the Karmaninsky district of the Navoi Region.

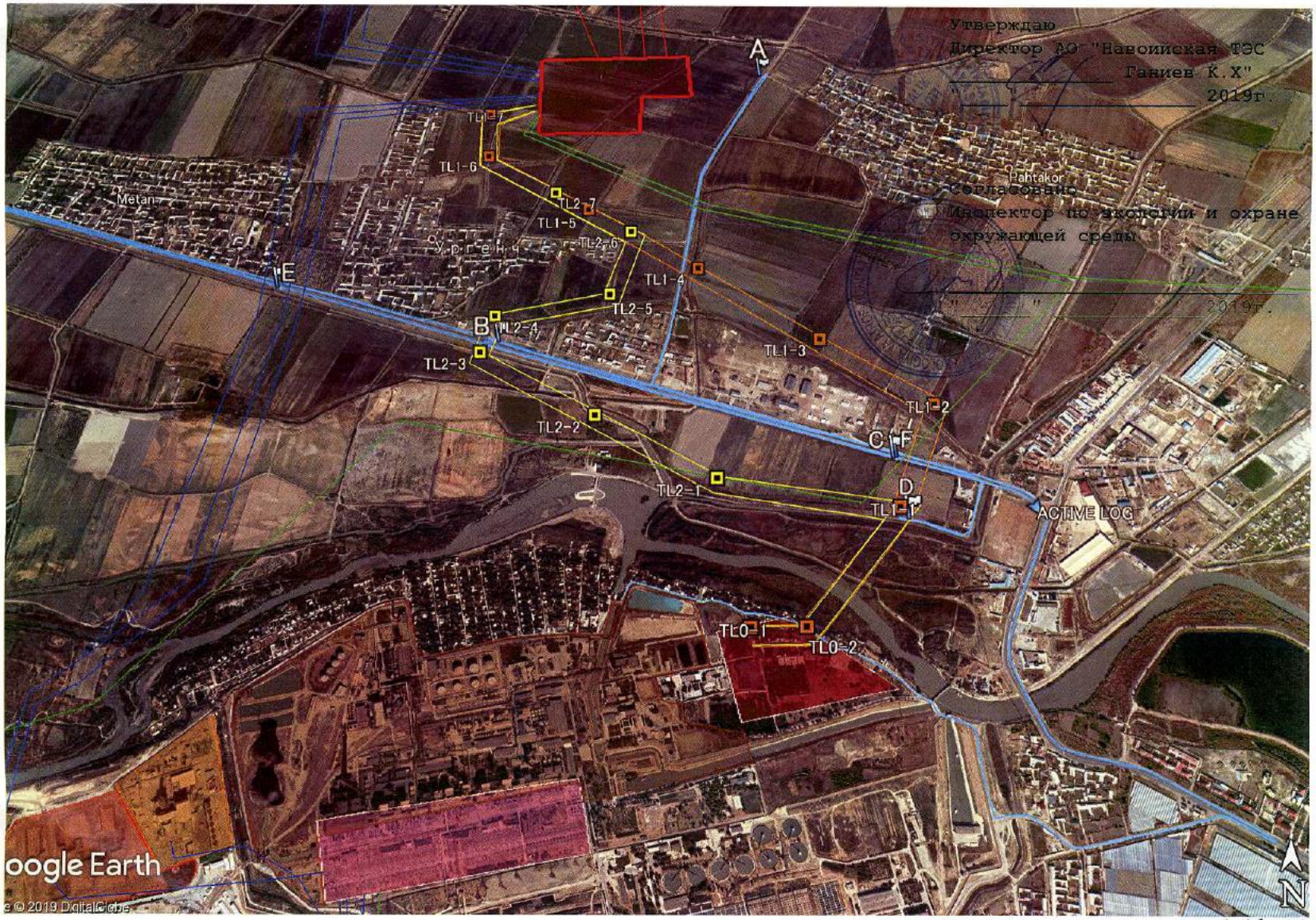
The Directorate for Ecology and Environmental Protection of Navoi Region needs to take control of compliance with the requirements of environmental legislation during the construction period.

It is not allowed to commission the facilities without a positive opinion on the Statement of Environmental Effects.

Chairman signed B. Kuchkarov.

**Annex No. 2**

# SITE LAYOUT PLAN, PROVISIONAL SITE PLAN


Утверждаю
Директор АО "Навоийская ТЭС
Ганиев К.Х"
"____" _____ 2019г.
Согласовано
Инспектор по экологии и охране
окружающей среды
"____" _____ 2019г.
A
B
C
D
E
F
TL1-1
TL1-2
TL1-3
TL1-4
TL1-5
TL1-6
TL1-7
TL2-1
TL2-2
TL2-3
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TL0-1
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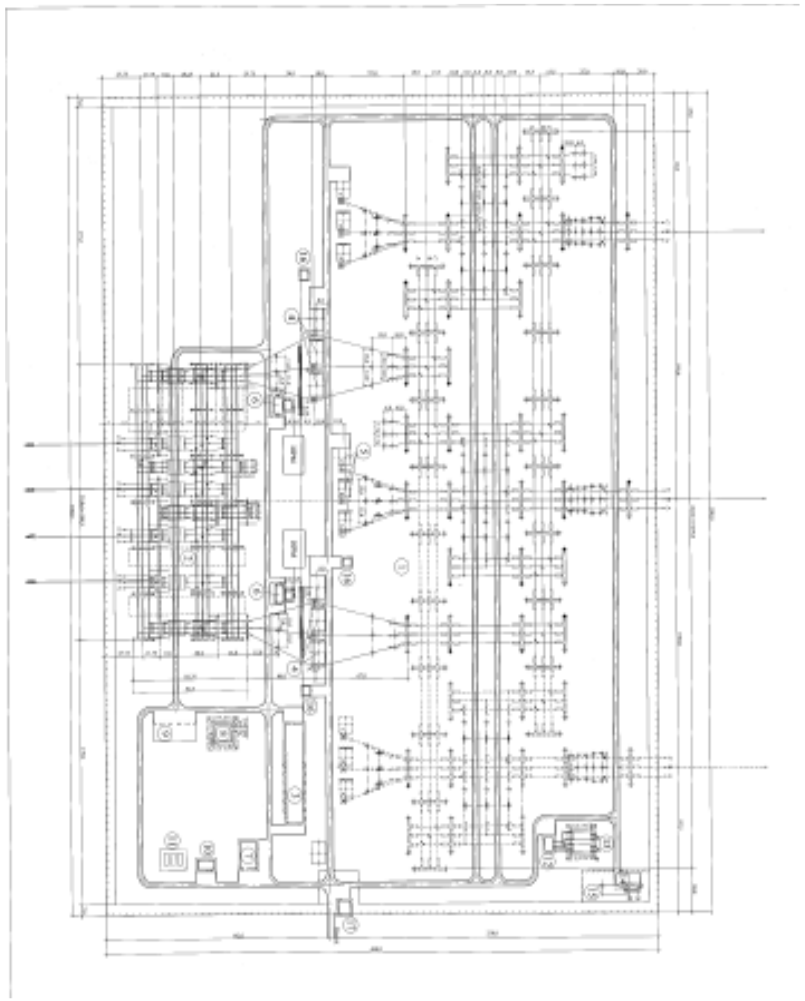


| Explanation of buildings and constructions | | | 3 |
|---|---|---|---|
| № Under site plan | Name | Building area, $m^2$ | Note |
| 1 | Outdoor switchgear -500 kilowatt | | |
| 2 | Outdoor switchgear -220 kilowatt | | |
| 3 | General substation control unit | | |
| 4 | Autotransformer 167000/500/200-У1 | | 6 pcs |
| 5 | Reactor RoDTS60000/500-У1 | | 3 pcs |
| 6 | Indoor switchgear -10 kilowatt с реакторными камерами | | 2 pcs |
| 7 | ZVN | | 3 pcs |
| 8 | premise 05 | | |
| 9 | inside storage | | |
| 10 | Control operating room of mineral oil facilities | | 4 pcs |
| 11 | Outside storage for oil | | |
| 12 | Fire extinguishing pump station | | |
| 13 | Water storage tank 2x100$m^3$ | | |
| 14 | Hydraulic power station over wellsite | | |
| 15 | Water tower | | |
| 16 | Gate valve shifting section | | |
| 17 | Check passage | | |
| 18 | Oil reservoir. 200 $m^3$ | | |
| 19 | Oil reservoir . 100 $m^3$ | | |
| 20 | Diesel building | | |
| 21 | Antenna support | | |
| 22 | Cesspool.18 $m^3$ | | |
| 23 | Yard lavatory for one | | |
| 24 | Free-standing lightning discharger | | |
| 25 | Observation tower (4pcs) | | |
| 26 | fungus (11pcs) | | |
| 27 | Dead-end support VL-500 kilowatt | | |
| 28 | Dead-end support VL-220 kilowatt | | |

| Equipment | | | |
|---|---|---|---|
| № Under site plan | Outdoor switchgear *500kilowatt with 5 boxes* | | |
| 1 | Switches 500 kilowatt | | |
| 2 | Breakers 500 kilowatt | | |
| 3 | Current transformers (CT) 500 kilowatt | | |
| 4 | Voltage transformers (VT) 500 kilowatt | | |
| 5 | Excess-voltage suppressor (EVT) 500 kilowatt | | |
| 6 | Coupling capacity and high-frequency rejector 500 kilowatt | | |
| № Under site plan | Outdoor switchgear *220kilowatt with 4 boxes* | | |
| 1 | Switches 220 kilowatt | | |
| 2 | Switches 220 kilowatt | | |
| 3 | Current transformers (CT) 220 kilowatt | | |
| 4 | Voltage transformers (VT) 220 kilowatt | | |
| 5 | Excess-voltage suppressor (EVT) 220 kilowatt | | |
| 6 | Coupling capacity and high-frequency rejector 220 kilowatt | | |

All data preliminary.
Final data would be specified as work proceeds.

| sub-station 500/220kilowatt | Phase | Sheet | Sheets |
|---|---|---|---|
| Preliminary site plan | | | |

**Appendix 3**

# Parameters of Sources of Emissions of Polluting Substances

**Table 3.1.**

## Sources of Emissions of Polluting Substances at the Stage of Operation of Remote ORU

| Production, Shop, Section | | Operating Time of Source | Source No. In Map | Height of Emission Source, m | Diameter, m | Parameters of Gas-Air Mixture | | | Coordinates of Sources in Schematic Map,m | | | | | Polluting Substance | Emissions of Polluting Substances | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources of Release | Source of Emission | | | | | Volume, m3/s | Speed, m/s | Temperature, °C | First End | | Second End | | Width, м | | g/s | mg/m3 | t/year |
| | | | | | | | | | X1 | У1 | X2 | У2 | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| **After Project Implementation** | | | | | | | | | | | | | | | | | |
| Oil-filled Equipment | unorganized | 8760 | 1 | 2 | | | | | 730 | 751 | 1123 | 730 | 370 | Hydrocarbons | 0.00025 | | 0.0078 |
| Electric Welding Device | | | | | | | | | | | | | | Iron oxide | 0.00005 | | 0.0003 |
| | | | | | | | | | | | | | | Compounds of manganese | 0.000005 | | 0.00003 |
| | | | | | | | | | | | | | | **Total** | **0.00030** | | **0.0081** |

**Table 3.2.**

## Sources of Emissions of Polluting Substances at Stage of Construction of ORU 220/500 kV

| Production, Shop, Section | | | | | Parameters of gas-air mixture | | | Coordinates of sources in Schematic map m | | | | | Polluting Substance | Emissions of polluting substances | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | First End | | Second End | | | | g/s | mg/m3 | t/year |
| Sources of Release | Source of Emission | | | | Volume, m3/s | Speed, m/s | Temperature, °C | X1 | У1 | X2 | У2 | | | 15 | 16 | 17 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | | | |
| **Construction works** | | | | | | | | | | | | | | | | |
| Bulldozer | unorganized | 1 | 2 | | | | | 730 | 751 | 1123 | 730 | 370 | Inorganic dust | 0.00461 | | 0.0026 |
| Excavator | | | | | | | | | | | | | Nitrogen dioxides | 0.13333 | | 0.4608 |
| | | | | | | | | | | | | | Nitrogen oxide | 0.02167 | | 0.0749 |
| | | | | | | | | | | | | | Carbon-black | 0.06667 | | 0.2304 |
| | | | | | | | | | | | | | Sulphur dioxide | 0.08333 | | 0.2880 |
| | | | | | | | | | | | | | Carbonic oxide | 0.41667 | | 1.4400 |
| | | | | | | | | | | | | | Formaldehyde | 0.01042 | | 0.0360 |
| | | | | | | | | | | | | | Hydrocarbons | 0.12500 | | 0.4320 |
| | | | | | | | | | | | | | **Total** | **0.86169** | | **2.9647** |
| **Installation works, waterproofing and painting** | | | | | | | | | | | | | | | | |
| Welding device | unorganized | 1 | 2 | | | | | 730 | 751 | 1123 | 730 | 370 | Iron oxide | 0.00030 | | 0.0007 |
| Diesel-generator | | | | | | | | | | | | | Manganese compounds | 0.00003 | | 0.0001 |
| Waterproofing | | | | | | | | | | | | | Nitrogen dioxides | 0.01529 | | 0.0528 |
| Painting | | | | | | | | | | | | | Nitrogen oxide | 0.00248 | | 0.0086 |
| | | | | | | | | | | | | | Carbon-black | 0.00095 | | 0.0033 |
| | | | | | | | | | | | | | Sulphur dioxide | 0.00500 | | 0.0173 |
| | | | | | | | | | | | | | Carbonic oxide | 0.01667 | | 0.0576 |
| | | | | | | | | | | | | | Formaldehyde | 0.00019 | | 0.0007 |
| | | | | | | | | | | | | | Hydrocarbons | 0.00476 | | 0.0165 |
| | | | | | | | | | | | | | Nephras | 0.03216 | | 2,0007 |
| | | | | | | | | | | | | | White spirit | 0.02840 | | 0.2685 |
| | | | | | | | | | | | | | Xylol | 0.03827 | | 0.3617 |
| | | | | | | | | | | | | | **Total** | **0.14450** | | **2.7884** |
| | | | | | | | | | | | | | **Grand total** | **1,00620** | | **5.7530** |

# Calculation of Emissions in Performance of Construction Works

| Work duration | **mnth.** | days | h/g (in 2 shifts) |
|---|---|---|---|
| construction of pits and installation sites | 2 | 60 | 960 |
| installation of foundations | 1 | 30 | 480 |
| installation of equipment | 2 | 60 | 960 |
| equipment to be installed | 18 | pcs. | |

| | m3 | tons |
|---|---|---|
| Excavation works using mechanisms | 6941 | 11592.292 |
| density | 1.67 | т/m3 |
| Consumption | | |
| Paint BT-177 | 4.147 | tons |
| Nephras | 2.668 | m3 |

**Construction works**

| **Bulldozer** | 22 | h/g |
|---|---|---|
| Mg/s = qj*Pch*K1*K2/3600, g/s | | |
| Mt/g = qn*Pg*K1*K2/1000000. | | |
| qj – specific release of solid particles per 1 ton | 1.660 | T-110 (strength class 2-4) |
| Preparation of site by removing of soil | 7.200 | m3 |
| layer in amount of | 129.600 | m3 |
| Pg – quantity of displaced material, | 216.432 | t/g |
| | 10.000 | t/h |
| $K_1$ – coefficient, moisture of material | 1 | moisture 5-7% |
| $K_2$ – coefficient, speed of wind | 1,00 | 1 m/s |

| | g/s | t/g |
|---|---|---|
| Inorganic dust | 0.00461 | 0.0004 |

| **Excavator** | Perm2003 | |
|---|---|---|
| work duration | 960 | h/g |
| q | 0.32 | |
| | 11592 | t/g |
| | 12,075 | t/h |
| K1 | 1 | moisture 5-7% |
| K2 | 1,00 | 1 m/s |
| K3 | 0.6 | height 1.5 m |
| K4 | 1 | Open on all sides |
| n | 0 | None dust-depressing |

| | g/s | t/g |
|---|---|---|
| Sodium chlorides | 0.00064 | 0.0022 |

| **Excavator** | kg/h | kg/s | h/g | t/g |
|---|---|---|---|---|
| Consumption of fuel | 15,00 | 0.0042 | 960 | 14.400 |

| | g/kg | g/s | t/g |
|---|---|---|---|
| Nitrogen oxides | 40 | 0.16667 | 0.5760 |
| Nitrogen dioxides | 32 | 0.13333 | 0.4608 |
| Nitrogen oxide | 5.2 | 0.02167 | 0.0749 |
| Carbon-black | 16 | 0.06667 | 0.2304 |
| Sulphur dioxide | 20 | 0.08333 | 0.2880 |
| Carbonic oxide | 100 | 0.41667 | 1.4400 |
| Formaldehyde | 2.5 | 0.01042 | 0.0360 |
| Hydrocarbons | 30 | 0.12500 | 0.4320 |

Site preparation, pit excavation, takes place at once
therefore, g/s emissions were accepted as maximum from drilling machine, gross (t/g) in total
**In total, the following is emitted from construction of pits and installation sites**

| | g/s | t/g |
|---|---|---|

| | | |
|---|---|---|
| Inorganic dust | 0.00461 | 0.0026 |
| Nitrogen dioxides | 0.13333 | 0.4608 |
| Nitrogen oxide | 0.02167 | 0.0749 |
| Carbon-black | 0.06667 | 0.2304 |
| Sulphur dioxide | 0.08333 | 0.2880 |
| Carbonic oxide | 0.41667 | 1.4400 |
| Formaldehyde | 0.01042 | 0.0360 |
| Hydrocarbons | 0.12500 | 0.4320 |

**Installation works, waterproofing and painting**

**Welding device**

Electrodes ANO - 4

| | | |
|---|---|---|
| Consumption | 121 | kg for all |
| | 0.200 | kg/h |
| Work duration | 960 | h/g |

| | | |
|---|---|---|
| Specific emissions | g/kg | |
| Iron oxide | 5.41 | |
| Compounds of manganese | 0.59 | |

| | g/s | t/g |
|---|---|---|
| Iron oxide | 0.00030 | 0.0007 |
| Compounds of manganese | 0.00003 | 0.0001 |

| **Diesel-generator** | kg/h | kg/s | h/g | t/g |
|---|---|---|---|---|
| Consumption of fuel | 4,00 | 0.0011 | 960 | 3.840 |

| | g/kg | g/s | t/g |
|---|---|---|---|
| Nitrogen oxides | 43 | 0.04778 | 0.1651 |
| Nitrogen dioxides | 34.4 | 0.03822 | 0.1321 |
| Nitrogen oxide | 5.59 | 0.00621 | 0.0215 |
| Carbon-black | 3 | 0.00333 | 0.0115 |
| Sulphur dioxide | 4.5 | 0.00500 | 0.0173 |
| Carbonic oxide | 30 | 0.03333 | 0.1152 |
| Formaldehyde | 0.6 | 0.00067 | 0.0023 |
| Hydrocarbons | 15 | 0.01667 | 0.0576 |

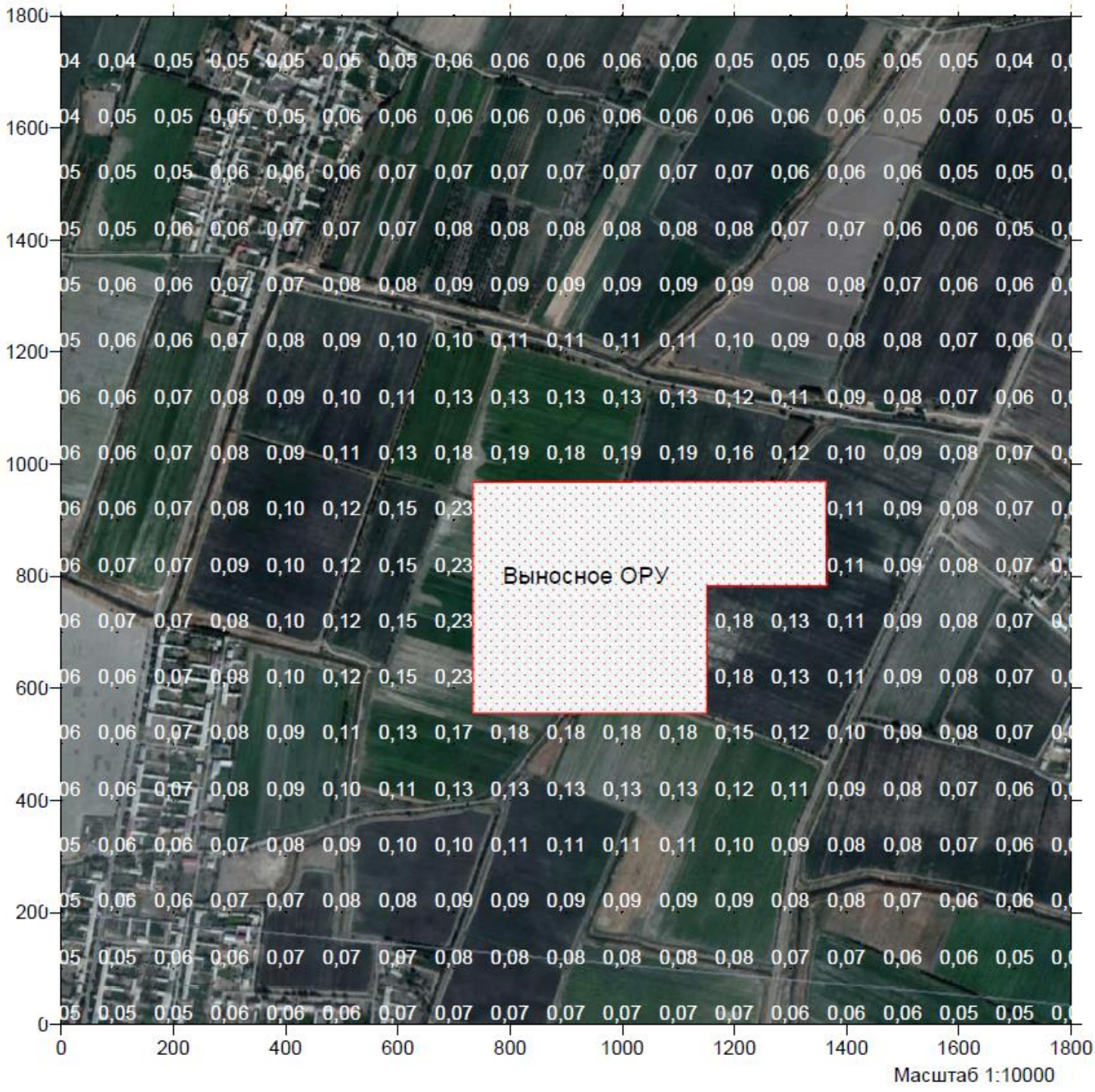
| | reduction | g/s | t/g |
|---|---|---|---|
| Nitrogen dioxides | 2.5 | 0.01529 | 0.0528 |
| Nitrogen oxide | 2.5 | 0.00248 | 0.0086 |
| Carbon-black | 3.5 | 0.00095 | 0.0033 |
| Sulphur dioxide | 1 | 0.00500 | 0.0173 |
| Carbonic oxide | 2 | 0.01667 | 0.0576 |
| Formaldehyde | 3.5 | 0.00019 | 0.0007 |
| Hydrocarbons | 3.5 | 0.00476 | 0.0165 |

# Appendix 4

## Calculation of Level of Atmospheric Pollution

Construction stage (excavation works)

Nitrogen dioxides



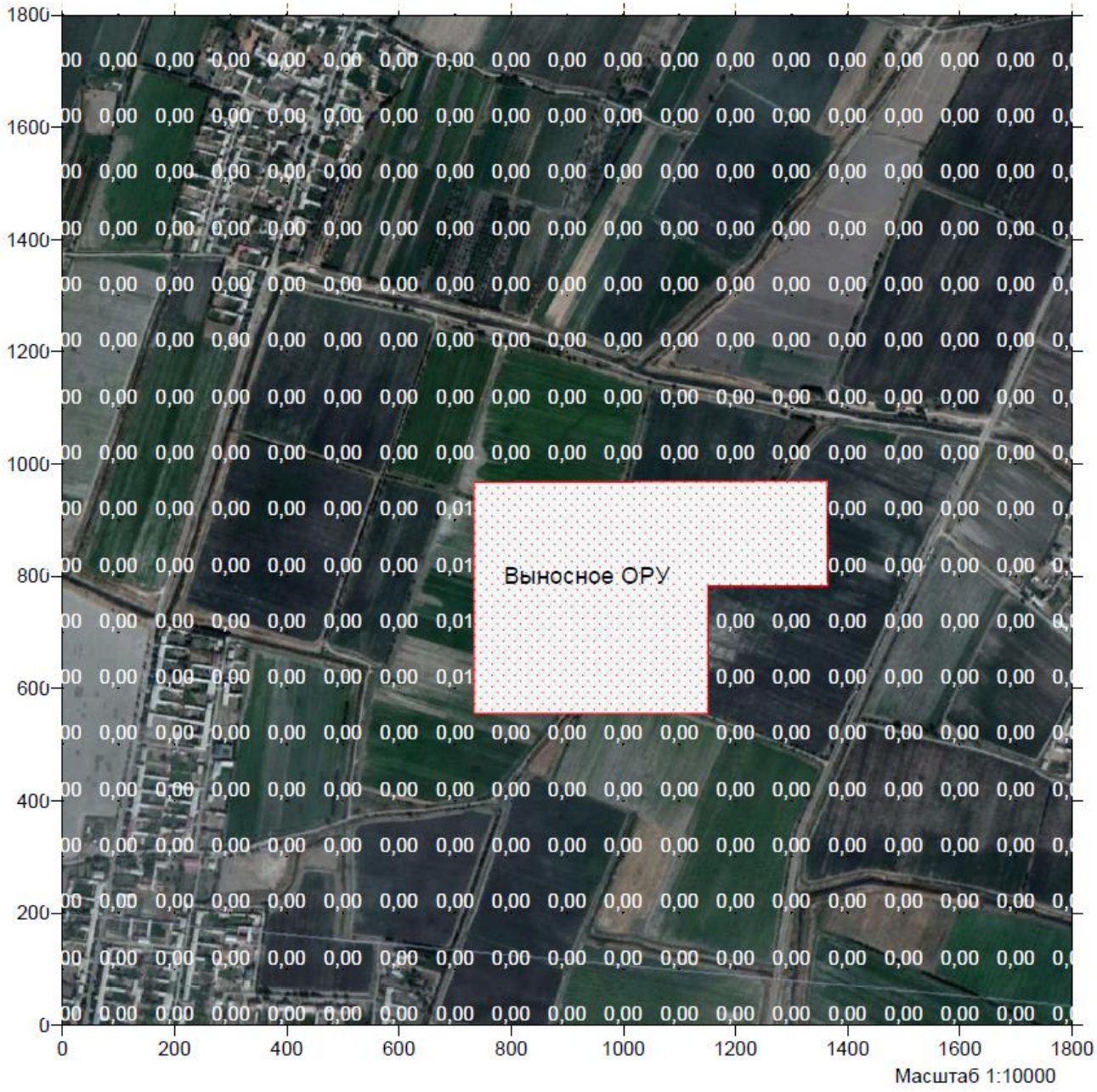

Remote ORU

Scale 1:10000

Figure 4.1

Construction stage (excavation works)

Nitrogen oxide



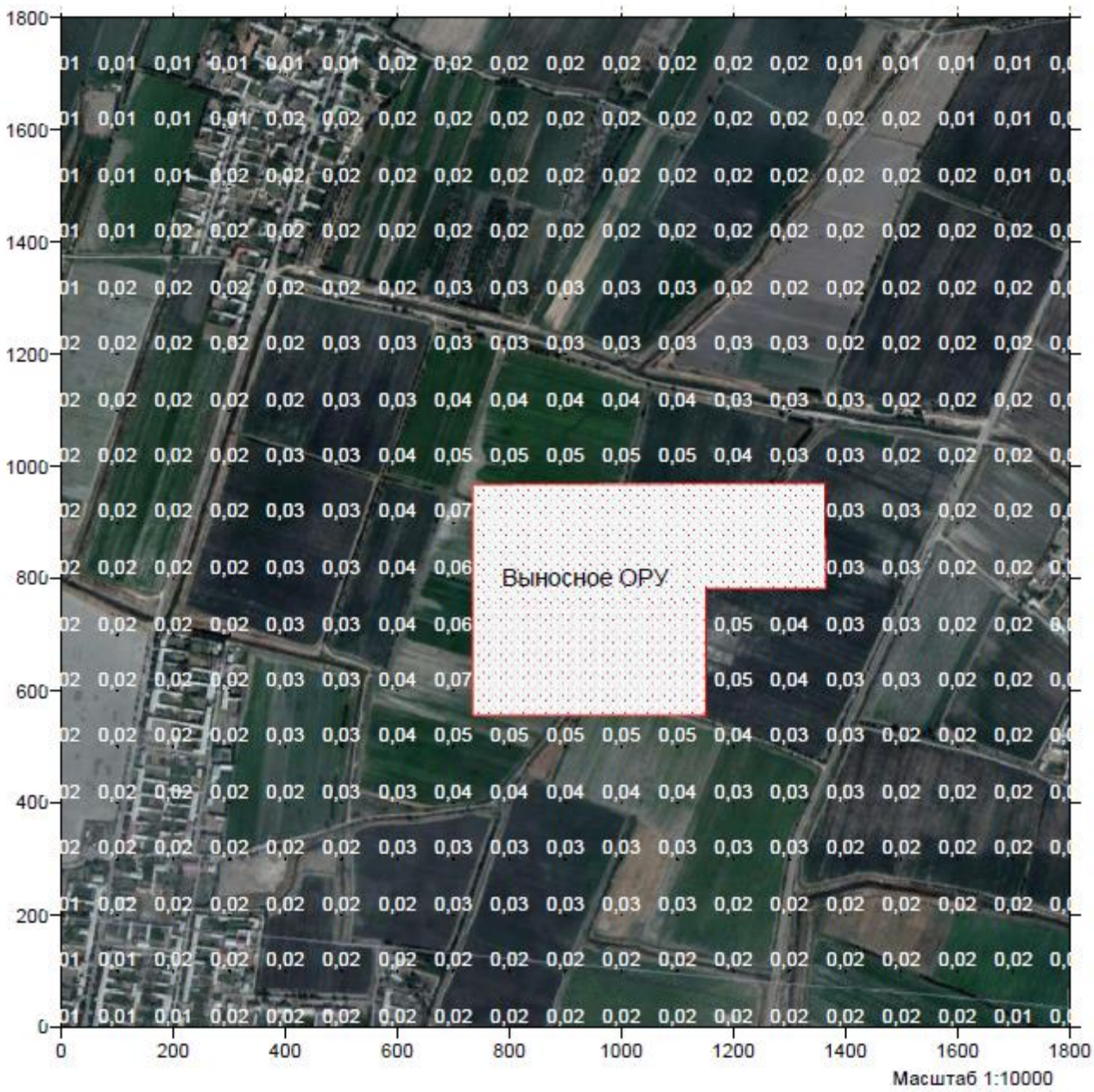

Remote ORU

Scale 1:10000

Figure 4.2

Construction stage (excavation works)

Carbon-black



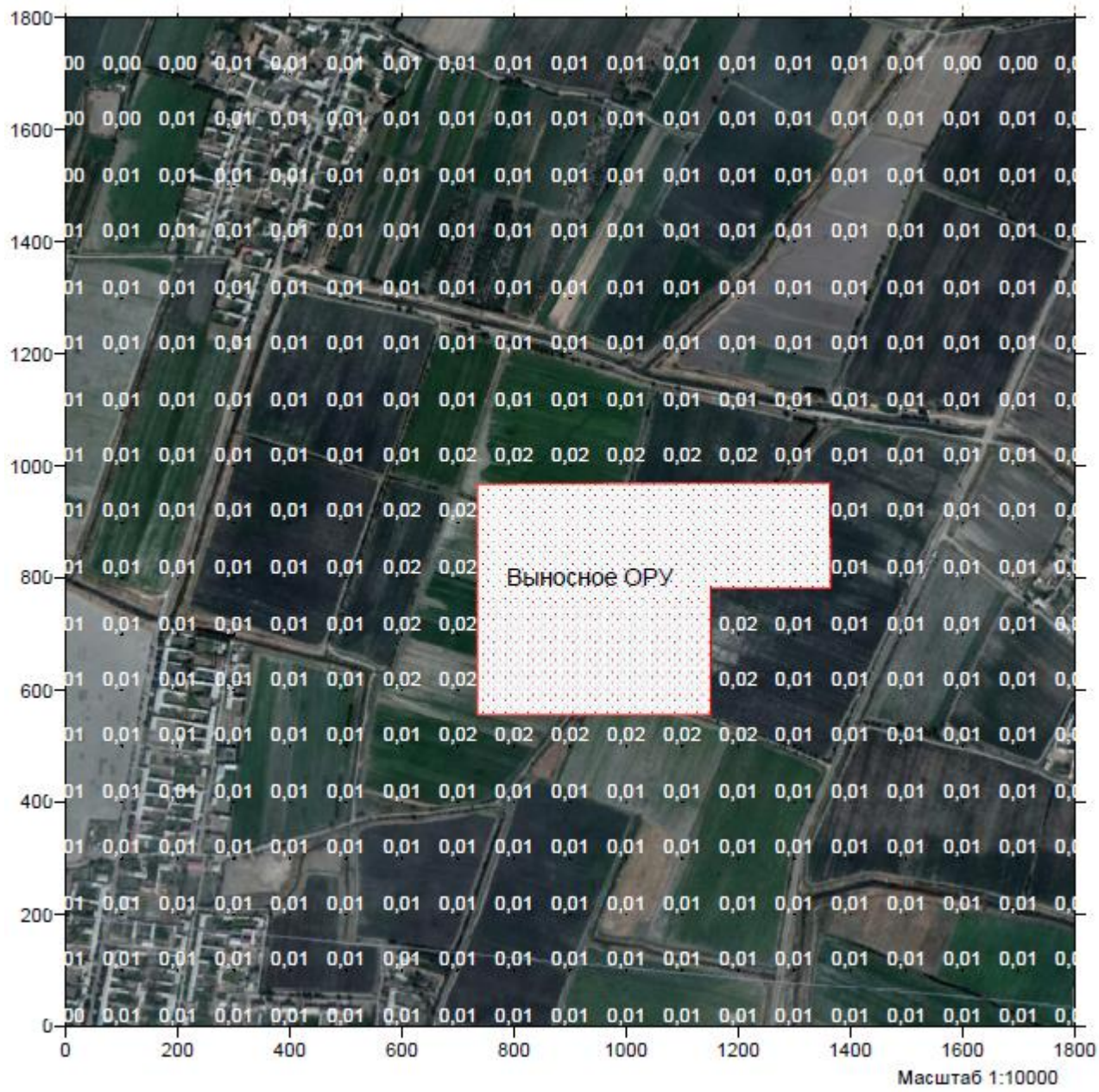

Remote ORU

Scale 1:10000

Figure 4.3

Construction stage (excavation works)

Sulphur dioxide



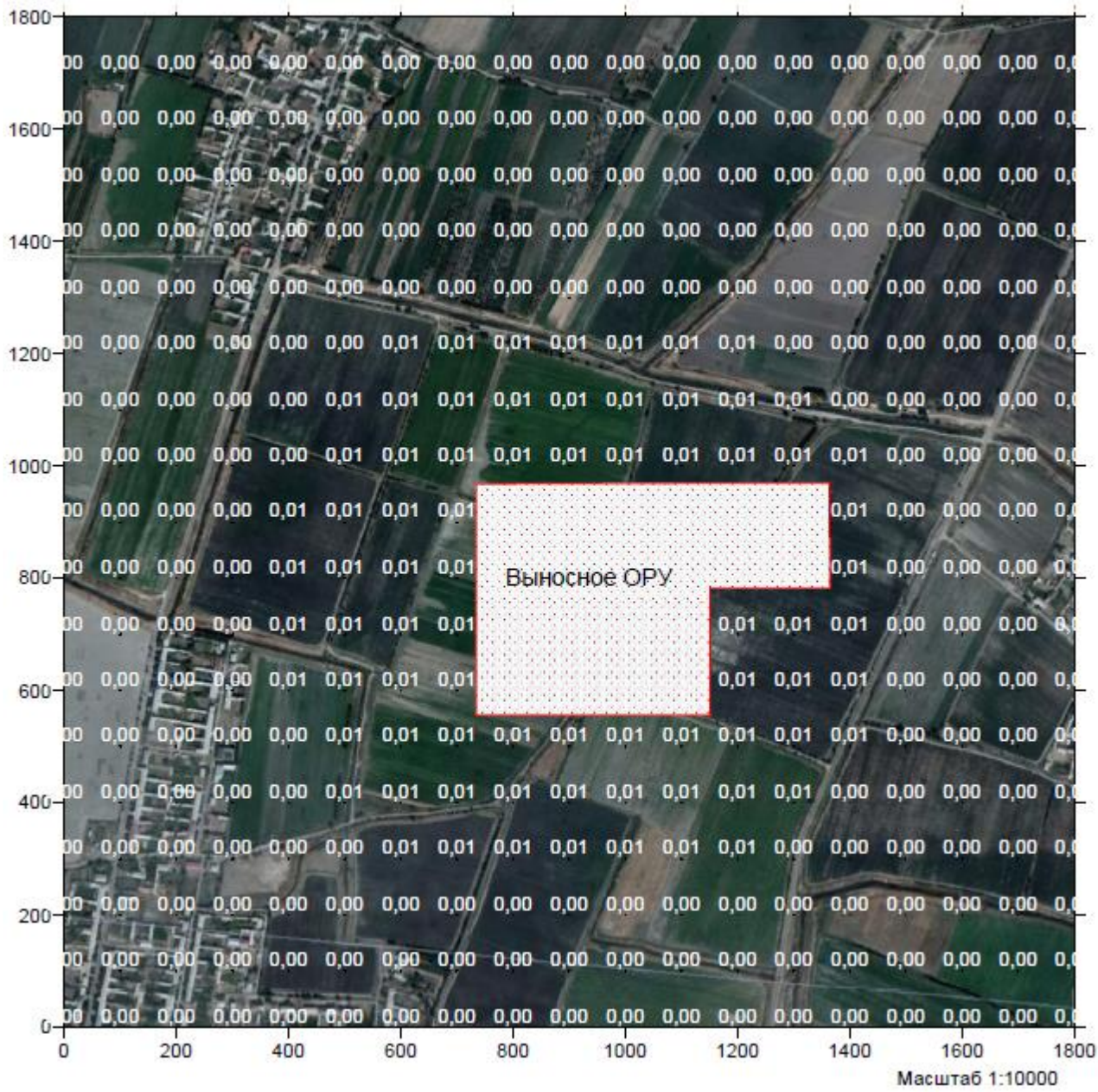

Remote ORU

Scale 1:10000

Figure 4.4

Construction stage (excavation works)

Carbonic oxide



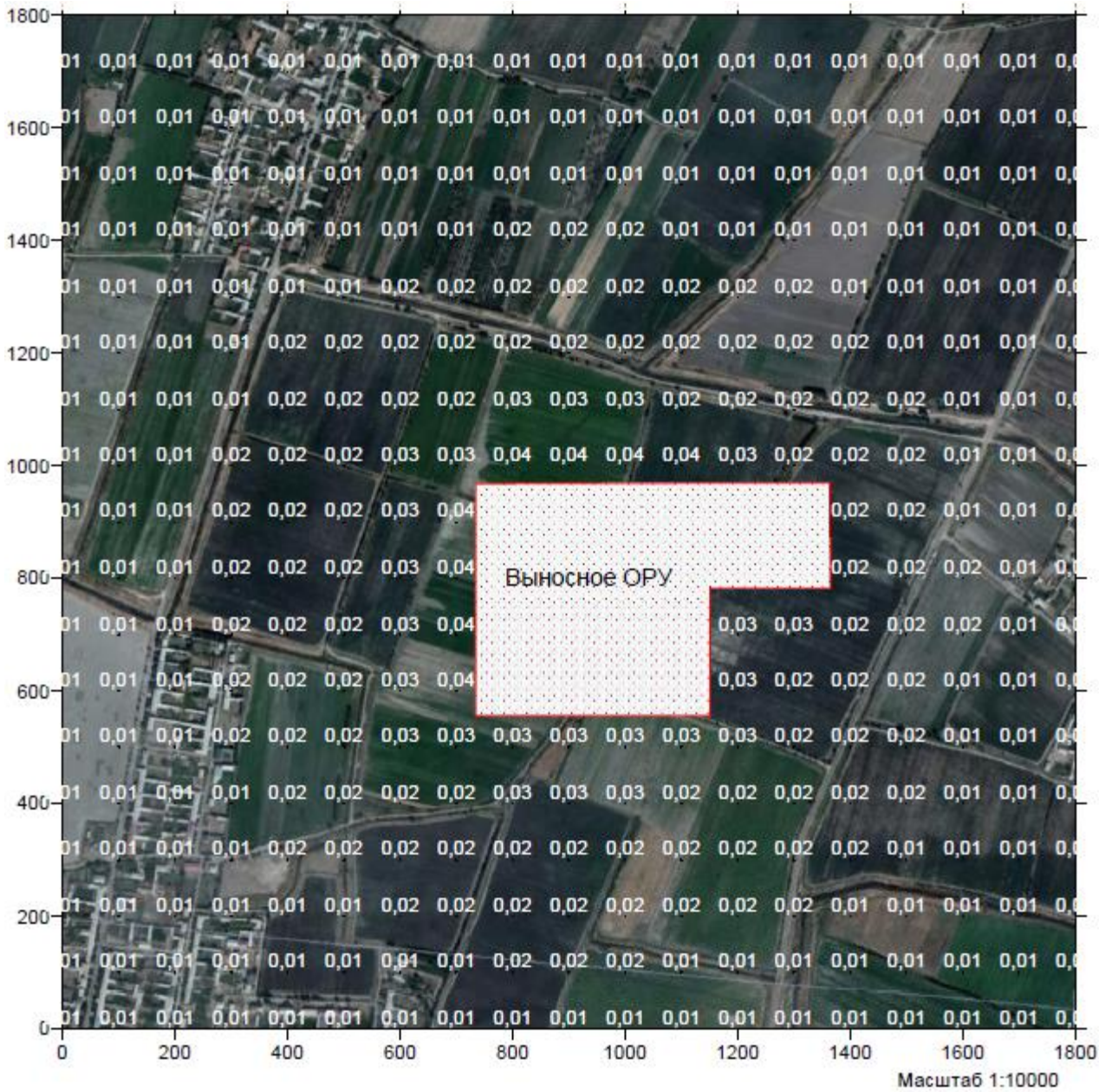

Remote ORU

Scale 1:10000

Figure 4.5

Construction stage (excavation works)

Formaldehyde



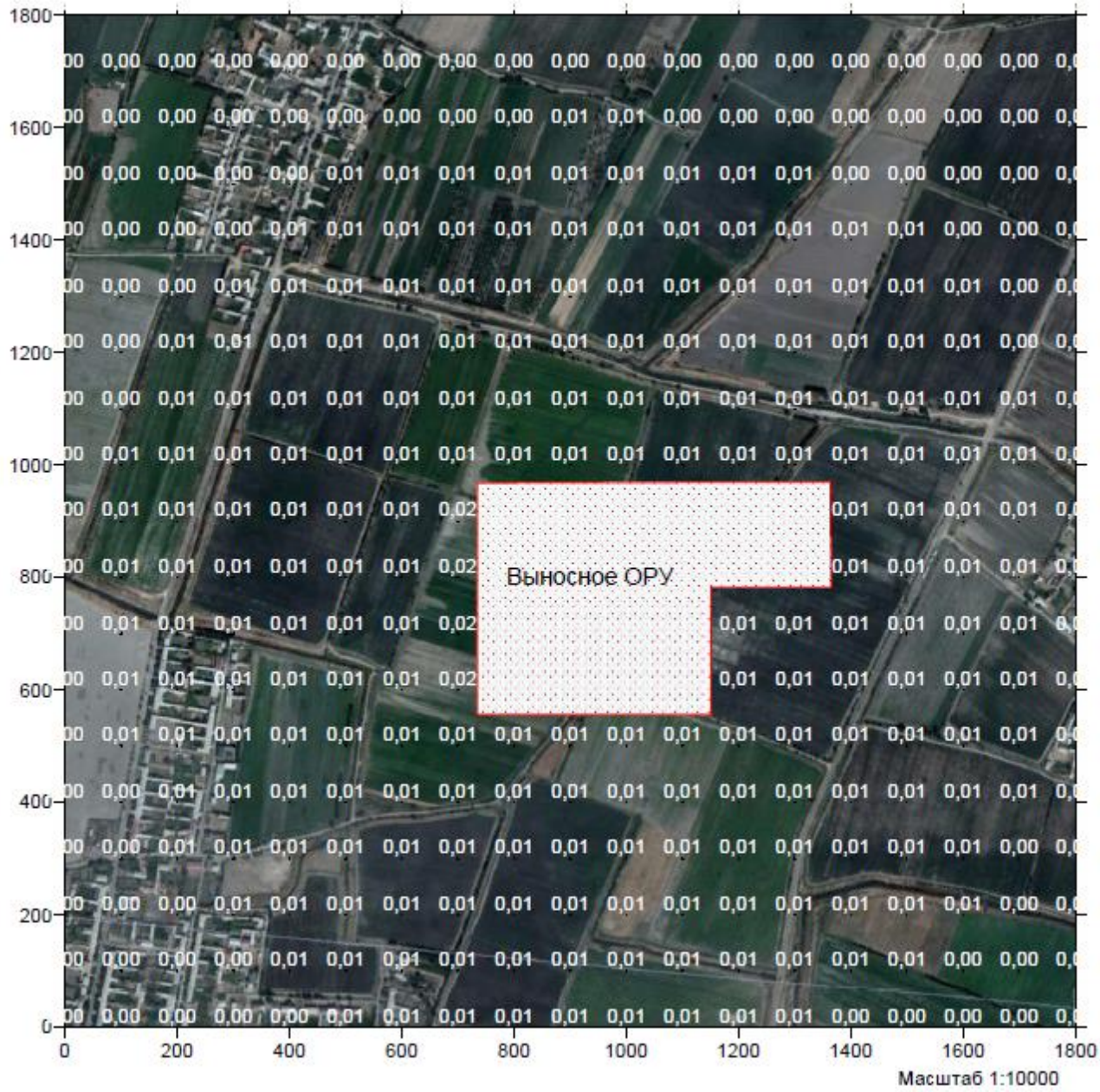

Remote ORU

Scale 1:10000

Figure 4.6

Construction stage (excavation works)

Hydrocarbons



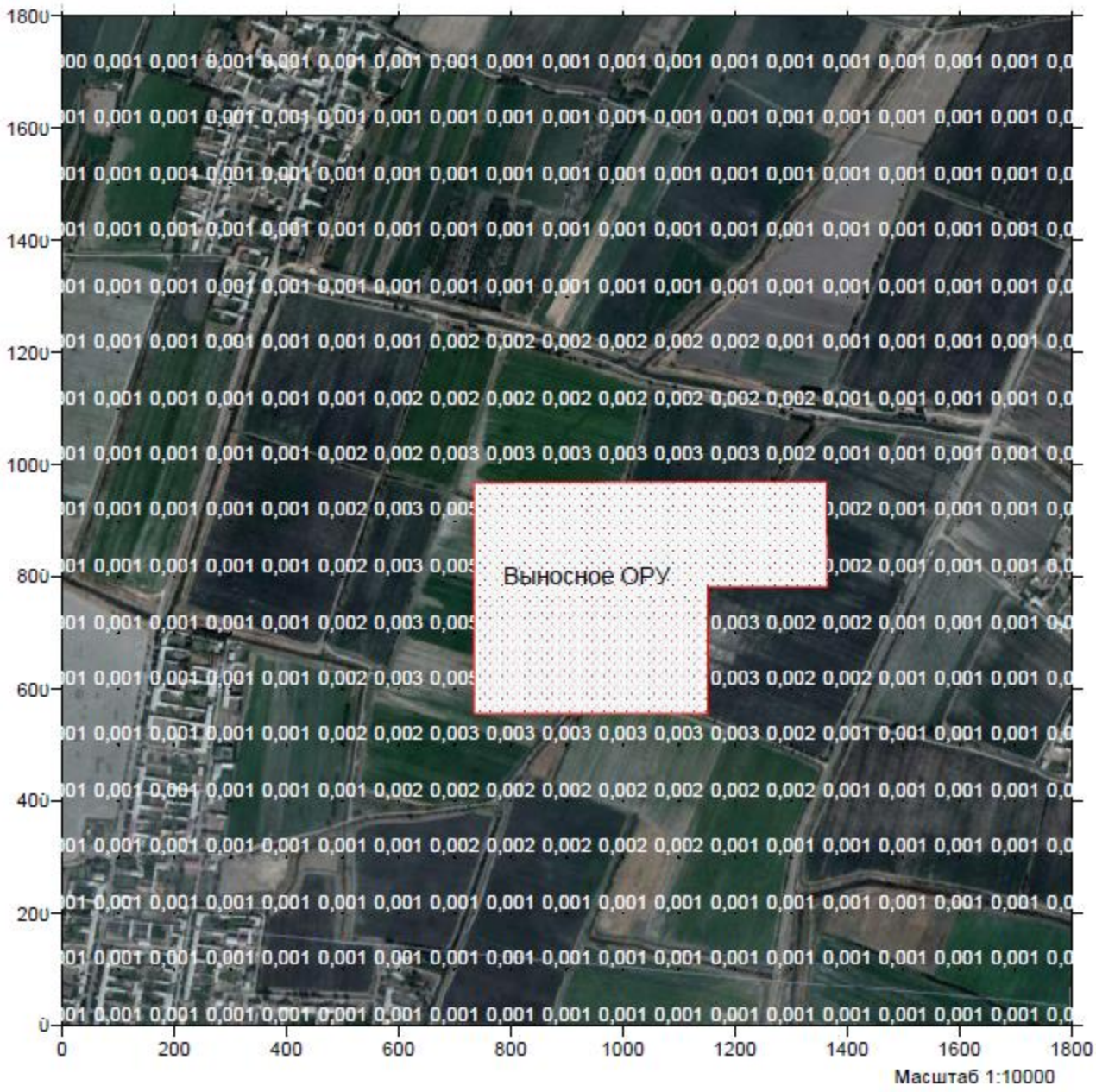

Remote ORU

Scale 1:10000

Figure 4.7

Construction stage (excavation works)

Inorganic dust



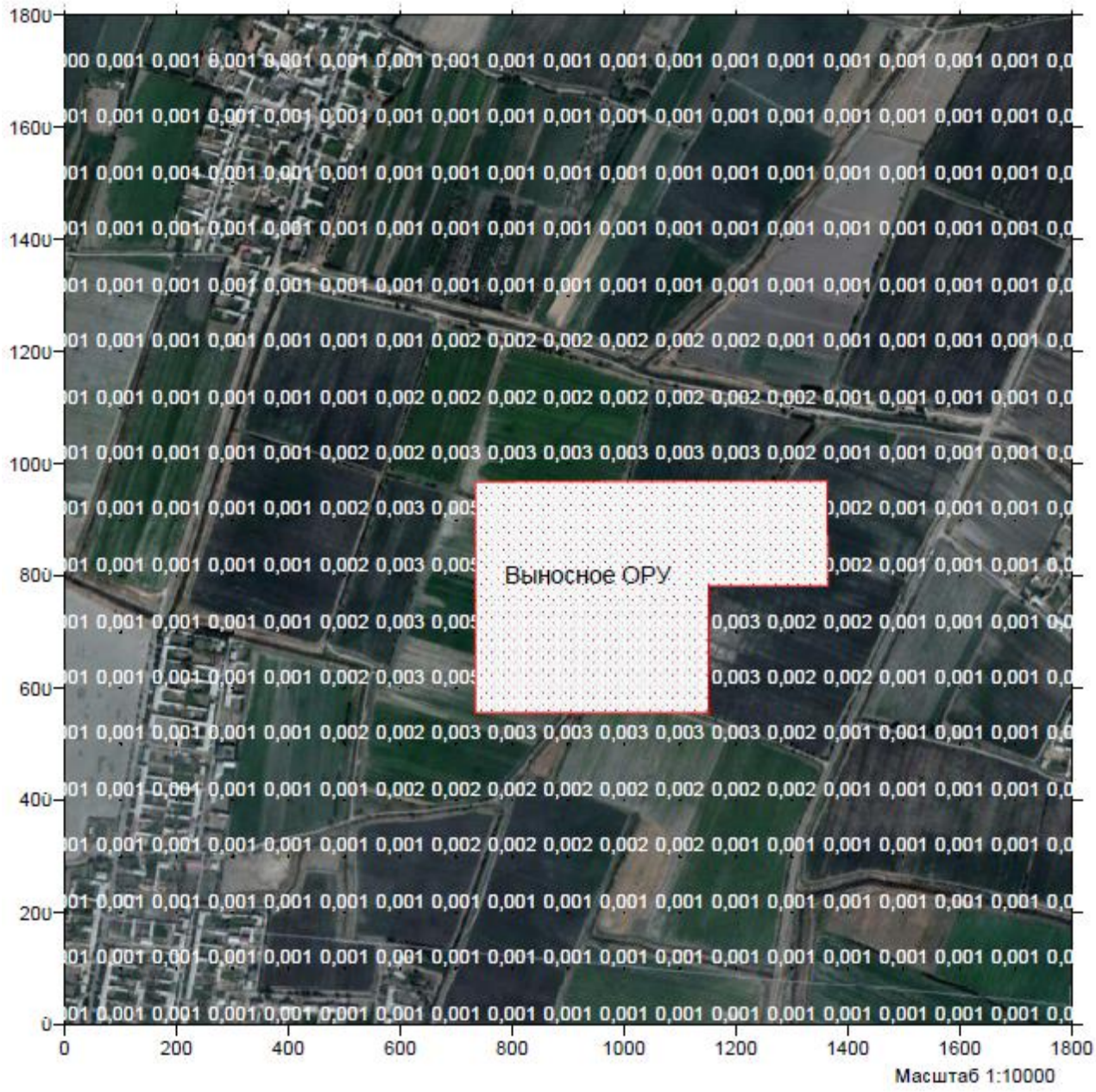

Remote ORU

Scale 1:10000

Figure 4.8

Construction stage (installation works)

Compounds of manganese



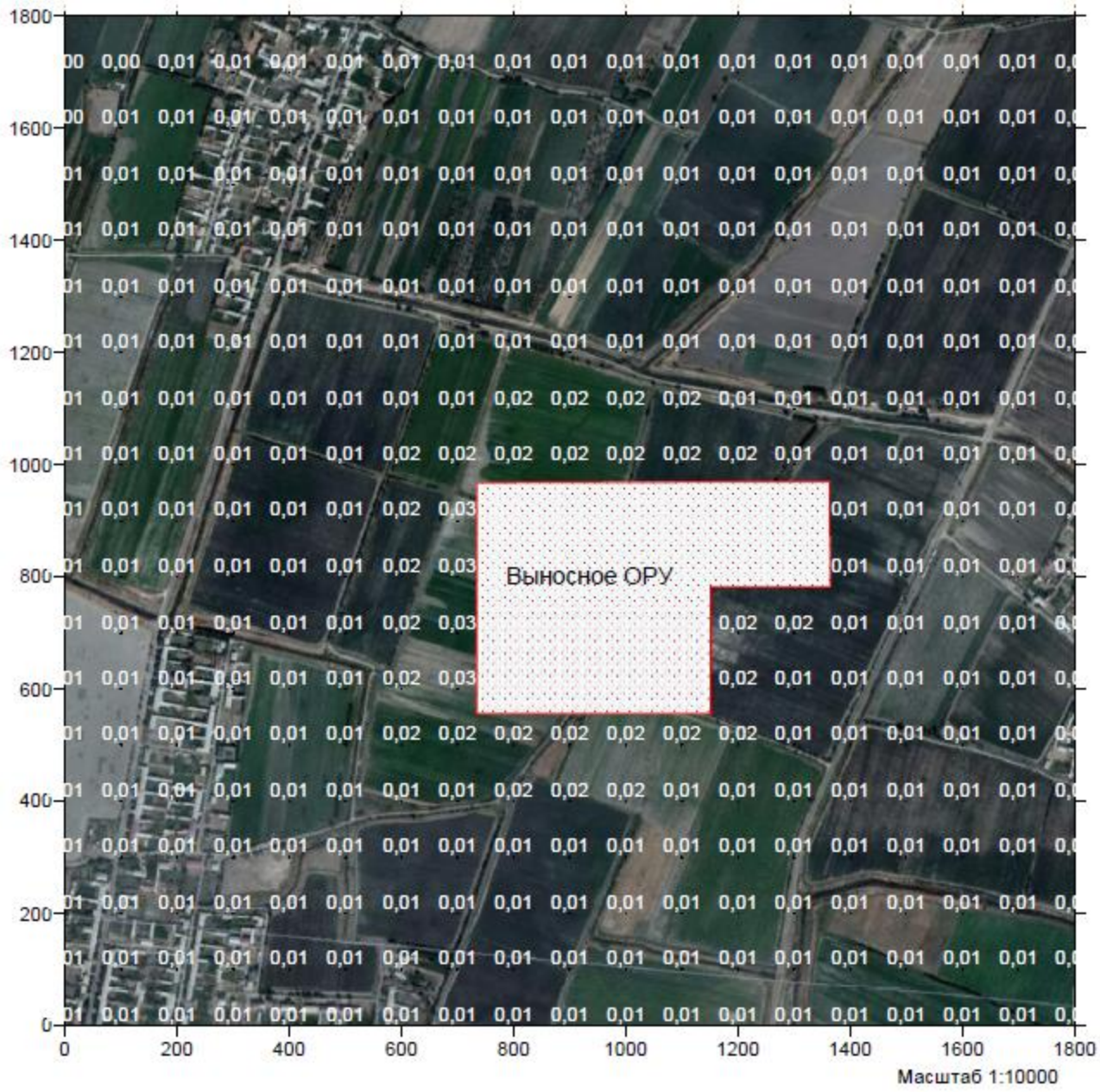

Remote ORU

Scale 1:10000

Figure 4.9

Construction stage (installation works)

Nitrogen dioxides



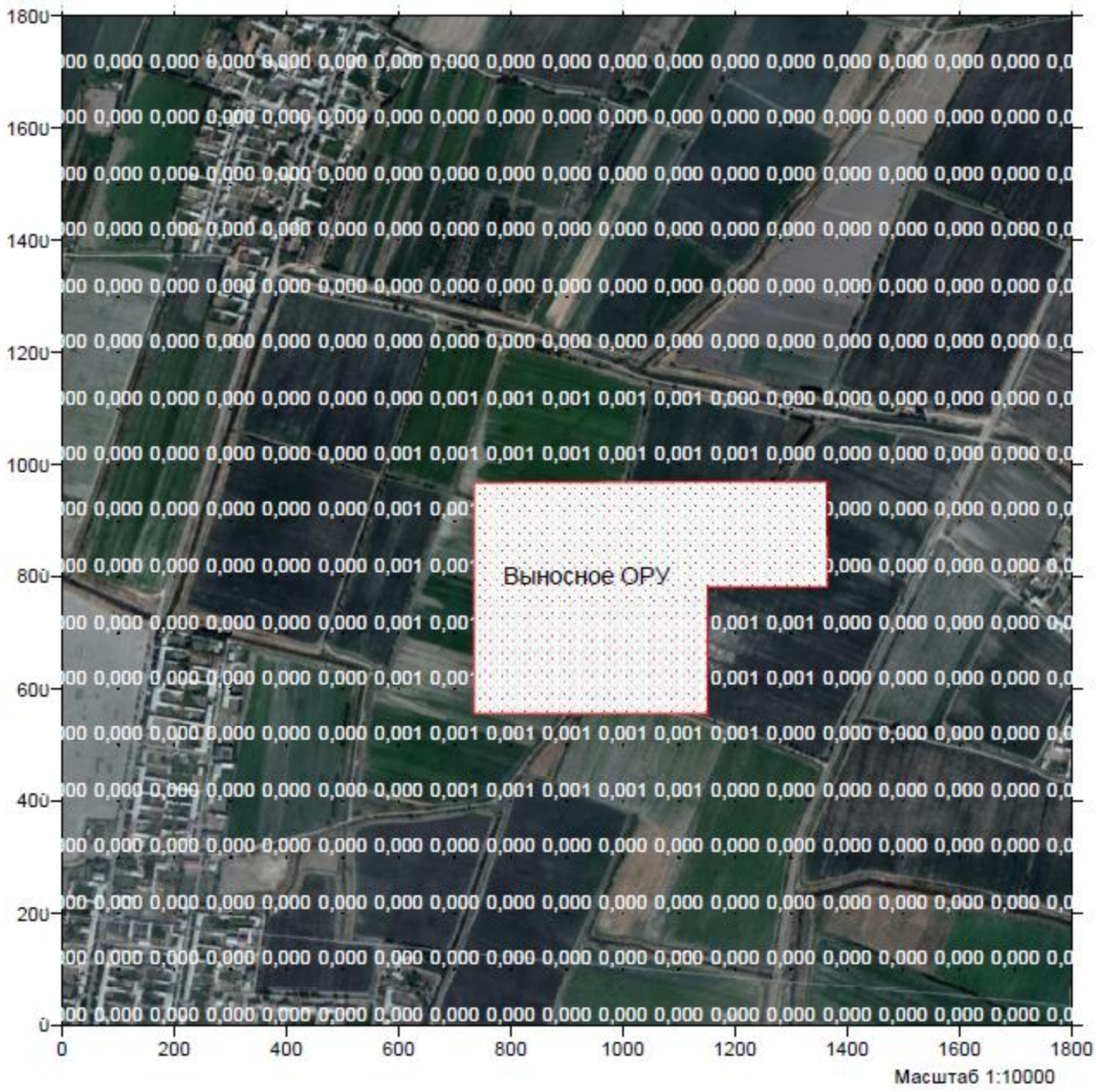

Remote ORU

Scale 1:10000

Figure 4.10

Construction stage (installation works)

Carbon-black



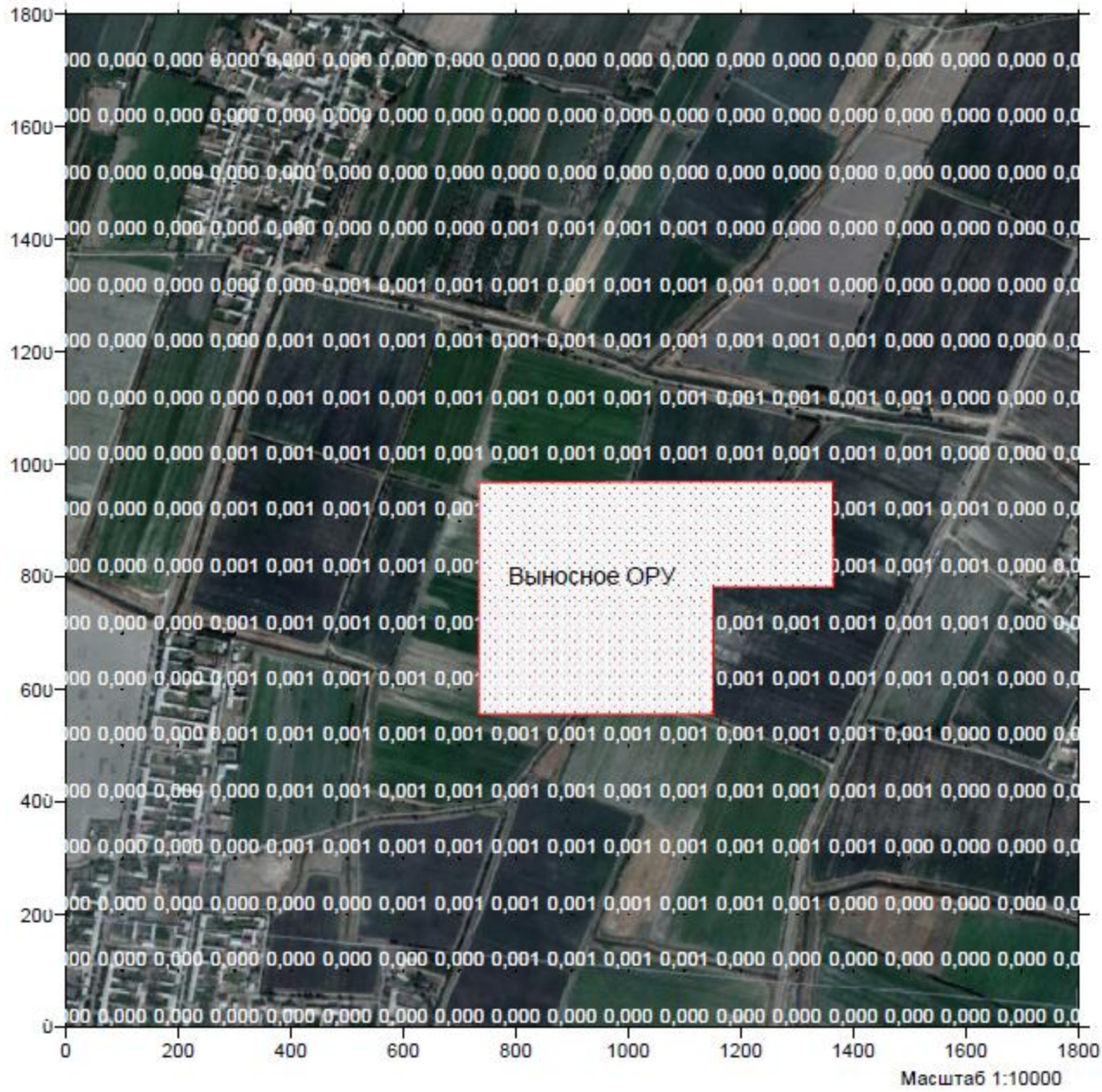

Remote ORU

Scale 1:10000

Figure 4.11

Construction stage (installation works)

Sulphur dioxide



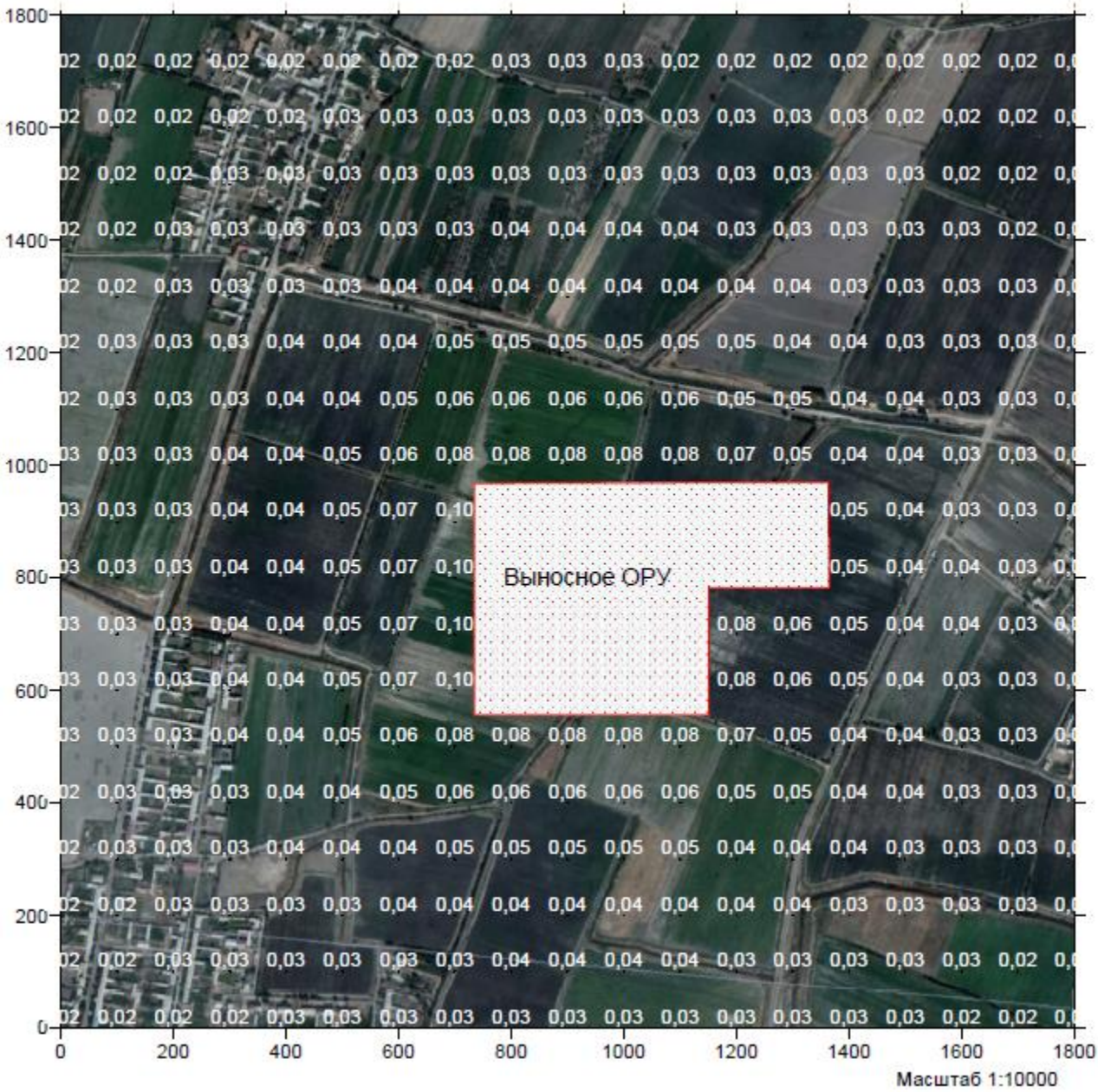

Remote ORU

Scale 1:10000

Figure 4.12

Construction stage (installation works)

Xylol



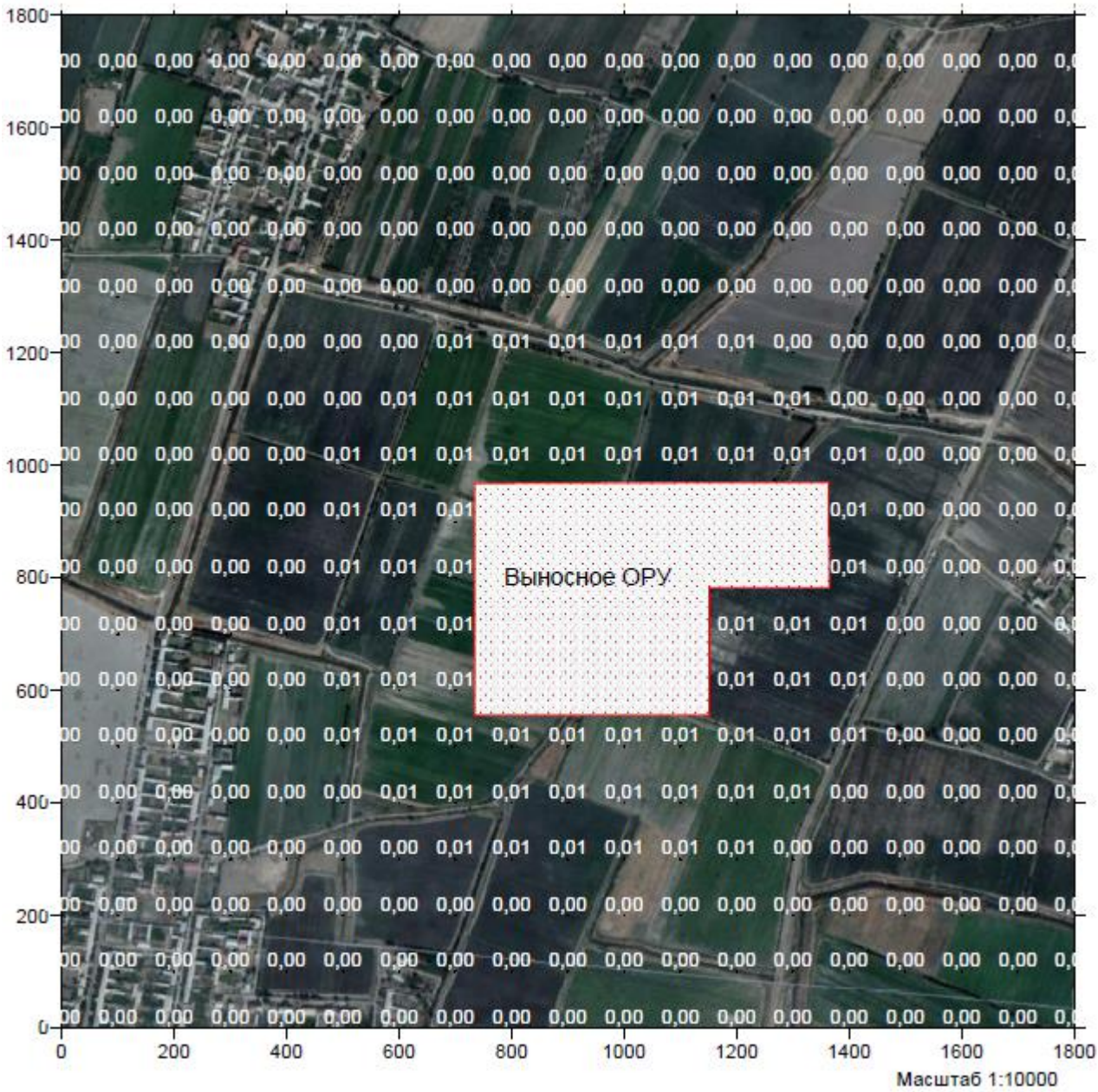

Remote ORU

Scale 1:10000

Figure 4.13

Construction stage (installation works)

Nephras



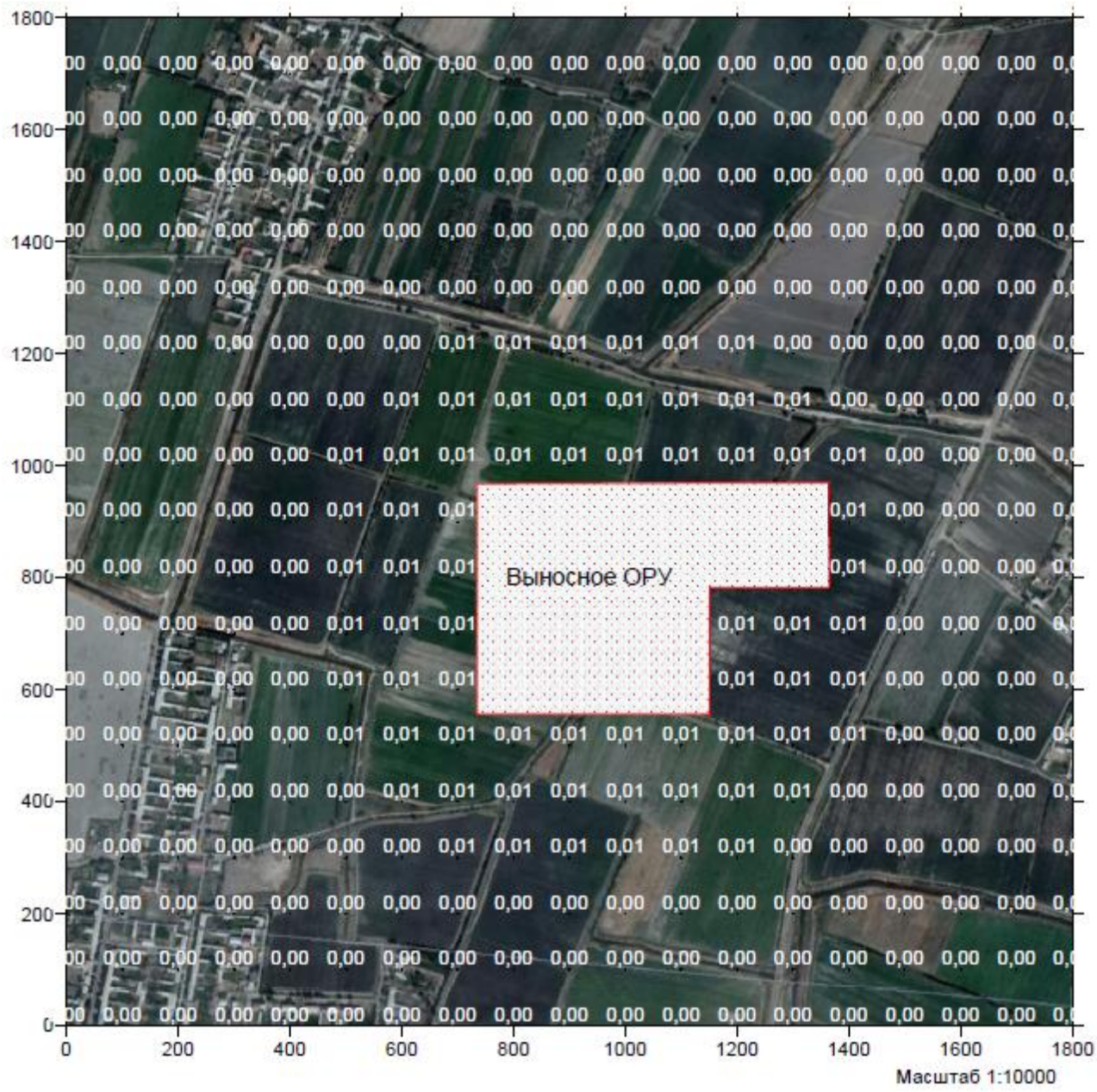

Remote ORU

Scale 1:10000

Figure 4.14

Construction stage (installation works)

White spirit




Remote ORU

Scale 1:10000

Figure 4.15

# UPRZA ECOLOG, version 3.00
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**Serial number 12-34-5678, JSC "Teploelektroproekt"**

## Enterprise number 266; Remote ORU 220/500 kV at Navoi Thermal Power Station

Location: Navoi Region

**Version of initial data: 2, Construction stage**
**Version of calculation: 1, Excavation works**
**Calculation was performed for summer**
**Calculation module: "OND-86 standard"**
**Calculation constants: E1= 0.01, E2=0.01, E3=0.01, S=999999.99 sq.km**

## Meteorological parameters

| | |
|---|---|
| Average temperature of outdoor air of the hottest month | 36.48° C |
| Average temperature of outdoor air of the coldest month | -3° C |
| Coefficient which depends on temperature stratification of atmosphere A | 200 |
| Maximum speed of wind in this area (recurrence of exceeding within range of 5%) | 7 m/s |

# Parameters of Sources of Emissions

Record:
"%" - source is recorded with exclusion from background;
"+" - source is recorded with no exclusion from background;
"-" - source is not recorded and its contribution is excluded from background.
A source is not recorded if there are no marks.

Types of sources:
1 - point-type;
2 - linear;
3 - unorganized;
4 - totality of point-type combined for calculation into one area-type;
5 - unorganized with non-stationary intensity of emission by time;
6 - point-type with hood or horizontal direction of emission;
7 - totality of point-type with hoods or horizontal direction of emission;
8 - motorway.

| Record in calc. | Site No. | Shop No. | Source No. | Source | Vers. | Type | Source Height (m) | Mouth Diameter (m) | Volume HWS (cub.m/s) | Speed HWS (m/s) | Temp. HWS (°C) | Coeff. rel. | Coord. X1-ax. (m) | Coord. Y1-ax. (m) | Coord. X2-ax. (m) | Coord. Y2-ax. (m) | Width of source (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 0 | 0 | 1 | New source | 1 | 3 | 2,0 | 0.00 | 0 | 0.00000 | 0 | 1,0 | 730.0 | 751,0 | 1123,0 | 751,0 | 370.00 |

| Subs.code | Substance | Emission, (g/s) | Emission, (t/g) | F | Summer: Cm/MPC | Xm | Um | Winter: Cm/MPC | Xm | Um |
|---|---|---|---|---|---|---|---|---|---|---|
| 0301 | Nitrogen (IV) oxide (Nitrogen dioxide) | 0.1333300 | 0.0000000 | 1 | 15.340 | 11.4 | 0.5 | 56,025 | 11.4 | 0.5 |
| 0304 | Nitrogen (II) oxide (Nitrogen oxide) | 0.0216700 | 0.0000000 | 1 | 0.353 | 11.4 | 0.5 | 1.290 | 11.4 | 0.5 |
| 0328 | Carbon-black (Carbon-black) | 0.0666700 | 0.0000000 | 1 | 4.347 | 11.4 | 0.5 | 15.875 | 11.4 | 0.5 |
| 0330 | Sulphur dioxide | 0.0833300 | 0.0000000 | 1 | 1.630 | 11.4 | 0.5 | 5.953 | 11.4 | 0.5 |
| 0337 | Carbon oxide | 0.4166700 | 0.0000000 | 1 | 0.815 | 11.4 | 0.5 | 2.976 | 11.4 | 0.5 |
| 1325 | Formaldehyde | 0.0104200 | 0.0000000 | 1 | 2.912 | 11.4 | 0.5 | 10.633 | 11.4 | 0.5 |
| 2754 | Maximum hydrocarbons C12-C19 | 0.1250000 | 0.0000000 | 1 | 1.222 | 11.4 | 0.5 | 4.465 | 11.4 | 0.5 |
| 2908 | Inorganic dust: 70-20% SiO2 | 0.0046100 | 0.0000000 | 3 | 1.647 | 5.7 | 0.5 | 1.647 | 5.7 | 0.5 |

## Calculation was performed for substances (summation group)

| Code | Substance | Maximum permissible concentration | | | Coeff. of ecol. situation | Background concentr. | |
|---|---|---|---|---|---|---|---|
| | | Type | Fair value | Correct. in calc. | | Record | Interp. |
| 0301 | Nitrogen (IV) oxide (Nitrogen dioxide) | MPC m/r | 0.085 | 0.085 | 1 | No | No |
| 0304 | Nitrogen (II) oxide (Nitrogen oxide) | MPC m/r | 0.6 | 0.6 | 1 | No | No |
| 0328 | Carbon-black (Carbon-black) | MPC m/r | 0.15 | 0.15 | 1 | No | No |
| 0330 | Sulphur dioxide | MPC m/r | 0.5 | 0.5 | 1 | No | No |
| 0337 | Carbon oxide | MPC m/r | 5 | 5 | 1 | No | No |
| 1325 | Formaldehyde | MPC m/r | 0.035 | 0.035 | 1 | No | No |
| 2754 | Maximum hydrocarbons | MPC m/r | 1 | 1 | 1 | No | No |
| | C12-C19 | | | | | | |
| 2908 | Inorganic dust: 70-20% | MPC m/r | 0.3 | 0.3 | 1 | No | No |
| | SiO2 | | | | | | |

## Results of calculation and contributions by substances (calculation points)

Types of points:
0 - user's calculation point
1 - point on border of protected zone
2 - point on border of production zone
3 - point on border CZZ
4 - on border of residential zone
5 - point on border of building

### Substance: 0301 Nitrogen (IV) oxide (Nitrogen dioxide)

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.23 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 1 | 0.23 | 100.00 |

### Substance: 0304 Nitrogen (II) oxide (Nitrogen oxide)

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.01 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 1 | 0.01 | 100.00 |

### Substance: 0328 Carbon-black

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.07 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 1 | 0.07 | 100.00 |

### Substance: 0330 Sulphur dioxide

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.02 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| | | Source | Contribution in fract. | Contribution % |
|---|---|---|---|---|
| Site | Shop | | MPC | |
| 0 | 0 | 1 | 0.02 | 100.00 |

**Substance: 0337 Carbon oxide**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.01 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 1 | 0.01 | 100.00 |

**Substance: 1325 Formaldehyde**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.04 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 1 | 0.04 | 100.00 |

**Substance: 2754 Maximum hydrocarbons C12-C19**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.02 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 1 | 0.02 | 100.00 |

**Substance: 2908 Inorganic dust: 70-20% SiO2**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.00 | 69 | 0.70 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 1 | 0.00 | 100.00 |

# UPRZA ECOLOG, version 3.00
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**Serial number 12-34-5678, JSC "Teploelektroproekt"**

## Enterprise number 266; Remote ORU 220/500 kV at Navoi Thermal Power Station

Location: Navoi Region

**Version of initial data: 3, Construction stage**
**Version of calculation: 1, Installation works**
**Calculation was performed for summer**
**Calculation module: "OND-86 standard"**
**Calculation constants: E1= 0.01, E2=0.01, E3=0.01, S=999999.99 sq.km**

## Meteorological parameters

| | |
|---|---|
| Average temperature of outdoor air of the hottest month | 36.48° C |
| Average temperature of outdoor air of the coldest month | -3° C |
| Coefficient which depends on temperature stratification of atmosphere A | 200 |
| Maximum speed of wind in this area (recurrence of exceeding within range of 5%) | 7 m/s |

# Parameters of sources of emissions

record:
"%" - source is recorded with exclusion from background;
"+" - source is recorded with no exclusion from background;
"-" - source is not recorded and its contribution is excluded from background.
A source is not recorded if there are no marks.

Types of sources:
1 - point-type;
2 - linear;
3 - unorganized;
4 - totality of point-type combined for calculation into one area-type;
5 - unorganized with non-stationary intensity of emission by time;
6 - point-type with hood or horizontal direction of emission;
7 - totality of point-type with hoods or horizontal direction of emission;
8 - motorway.

| Record In calc. | Site No. | Shop No. | Source No.. | Source | Vers. | Type | Height source (m) | Diameter of mouth (m) | Volume HWS (cub.m/s) | Speed HWS (m/s) | Temp. HWS (°C) | Coeff. rel. | Coord. X1-ax. (m) | Coord. Y1-ax. (m) | Coord. X2-ax. (m) | Coord. Y2-ax. (m) | Width of source (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 0 | 0 | 1 | New source | 1 | 3 | 2,0 | 0.00 | 0 | 0.00000 | 0 | 1,0 | 730.0 | 751,0 | 1123,0 | 751,0 | 370.00 |

| Subs.code | Substance | Emission, (g/s) | Emission, (t/g) | F | Summer: Cm/MPC | Xm | Um | Winter: Cm/MPC | Xm | Um |
|---|---|---|---|---|---|---|---|---|---|---|
| 0301 | Nitrogen (IV) oxide (Nitrogen dioxide) | 0.0152900 | 0.0000000 | 1 | 1.759 | 11.4 | 0.5 | 6.425 | 11.4 | 0.5 |
| 0304 | Nitrogen (II) oxide (Nitrogen oxide) | 0.0024800 | 0.0000000 | 1 | 0.040 | 11.4 | 0.5 | 0.148 | 11.4 | 0.5 |
| 0328 | Carbon-black (Carbon-black) | 0.0009500 | 0.0000000 | 1 | 0.062 | 11.4 | 0.5 | 0.226 | 11.4 | 0.5 |
| 0330 | Sulphur dioxide | 0.0050000 | 0.0000000 | 1 | 0.098 | 11.4 | 0.5 | 0.357 | 11.4 | 0.5 |
| 0337 | Carbon oxide | 0.0166700 | 0.0000000 | 1 | 0.033 | 11.4 | 0.5 | 0.119 | 11.4 | 0.5 |
| 1325 | Formaldehyde | 0.0001900 | 0.0000000 | 1 | 0.053 | 11.4 | 0.5 | 0.194 | 11.4 | 0.5 |
| 2754 | Maximum hydrocarbons C12-C19 | 0.0047600 | 0.0000000 | 1 | 0.047 | 11.4 | 0.5 | 0.170 | 11.4 | 0.5 |
| 0123 | Iron oxide (in terms of iron) | 0.0003000 | 0.0000000 | 1 | 0.054 | 11.4 | 0.5 | 0.054 | 11.4 | 0.5 |
| 0143 | Manganese and its compounds | 0.0000300 | 0.0000000 | 1 | 0.214 | 11.4 | 0.5 | 0.214 | 11.4 | 0.5 |
| 0616 | Xylol (mixture of isomers) | 0.0382700 | 0.0000000 | 1 | 6.834 | 11.4 | 0.5 | 6.834 | 11.4 | 0.5 |
| 2741 | Heptane fraction Nephras ChS 94/99 | 0.0321600 | 0.0000000 | 1 | 0.766 | 11.4 | 0.5 | 0.766 | 11.4 | 0.5 |
| 2752 | White spirit | 0.0284000 | 0.0000000 | 1 | 1,014 | 11.4 | 0.5 | 1,014 | 11.4 | 0.5 |

## Calculation was performed for substances (summation group)

| Code | Substance | Maximum permissible concentration | | | Coeff. of ecolog. situation | Background concentr. | |
|---|---|---|---|---|---|---|---|
| | | Type | Fair value | Correct. in calc. | | Record | Interp. |
| 0123 | Iron oxide (in terms of iron) | MPC m/r | 0.2 | 0.2 | 1 | No | No |
| 0143 | Manganese and its compounds | MPC m/r | 0.005 | 0.005 | 1 | No | No |
| 0301 | Nitrogen (IV) oxide (Nitrogen dioxide) | MPC m/r | 0.085 | 0.085 | 1 | No | No |
| 0304 | Nitrogen (II) oxide (Nitrogen oxide) | MPC m/r | 0.6 | 0.6 | 1 | No | No |
| 0328 | Carbon-black (Carbon-black) | MPC m/r | 0.15 | 0.15 | 1 | No | No |
| 0330 | Sulphur dioxide | MPC m/r | 0.5 | 0.5 | 1 | No | No |
| 0337 | Carbon oxide | MPC m/r | 5 | 5 | 1 | No | No |
| 0616 | Xylol (mixture of isomers) | MPC m/r | 0.2 | 0.2 | 1 | No | No |
| 1325 | Formaldehyde | MPC m/r | 0.035 | 0.035 | 1 | No | No |
| 2741 | Heptane fraction Nephras | OBUV | 1.5 | 1.5 | 1 | No | No |
| | ЧС 94/99 | | | | | | |
| 2752 | White spirit | OBUV | 1 | 1 | 1 | No | No |
| 2754 | Maximum hydrocarbons | MPC m/r | 1 | 1 | 1 | No | No |
| | C12-C19 | | | | | | |

## Substances calculation for which is not expedient

**Expediency consideration criteria for calculation E3=0.01**

| Code | Name | Sum Cm/MPC |
|---|---|---|
| 0123 | Iron oxide (in terms of iron) | 0.000897 |
| 0304 | Nitrogen (II) oxide (Nitrogen oxide) | 0.000677 |
| 0337 | Carbon oxide | 0.000546 |
| 1325 | Formaldehyde | 0.000889 |
| 2754 | Maximum hydrocarbons C12-C19 | 0.00078 |

## Results of calculation and contributions by substances (calculation of point)

Types of points:
0 - user's calculation point
1 - point on border of protected zone
2 - point on border of production zone
3 - point on border CZZ
4 - on border of residential zone
5 - point on border of building

**Substance: 0143 Manganese and its compounds**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.00 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Source | Site | Shop | Contribution in fract. | MPC | Contribution % |
|---|---|---|---|---|---|
| | 0 | 0 | 2 | 0.00 | 100.00 |

**Substance: 0301 Nitrogen (IV) oxide (Nitrogen dioxide)**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.03 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Source | Site | Shop | Contribution in fract. | MPC | Contribution % |
|---|---|---|---|---|---|
| | 0 | 0 | 1 | 0.03 | 100.00 |

**Substance: 0328 Carbon-black (Carbon-black)**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.00 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 1 | 0.00 | 100.00 |

**Substance: 0330 Sulphur dioxide**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.00 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 1 | 0.00 | 100.00 |

**Substance: 0616 Xylol (mixture of isomers)**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.10 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 2 | 0.10 | 100.00 |

**Substance: 2741 Heptane fraction Nephras ChS 94/99**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.01 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 2 | 0.01 | 100.00 |

**Substance: 2752 White spirit**

| No. | Coord. X(m) | Coord. Y(m) | Height (m) | Concentr. (m. MPC) | Direct. of wind | Adjust. of wind | Background (m. MPC) | Background before excl. | Type of point |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 600 | 2 | 0.02 | 64 | 0.50 | 0.000 | 0.000 | 0 |

| Site | Shop | Source | Contribution in fract. MPC | Contribution % |
|---|---|---|---|---|
| 0 | 0 | 2 | 0.02 | 100.00 |

**Appendix 5**

# Environmental Management Plan (EMP)

# Environmental Management Plan

| Activity | Potential Environmental Impacts | Mitigation measures | Institutional responsibility | |
|---|---|---|---|---|
| | | | Implementation | Monitoring |
| **Stage of construction** | | | | |
| Hydrology | To ensure proper implementation of all requirements of the State Ecology Committee for protection of surface and underground waters, especially in places of close occurrence of ground waters and taking into account spillages and pollution. | Record of weather conditions during implementation of construction in order to minimize leakages of pollutants to soil. Restrictions in respect to depth of digging in feed area for usage of materials or placement of excavated ground. Usage verdurization as an integral component of construction as measures to control erosion around supports if necessary. Minimization of removal of vegetation cover as possible and its restoration in places where construction sites were cleaned. | Contractor | JSC “Navoi TES” / State Ecology Committee |
| Quality of air | To effectively minimize and to avoid complaints due to air transmitted solid particles emitted to atmosphere. | All heavy equipment and machinery must be adjusted in complete conformance to state standards. Gasoline and diesel fuel fired machinery must be checked in advance in one of well equipped stations for technical inspections before usage. To strictly exclude visible smoke in exhaust pipes. Fuel saving and well maintained trucks must be used in order to minimize emissions of exhaust gases. Trucks must be also checked at the technical inspection station. Trucks with visible smoke in exhaust pipe must be excluded from work. Reserves of soil and sand must be moistened before loading, especially under windy conditions. Transport vehicles transporting soil, sand and other construction materials must be covered. It is necessary to restrict speed of transport vehicles with bulk materials that must be established and controlled.<br>It is necessary to avoid transportation via densely populated districts, especially near schools.<br>To plan minimization of dust near gardens and fruit farms.<br>To implement watering of dust emitting surfaces with water. For any sprinkling plan, at first, it necessary to asses required quantity of water and availability of water on site in order to avoid overconsumption of water and deficit of resources in the region for population. Cement plants (if necessary) must be managed in accordance with requirements established by laws and must not be nearby to sensitive recipients. | Contractor | JSC “Navoi TES” / State Ecology Committee |

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| Quality of water | To prevent adverse impacts to quality of water due to disregard of best environmental practice. To ensure effective management of inevitable impacts. To ensure minimization of adverse impacts on quality of water as a result of construction. | To make a temporary plan of drainage management one month prior to commencement of works. Proper installation of temporary of drainage and control over erosion before works within 50 m from water courses. Proper construction of temporary drainage and measures to control erosion, maintenance and management including training of operators and other workers in order to avoid pollution of water courses as a result of operation of constructions of machinery and equipment (machinery transport fleet with drainage system), Storage of lubricating materials, fuel and other oil products in separate special tanks at a distance more than 50 m from water reservoirs.<br>Proper utilization of solid wastes from construction sites and shift camps (construction bases).<br>To cover stocks of construction material and soil using a proper material in order to reduce losses of material and sedimentation and to avoid their accumulation near water ponds.<br>Cut material of upper layer of soil must not kept in places with disruptions in natural drainage.<br>Pits (if necessary) must not be located near to sources of drinking water and residential settlements. | Contractor | JSC “Navoi TES” / State Ecology Committee |
| Noise / Vibration of ground | To minimize increase in level of noise and vibration of ground during construction. | Entire heavy machinery and equipment must be adjusted complete conformance to national and local resolutions and with installation of effective dampers for minimization of noise. If required, equipment with excessive noise must be additionally sealed and noise damping shields must be installed for minimization of noise. As a rule, operation of heavy machinery must be carried out during day time; shock types of works must be banned during night time.<br>Well maintained trucks must be used with speed regulation. The Contractor must take respective measures in order to minimize noise impact near construction sites by application of available acoustic methods. Record and conformance to Sanitary Norms to comply with standards of noise levels on permanent working places and in residential areas during day and night time (KMK 2.01.08-96. Protection against Noise. State Committee of the Republic of Uzbekistan on Architecture and Construction. Tashkent, 1996; San PiN No.0325-16 “Sanitary Norms of Permissible Levels of Noise in Working Places” | Contractor | JSC “Navoi TES” / State Ecology Committee |

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| Erosion of soil/ Landslide | To prevent adverse impacts on quality of water due to disregard of expected impacts and ensuring effective management of inevitable impacts. To minimize erosion of soil as a result of construction of foundations, creation of access roads for transport vehicles of the project | Temporary plan of control over erosion one month prior to commencement of works for special sensitive regions especially in irrigated zones.<br>Proper installation of temporary drainage and control of erosion before works within 50 m from collectors and canals.<br>Backfill must be in layers (as it was prior to implementation of the project) and must be properly compacted in accordance with design norms and must be leveled to initial contours, when possible. Excavation areas should be considered against flow acceleration, at the same time, filling zones must be thoroughly designed in order to avoid improper drainage. Embankments must not be formed within such distances behind excavated or natural slopes which reduce slope stability.<br>Embankments must be covered, if possible; drainages around embankments must prevent spillages and erosion. In nearest perspective, temporary or permanent drainage works must protect all areas subject to erosion.<br>Measures must be taken to prevent accumulation of surface waters in form of ponds and slope washing. Canals destructed during construction works must be backfilled and restored to previous contours.<br>The Contractor must ensure adoption of suitable measures in order to minimize erosion of soil during construction and erosion of soil around supports during operation of supports by application of respective systems of drainage and vegetation protecting soil. regular monitoring of soil is necessary during operation. The Contractor must consult with concerned authorities on site before applying measures on mitigation.<br>Cleaning of grass cover will be minimized during section preparation.<br>If trees on edges of agricultural fields of the section of construction are cut or removed, they are needed to be replanted before the section will be cleaned and to return respective trees (or other vegetation cover) in order to guarantee collection of rain water and slowdown of landslides. | Contractor | JSC “Navoi TES” / State Ecology Committee |
| Utilization | Minimization of impacts | Plan of utilization of wastes which will be submitted | Contractor | JSC “Navoi |

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| of construction waste | from utilization of construction waste. | to the State Ecology Committee and approved one month prior to commencement of works. Assessment of quantity and types of construction waste which will be made by the Contractor. Study of whether wastes may be used again in the project or other concerned parties. Determination of potentially safe Solid waste burial sites near the project area or waste storage determined the contract. Study of environmental conditions of the existing solid waste burial sites and recommendation of most suitable and safest locations. Accumulation of bulk materials must be made in certain districts in order to avoid soil washing. Construction waste must be left in places when it can be washed away by water flows downstream to flood lands, dams, rivers, canals and so on. Used oil and lubricating materials must be restored and reused or removed from the section in complete conformance to national requirements.<br>Oil wastes must not combusted! Dump location must be agreed upon with local authorities and the State Ecology Committee. Used transformer oil which is subject to processing, restoration or re-usage in respective facilities with permission and under state control. Control of used transformer oil is mandatory in respect to PHB content by efforts of engaged specialized accredited laboratories.<br>Machinery must be properly maintained in order to minimize spillages of oil products during construction.<br>Solid wastes / domestic wastes must be collected and removed under a contract with the Municipality to Solid Waste burial sites agreed upon with TsGSEN.<br>Open combustion of any material is illegal and is strictly banned as contradicting to good environmental practice. All liquid materials and lubricants must be kept in closed containers or barrels. | | TES" / State Ecology Committee |
| HVL wire strain | Possible impediment and disturbance of wild nature from materials stored along HVL | To remove all kept materials as soon as work will be finished. To inform in advance local residents about works schedule. | Contractor | JSC "Navoi TES" |
| Operation and location of construction bases | Guarantees of absence of negative impact on environment and | To determine location of construction bases after consultations with local authorities. Location must be approved with territorial organs of the State Ecology Committee. | | JSC "Navoi TES" |

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| (if necessary) | population during operation of temporary construction bases | If possible, temporary construction bases must not be located near residential settlements or near water intakes of drinking water.<br>It is necessary to avoid cutting of trees, removal of vegetation must be minimized – on contrary, workers camps must be landscaped. For workers must be provided water supply and sewage facilities (connected with septic).<br>Areas of construction bases must be restored by rediggins, planting of vegetation after release of the section. Solid wastes and waste waters must be managed according to the existing requirements, within the existing official system of removal and utilization of wastes.<br>The Contractor must organize and maintain waste sorting, collection and transportation system. As a rule. solid wastes must not be dumped, buried or combusted on or near construction sites, they must be removed to the nearest solid waste site, after obtaining necessary permissions of local authorities and TsGSEN.<br>The Contractor must control that all liquid and solid hazardous and non-hazardous wastes are separated, collected and removed according to the existing requirement and instructions.<br>After completion of the project, entire construction waste and wastes must be removed. All temporary buildings including office buildings, houses and toilets must be removed.<br>Open areas must be planted with proper vegetation. | | |
| Destruction of trees and of vegetation cover for foundations and temporary working space | To avoid certain negative impacts due to removal boundaries, trees as well as grass green vegetation and upper layer. | Land owners are to be paid with compensation for cut trees in accordance with established rates and market prices.<br>Land owners are permitted to keep woods of affected trees. Contractor's personnel and workers will be strictly prescribed not to damage any vegetation, such as trees or bushes.<br>Cleaning of green surface cover for construction, cutting of trees and destruction of other vegetation in form of bushes and grass during construction must be minimized. Landscape and curbs be restored anew after works completion. | Contractor | JSC "Navoi TES" |
| Safety measures for workers | To ensure safety of workers | Provision of respective warning signs.<br>Provision of workers with protective helmets or caps.<br>The Contractor must instruct own workers on matters of hygiene and safety and to demand in order to workers used | Contractor | JSC "Navoi TES" |

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| | | Provided protective means and equipment for ensuring safety.<br>To take all respective measures on ensuring safety in accordance with the legislation and good technical practice.<br>Conformance to all manuals and obligations related to Norms of Construction Safety**,** by providing detailed regulations on hygiene and labor protection of constructing workers. Workers need to be trained to matters of hygiene and safety and certain risks of their works. | | |
| Traffic state | Minimization disturbance to motor traffic and pedestrians during transportation of construction materials, excavated ground, equipment and machinery by closing access roads during works; damage / problems related to maintenance of roads and bridges used by trucks, inconvenience from dust nearby routes of transportation, especially near schools and hospitals | To provide plan of temporary access roads one month prior to works commencement.<br>To formulate and implement a plan of reserve routes for truck cars.<br>Proximity of schools and hospitals must be taken into account.<br>Installation warning road signs and observance of traffic rules during transportation of materials, equipment and machinery. The state of roads and bridges must be taken into account.<br>Installation of water passing pipes in canals and drainages. Expansion /renewal of access routes/roads.<br>To take into account rural houses from vibration (old houses made clay bricks or raw bricks) along narrow and unasphalted rural streets. | | JSC “Navoi TES” |
| Impact to flora and fauna during construction | | Determination of necessary layout plans together with foreman and ecologist in order to prevent removal of vegetation.<br>Briefing of employees for performance of construction works in order not to disturb animals. Hunting must be prohibited in general. Vegetation must be replanted on unused areas in order to prevent weathering of ground and to exclude disturbance of habitats of birds, reptiles and insects. | | JSC “Navoi TES” |
| Social impacts | To ensure minimum impact from of building workers. To ensure minimum impact on health of population. To ensure minimum consequences of indirect impacts from | It is necessary to avoid possibility of spread of transmitted and infectious diseases from temporary construction bases (it is necessary regularly informing workers and maintain respective hygiene).<br>Requirements/complaints of people on inconveniences /damages from construction near remote ORU 220/500 kV must be examined within shortest time and satisfied by the Contractor. The Contractor must organize temporary access and make alternative preparations in order to avoid impacts to | Contractor | JSC “Navoi TES” |

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| | construction to humans living near remote ORU under construction. To minimize impacts of dust, noise, vibration. Minimization of problems must be available for local population during construction. It is necessary to resolve problems with new acquisition of lands. To mitigate impacts on agricultural lands taking into account expected income losses. | local population and to avoid similar short-term negative impacts.<br>Plan of damage compensation must be completed within detailed designing.<br>Logistics for acquisition of lands and temporary withdrawal of lands must take into account provision of temporary replacement.<br>Provision of compensation under schedule taking into account minimum disturbance of people affected by the project. | | |
| **Stage of operation** | | | | |
| Uncompleted removal of project materials | Risk of impact of wastes on soil, underground and surface waters as a result of construction waste left after completion of the project | • To clean all working sites/workers camps after completion of the project;<br>• Restoration of vegetation cover on all working sections. | | JSC “Navoi TES”“ |
| Operation and technical maintenance of equipment of remote ORU 220/500 kV | Risk of electric shock of workers on maintenance and local residents | • to inform in advance local residents about commencement of works on technical maintenance of ORU;<br>• To train officials and local residents about risks during operation of electric technical equipment of ORU. | | JSC “Navoi TES” |
| Electric shock of birds | Accidental electric shock of birds by electricity transmission lines resulting in injuries and death | • Placement of color/ fluorescent tapes on end supports of HVL near ORU;<br>• Sufficient distance of wires from phase to phase and phase to ground. | | JSC “Navoi TES” |
| Accidents | Risks and hazards from catastrophes | • Selection of constructions and materials of foundations of ORU, based on detailed geological surveys.<br>• to apply respective construction norms and rules and project infrastructure;<br>• Awareness of population on disasters, emergency situations;<br>• To carry out regular inspections and maintenance of HVL. | | JSC “Navoi TES” |

**Appendix 6**

# Plan of Environmental Monitoring (PEM)

# Plan of Environmental Monitoring

| Problem | Monitoring Parameter | Location of Monitoring | Type of Monitoring | Time/Periodicity of Monitoring | Institutions Responsible for Monitoring |
|---|---|---|---|---|---|
| | | | | | |
| **PERIOD OF CONSTRUCTION** | | | | | |
| Preservation of upper layer of soil | Warehousing of materials and protection means | Construction site | Inspections; observations | After preparation of construction sites, after warehousing of materials and after completion of works on fillets | JSC “Navoi TES” / State Ecology Committee |
| Maintenance and fueling of equipment | Prevention of oil and fuel spillage | Contractor’s site | Inspections; observations | Sudden inspections during construction | JSC “Navoi TES” / State Ecology Committee |
| Hygiene and safety of workers | Official approval of location of temporary construction bases. Existence of respective means of individual protection of personnel. Traffic organization on construction site. | Construction site and worker’s camps | Inspections, interview, comparisons with methods stated by the Contractor | Sudden inspections during construction and in case of complaints | JSC “Navoi TES” / State Ecology Committee |
| Protection of surface waters | Conformance by the Contractor to its approved methods | Works near surface water courses (canals, collectors and aryks) | Inspections | Sudden inspections during works near rivers and water reservoirs | JSC “Navoi TES” / State Ecology Committee |
| Protection of trees | If applicable, i.e. preservation of trees near construction sites, installation of fencing of trees | In sections where trees are located along construction sites | Supervision | After commencement of construction works on a respective section | JSC “Navoi TES” / State Ecology Committee |

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|---|---|---|---|---|---|
| Pollution of air from incorrect maintenance of constructions, machinery and mechanisms | Exhaust gases, dust | In section | Visual inspection | Sudden inspections during construction works | JSC “Navoi TES” / State Ecology Committee |
| Damage of drainage or uncontrolled erosion | Leakages to drainage system and damages as a result of erosion | Water passage pipes and drainage facilities | Documentation | During a year | JSC “Navoi TES” / State Ecology Committee |
| **PERIOD OF OPERATION** | | | | | |
| Protection atmospheric air | Leakages of elegas<br><br>From breakers of hydrocarbons from transformer oil oil-filled equipment | Automatic<br>And elegas<br>Breakers are equipped with leak detectors<br><br>Regular control Of elegas of level filling .<br><br>Conformance to international guideline principles of work with $SF_6$ gas.<br><br>Provision of technical personnel with handling rules with $SF_6$ .<br><br>To provide all necessary SIZ during operations with transformer oil and $SF_6$ | Supervision | During a year | JSC “Navoi TES” |

| | | | | | |
|---|---|---|---|---|---|
| Protection of surface waters | Conformance to approved methods | Works near surface water courses (canals, collectors and aryks) during transportation of transformer oil for regeneration | Inspections | Sudden inspections during transportation near rivers and water reservoirs | JSC “Navoi TES” |
| Protection of soil, grounds and ground waters, preservation of upper layer of soil | Warehousing of generated solid wastes by types, on special allocated concreted sites and vessels | Territory of remote ORU 220/500 kV | Inspections, visual inspection | Permanent | JSC “Navoi TES” / State Ecology Committee |
| Storage and utilization of wastes | Warehousing of generated solid wastes by types, on special allocated concreted sites and vessels | Development of program of waste management | Documentation, inspections, visual Inspection | Permanent | JSC “Navoi TES” / State Ecology Committee |
| Hygiene and safety of personnel | Existence of respective of personal protective equipment of personnel. Training of personnel safety rules | Territory of remote ORU 220/500 kV | Documentation, inspections, | Sudden inspections during of operation and in case of complaints | JSC “Navoi TES” |
| Protection of fauna from electric shock | Existence of fencing around ORU Existence of anti-bird barriers on end supports of HVL 220 kV | Territory of remote ORU 220/500 kV | Inspections, visual inspection | During a year | JSC “Navoi TES” |

| | | | | | |
|---|---|---|---|---|---|
| Acoustic impact | Existence of dead fencing around ORU, with shielding effect for reduction of level of noise . | Territory of remote ORU 220/500 kV | Inspections, visual inspection | During a year | JSC “Navoi TES” |
| Natural disasters (Natural hazards) | Seismic hazard for damage of equipment and of operation. Lightning | Design features include resistance of equipment to level 8 under Richter’s scale of seismic activity in the project provides for lightning protection of equipment ORU | Inspections, field supervision | Permanent | JSC “Navoi TES” |
| Emergency situations (fire) from oil leakage from equipment | Design features of equipment ORU in accordance with requirements on fire protection of power enterprises (RD 153-34-49.0-49.101-2003) Cables will be made of fire resistance materials Management of fire hazard and liquidation of emergency situations will be included to Plan on Emergency Situations of ORU | Territory of remote ORU 220/500 kV | Inspections, field supervision | Permanent | JSC “Navoi TES”/Ministry of Emergency Situations |