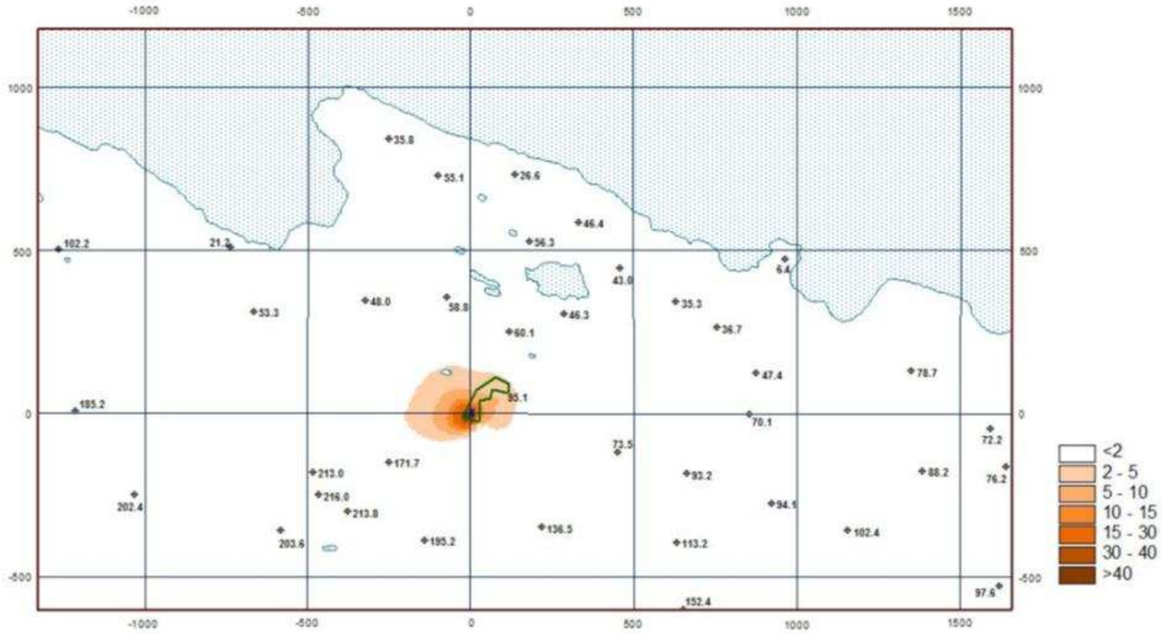

Figure 4.17 – Distribution of monthly average NO_2 concentrations in atmospheric air from BAS stationary sources operation, averaged for summer seasons (December-March), μg/m^3, Scenario 1

Fine suspended solid particles (PM10)

Hourly average concentrations

The maximum estimated hourly PM10 concentration – 23.7 μg/m^3, which is significantly lower than the established MPC (150 μg/m^3). Such value is expected 110-130 m SSW from DG-60 (Figure 4.18). The average hourly PM10 concentrations at this site – 2.5 μg/m^3.

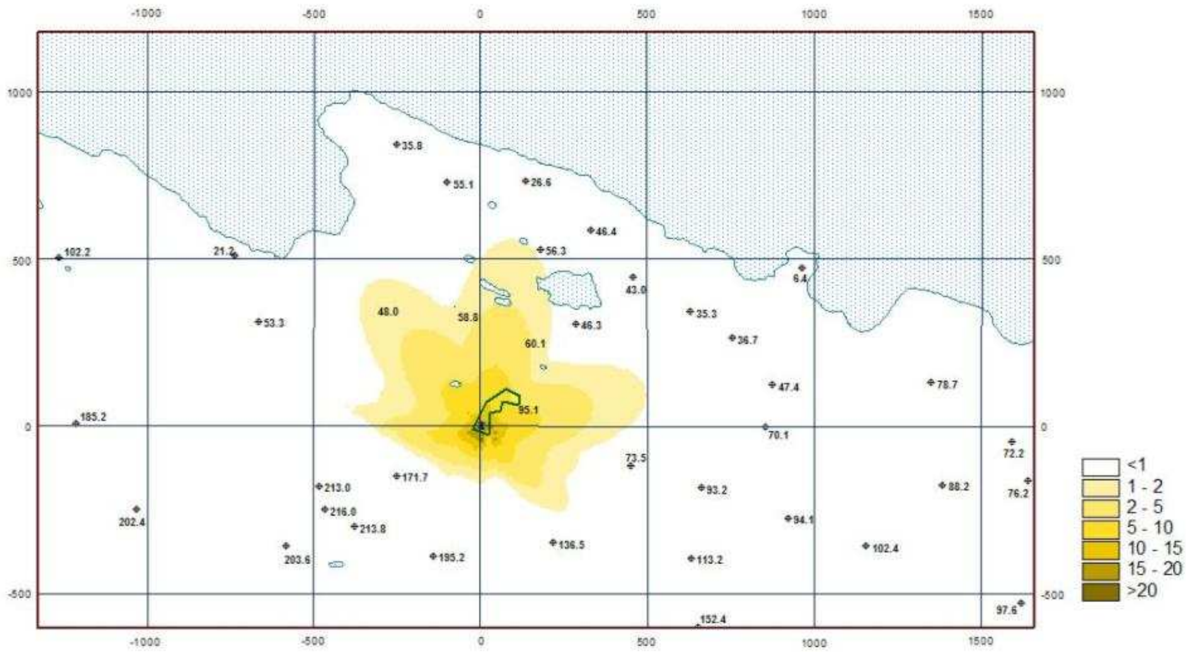

Figure 4.18 – Distribution of maximum hourly PM10 concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 1

The maximum hourly PM10 concentrations will make 5.6-8.3 μg/m^3 at the laboratory & residential module locations and 10.2 μg/m^3 at the protected area (Figure 4.17), which is more than tenfold less than the reference value. The average hourly PM10 concentration in the surface air at 5 receptor sites – 0.1-0.2 μg/m^3.

24-hour average concentrations

The maximum daily PM10 concentration (10.7 μg/m^3) is expected 20-30 m SW from DG-60 (Figure 4.19); the average daily PM10 concentrations at this site will be 2.7 μg/m^3.

At the laboratory & residential module locations the maximum daily PM10 concentrations will amount to 1.3-2.4 μg/m^3, at the protected area – 2.4 μg/m^3 (Figure 4.19). The average daily PM10 concentrations at these sites will be 0.1-0.3 μg/m^3.

The calculated maximum daily PM10 concentrations are several times lower than the daily average MPC (50 μg/m^3).

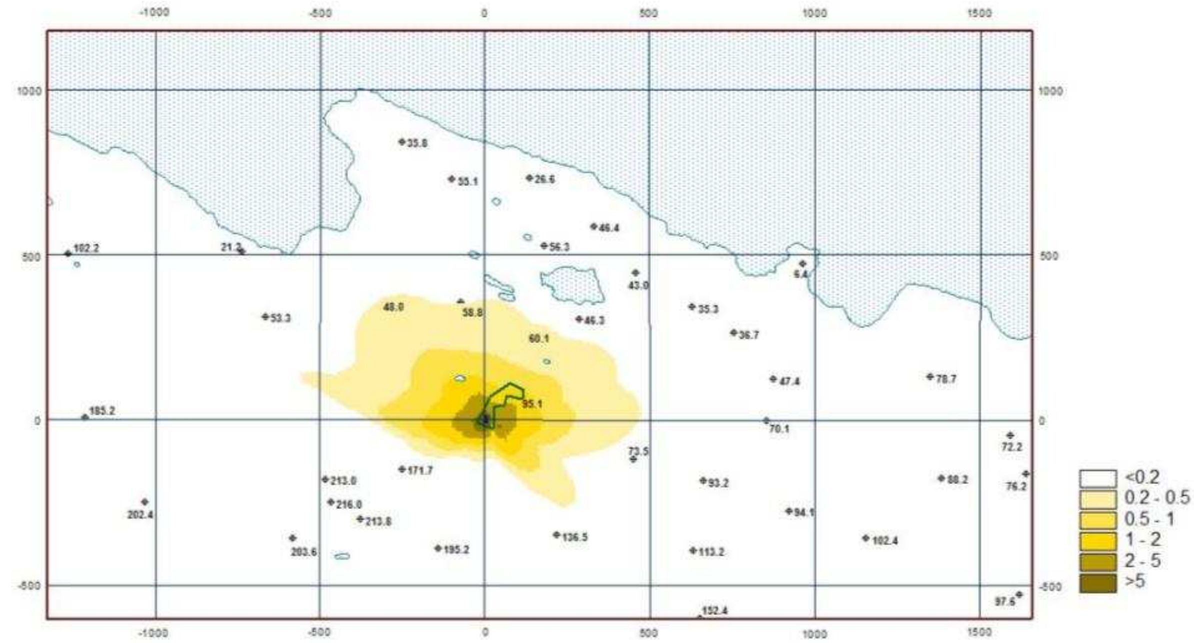

Figure 4.19 – Distribution of maximum 24-hour PM10 concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 1

Monthly average concentrations

During summer seasons (December-March) the maximum monthly average PM10 concentrations can reach 4.3 μg/m^3 and similarly to the daily average concentrations is expected at the site located 20-30 m SW from DG-60 (Figure 4.20). At the laboratory & residential module locations and within the protected area the maximum monthly average PM10 concentrations will be 0.3-0.5 μg/m^3, mean – 0.13-0.26 μg/m^3 (Figure 4.20).

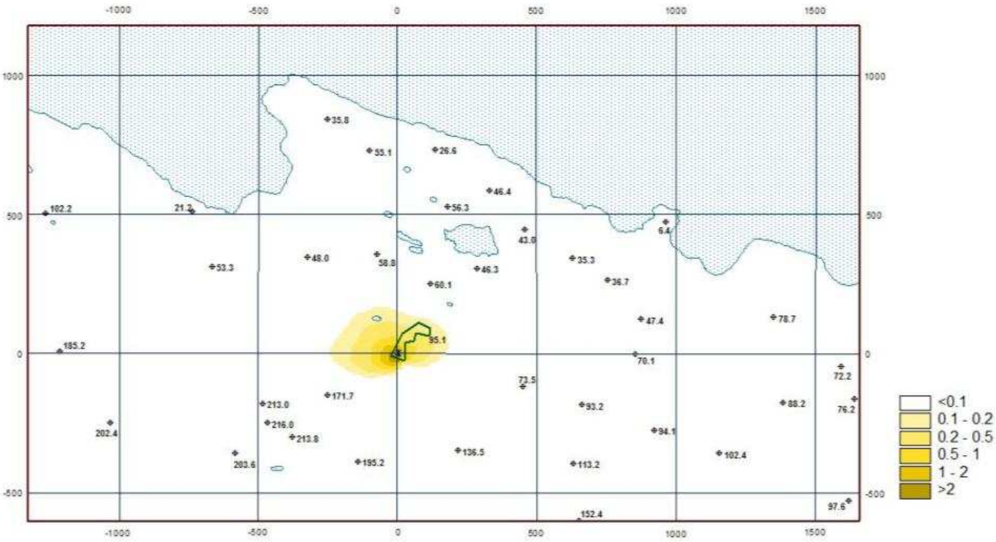

Figure 4.20 – Distribution of monthly average PM10 concentrations in atmospheric air from BAS stationary sources operation, averaged for summer seasons (December-March), μg/m^3, Scenario 1

The maximum monthly average concentrations can be considered negligible, since they account for less than 1.3% MPC (40 μg/m^3).

Sulfur dioxide

Hourly average concentrations

The maximum hourly sulfur dioxide concentration will be 34.5 μg/m^3 and is expected at 120-125 m distance SSW of the DG-60 location (Figure 4.21).

At the laboratory & residential module locations the maximum hourly SO_2 concentrations will amount to 8.2-12.1 μg/m^3, in the protected area – 14.8 μg/m^3 (Figure 4.21). On average for the receptor sites the hourly sulfur dioxide concentrations may increase by 0.15-0.29 μg/m^3.

The calculated maximum hourly sulfur dioxide concentrations at DG-60 location can be considered as minor (20-min. averaged MPC – 500 μg/m^3).

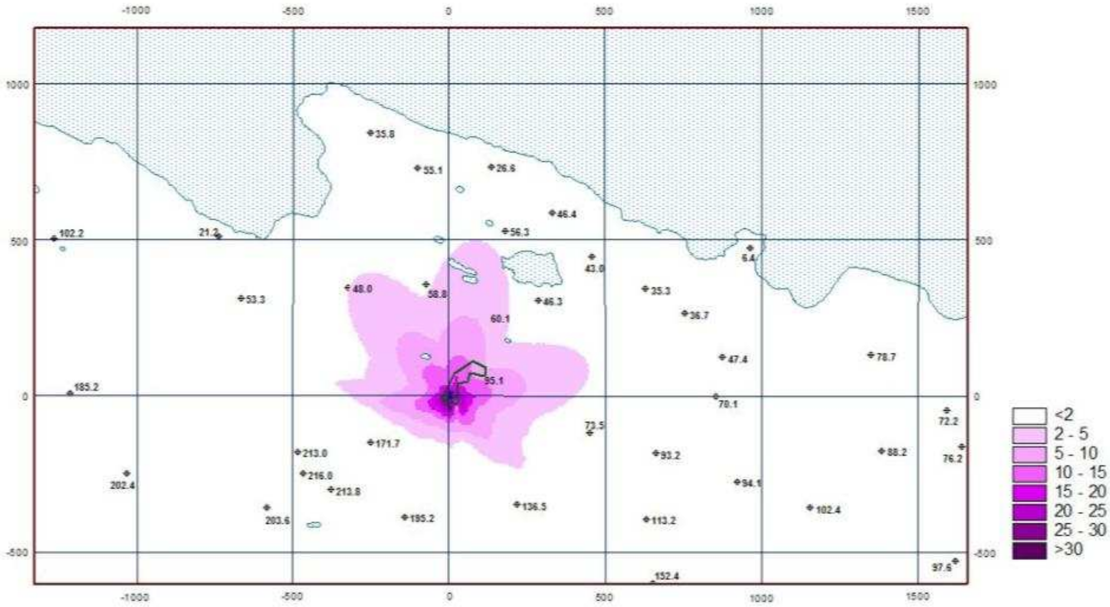

Figure 4.21 – Distribution of maximum hourly SO_2 concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 1

24-hour average concentrations

The maximum daily SO_2 concentrations are expected 20-30 m southwest of DG-60 and amount to 15.6 μg/m^3 (Figure 4.22). The average daily sulfur dioxide concentrations in this area – 3.9 μg/m^3.

At the laboratory & residential module locations the maximum daily SO_2 concentration will be 2.0-3.4 μg/m^3 and at the protected area – 3.5 μg/m^3 (Figure 4.22). On average the daily sulfur dioxide concentration at these sites will increase by 0.2-0.4 μg/m^3.

The sulfur dioxide concentrations as calculated for the receptor sites are several times less than the maximum permissible concentration (100 μg/m^3, daily average).

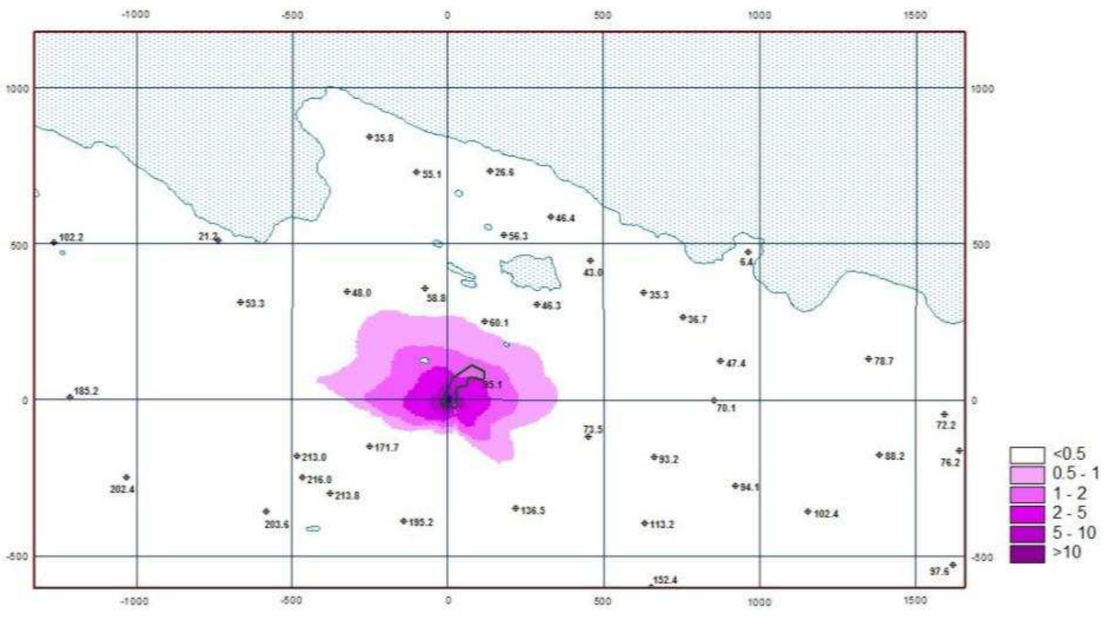

Figure 4.22 – Distribution of maximum 24-hour SO_2 concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 1

Monthly average concentrations

The maximum monthly average sulfur dioxide concentration of 6.2 μg/m^3 (for summer seasons) can be expected at 20-30 m distance SW of the DG-60 location (Figure 4.23).

At the laboratory & residential module locations the maximum monthly average SO_2 concentrations will be 0.4-0.7 μg/m^3, at the protected area – 0.67 μg/m^3 (Figure 4.23). The monthly average sulfur dioxide concentrations at these sites – 0.2-0.4 μg/m^3.

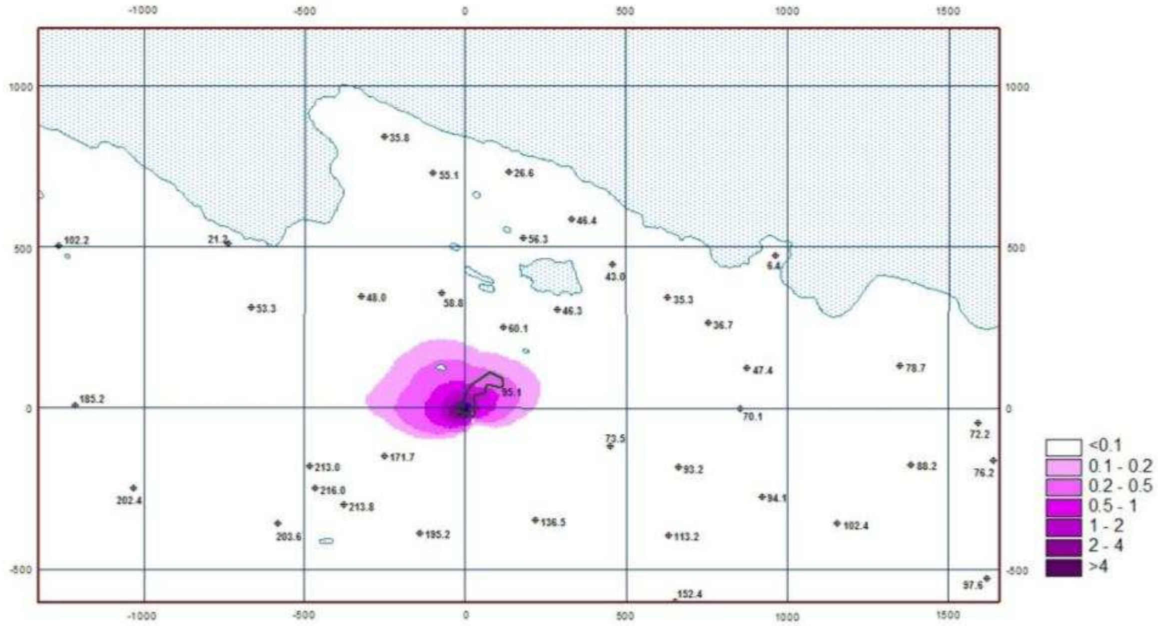

Figure 4.23 – Distribution of monthly average SO_2 concentrations in atmospheric air from BAS stationary sources operation, averaged for summer seasons (December-March), μg/m^3, Scenario 1

The monthly average SO_2 concentration due to DG-60 emission can be assessed as minor; its value at the receptor sites will not exceed 1.3 percent of MPC (50 μg/m^3, year average).

Hydrocarbons

Hourly average concentrations

At the most adverse weather conditions the maximum increase of hourly hydrocarbon concentrations as may result from the DG-60 operation will be 116.4 μg/m^3. Such concentration may be expected at 110-130 m SSW from the emission source location (Figure 4.24). The average hourly average hydrocarbon concentrations in this area will amount to 12.2 μg/m^3.

At the laboratory & residential module locations the maximum daily concentration of hydrocarbons is estimated to increase up to 27.5-40.9 μg/m^3, at the protected site – up to 50.0 μg/m^3 (Figure 4.24). The average hourly hydrocarbon concentrations at these sites will be 0.5-1.0 μg/m^3.

No reference values for hydrocarbon concentrations in the ambient air are currently available.

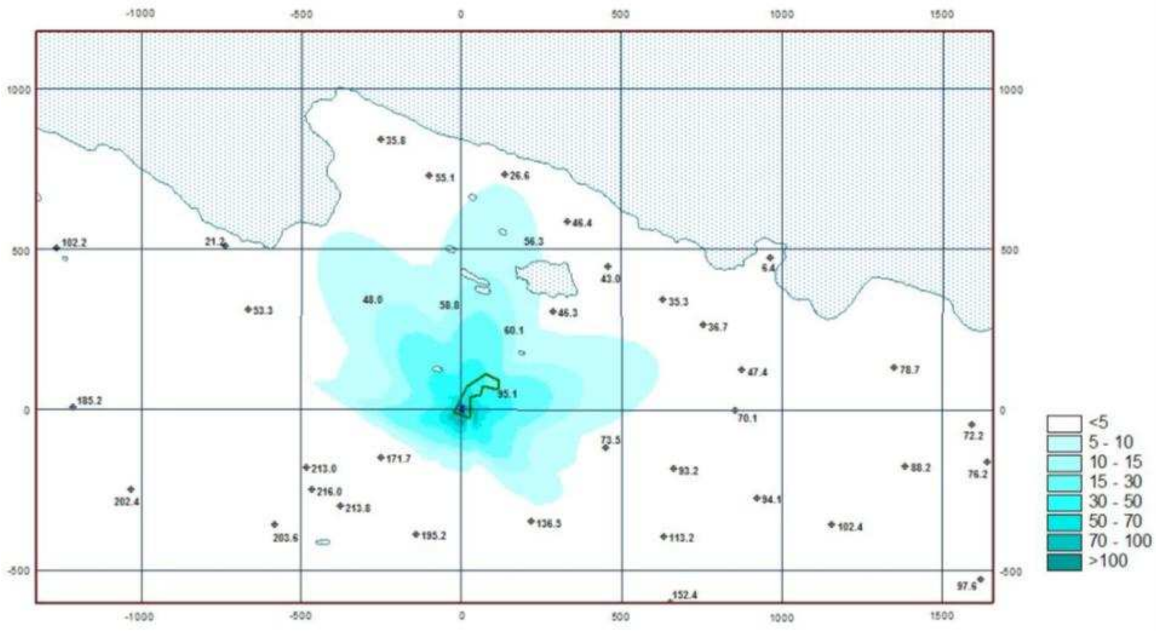

Figure 4.24 – Distribution of maximum hourly hydrocarbon concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 1

24-hour average concentrations

The highest value (52.7 μg/m^3) of the daily hydrocarbon concentrations can be expected at a point located 20-30 m southwest from DG-60 (Figure 4.25). The average daily average hydrocarbon concentrations at this point will be 13.2 μg/m^3. The maximum values of daily concentrations of hydrocarbons at the laboratory & residential module locations will make 6.6-11.6 μg/m^3, at the protected area - 11.7 μg/m^3 (Figure 4.25). The average daily hydrocarbon concentrations at these sites will be 0.6-1.2 μg/m^3.

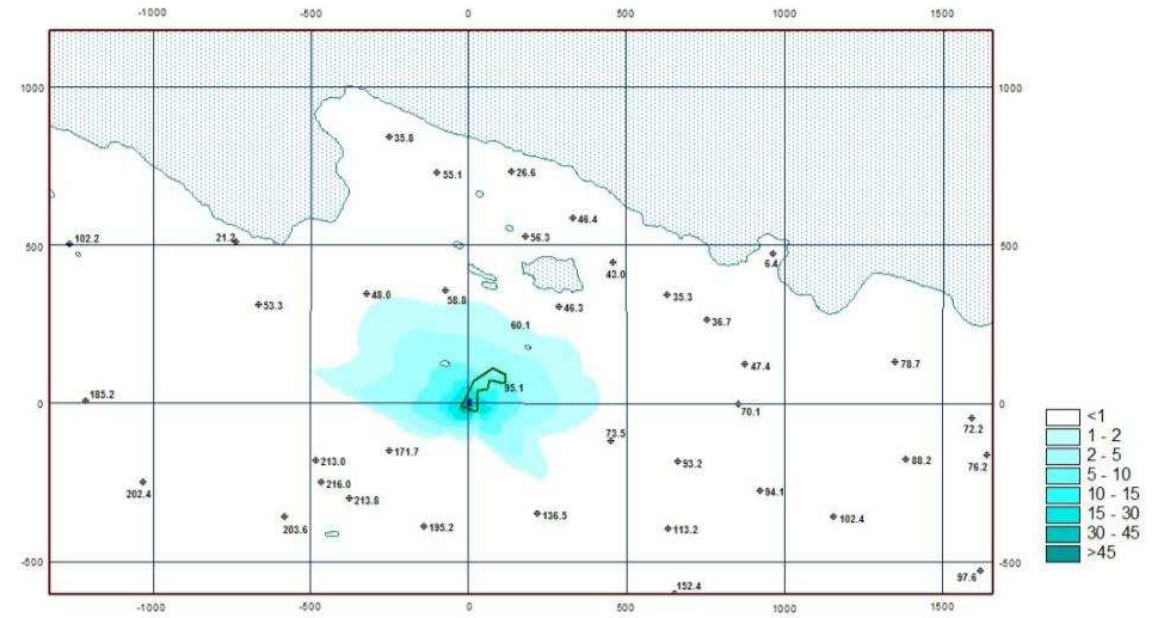

Figure 4.25 – Distribution of maximum 24-hour hydrocarbon concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 1

Monthly average concentrations

The maximum estimated increase of monthly average hydrocarbon concentrations – 20.9 µg/m^3; it is expected 20-30 m southwest of the DG-60 location (Figure 4.26). Close to the laboratory & residential modules and within the protected area the maximum increase of monthly average concentrations of hydrocarbons – 1.4-2.5 µg/m^3, average – 0.7-1.3 µg/m^3 (Figure 4.26).

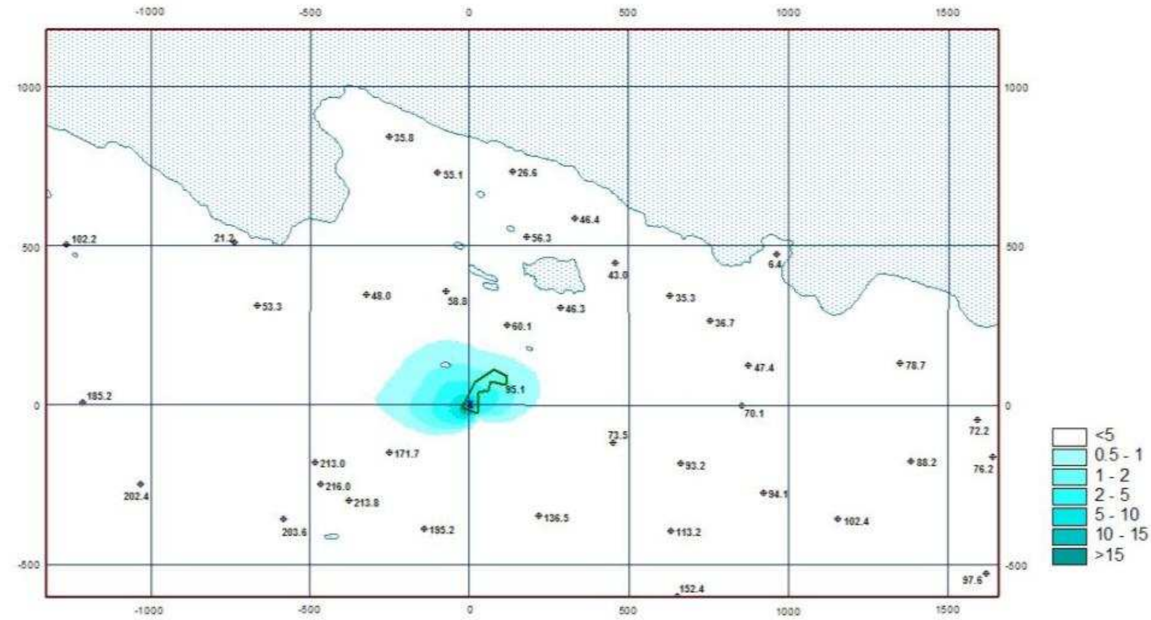

Figure 4.26 – Distribution of monthly average hydrocarbon concentrations in atmospheric air from BAS stationary sources operation, µg/m^3. Scenario 1

Conclusions to Scenario 1

The simulation results of Scenario 1 pollutant dispersion demonstrated that under the most adverse weather conditions the DG-60 operation will not result in exceeding the ambient air quality standards at the receptor sites in respect of any pollutant assessed.

Within the territory adjacent to the source of contamination, the MPC values may be exceeded only by nitrogen dioxide. Such excess will be local, and its recurrence is assessed to be low.

The calculated short-term and long-term concentrations of other pollutants will not exceed the limit values.

Scenario 2

Exposure sources:

- DG-100 kVA diesel generator, full-power operation;
- KTO-50.K20 wastes incinerator, full-power operation once a week.

DG-100 power station parameters are as follows:

Stack height - 3.5 m;

Stack diameter - 0.08 m;

Flue gas temperature - 478ºC;

Flue gas flow - 54.4 m/sec.

KTO-50.K20 incinerator parameters are as follows:

Stack height - 9 m;

Stack diameter - 0.3 m;

Flue gas temperature - 200ºC;

Flue gas flow - 12 m/sec.

Calculation parameters:

- reporting period – calendar year;
- source files with weather information obtained from the boundary atmospheric layer monitoring at Molodyozhnaya Antarctic station (WMO index 895420) for 1995, and atmosphere morning sensing data, as obtained by Syowa Japanese Antarctic station (WMO index 895320) for 1995 were obtained for analysis;
- the topographic features of the receptor territories for the regular receptor network sized 2980 x 1780 m with 20 m increments were taken into consideration;
- any influence of the existing buildings was ignored;
- maximum and average hourly, 8-hour, 24-hour and monthly concentrations were modelled;
- pollutants: NO_2, SO_2, CO, PM10, hydrocarbons.

The maximum short-term and long-term evaluations of the surface pollutant concentrations at the BAS site, reference to Scenario 2 are presented in Table 4.22 (5 receptors), as well as at Figures 1-15 of Annex 2.

The area – specific distribution of the pollutant concentrations, as obtained for Scenario 2, is a bit different from those for Scenario 1. However, the MPC limits of pollutant concentrations at the locations of 5 key receptors (laboratory & residential modules and protected area) are not expected to be exceeded.

Carbon monoxide

In the case of Scenario 2 and the most unfavorable surface air meteorological conditions, the hourly carbon monoxide concentrations can reach 301 $\mu g/m^3$. The top CO concentrations exceeding 250 $\mu g/m^3$ may be expected at 4 local areas SE, N, SW and SSW of DG-100 at 45-130 m distance (Annex 2, Figure 1). The average maximum hourly CO concentration will reach 47.2 $\mu g/m^3$.

At the laboratory & residential module locations the maximum hourly CO concentrations will amount to 43.5-80.6 $\mu g/m^3$, at the protected area – 63.0 $\mu g/m^3$ (Annex 2, Figure 1), the average hourly concentrations of carbon monoxide at these objects – 0.6-1.2 $\mu g/m^3$. The calculated hourly CO concentrations at the receptor locations can be assessed as minor: their maximum level makes 0.9-1.6% of the MPL as established in Belarus.

The maximum daily CO concentrations according to Scenario 2 calculations may increase up to

186.8 μg/m^3 and is expected 80-85 m SW of DG-100 location (Annex 2, Figure 2). The average daily CO concentration at this point will be 26.7 μg/m^3.

Table 4.22 – Estimated concentrations of air pollutants for the laboratory & residential and protected area locations (Scenario 2), μg/m^3

Parameter and averaging period	Module 1	Module 2	Module 3	Module 4	Protected area
Carbon oxyde (CO)					
Maximum 1-hour average	49.17	43.54	64.11	80.59	63.01
Mean 1-hour average	0.60	0.48	0.78	1.22	0.78
Maximum 24-hour average	17.28	16.91	23.43	32.07	26.41
Mean 24-hour average	0.96	0.85	1.28	1.93	1.35
Maximum 1-month average	3.02	2.66	3.95	5.46	3.92
Mean 1-month average	1.01	0.89	1.34	2.03	1.42
Nitrogen dioxide (NO_2)					
Maximum 1-hour average	70.64	62.55	92.09	115.25	89.56
Mean 1-hour average	0.86	0.68	1.13	1.75	1.12
Maximum 24-hour average	24.83	24.29	33.65	46.07	37.93
Mean 24-hour average	1.37	1.22	1.83	2.76	1.94
Maximum 1-month average	4.33	3.81	5.66	7.84	5.63
Mean 1-month average	1.44	1.28	1.93	2.91	2.04
Sulfur dioxide (SO_2)					
Maximum 1-hour average	7.49	6.63	9.76	12.46	9.94
Mean 1-hour average	0.09	0.07	0.12	0.19	0.12
Maximum 24-hour average	2.63	2.57	3.57	4.88	4.02
Mean 24-hour average	0.15	0.13	0.20	0.29	0.21
Maximum 1-month average	0.46	0.41	0.60	0.83	0.60
Mean 1-month average	0.15	0.14	0.21	0.31	0.22
PM10					
Maximum 1-hour average	4.99	4.42	6.51	8.16	6.35
Mean 1-hour average	0.06	0.05	0.08	0.12	0.08
Maximum 24-hour average	1.75	1.72	2.38	3.26	2.68
Mean 24-hour average	0.10	0.09	0.13	0.20	0.14
Maximum 1-month average	0.31	0.27	0.40	0.55	0.40
Mean 1-month average	0.10	0.09	0.14	0.21	0.14
Hydrocarbons (CH)					
Maximum 1-hour average	1.97	1.75	2.57	3.23	2.52
Mean 1-hour average	0.02	0.02	0.03	0.05	0.03
Maximum 24-hour average	0.69	0.68	0.94	1.29	1.06
Mean 24-hour average	0.04	0.03	0.05	0.08	0.05
Maximum 1-month average	0.12	0.11	0.16	0.22	0.16
Mean 1-month average	0.04	0.04	0.05	0.08	0.06

In the laboratory & residential module areas the maximum daily concentration of carbon monoxide may reach 16.9-32.1 μg/m^3, at the protected area – 26.4 μg/m^3 (Annex 2, Figure 2). On average the daily CO concentrations at the receptor sites will increase by 0.9 – 1.9 μg/m^3.

The calculated maximum CO concentrations at the receptor sites will be less than 1.1% of the average daily MPL as established in Belarus.

By Scenario 2 maximum monthly average CO concentrations will be 92.0 μg/m^3 and may be expected 80-85 m southwest of DG-100 (Annex 2, Figure 3).

At the receptor locations the maximum monthly average CO concentrations can reach 2.7-5.5 μg/m^3 with an average increase by 0.9 - 2.0 μg/m^3 (Annex 2, Figure 3), which is significantly below the MPC values, as established in Belarus for annual averages.

Nitrogen dioxide

According to Scenario 2, the maximum hourly concentration of nitrogen dioxide may be expected 80-85 m SE of DG-100 location and will amount to 398.7 μg/m^3, thus exceeding the MPC values.

Hourly average concentrations above the established limits can be observed at 10 locations of the regular grid at 150 m SE, S and SW of DG-100. At the other locations of the regular grid MPC will not be exceeded (Annex 2, Figure 4). The maximum average hourly NO_2 concentration – 47.2 μg/m^3 and is reported for the point with coordinates x = 1320; y = 600.

The maximum hourly nitrogen dioxide concentrations at the laboratory & residential module area will be 62.6-115.3 μg/m^3, and at the protected area – 89.6 μg/m^3 (Annex 2, Figure 4), which is significantly lower than the MPC limits. On average for 5 receptor sites hourly nitrogen dioxide concentrations will reach 0.7-1.8 μg/m^3.

The maximum daily NO_2 concentration – 259 μg/m^3 at 80-85 m SW of DG-100, exceeding the established MPC limit. The area of highest concentrations will be located southwest of the pollution source, extending over a distance of approximately 150 m from it (Annex 2, Figure 5).

At the laboratory & residential module locations the daily nitrogen dioxide concentration may increase by max. 24.3-46.1 μg/m^3, at the protected area – by 37.9 μg/m^3 (Annex 2, Figure 5). These values are less than the established standards. The mean daily nitrogen dioxide concentrations for the receptor sites at the DG-100 and KTO-50.K20 joint operation will increase by 1.2 - 2.8 μg/m^3.

The maximum monthly average nitrogen dioxide concentration – 92.0 μg/m^3, which is higher than MPC. Excessive concentrations may be expected at a small area SW of DG-100 (Annex 2, Figure 6).

At the laboratory & residential module locations and within the protected area the maximum average NO_2 concentrations will be 3.8 - 7.8 μg/m^3 (Annex 2, Figure 6), which is significantly lower than MPC.

Fine suspended solid particles (PM10)

The maximum hourly PM10 concentrations under Scenario 2 are expected at a location 80-85 m SW of DG-100 and amount to 30.6 μg/m^3, which is several times lower than the MPC level (Annex 2, Figure 7). The maximum hourly PM10 concentration at this point – 4.8 μg/m^3.

The maximum hourly PM10 concentrations at the laboratory & residential module locations are assessed at 4.4-8.2 μg/m^3, within the protected area – 6.4 μg/m^3 (Annex 2, Figure 7), which is significantly lower than MPC. The average hourly PM10 concentrations for the receptor sites is estimated at 0.05-0.1 μg/m^3.

The maximum daily PM10 concentration is expected 80 m southwest of DG-100, reaching 19.0 μg/m^3 (Annex 2, Figure 8); the maximum hourly PM10 concentration will be 5.0 μg/m^3.

At the laboratory & residential module locations the maximum daily concentrations will increase up to 1.7-3.3 μg/m^3, at the protected area – up to 2.7 μg/m^3 (Annex 2, Figure 8).

The calculated maximum daily PM10 concentrations will be significantly lower than MPC.

The maximum monthly average PM10 concentrations could reach 9.3 μg/m^3 and will be possibly detected at the site located 45-50 m WSW of DG-100 (Annex 2, Figure 9).

Close to the laboratory & residential module locations and within the protected area the maximum monthly average PM10 concentrations will be 0.3-0.6 μg/m^3 (Annex 2, Figure 3).

The maximum monthly average PM10 concentrations at the receptor sites will be less than 1.5 percent of MPC.

Sulfur dioxide

The maximum hourly sulfur dioxide concentration according to Scenario 2 calculations – 45.9 μg/m^3 and may be expected at a site located 80-85 m southwest of DG-100 (Annex 2, Figure 10). At the laboratory & residential module locations the maximum hourly SO_2 concentrations will amount to 6.6-12.5 μg/m^3, at the protected area – 9.9 μg/m^3 (Annex 2, Figure 10). On average for the receptor sites the hourly average sulfur dioxide concentration will increase by 0.1-0.2 μg/m^3.

The maximum daily sulfur dioxide concentration at the receptor sites in case of DG-100 and KTO-50.K20 joint operation will be significantly lower than MPC. The maximum daily sulfur dioxide concentration – 28.4 μg/m^3 – may be observed 80-85 m southwest of DG-100 location (Annex 2, Figure 11). The average daily SO_2 concentration at this area will be 7.5 μg/m^3.

At the laboratory & residential module locations the maximum daily SO_2 concentrations will be 2.6-4.9 μg/m^3, at the protected area – 4.0 μg/m^3 (Annex 2, Figure 11). The average daily sulfur dioxide concentrations at the receptor sites is estimated at 0.1-0.3 μg/m^3.

The calculated maximum daily SO_2 concentrations are expected to be much lower than MPC.

The maximum monthly average sulfur dioxide concentration will be 9.3 μg/m^3 and is expected 80-85 m SW of DG-100 location (Annex 2, Figure 12).

At the laboratory & residential module locations the maximum monthly average SO_2 concentrations may reach 0.4-0.8 μg/m^3, at the protected area – 0.6 μg/m^3 (Annex 2, Figure 12). The average monthly average sulfur dioxide concentrations for these objects will be 0.1-0.3 μg/m^3. The average monthly average sulfur dioxide concentration resulting from DG-100 and KTO-50.K20 operation will be minor and is expected to reach less than 1.6 percent MPC.

Hydrocarbons

At the most adverse weather conditions the maximum hourly concentration of hydrocarbons according to Scenario 2 will be 12.1 μg/m^3 80-85 m SW of DG-100 (Annex 2, Figure 13). The average hourly concentrations at this sector will be 1.9 μg/m^3. At the laboratory & residential module locations the maximum hourly concentrations of hydrocarbons are estimated to increase up to 1.7-3.2 μg/m^3, and at the protected site – to 2.5 μg/m^3 (Annex 2, Figure 13). The average hourly hydrocarbon concentrations at these sites will be 0.05-0.12 μg/m^3.

The highest daily average concentration value – 7.5 μg/m^3 – may be expected 80 m SW of DG-100 location (Annex 2, Figure 14). The average concentration there will be 2.0 μg/m^3.

At the laboratory & residential module locations the maximum daily concentrations of hydrocarbons will be 0.7-1.3 μg/m^3, at the protected area – 1.1 μg/m^3 (Annex 2, Figure 14). The average daily hydrocarbon concentrations at these sites is expected to range 0.03-0.08 μg/m^3.

The maximum monthly average concentrations of hydrocarbons may be expected 80 m southwest of DG-100 (3.7 μg/m^3) (Annex 2, Figure 15). At the laboratory & residential module locations and within the protected area the maximum monthly concentrations may be 0.1-0.2 μg/m^3 (Annex 2, Figure 15), average – 0.04-0.08 μg/m^3.

Conclusions as related to Scenario 2

The simulation results of pollutant dispersion under Scenario 2 demonstrated that the joint operation of DG-100 and KTO-50.K20 under the most unfavorable weather conditions for 5 receptor sites will not result in any pollutant concentration to exceed the air quality standards.

At the territory adjacent to DG-100 and KTO-50.K20 locations the maximum permissible concentrations may be exceeded at several areas only for nitrogen dioxide.

It should be noted that the excessive concentration values can be avoided by extending the DG-100 stack height by 2 meters.

The calculated short-term and long-term values of the other pollutant concentrations will not exceed the MPC values.

Increased concentrations of pollutants will refer due to emissions generated by the stationary sources and will be peculiar to the BAS territory only; the emissions will not be transferred at large distance from the station and will be generally assessed as minor.

4.2.2.2. Noise exposure

General methodological approaches

Noise calculations were made under the algorithms in compliance with:

- Standard TCP 45-2.04-154-2009 (02250) – Noise protection. Building design standards;
- International Standard GOST 31296.1-2005 (ISO 1996-1:2003) – Acoustics. Description, measurement and assessment of environmental noise. Part 1: Basic quantities and assessment procedures;
- International Standard GOST 31295.2- 2005 (ISO 9613 - 2:1996) – Acoustics. Description, measurement and assessment of environmental noise. Part 2: Determination of environmental noise attenuation, with reference to Standard SP СП 51.13330.20 – Noise protection.

The major national technical regulation on noise impact assessment during construction is TCP 45-2.04-154-2009 (02250) – Noise protection. Building design standards. This technical code of practice (hereinafter - TCP) stipulates the mandatory requirements that must be met in the noise protection design of residential, public and industrial buildings for various purposes, in planning and development of settlements to ensure the regulatory parameters of the acoustic environment in the industrial, residential and public buildings and residential areas. TCP also sets the standards for noise exposure in industrial, residential and public buildings and residential areas.

Noise exposure sources

The major and permanent sources of noise exposure at the BAS site are diesel generators, primarily DG- 60. Geko 6401ED-AA and DG-20 diesel generators were not taken into account for calculation purposes, since they are expected to alternate the DG-60. Other permanent sources (pumps, motorised saw, etc.) will have significantly lower and irregular noise generation, and they were neglected for calculations. DG-100 diesel generator will have noise parameters similar to DG-60. The noise impact of mobile sources was partly taken into account in calculations of noise exposure during the BAS construction (particularly, helicopter) (Section 4.2.2). Noise from snowmobiles, due to the peculiarities of their operation (off-road routes, scattering around a large area), will not exceed the established standards and has not been evaluated quantitatively.

Reference data

- DG-60 noise performance, reference to the manufacturer's specifications, references and manuals;
- DG-60 noise parameters in octave bands, according to similar diesel generator parameters (*Reconstruction of the passenger berth*...);
- distance from the nearest residential module - 90 m.

Calculation procedure

Octave sound pressure levels L, dB, at reference points were calculated according to the method specified by TCP 45-2.04-154-2009 under equation 4.1 below.

$$L = 10\lg\left(\sum_{i=1}^{m} \frac{10^{0.1Lwi} \cdot \chi_i \cdot \Phi_i}{\Omega r_i^2} + \frac{4}{kB}\sum_{i=1}^{n} 10^{0.1Lwi}\right) \qquad (4.1)$$

where L_{wi} – the octave sound pressure level of i-th source, dB;

Φ – the noise source direction factor;

Ω – the solid angle of the exposure source, rad;

r_i – the distance from the source's acoustic centre to the calculation point, m;

β_a – atmospheric attenuation, dB/km;

m – the number of noise sources, the nearest to the calculation point at distance r_i <= 5 r_{min}, where r_{min} means the distance from the calculation point to the acoustic centre of the nearest noise exposure source;

n - total number of noise sources.

The following factors affecting the sound pressure were further taken into account, i.e.: area-related dispersion, atmospheric attenuation (which, in its turn, is dependent on air temperature, humidity, and several other parameters). The underlying surface influence was ignored.

The calculation points were selected at 20, 50, 100, 200 m distances from the source and close to the residential module (nearest point - 90 m distance).

Results

The calculation results are given in Table 4.23 below.

Thus, the sound pressure levels, as exposed by DG-60 at calculation point 3 (area adjacent to the laboratory & residential modules), will not exceed the established standards for the territory itself and for the residential and production premises. The radius of major noise exposure, exceeding significantly the permitted level (> 50 dB), is less than 50 m (Figure 4.27).

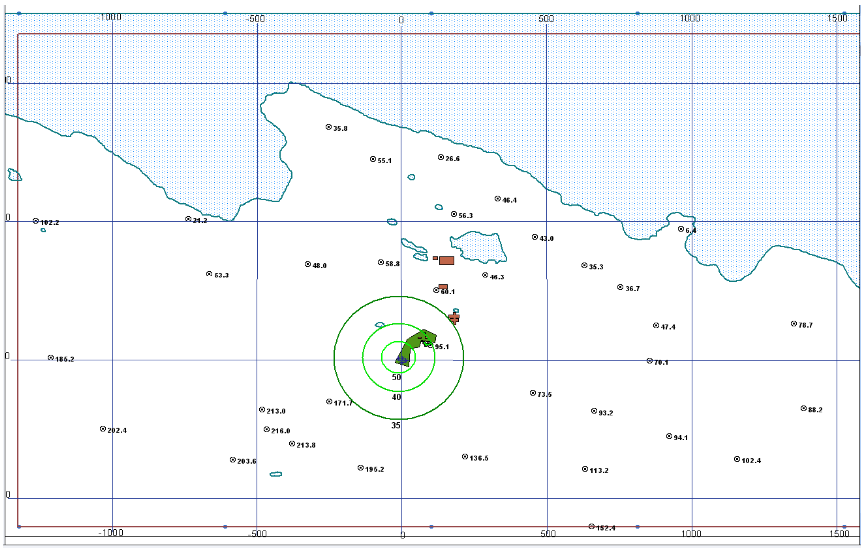

Figure 4.27 – Calculated areas of the equivalent sound levels, as related to DG-60 diesel generator operation at BAS, dBA

Table 4.23 – Sound pressure calculation results for DG-60 diesel generator at specific calculation points, dBA

Calculation point and distance from the exposure source	Octave band, Hz								
	63	125	250	500	1000	2000	4000	8000	дБ(А)
1 (30 m)	62.3	61.3	54.8	49.3	44.9	40.1	34.0	27.7	52.4
2 (50 m)	57.8	56.9	50.3	44.9	40.3	35.7	30.3	24.8	47.9
Calculation point and distance	63	125	250	500	1000	2000	4000	8000	дБ(А)
3 (90 m)	52.7	51.8	45.2	39.5	35.0	30.1	24.3	17.8	42.8
4 (200 m)	45.8	44.7	38.1	32.3	27.4	21.9	14.7	5.6	35.9
(90 m), with closed sound-proof window (-25 dB), dB	27.7	26.8	20.2	19.5	10.0	5.1	-	-	17.8
Ref. value acc. to TCP 45-2.04-154-2009 (hostel) day night	67 59	57 48	49 40	44 34	40 30	37 27	35 25	33 23	45 35
Ref. value acc. to TCP 45-2.04-154-2009, offices Category A	67	57	49	43	40	37	35	33	45
Ref. value acc. to TCP 45-2.04-154-2009 – areas adjacent to hotels and hostels day night	79 71	70 61	63 54	59 49	55 45	53 42	51 40	49 39	60 50

4.2.2.3. Exposure on soils and rocks

Soils, ground and rocks will be subjected to mechanical impacts during the station operation due to use of motor vehicles and walking of explorers. This impact will be limited to the station boundaries and surrounding areas (for geological, biological, environmental and other investigation) with sampling of rocks, snow, biota, etc. However, the impact will increase following the growth of the station staff engaged and scope of research works to be performed. At places of the most active mechanical loads, soil erosion may occur.

No drilling or other impact on rocks is expected to be involved.

Deposition of pollutants on snow/ice-uncovered surfaces at the operation stage will be minor. This is due to small amounts of polluting emissions and their dispersion; in general, this will not result in any significant increase in pollutant content in soils. However, some persistent pollutants may be accumulated in soils, e.g. products of fuel combustion (soot).

Wastewater impact on soils during the station operation may occur due to possible leakages and/or emergency spills of sewage. However, their effect will be minor, local and short-timed. Special measures to prevent wastewater leakages and to localise the possible impacts will have to be implemented.

Impact due to fuel leaks from storage tanks may occur, but they would not be regular. Special measures to prevent fuel leaks and to improve fuel transfer systems will have to be implemented.

During the station operation, the impact of solid wastes is also expected to be minor. It will be mostly from packages of fuel and lubricants, domestic wastes (non-hazardous, according to the wastes classification), which are not dangerous in terms of toxic substances accumulation in soils. Temporary storage of solid wastes and their further transfer is planned to be performed. Whereas some part of such wastes is expected to be incinerated, a particular attention will be paid to ash handling to avoid its dispersion in the environment (when removing the ash from the incinerator, packing in a container for subsequent transfer to the mainland).

Noise, heat and electromagnetic exposure during the station operation are not expected to have any impact on soils and rocks.

4.2.2.4. Exposure on surface waters, snow and ice cover

As stated in Section 2, potable and domestic purpose waters will be supplied from temporary lakes (in December-January) and from the Nizhneye Lake. As specified in Section 4.2.1.3, water intakes per month for the station's seasonal option will range 5-6 to 10-12 m^3. Small amounts of water intake will not have a negative impact on the hydrological situation.

Emissions and deposition of pollutants to surface waters and snow & ice cover during the operation stage will be negligible.

During the station operation, the system of wastewater collection and discharge into the sea is expected to be build; however, the risk of leaks and spills of wastewater and sewage and their fall into water basins may not be excluded. At the same time, due to the small amount of wastewater generated (and small capacity of tanks to collect them), the impact on the lakes will be minor and limited in time.

Impact due to pollutants exposure from fuel leaks may occur, but it will not be regular. Special measures will be taken to prevent leaks from fuel storage tanks and their spreading in case of accidental spills. If get into water basins, pollutant may be deposited in bottom sediments.

No solid waste impact is expected to water basins and/or snow & ice cover.

Noise, heat and electromagnetic exposure during the station operation are not expected to have any impact on surface waters and glaciers.

During the station operation, mechanical impact on the icecap will occur mainly in the process of vehicle driving and transportation of goods. This impact will be minor and transitory. In the course of research activities at the station location, impact on ice sheet will include the impact of snowmobiles when moving off the main roads, ice sampling. Such impacts would be episodic and transitory.

4.2.2.5. Impact on aesthetic features of the landscape and natural surroundings

Accumulation of wastes, fuel leaks, wastewater spills may affect the aesthetic appearance of the landscape. However, their impact will be minor, considering the actual transformation of the surroundings. Special measures will be implemented to reduce the negative impact on the aesthetic value of the landscape. The construction of new BAS production and residential complexes, which are designed to apply the modern architectural and construction solutions, is anticipated to harmonise with the Mount Vechernyaya landscape, taking into account the natural features of the Antarctic topography and environmental conditions, and will benefit to the aesthetic values of the area.

4.2.2.6 Exposure on biota

Air emission impact. Air pollutants, as generated by stationary and mobile sources during the BAS operation, may impact the vegetation habitat (mosses, lichens) adjacent to the construction site areas and seabird colonies located close to the station (at 1-2 km distance to the west). However, as shown in Section 4.2.2.1, due to low levels of polluting emissions, their dispersion due to strong winds with predominant south-eastern blasts, specific topography of the area, the impact will be limited and minor. Potential impacts on birds due to their seasonal migration are assessed to be temporary.

Critical levels of sulfur dioxide for the natural vegetation, as recommended by WHO, amount to 15-20 μg/m^3 (average annual and winter), for lichens – 10 μg/m^3 (Table 4.24).

Table 4.24 – Critical levels of sulfur dioxide exposure on the natural vegetation *(WHO Air Quality Guidelines, 2000)*

Vegetation group	Critical level, μg/m^3	Period	Limitations
Forests and natural vegetation	20	Average annual and winter	
	15	Average annual and winter	Accumulated temperatures above +5°C <1000°C days per year
Lichens	10	Average annual	
Forests	1.0	Average annual	In areas where the near-surface clouds are present at least 10% of time

The calculations of emissions from stationary sources (Section 4.2.2.1) demonstrated that such annual average concentrations of sulfur dioxide in the area of BAS emission sources are not expected.

According to the WHO recommendations, the critical level of nitrogen oxides in the atmosphere for the vegetation is established to be 20 µg/m^3, based on NO_2 (annual average). Reference to the calculations made, such high concentrations of nitrogen dioxide due to permanent emission source operation can be observed only at a very limited area.

Mechanical impact. New elements of the station and vehicles, as required for the construction and operation, may have a minor impact on vegetated areas near the station. Motor vehicles (snowmobiles) are routes to move mainly on snow, where no plants and/or animals exist. Compact station design and proximity of field study points provide for minimal use of mechanical facilities. Walking can cause minor disturbance to vegetation and micro-fauna habitats in the areas adjacent to the station. Driving and walking may cause minor disturbance to birds, when they move in the station vicinity. No impact on areas of major biological diversity will be expected due to their remote location.

The expected soil contamination impact on the biota is estimated as minor. No significant contamination of soils in the BAS deployment area, as may be caused by leaking fuel, lubricating oils, wastewater, atmospheric depositions, waste exposure, is eventually expected. Some small areas of soil and growing lower vegetation and plant-based micro-organisms may be subject to minor pollution.

Wastewaters may potentially affect the flora and fauna in the vicinity of the station due to emergencies only, since the station design provides for water collection system with subsequent discharge into the sea. Given the nature of the station location, the absence of major natural ecosystems in the immediate vicinity of the construction site, a small number of BAE staff (max. 10-12 people), the impact on the biota will be minor even in the event of emergency.

Solid wastes. Accumulation of solid wastes may potentially affect the lower plants and micro-fauna at the base location only at the places of storage and pre-processing. Whereas the storage facilities will located in areas with little biodiversity, the solid waste impact on the biota can be assessed as minor.

Noise exposure. Given the remoteness of flocks of birds and marine mammals, the noise impact, as may be caused by BAS, will not be expected. The potential factor of concern will be short-term noise from the aircraft involved (airplanes and helicopters). Due to the landscape profile, land motor vehicles (snowmobiles, ATVs) can not be used to move people and equipment in the immediate vicinity of vertebrates and, as a result, will cause no noise impact on them. For lower plants and invertebrates, this human factor, due to the climatic features of the area (constant noise from winds) will make no effect.

Heat and electromagnetic effects are assessed to have less than a minor impact on the biota.

Microorganisms and diseases. Human activity can potentially result in introduction of alien microorganisms, including pathogens, to the local ecosystem, as well as in invasion of alien species and lower fungi. In freshwater lakes, minimum content of microorganisms is detected, thus making it possible to use it for potable water supplies. In small temporary lakes (accumulation of waters in hollows of rocks formed by melting snow in springs and summers), the number of microorganisms reaches high values, but this water is not used for drinking or catering purposes.

4.2.2.7. Exposure on marine environment and marine ecosystems

The planned BAS site deployment located at a distance of about 0.5 km from sea cost and will not be connected directly with the sea by watercourses, a direct impact on the marine environment and marine ecosystems is not expected. Minor impact will be through the discharge of domestic wastewaters to the Terpeniya Bay area near the Dostupny Cape. The calculations show (Section 4.1) that about 40 m^3 of BAS wastewaters will be discharged during the first phase operation for the season, thus dissolving about 4.4 kg of suspended solids, 7.2 kg of organic matter (BOD), 0.72 kg of ammonia, 1.8 kg of chlorides, 1.6 kg of sulfates, 0.04 kg of oil products, 0.1 kg of surfactants, 0.09 kg of iron, and other pollutants. During the all-year-round operation, the amounts of pollutants will increase 5.4 times.

The dilution rate of wastewater discharges to the sea was evaluated using U.S. EPA Visual Plumes model (*Dilution Models for Effluent Discharges, 2003*). It is assumed that the discharges will take place at 4 m depth and about 1 m above the bottom. According to the calculations, the BOD concentration will reduce from 180 mg/l in the effluent waters to 1.93 mg/l, or 91 times less at 1.5-5.5 m distance from the discharge point.

Impact on marine ecosystems may be affected also during scientific research activities, but it will be minimal. Marine fauna sampling for scientific purposes will be negligible. The maximum impact on flora and fauna of marine ecosystems can be expected only from icebergs as they drift in the area. A minor impact on marine ecosystems is expected at shoals and shallow shelf, where the iceberg drifts are practically excluded. A minor impact on benthic communities may be expected during the formation of anchor ice, which may slightly change the bottom ecosystem, but the restoration of species and quantities happens fast, due to the migration of moving forms (sea urchins, starfish, fish, shellfish).

4.2.2.8. Specially Protection Areas (ASPA), Specially Managed Areas (ASMA), Historic Sites and Monuments (HSM), Sites of Special Scientific Interest (SSSI)

No SPA, SSSI and/or SMA are reported at the planned BAS construction location. In this regard, no development of any management plans for such objects is required. The area is not included in any Antarctic Specially Managed Area (marked out for possible conflicts of interest or danger of cumulative impacts on the environment) either.

4.3. Risk level matrix related to the BAS construction and operation

The levels of risk associated with exposure on each of the environmental components are given in the risk matrix (Table 4.25), where the lines display the exposure types and the columns specify the environmental components.

The exposure-associated risk levels were assessed under the 4-point scale as follows:

- *None* - no impact is expected;
- *Low* - irregular adverse effects of low intensity;
- *Moderate* - regular exposure of low intensity or irregular effects of moderate intensity;
- *High* - regular exposure of moderate intensity or high-intensity irregular effects.

Table 4.25 – Evaluation matrix of the levels of risk for the environmental components associated with the Mount Vechernyaya BAS construction

Exposure	Environmental components / valuables						
	Flora	Fauna	Ice-free surface (soils, rocks)	Ambient air	Ice	Fresh water ponds and sea	Aesthetic values
Air pollutant exposure	X (moderate) In certain cases, pollutants can potentially reach places with vegetation in the surrounding areas, but, due to small amounts of emissions, dispersion and prevailing wind directions, the impact is assessed as transitory and minor.	X (low) In certain cases, pollutants can poten-tially reach the seabird colonies in the imme-diate vicinity of the station, but the concentration will increase slightly due to small amounts of emissions, dispersion and prevailing wind directions. The impact will be seasonal due to migration of birds.	X (low) Pollutant emissions will continue as long as the station is in operation. Ice-free areas will be less affected due to remoteness and pre-vailing wind direc-tions. The exposure may increase upon construction of new structures of the station.	X (moderate) The ambient air in the vicinity of the station will be exposed to emissions from permanent sources and vehicles. The exposure may increase upon new exposure sources commissioning.	X (low) Some products of combustion can get on the snow & ice surface. The exposure may increase upon new exposure sources commissioning.	X (low) Emission growth may lead to some increase in atmospheric pollutant depositions.	None
Soil conta-mination	X (low) Some small areas with (lower) vegetation may be contaminated. Pollutant leaks with wastewaters (due to accidental fuel spills) may affect vegetation micro-depressions and streams with vegetation.	X (low) Some micro-fauna species may be exposed to contamination	X (moderate) Possible contamination of soils due to fuel spills during transportation, refueling; pollution will be local. Possible redistribution of pollutants from local sources and local areas of contamination.	None	X (low) Soil pollution due to fuel spills (caused by mechanical transfer) can lead to contamination of the adjacent ice.	X (low-moderate) Fuel spills near the station can lead to penetration into freshwaters and sea.	X (low) Spills can affect the visual aesthetics, but the impact will be limited.
Solid wastes	X (low) Accumulation of solid wastes can affect the micro-flora at the station location. Increased exposure is expec-ted due to the base expansion, longer seasons and expected growth in solid waste amounts.	X (low) Accumulation of solid wastes can affect the micro-fauna at the station location. Increased exposure is expected due to the base expansion, longer seasons and expected growth in solid waste amounts.	X (moderate) As a result of the station operation and maintenance, solid wastes will trend to accumulate. Possible contamination of soils at the wastes storage locations.	None	X (low) The impact of wastes on ice is expected to be minor.	None	X (moderate) Pollution affects the visual aesthetics of the landscape.

Continuation of Table 4.25

Exposure	Environmental components / valuables						
	Flora	Fauna	Ice-free surface (soils, rocks)	Ambient air	Ice	Fresh water ponds and sea	Aesthetic values
Wastewaters	X (low) Wastewaters can potentially affect the micro-flora in the vicinity of the station (in case of emergency leaks) and aquatic plants on discharge of wastewaters into the sea. The exposure may increase due to longer seasons and expected increase in wastewater discharge amounts.	X (low) Wastewaters can potentially affect the micro-fauna in the vicinity of the station (in case of emergency leaks) and marine fauna on discharge of wastewaters into the sea. The exposure may increase due to longer seasons and expected increase in wastewater discharge amounts.	X (low) Resulting from the station operation and maintenance, wastewater leaks may happen; any possible adverse effects will be local.	None	X (low) Resulting from the station operation and maintenance, wastewater leaks may happen. The probability of impact on snow and glacier surfaces is low.	X (moderate) Wastewaters can potentially affect the chemical composition of lake waters and sediments (in case of emergency leaks). Wastewater discharges into the sea will cause localised and transitory pollution.	None
Noise	None	X (moderate) Birds from the neighboring colonies may be exposed to noise, but it will be limited due to remote distance and prevailing routes as scheduled. Seasonal effects due to migrations.	None	None	None	None	None
Mechanical impact	X (moderate) New elements of the base and transport due to the station construction and operation can disturb the areas of vegetation adjacent to the station. Walking may cause disturbance to vegetation near the station. Due to small area of vegetation, the impact will be transitory.	X (moderate) New elements of the base and transport due to the station construction and operation can disturb the micro-fauna areas adjacent to the station. Walking may cause disturbance to micro-biocenoses near the station. Due to small area of zoocenoses, the impact will be transitory.	X (moderate-) The station construction will cause some load on the ground. Scientific and logistic activities will require the use of vehicles in the vicinity of the station and thereby erode soils. Walking can lead to soil erosion due to increased activity.	None	X (low) Increased impact on glaciers due to the use of vehicles.	Low Some impact on water bodies will be observed due to water intake and research activities.	x (low) As a result of mechanical impact, the aesthetic value of the landscape can be affected.
Micro-organisms and diseases	X (low) Activity can potentially lead to introduction of alien microorganisms. The invasion of non-native species or diseases may occur, but the probability is low.	X (moderate) Activity can potentially lead to introduction of alien microorganisms. The invasion of non-native species or diseases may affect the local species, but the probability is low.	None	None	None	None	None

Thus, the analysis performed evidences that the BAS construction and further operation will be accompanied by emissions, discharges, waste accumulation, mechanical impact on the ground and ice, as well as heat, noise, electromagnetic exposure and possible microorganism introduction. However, the consequences of such impacts on the environmental components are considered to be low due to seasonal operation of the station, small number of staff engaged, minimum scope of construction works involving the landscape transformation, small amounts of fuel combustion. In general, the level of impact can be assessed as "minor or transitory".

4.4. Exposure matrix related to the BAS construction and operation

Level of exposure in connection with BAS construction and operation are summarized in exposure matrix (Table 4.26) by four main indicators: probability, scale, duration, significance. Scales applied are shown below.

Probability

- unlikely
- low
- medium
- high
- very high (certain)

Scale

- local
- subregional
- regional
- continental
- global

Duration

- very short – days
- short – weeks-month
- medium – years
- long – decades
- very long – centuries

Significance

- very low – impact practically absent
- low – insignificant impact
- medium – medium-level impact
- high – significant impact

- very high – serious impact

Table 4.26 – Exposure matrix related to the BAS construction and operation

Activity	Result	Stressors	Impact	Probability	Scale	Duration	Significance	Measures
Ships	Transportation and unloading	Atmospheric emission	Ambient air	High	Regional	Short	Vey low	Adherence to the IMO requirements Usage of low-sulfur fuel according to MARPOL
			Snow cover, glaciers, marine environment, soils, ecosystems	Low	Regional	Short	Vey low	
		Leaks of fuel and wastewaters	Marine environment	Medium	Local	Short	Medium	Plan to prevent leaks Absorbents stock
		Solid wastes and wastewaters		Low	Local	Short	Vey low	Wastes and wastewaters management according to MARPOL
Helicopters	Take-off, flight, landing	Atmospheric emission	Ambient air	Low	Subregional	Short	Vey low	Optimal routes
		Noise	Birds	High	Subregional	Very short	Средняя	Optimal routes and terms
	Service	Leaks of fuels and lubricants	Marine environment	Low	Local	Very short	Very low	Plan to prevent leaks Absorbents stock
Construction	Construction of labora-tory & living and pro-duction & living mo-dules and infrastructure	Mechanical impact	Soils, snow cover, glaciers	High	Local	Short	Low	Construction technology without area planning Reduction of the area of construction site
			Biota	Very low	Local	Short	Low	Construction outside valuable ecosystems
		Atmospheric emission	Ambient air	High	Local	Short	Low	Regular maintenance of equipment Usage of certified helicopters
			Soils, snow cover, glaciers, lakes	Very low	Local	Short	Vey low	
			Biota	Very low	Local	Short	Vey low	Emission sources outside valuable ecosystems
		Noise		Medium	Local	Short	Low	Regulation of helicopters application in certain periods
		Solid wastes	Soils, snow cover, glaciers	High	Local	Short	Low	Separate collection and storage Minimisation of wastes generation Wastes transmission
			Biota	Low	Local	Short	Low	Introduction of alien species control
		Wastewaters	Soils, snow cover, glaciers, lakes	Low	Локальный	Short	Low	Control and prevention of leaks
			Marine environment	High	Local	Short	Low	
			Biota	Low	Local	Short	Low	
		Fuels and lubricants management, spills	Soils, snow cover, glaciers, lakes	Medium	Local	Short	Medium	Plan to prevent leaks, leaks control Absorbents stock
			Biota	Medium	Local	Short	Low	

Continuation of Table 4.26

Activity	Result	Stressors	Impact	Probability	Scale	Duration	Significance	Measures
Station operation	Station's activity in operation mode	Mechanical impact	Soils, snow cover, glaciers	High	Local	Short	Low	Moving on routes Erosion control
			Biota	Medium	Local	Short	Low	Prevention of damage of valuable ecosystems
		Atmospheric emission	Ambient air	High	Local	Medium	Low	High-quality fuel doe diesel generators Regular technical maintenance of diesel generators Ecologically sound vehicles
			Soils, snow cover, glaciers, lakes	Low	Local	Medium	Very low	
			Biota	Low	Local	Medium	Low	Emission sources outside valuable ecosystems
		Noise	Biota	Medium	Local	Medium	Low	Regulation of equipment application in certain periods
		Solid wastes	Soils, snow cover, glaciers	High	Local	Medium	Low	Wastes management plan Separate collection and storage Minimisation of wastes generation Wastes transmission
			Biota	Low	Local	Medium	Low	Introduction of alien species control
Station operation	Station's activity in operation mode	Wastewaters	Soils, snow cover, glaciers, lakes	Low	Local	Short	Low	Control and prevention of leaks Account of dispersion conditions in discharge point
			Marine environment	Very high	Local	Medium	Low	
			Biota	Low	Local	Medium	Low	
		Fuels and lubricants management, spills	Soils, snow cover, glaciers, lakes	High	Local	Short	Low	Plan to eliminate leaks Absorbents stock
			Biota	Низкая	Local	Short	Low	
Scientific investigations	Observation at the territory of station and outside	Birdwath-ching	Biota	High	Local	Short	Low	Limitation of concern
		Licheno-metric and bryometric observations		High	Local	Short	Low	Optimal routes
		Observations of marine faune		Medium	Local	Short	Low	Limitation of concern
		Hydro-chemical investiga-tions		High	Local	Short	Low	Sampling plans
		Soil and geochemical investigations		High	Local	Short	Low	Sampling plans
		Snow and atmospheric depositions observations	Snow cover, glaciers	High	Subregional	Short	Low	Optimal routes

4.5. Possible indirect or secondary impacts

Electromagnetic exposure, as evaluated above, can be considered to cause a secondary impact. Each of the types of impacts on the natural components forms the chain, with its first component to be subject to direct exposure and the other – to indirect exposures. Thus, atmospheric depositions, in addition to direct impact on the biota, affect it indirectly by accumulation of pollutants in soil and water. Contamination of soils due to atmospheric precipitations, leaks, spills, waste discharges will have an indirect impact (in addition to the biota) on surface waters and marine environment. Accumulation of wastes has a direct impact on soils at storage site locations and an indirect impact through redistribution of pollutants on the adjacent soils, surface waters, marine environment and biota. The major indirect effects on the environment, along with the direct impacts, were discussed in Sections 4.2-4.3. In particular, contamination of soils, surface waters, marine environment can be considered an indirect impact on the biota.

4.6. Cumulative exposure

Cumulative impact is defined as the resulting superposition of impact from certain activities in concern on the impacts from the activities that is already in process at the same area. The station construction will increase man-caused activities at the area, especially during summer seasons: increased amounts of air emissions, wastewater generation and discharge, solid waste accumulation. It should be taken into account that the station construction site had been subjected to RAE and BAE scientific and logistic activities for a long time (over 30 years). The evidences of the environmental transformations are given in Section 3. Referring to the prior environmental impact, the contribution of the station construction and operation in the total transformation of the local natural components will be minor, as shown in Section 4. Extra research is needed in respect of a number of sensitive natural systems, i.e.: lakes, moss and lichen cenoses, soils.

4.7. Effect of proposed activity on scientific investigations and other types of activities and valuables

The proposed activities (station construction) will benefit to scientific investigations in the Mount Vechernyaya surroundings both for BAE explorers and scientists of other countries: the station will provide comfortable conditions for accommodation and work for 5-6 people in summer seasons at the first phase and 10-12 people in year-round periods at the second phase. No other activities are expected to be performed in the area.

5. Measures to mitigate or remediate the impacts of the proposed activity and monitoring programs

5.1. Mitigation and remediation measures

The impact on the environment during the BAS construction and operation is expected to mitigate as a result of the following actions.

Referring to the exposure factors:

Air emission reduction will be achieved due to regular maintenance of diesel generators and motor vehicles, route optimisation, improved quality of fuel to be used. Reduced emissions from waste incineration will be implemented through careful monitoring of combustible substrates, compliance control of waste feeding and burning, dust & gas abatement performance control.

Wastewater discharge reduction will be achieved by decrease of wastewater generation through the use of more efficient water-consuming systems, as well as the introduction of new systems for wastewater discharge collection, storage and sewage.

Reduction of the impacts due to the formation and accumulation of wastes will be attained by improving the waste management system. A specific Waste Management Plan will be developed to distribute the functions and responsibilities of BAE staff for wastes handling, to specify the procedures related to wastes collection, separation, storage, incineration and other actions aimed at minimisation of wastes impact on the Antarctic environment.

Special measures will be implemented to prevent oil spills during storage, loading and refueling. A specific Oil Spills Control Program (Plan) will be developed to determine the functions and responsibilities for oil spills control and prevention, as well as for timely removal of oil spills, if occurred, oil product absorption procedure, recommended materials (sorbents), polluted substrate storage conditions.

Referring to the types of exposure and components (recipients):

Mitigation of mechanical impact on soils, snow & ice cover:

- optimised use of off-road vehicles, purchase of modern snowmobiles, optimised transportation routes.

Mitigation of impact on water basins:

- prevention of sewage and wastes discharges into lakes, optimised water intake, environmental protection measures in studies of lakes, in deep-sea diving; avoidance of coastal area pollution and littering.

Mitigation of impact on biota (phyto- and zoocenoses), biota protection:

- route optimisation to reduce the impact on phyto- and zoocenoses, protection of rare species, identification of areas with limited access (protected ecosystems), restricted access in certain seasons.

In order to preserve the biological diversity at the BAS location and at the surrounding areas, a continuous monitoring of environmental impacts will be performed by the expedition staff members and station technicians. The BAS explorers will undergo regular briefings on environmental safety and biological ethical conduct in Antarctica. The area of major biological diversity will be monitored at monitoring points and will be placed under protection. Besides, single localities of flora and fauna (local detached colonies of mosses and lichens) will also be subject to protection measures. Colonies of nesting birds and mammals in that area will also be protected and subjected to monitoring. In particular, the moss and lichen cenose near the BAS construction site will be secured, as described in Section 3.1.

5.2. Monitoring programs

An environmental monitoring program will be developed and implemented at the BAS site to establish the relationships between the current environmental situation, its forecast indicators and actual values in the future, following the station construction and operation startup. It will help to implement measures in remediating the negative effects of activities. An environmental monitoring lab will be established and equipped for monitoring of chemical, physical and biological indicators.

The monitoring program will be developed in accordance with the Practical Guidelines for Developing and Designing Environmental Monitoring Programs in Antarctica (2005).

Meteorological observations

A BAS weather station will perform observations under WMO - recommended surveillance programs.

Ambient air

The ambient air will be monitored for surface ozone concentrations, as well as for content of particulate matter and gas components.

Ice cover and atmospheric precipitations

It is planned to proceed with the observations of the chemical composition of snow waters both at the BAS site and at exposed areas. Snow waters will be monitored for content of major ions and heavy metals as indicators of anthropogenic impact. Such procedures will also help to control the composition and level of atmospheric deposition of pollutants.

Surface water monitoring

Monitoring of the hydro-chemical situation of the Verkhneye and Nizhneye Lakes is planned to continue. The content of major ions, oil products, heavy metals in water, as well as heavy metals and oil products in sediments as indicators of anthropogenic impact on the environment, will be subject to further control.

Monitoring of soils

Reference sites (points) for soil monitoring have been selected. It is planned to expand the network of the observation points to cover the entire diversity of soils around the station. The main types of soils and their properties will be subject to analysis. The content of oil products, heavy metals, PAHs will be tested.

Monitoring of biota (lichens, mosses, tardigrades, plankton, benthos)

The aim of monitoring is to assess the status of populations and communities of the most representative species of plants and animals, to measure changes in biodiversity both in the entire Antarctic ecosystem and at specific areas, particularly at the BAS location.

The monitoring activities are mainly aimed at:

- control of flora and fauna complexes and specific plant and animal species in different types of natural and modified biogeocenoses at the BAS deployment area;
- monitoring the situation and use of commercial species (fish, krill, algae, etc.), having the most important resource value;
- tracking the changes of rare and endangered species of animals and plants;
- monitoring of selected indicator species and groups of plants and animals in terrestrial and aquatic ecosystems, which serve the best reflectors of the environment quality;
- creation of computer databases for the purpose of monitoring data online processing, analysis and output for making decisions and forecast estimates.

Major actions to achieve the enlisted targets and objectives will be:

- selection of indicator species and groups of plants and animals, being representative for the entire situation and dynamics of flora and fauna (lichens, phytoplankton, zooplankton, etc.);
- selection of representative characteristics of populations and communities, which will be dealt with in future bio-monitoring procedures (number of species, density, additionally for mosses and lichens - accumulation of heavy metals and radionuclides);
- selection of specific areas that reflect the diversity of the main types of terrestrial and aquatic ecosystems (including types of terrains and degree of anthropogenic exposure);
- creation of a reference network for environmental control via flora and fauna representatives.

Since the organic life variability is extremely high, it is essential to select organisms that serve the best indicators of trends in environmental changes. In Antarctica, objects of monitoring may include lichens, mosses, tardigrades, plankton, benthos, birds, pinnipeds.

As it was previously mentioned in Section 3, there is a plot of land occupied by the community of lower plants in the vicinity of the BAS construction site (Figure 5.1, point 6), having the total area of approximately 150 m^2. Similar sites selected for monitoring are located at a considerable distance from the BAS site. Large patches of mosses, lichens and algae are located at the foot of the Rubin Hill (78.7 m high, about 600 m NE from BAS, point 1), at the foot of Mount Vechernyaya on the east of the Gnezdovoy Cape (about 1 km NW from BAS, point 7), near Hill 46.8 (Adelie penguin colony at the Gnezdovoy Cape and surroundings, about 1.5 km NW from BAS, point 4), near Hill 64.2 (about 3.5 km W from BAS, point 8).

Freshwater ecosystems of major interest include cenoses of the Nizhneye Lake (about 400 m S from BAS), the lake at the Gnezdovoy Cape (within the boundaries of Adelie penguin colony and in the immediate vicinity).

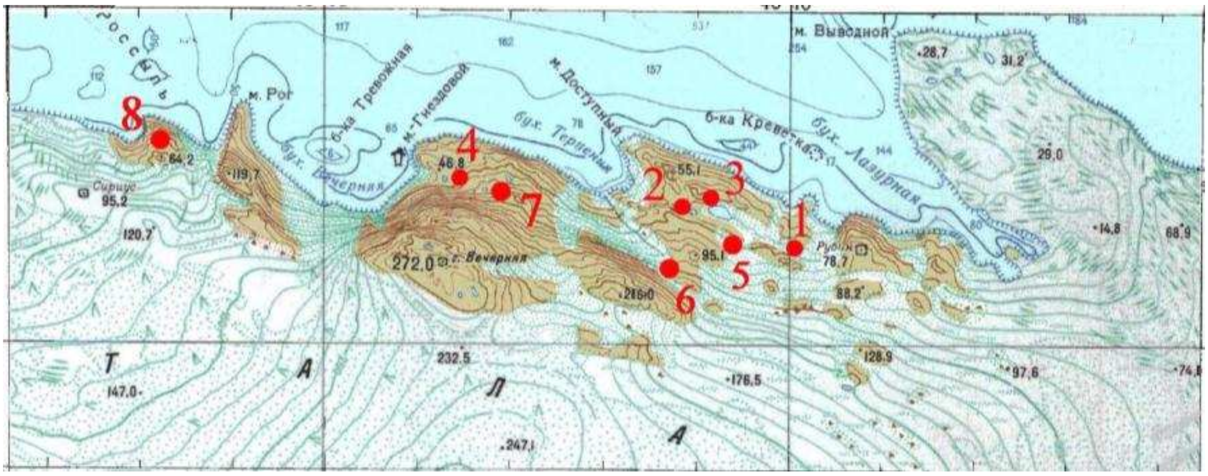

Figure 5.1 – Locations of the major types of ecosystems, most valuable ecosystems and ecosystems recommended for protection and monitoring at Mount Vechernyaya

5.3. Operational monitoring and actions in emergency

In addition to monitoring of the natural surrounding situation and impacts, an operational monitoring system will be established to monitor the major ecologically dangerous objects, primarily, fuel storage facilities, sewage ponds, pipelines, diesel generators, etc. Detailed protocols (instructions) will be developed to specify the service & maintenance procedures, minimising the possibility of accidents and leakages. The volumes of emissions, discharges, wastes generation, accumulation and disposal, scheduled equipment maintenance works will be properly controlled. The protocols will also regulate the actions in case of emergency: leakages, spills, fires, etc. All such cases will be recorded; any measures implemented will be reported. For emergency purposes, accident-eliminating facilities, e.g., sorption materials and other aids of preventing leakages will be stored on site, as minimally required.

Monitoring and control of alien species introduction will also be organised and implemented.

6. Gaps in knowledge and uncertainties

A number of factors introduce uncertainty in the prepared Draft Comprehensive Environmental Evaluation.

One of the factors are knowledge gaps about some natural elements of the environment due to insufficient study of the natural conditions of the station location, such as the dynamics of snow and ice cover, Cosmonauts Sea hydrology in the area, lakes hydrology, soil processes and their transformation conditions due to long-term operation of the Mount Vechernyaya field base.

The information about inputs, accumulation and migration of chemical elements in soils, bottom sediments due to the previous activities in the Mount Vechernyaya field base areas is limited.

We have got only the initial data on biodiversity of marine biota in the Vechernyaya, Terpeniya and Lazurnaya Bays (Alasheeva Gulf, Cosmonaut Sea). No information about the areas of potentially greatest biological diversity – Trevozhnaya Bank (Vechernyaya Bay) and Shrimp Bank (Lazurnaya Bay) – is currently available. These gaps in knowledge will be filled up in the process of further research in this area.

The prepared Draft Comprehensive Environmental Evaluation is based on the existing design materials, including specifications for the equipment and tools to be used, but there is a possibility of modifications, particularly in connection with a rather long period of BAS construction. There is also the probability of deviations from the schedule due to unforeseen circumstances, “last minute” changes, etc.

A number of forecast data, in particular, the dispersion of pollutants, are based on simulations and predicted environmental parameters (such as weather conditions), which are characterised by variability.

During the lifetime of the station, scientific and domestic activities may change the equipment used, and the level and composition of exposure sources, their characteristics, scientific programs. These changes will require the preparation of specific impact assessments.

7. Conclusions

The Republic of Belarus intends to establish a research station at the Tala Hills, Enderby Land, in order to promote its investigations in the area. The first phase of the station facilities will be implemented in 2014-2018. The station will be designed under the modular principle, thus minimising the construction costs, speeding up and simplifying the framework. The station is planned to start as a seasonal facility, with subsequent enhancement to wintering (year-round) operation. Limited staff, efficient power, heat, water supply, sewerage and waste management systems will contribute to minimum impact on the environment.

Earlier, in accordance with the requirements of the Protocol on Environmental Protection to the Antarctic Treaty and based on the Action Plan (2012), an Initial Environmental Evaluation (IEE) was prepared in connection with the Belarusian Antarctic station construction. The assessment included all the basic elements required by the *Guidelines for Environmental Impact Assessment in Antarctica (1999)*. The exposure caused by the station construction of stations was characterised as having “a minor or transitory impact”.

In this connection, the stated activities could be implemented without a Comprehensive Environmental Evaluation (CEE) to be prepared. However, according to the ATCM Recommendation XV-17, when considering the issue of opening a new station or supply facility, the Contracting Parties should prepare a Comprehensive Environmental Evaluation prior to such station or supply facility deployment. In connection with this project, a draft Comprehensive Environmental Evaluation for the proposed Belarusian Antarctic station deployment site was prepared to be further presented to the Antarctic Treaty Parties, Committee for Environmental Protection (CEP) and Antarctic Treaty Consultative Meeting (ATCM) in accordance with the established terms and procedures.

The impact assessment performed in accordance with the requirements of the Protocol on Environmental Protection demonstrated that the construction and the continued operation of BAS will be accompanied by emissions, discharges, waste accumulation, mechanical action on the ground, ice, as well as noise, electromagnetic radiation and possible introduction of alien microorganisms. However, the consequences of such impacts on the environmental components are assessed as minor, mainly due to the seasonality of the station operation, small number of staff, minimum scope of construction works involved in the transformation of the landscape, small amounts of fuel combustion.

Proposals for remediation of the environmental impacts have been developed. They include measures to reduce emissions, discharges, waste generation, waste management plans, routes planning, leak-preventing actions.

Proposals have been also prepared on monitoring programs focused on confirming the accuracy of predictions made regarding the environmental impacts and on detecting unforeseen impacts and exposures of greater impact than expected. They include selection of reference points and bookmark sites of systematic observations, control of the major natural components and sites (lakes, phytocenoses, bird colonies), industrial environmental monitoring and actions in case of accidents. The evaluation of the gaps in knowledge and uncertainties has been made.

In general, the impact due to the station (base) construction and operation can be identified as "minor or transitory". The construction of a permanent research station is demonstrated to expand the research capacity in the area and benefit to fruitful international cooperation in Antarctica.

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9. Preparers and advisors

The Draft Comprehensive Environmental Evaluation was prepared by the Institute for Nature Management of the National Academy of Sciences (NAS) of Belarus, the Scientific and Practical Centre for Bioresources and the Republican Centre for Polar Research of the National Academy of Sciences of Belarus within the framework of the National Program on Monitoring of the Earth's Polar Areas and Promotion of the Arctic and Antarctic Expeditions for the period 2011-2015.

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BAS modules description and major specifications

1. Laboratory & residential module, single-storey

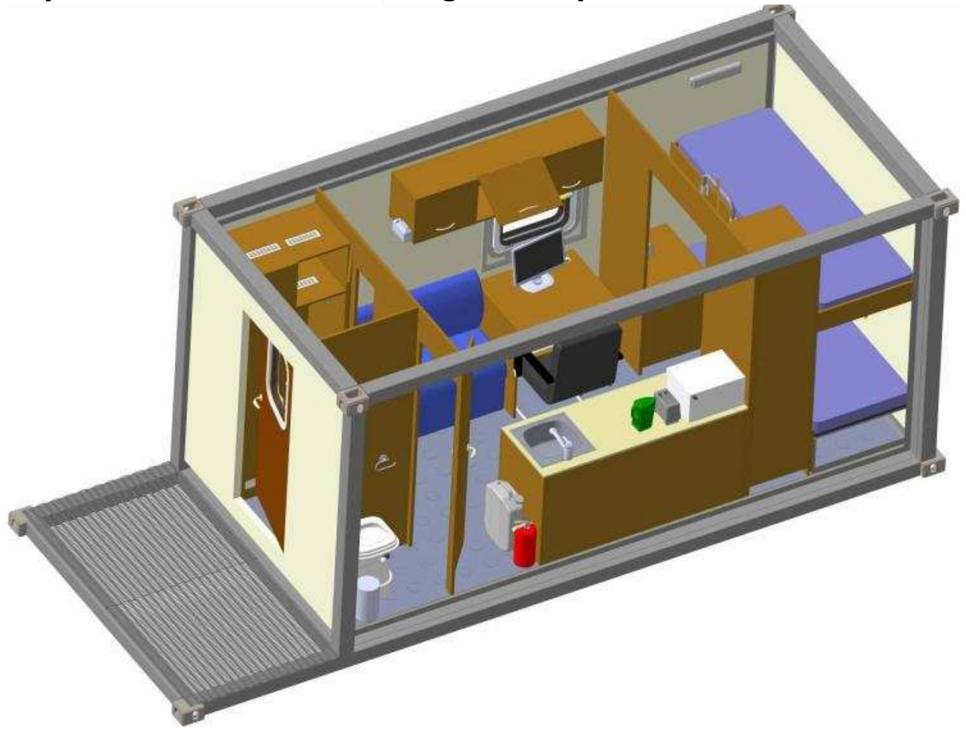

Figure 1 - Left section of the module. Right-side view

Figure 2 – Middle section of the module. Right-side view

Function:

The laboratory & residential module is designed for:

- observations and laboratory tests to be performed;
- sanitary & hygienic purposes, rest (sleep) and catering of max. 3 people;
- laboratory equipment installation (oven, autoclave, microscope, binocular microscope, laboratory tables, shelves, etc.);

- hydro-biological instrument storage (water bottles, sediment samplers, plankton nets, sweep nets, fishing rods, sleds, motor-drill, etc.);

- biological samples container-packed storage, storage of dry samples, storage of chemicals, storage of diving equipment, food emergency packs, safety and firefighting equipment, spare parts, tools and accessories (single set) (STA-1) and outdoor equipment.

The module comprises of:

- 2-section prefabricated platform-basement (positioned on outrigger jacks and additional telescopic adjustable legs) to set the wagon container-type sections, equipped with easy-removable ladders and enclosures;

- one lab & household ‘butterfly-type’ (one-sided) wagon section with a set of furniture (cabinets, shelves, safe), life-supporting and power supply systems comprising of: refrigerator-freezer, shower, self-contained water supply system (a water pumping system without a water tower installed, horizontal water heater of 50-70 l capacity, water tank of 400-500 l capacity), as well as domestic wastewater collection and discharge system (400 l storage tank with internal heating, water pump for jet discharge of domestic wastewaters to a central sewer or drain in a mobile tank);

- one container-type service & residential wagon section with life-support and power supply systems comprising of: a mini-kitchen unit (microwave, teakettle, toaster, sink, kitchen cabinet with pull-out cutting board, double wall cupboard, 20 l water accumulation heater), electric toilet (Insinolet).

The major engineering specifications are given in Table 1 below.

Table 1 – Major engineering specifications of the laboratory & residential single-storey module

Engineering specifications	Value	
1. Dimensions, max., mm - length - width - height	 6058 7314 2438	
2. Module’s gross weight, kg	8900	
3. Dimensions of the laboratory & utility wagon section, max., mm	external	internal
- length - width - height	4 558 2 438 2 438	4 408 2 238 2 218
4. Dimensions of the service & residential wagon section, max., mm	external	internal
- length	4558	4408
- width	2438	2238
- height	2438	2218
5. Laboratory & utility wagon section gross weight, kg	3900	
6. Weight of one basement section	500	
7. Platform-basement’s gross weight	1500	
8. Service & residential wagon section gross weight, kg	3500	

2. Service & residential module, single-storey

Figure 3 - Left section of the module. Right-side view

From the entrance: a lobby, wardrobe with heating elements, lab workplace, compartment for recreation.

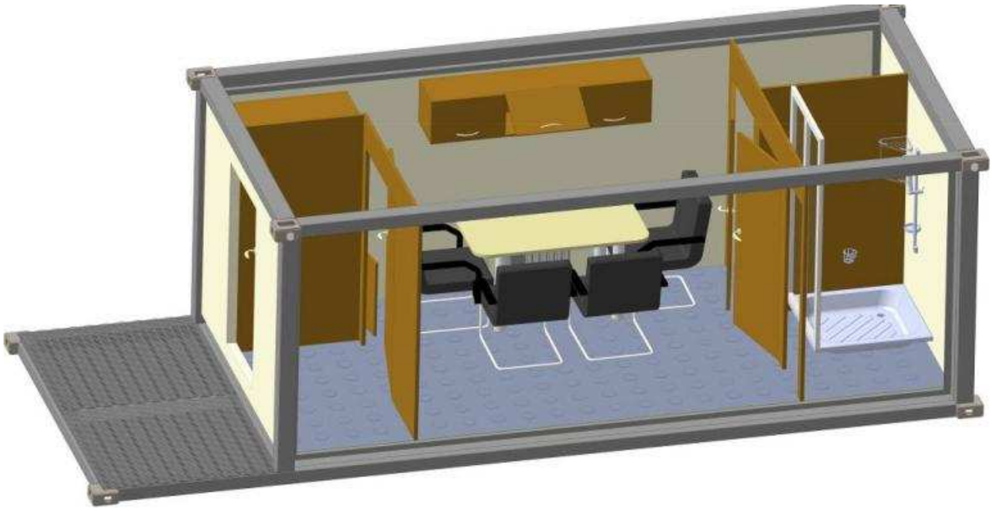

Figure 4 - Middle section of the module. Right-side view

From the entrance: a lobby, wardrobe, catering zone, mini-kitchen, toilet, shower, water treatment, heating and storage area.

Figure 5 - Right section of the module. Right-side view

The service & residential module is designed for:

- observations and laboratory tests to be performed;
- sanitary & hygienic purposes, rest (sleep) and catering of max. 4 people;
- laboratory equipment installation (lidar, radiometer, ozonometer, other equipment for atmosphere investigation);
- storage of i tools and accessories for scientific equipment repair;
- storage of additional equipment, food emergency packs, safety and firefighting equipment, spare parts, tools and accessories (single set) and outdoor equipment.

The module comprises of:

- 3-section prefabricated platform-basement (positioned on outrigger jacks and additional telescopic adjustable legs) to set the wagon container-type sections, equipped with easy-removable ladders and enclosures;
- two container-type service & residential wagons section with a set of furniture as well as life-support and power supply systems;
- one container-type household wagon with a set of furniture (cabinets, shelves, safe), life-supporting and power supply systems comprising of: refrigerator-freezer, shower, self-contained water supply system (a water pumping system without a water tower installed, horizontal water heater of 50-70 l capacity, water tank of 400-500 l capacity), as well as domestic wastewater collection and discharge system (400 l storage tank with internal heating, water pump for jet discharge of wastewaters to a central sewer or drain in a mobile tank).

The major engineering specifications are given in Tables 2-3 below.

Table 2 – Major engineering specifications of the service & residential single-storey module

Engineering specifications	Value	
1. Dimensions, max., mm		
- length	6 058	
- width	7314	
- height	2 438	
2. Module’s gross weight, kg	10250	
3. Dimensions of the laboratory & utility wagon section, max., mm	external	internal
- length	4 558	4 408
- width	2 438	2 238
- height	2 438	2 218
4. Dimensions of the service & residential wagon section, max., mm	external	internal
- length	4558	4 408
- width	2 438	2 238
- height	2 438	2 218
5. Laboratory & utility wagon section gross weight, kg	3900	
6. Weight of one basement section	500	
7. Platform-basement’s gross weight	1500	
8. Service & residential wagon section’s gross weight, kg	3550	

Table 3. Package set of the laboratory & residential single-storey module

Component name	Number	Special note
Basement positioned on outrigger jacks with external easy-removable enclosure and corner elements (fixing brackets) for wagon section positioning	3	3 separate sections of the platform are transported in a bundle and installed on-site by helicopter separately, and then mounted (connected) to each other in a single (joint) platform-basement
Replaceable adjustable legs (the outriggers are set manually with fastening anchors to the surface)	8	Transported together (in one package) with the basement sections. Mounted under the basement following its installation on-site on the jacks
Container-type wagon section	3	Including one section without front and rear walls. Transported separately. Assembled by helicopter onto the basement following its installation on-site.
Vertical service ladder	1	Mounted on the front side wall of the module
Entry platform ladders	2	Transported together (in one package) with the basement sections. Mounted to the entry (side) platforms of the basement after its final installation on-site.
Collector tank for domestic wastewaters of 400 l capacity, double wall and heated.	1	Transported separately. Mounted underneath the laboratory & household wagon section following its installation onto the basement.

3. Laboratory & residential block module, two-storey

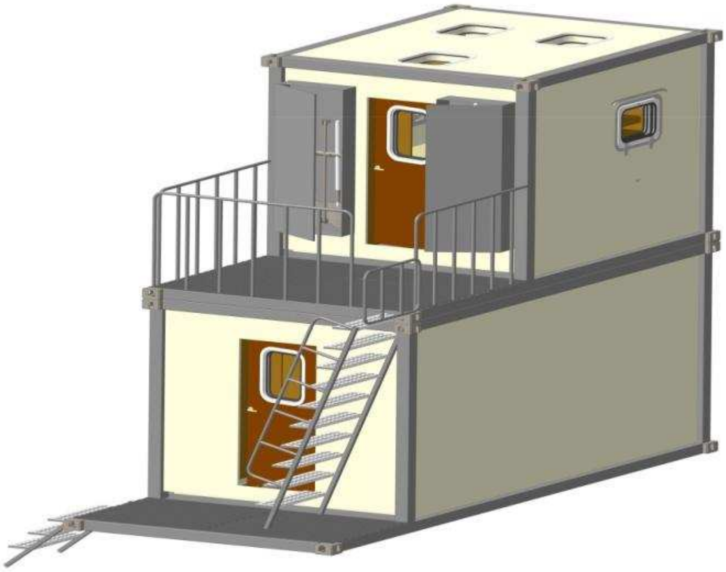

Figure 6 – General view of the laboratory & residential two-storey block module

Function:

The laboratory & residential two-storey block module is designed for:

- rest (sleep) and catering of max. 2 people;
- sanitary & hygienic purposes;
- installation of communication, navigation and monitoring equipment for the major meteorological parameters (satellite station, VHF and HF communication, satellite data receiving and processing equipment, recording blocks of automatic weather stations and similar equipment and instrumentation);
- storage of spare parts, tools and accessories for repair and adjustment of communication and navigation equipment (STA-CN) and outdoor equipment;
- storage of spare parts, tools and accessories (single set) (STA-1) and outdoor equipment;
- storage of food emergency packs, safety and firefighting equipment.

The module comprises of:

- one container-type service & residential wagon section, positioned on outrigger jacks and additional telescopic (replaceable) adjustable legs, equipped with easy-removable three-stairway ladder platform with easy-removable rails (entry enclosure), which include: set of furniture, life-supporting and power supply systems with 2.5-3.5 kW emergency backup, mini-kitchen unit (microwave, teakettle, toaster, sink with hinged dryer, single floor kitchen cabinet with pull-out cutting board, single wall-mounted kitchen cupboard, double wall cupboard, 20 l water accumulation heater, shower, electric toilet (Insinolet), self-sustained water supply system (water pumping system without a water tower installed, horizontal water heater of 50-70 l capacity, water tank of 200 l capacity), as well as domestic wastewater collection and discharge system (200-250 l storage tank with internal heating, water pump for jet discharge of domestic wastewaters to a central sewer or drain in a mobile tank);

- one block (wagon section) for communications, navigation and routine weather monitoring, including: life-supporting and power supply systems with 1.0-1.5 kW emergency backup, outdoor platform with easy-removable rails sized 2,500 x 2,400 mm, metal frames with adjustable angle for installation of solar panels, set of furniture: wardrobe (coupé) with shelves for STA, wardrobe (coupé) for multifunctional Modulus UPS installation, central operator desk with angular desktop shelves for communication and navigation equipment, fitter's table with drawers, side operator desk with drawers and a niche for computer, open wall-mounted shelves for equipment .

The major engineering specifications and package set details are given in Tables 4-5 below.

Table 4 – Major engineering specifications of the laboratory & residential two-storey module

Engineering specifications	Value	
1. Dimensions, max., mm		
- length	6 058	
- width	2 438	
- height	4 876	
2. Module's gross weight, kg	6300	
3. Dimensions of the service & residential wagon section, max, mm	external	internal
- length	4 558	4 408
- width	2438	2 238
- height	2 438	2 218
4. Service & residential wagon section's gross weight, kg	3900	
5. Dimensions of the communication, navigation & monitoring section, max, mm	external	internal
- length	3 029	2 879
- width	2 438	2 238
- height	2 438	2 218
6. Communication, navigation & monitoring section's gross weight, kg	2 000	

Table 5. Package set of the laboratory & residential two-storey block module

Component name	Number	Special note
Telescopic (replaceable) adjustable legs	4	Transported separately. Mounted under the service & residential section following its installation on-site on the jacks.
Container-type wagon section	2	Transported separately. Mounted by Ka-32 helicopter in a two-storey structure (one section onto another).
Vertical service ladder, two-section	2	Mounted on the front side wall of each container-type wagon section
Three-stairway ladder platform with easy-removable rails (entry enclosure)	1	Transported by a separate package. Mounted from the entry side of the sections following their final installation on-site.
Outdoor platform with easy-removable rails sized 2,500 x 2,400 mm	1	Transported together with the service & residential wagon section. Mounted on the roof of the service & residential wagon section following its final installation on-site.
Collector tank for domestic wastewaters of 200-250 litres capacity, double wall and heated.	1	Transported separately. Mounted underneath the service & residential wagon section following its final installation on-site.

4. Production & residential module, two-storey

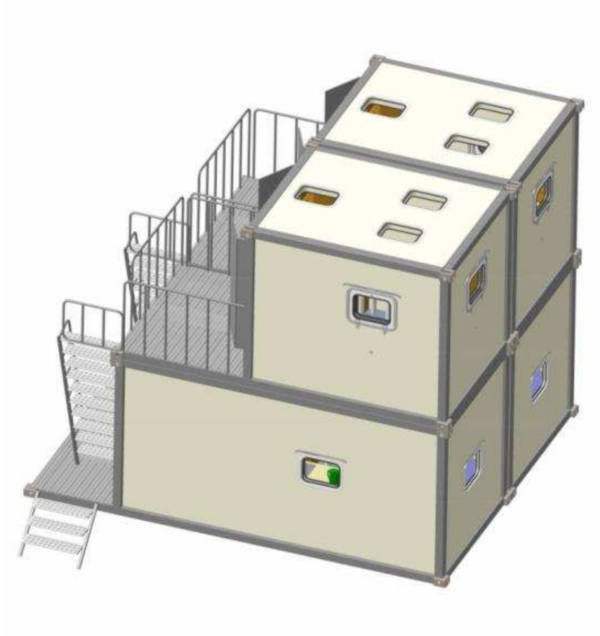

Figure 7 – General view of the production & residential two-storey module

Function:

The production & residential two-storey module is designed for:

- rest (sleep) and catering of max. 2 people;

- repair works;
- sanitary & hygienic purposes;
- storage of mechanic and woodwork tools;
- storage of equipment;
- storage of food emergency packs, safety and firefighting equipment;
- storage of spare parts, tools and accessories (STA) and outdoor equipment.

The module comprises of:

- simplex prefabricated platform-basement (positioned on outrigger jacks and additional telescopic adjustable legs) to set the wagon container-type sections, equipped with easy-removable ladders and enclosures;
- container-type residential wagon section (lower block) with life-supporting and power supply systems comprising of: 20 l water accumulation heater, electric toilet (Insinolet), sink, shower, twin residential compartment, wardrobe, self-contained water supply system (a water pumping system without a water tower installed, horizontal water heater of 50-70 l capacity, water tank of 200 l capacity), as well as domestic wastewater collection and discharge system (400 l storage tank with internal heating, water pump for jet discharge of domestic wastewaters to a central sewer or drain in a mobile tank);
- container-type production wagon section (upper block) for two workplaces (mechanics & woodwork), life-supporting system (bio-toilet and washbasin unit), wardrobe for work outerwear, wardrobe for tools and accessories, desk, workbench and vise, grinding machine, drilling machine, portable cutting machine with a holder for the cutting machine.

The major engineering specifications and package set details are given in Tables 6-7 below.

Table 7 – Major engineering specifications of the production & residential two-storey module

Engineering specifications	Value	
1. Dimensions, max., mm		
- length	6 058	
- width	6 058	
- height	4 876	
2. Module's gross weight, kg	9 300	
3. Dimensions of the residential wagon section, max., mm	external	internal
- length	6058	5 908
- width	2438	2238
- height	2438	2218
4. Dimensions of the repair wagon section, max., mm	external	internal
- length	6058	5908
- width	2438	2238
- height	2438	2218
5. Production & residential wagon section's gross weight, kg	4400	
6. Weight of one basement section	500	
7. Platform-basement's gross weight	500	
8. Service & residential wagon section's weight, kg	4400	

Table 8. Package set of the production & residential two-storey module

Component name	Number	Special note
Basement positioned on outrigger jacks with external easy-removable enclosure and corner elements (fixing brackets) for wagon section positioning	1	1 section of the platform is transported in a bundle and installed on-site by helicopter, and then mounted (connected) to each other in a single (joint) platform-basement
Replaceable adjustable legs	4	Transported together (in one package) with the basement sections. Mounted under the basement following its installation on-site on the jacks
Container-type wagon section	2	Transported separately. Assembled by helicopter onto the basement following its installation on-site.
Vertical ladder for climbing to the 2nd level	1	Mounted on the front wall of the wagon section
Entry platform ladder with easy-removable rails	2	Transported together (in one package) with the basement sections. Mounted to the entry (side) platforms of the basement after its final installation on-site.
Collector tank for domestic wastewaters of 400 l capacity, double wall and heated.	1	Transported separately. Mounted underneath the laboratory & household wagon section following its installation onto the basement.

Maps of air pollutants dispersion from stationary sources at BAS operation. Scenario 2

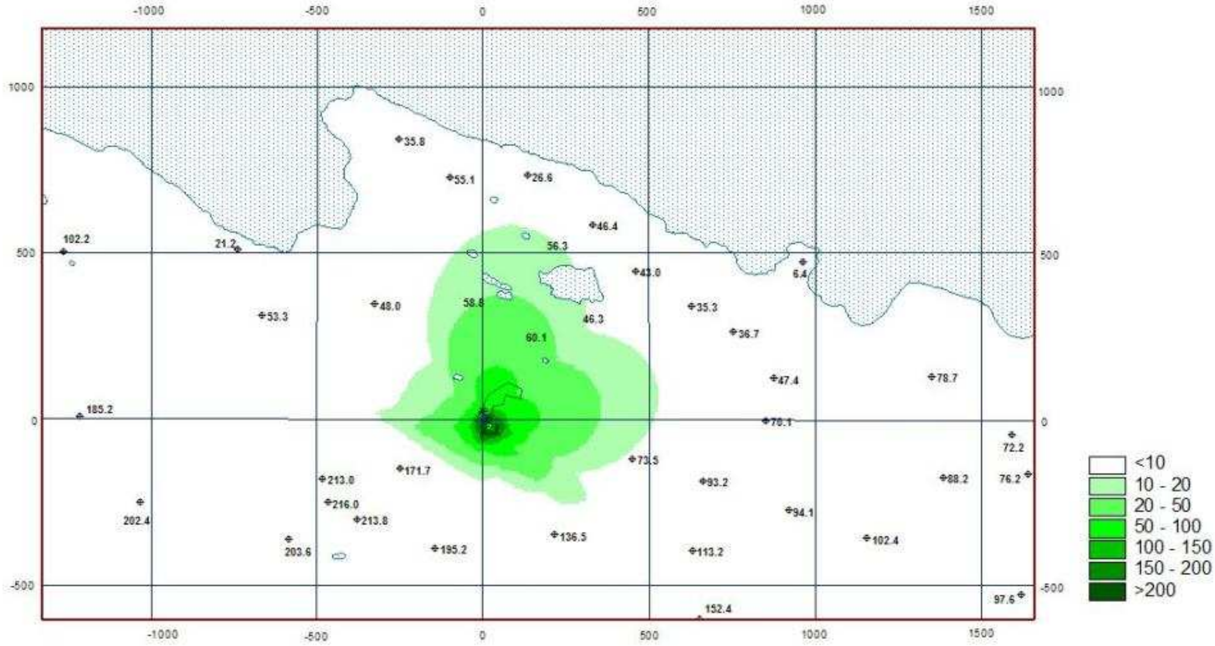

Figure 1 – Distribution of maximum 1-hour carbon oxide concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

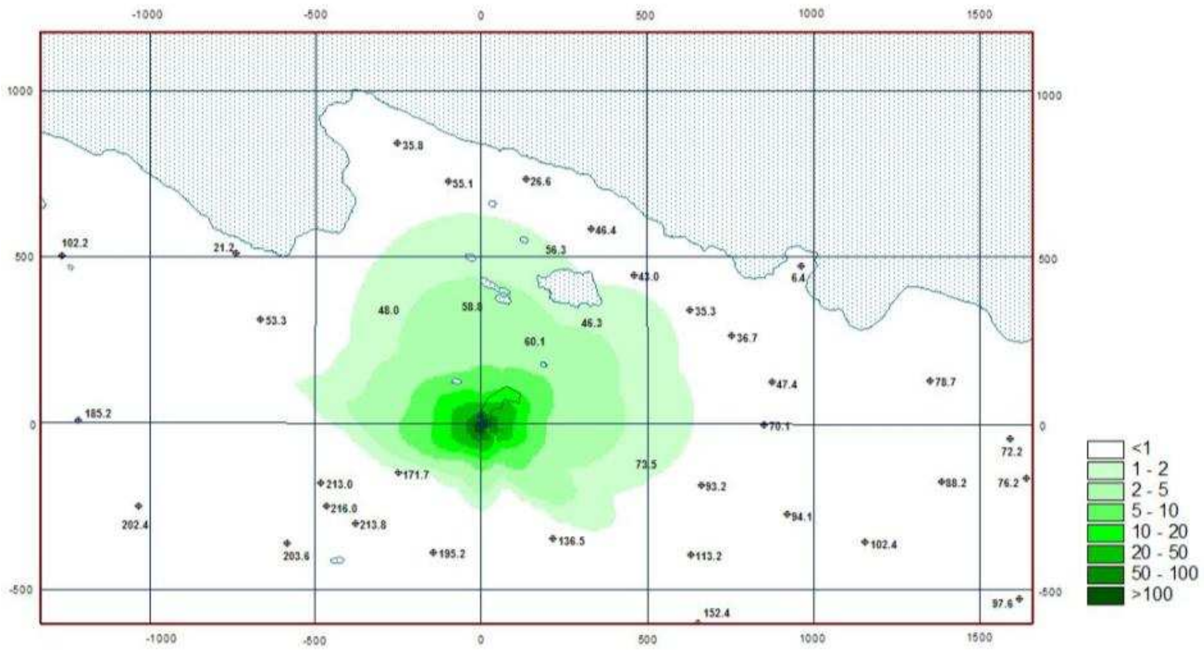

Figure 2 – Distribution of maximum 24-hour carbon oxide concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

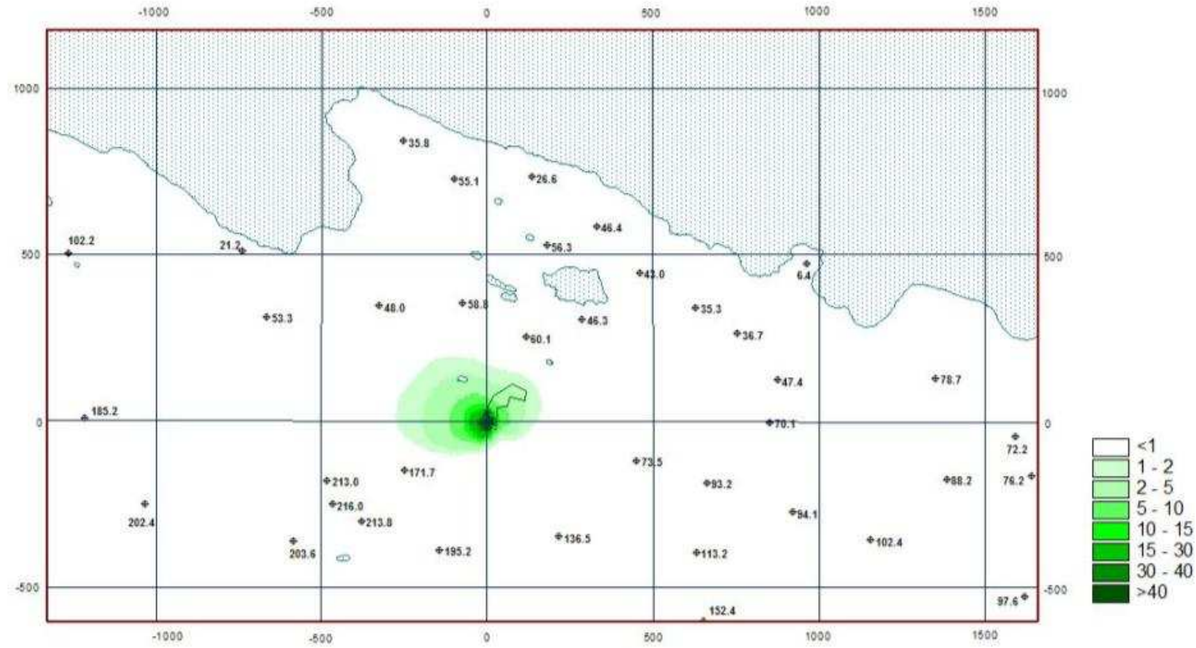

Figure 3 – Distribution of monthly average carbon oxide concentrations in atmospheric air from BAS stationary sources operation, µg/m^3. Scenario 2

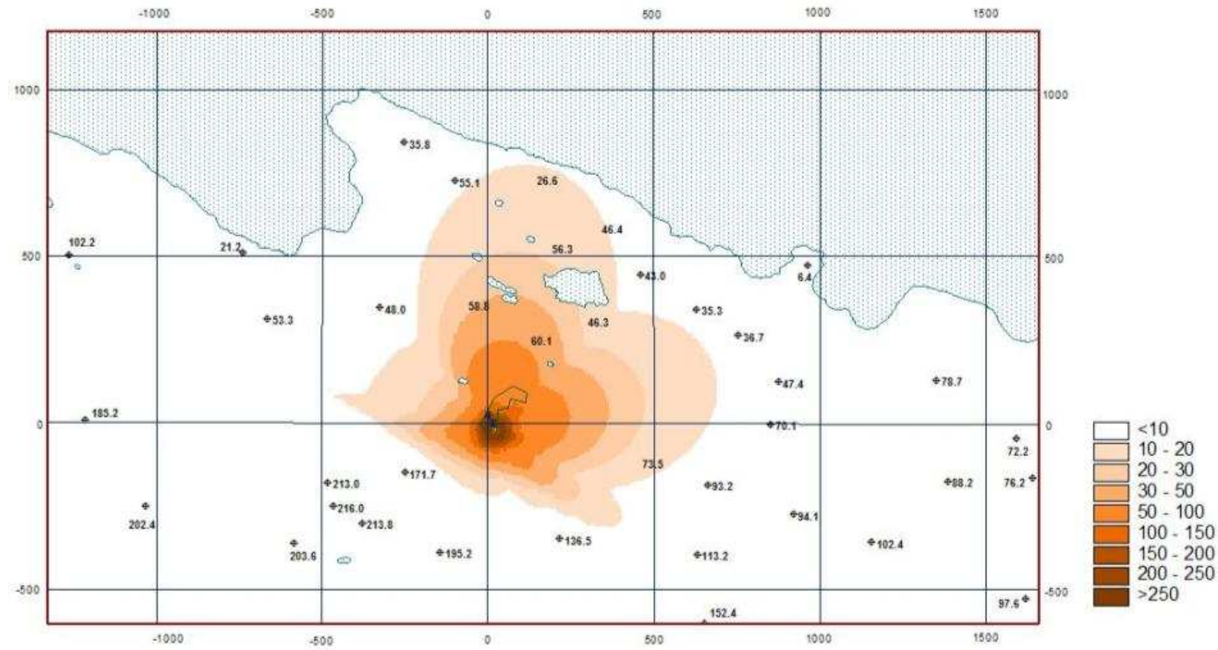

Figure 4 – Distribution of maximum 1-hour nitrogen dioxide oxide concentrations in atmospheric air from BAS stationary sources operation, µg/m^3. Scenario 2

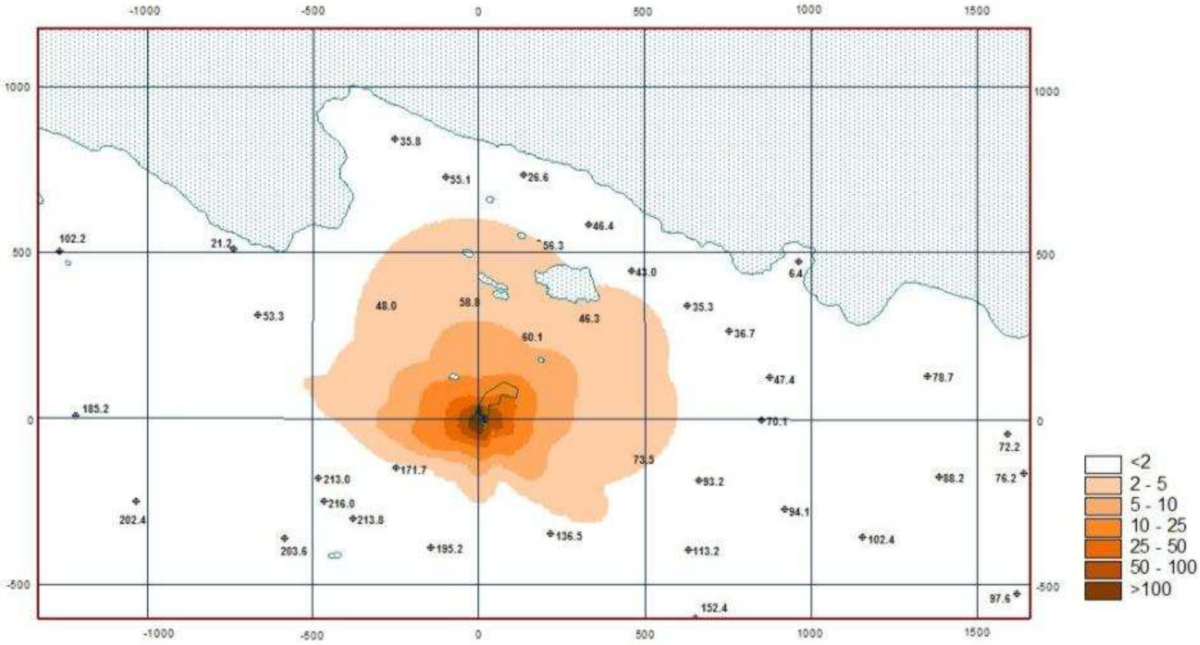

Figure 5 – Distribution of maximum 24-hour nitrogen dioxide concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

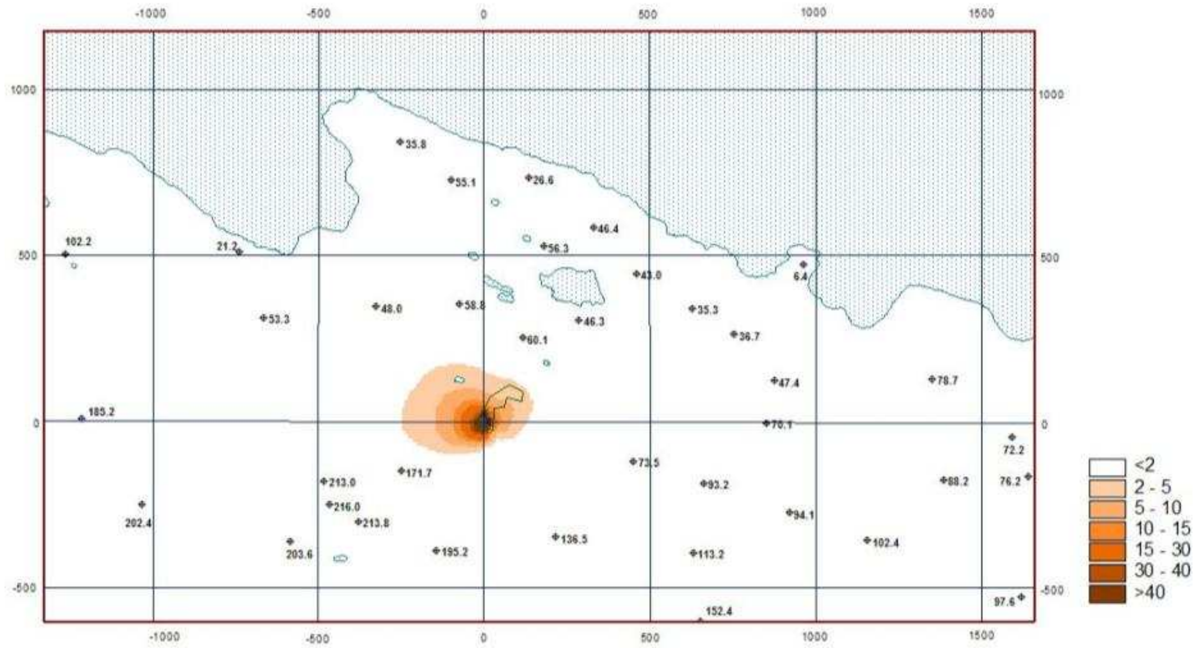

Figure 6 – Distribution of monthly average nitrogen dioxide concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

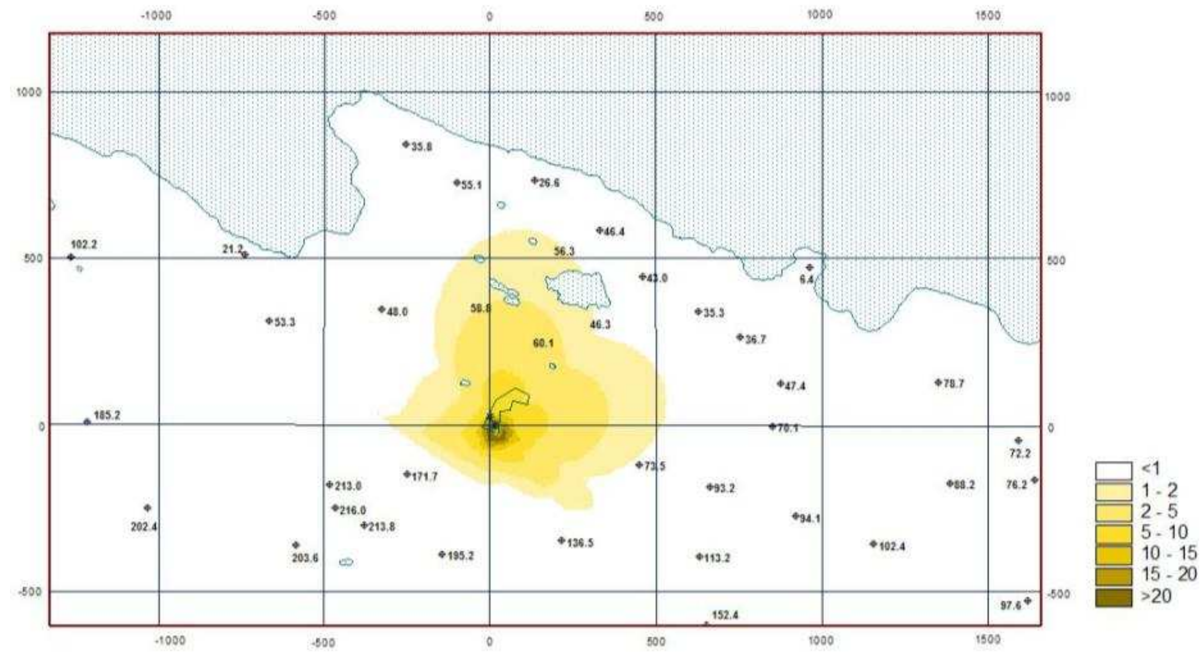

Figure 7 – Distribution of maximum 1-hour PM10 concentrations in atmospheric air from BAS stationary sources operation, µg/m^3. Scenario 2

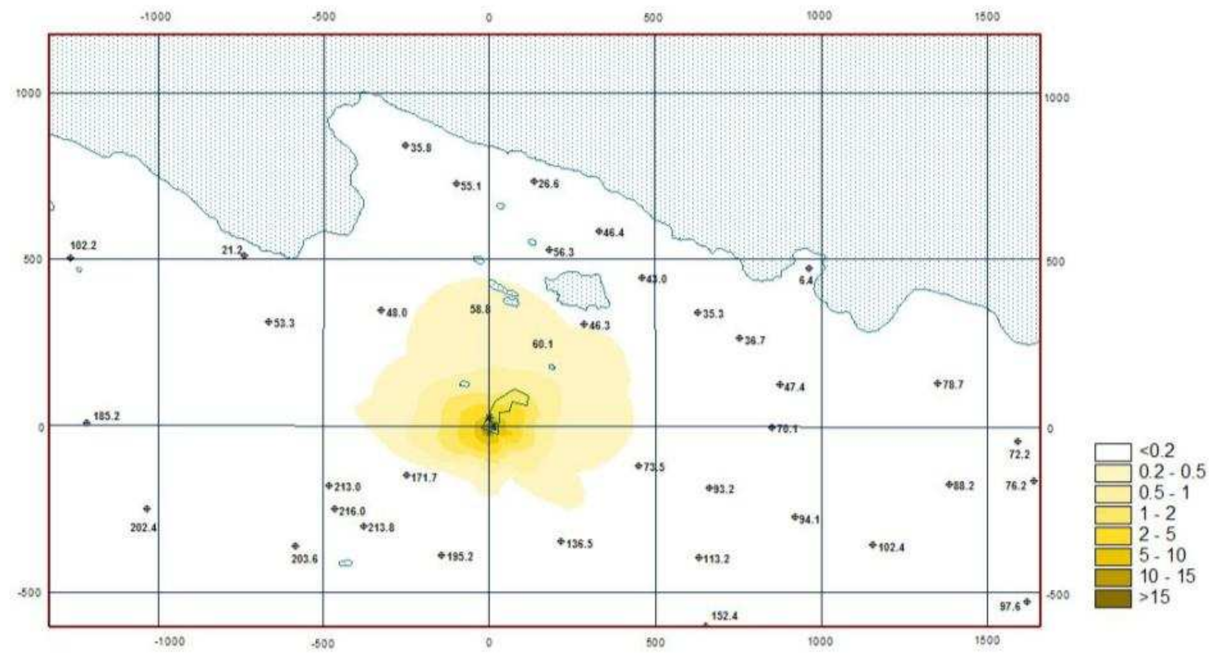

Figure 8 – Distribution of maximum 24-hour PM10 concentrations in atmospheric air from BAS stationary sources operation, µg/m^3. Scenario 2

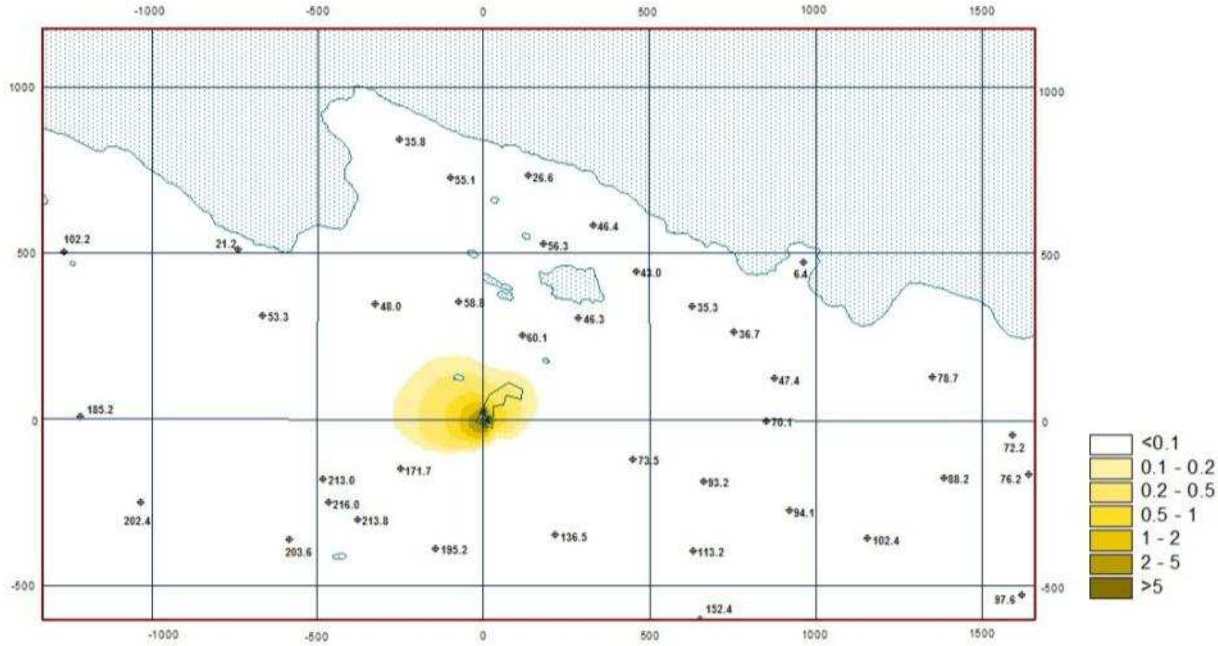

Figure 9 – Distribution of monthly average PM10 concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

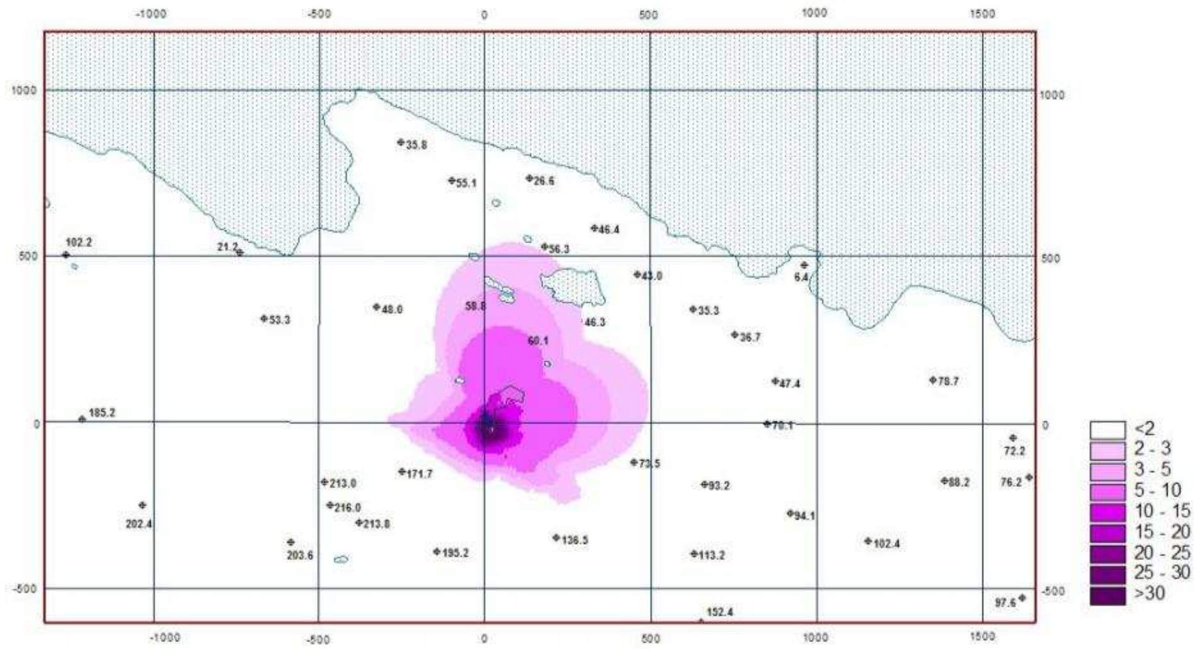

Figure 10 – Distribution of maximum 1-hour sulfur dioxide concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

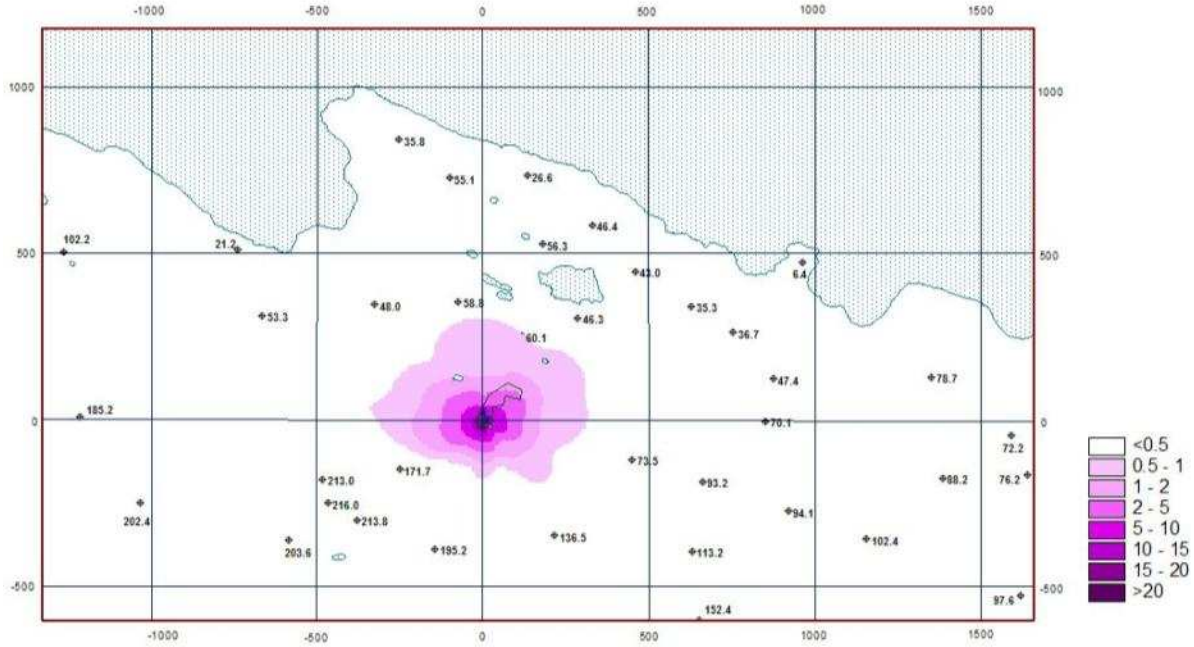

Figure 11 – Distribution of maximum 24-hour sulfur dioxide concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

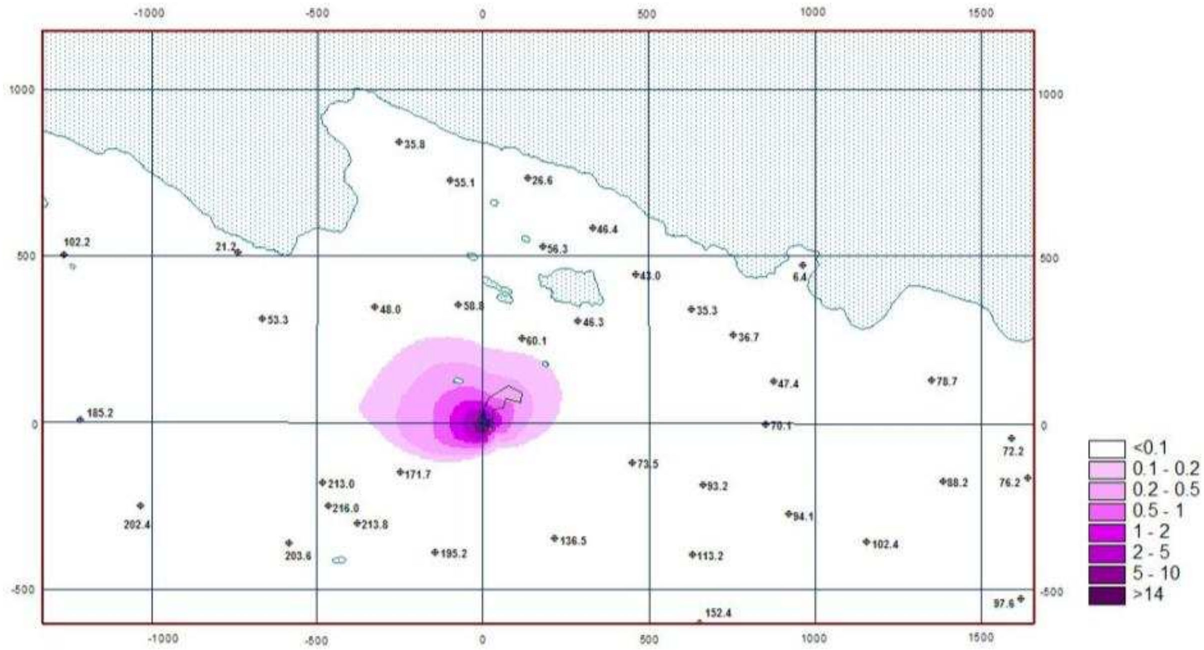

Figure 12 – Distribution of monthly average sulfur dioxide concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

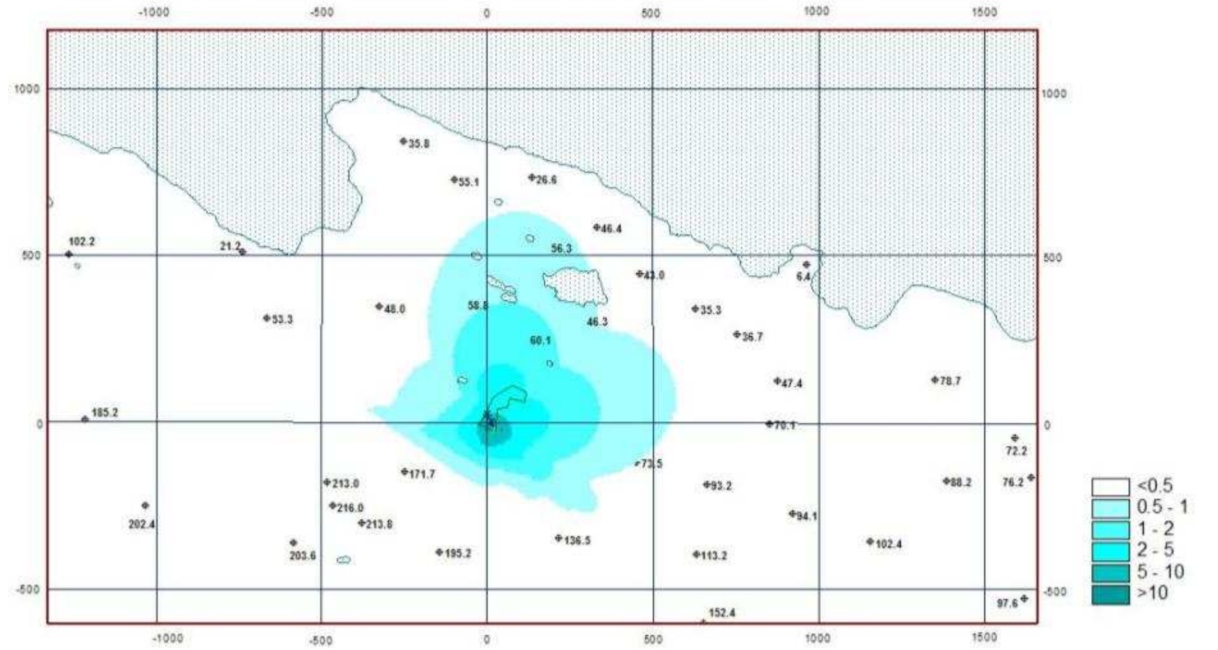

Figure 13 – Distribution of maximum 1-hour hydrocarbon concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

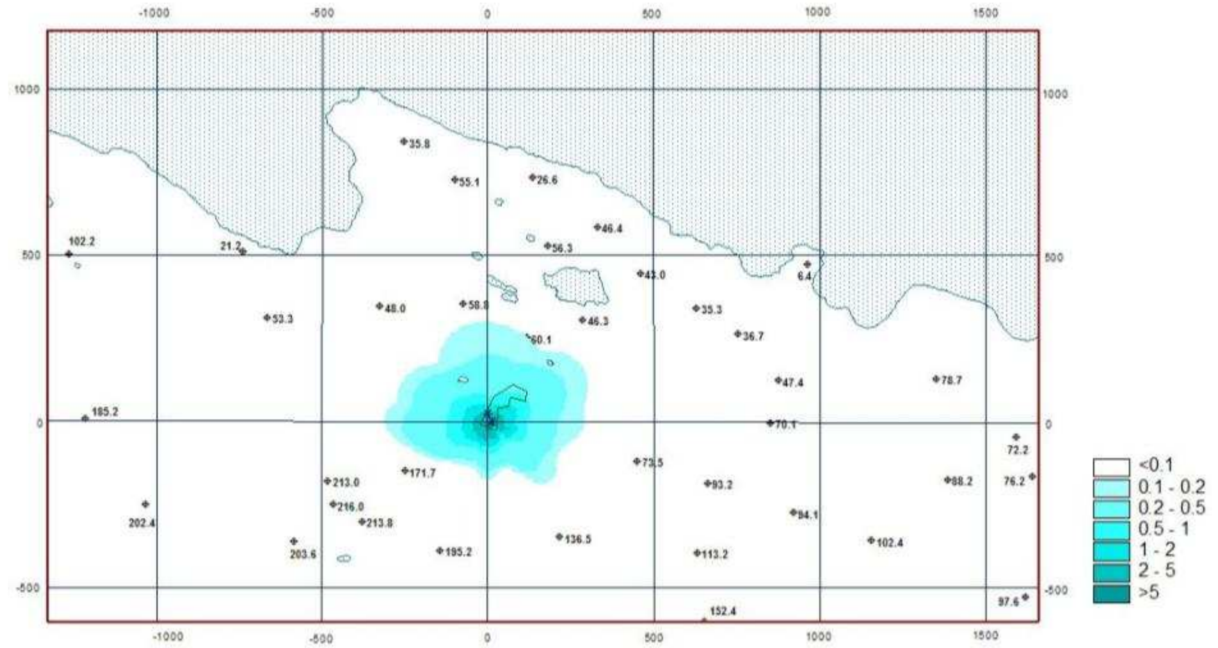

Figure 14 – Distribution of maximum 24-hour hydrocarbon concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2

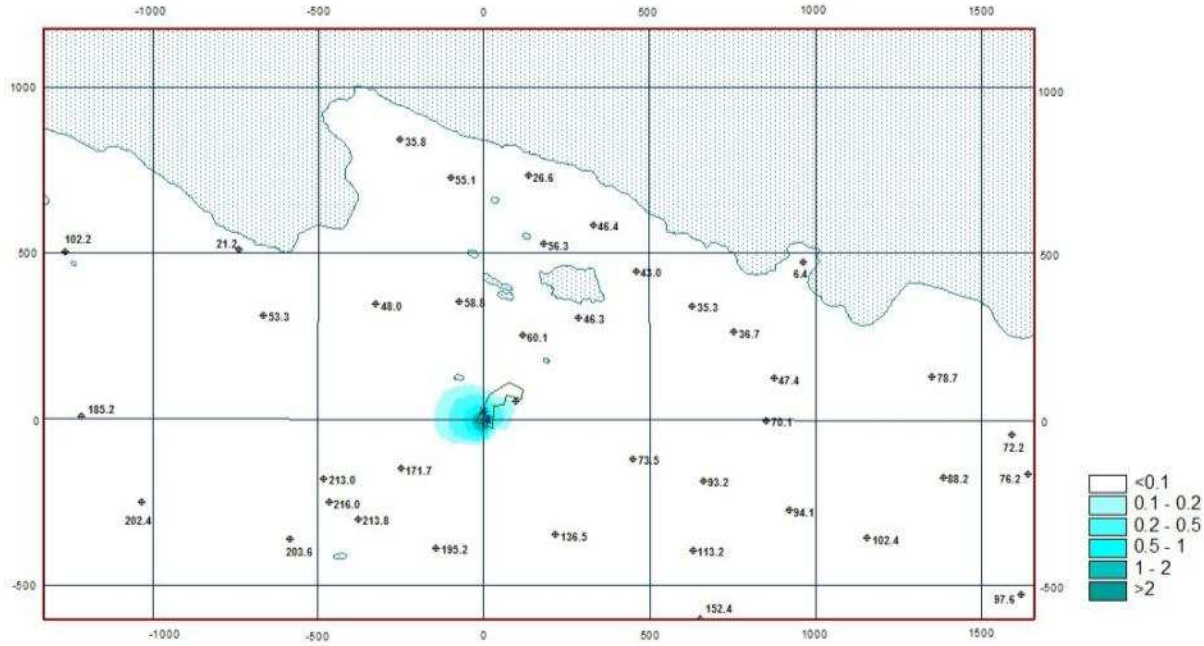

Figure 15 – Distribution of monthly average hydrocarbon concentrations in atmospheric air from BAS stationary sources operation, μg/m^3. Scenario 2