SAKARYA GAS FIELD DEVELOPMENT PROJECT - ESIA

CONTRACT NO: SC26-PRJ-PU-CNT-00179

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

Chapter 7.2. Onshore Physical and Biological Components Impact Assessment

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Table of Contents

TABLES

FIGURES

7.0 IMPACT ASSESSMENT AND MITIGATION

7.2 Onshore Physical and Biological Components

7.2.1 Physical

7.2.1.1 Soil and Subsoil

Based on the information collected for the definition of the baseline (see Chapter 6.2.1.5), the physical component *Soil and Subsoil* was assigned a **Medium** value of sensitivity for the following reasons:

- Limited presence of soil with agricultural potential;
- Presence of some zones with soil potential erosion;
- Limited soil contamination.

Potential impacts to soil and subsoil associated with construction and operation phases of the Project include;

- Removal of soil;
- Minor leakage of contaminants into soil.

The project actions related to the abovementioned impact factors are the following:

- Site levelling and grading;
- General onshore engineering/construction works;
- Plant/infrastructure onshore operation.

7.2.1.1.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting soil and subsoil during construction phase are listed in Table 7-1.

Table 7-1: Project actions and related impact factors potentially affecting soil and subsoil during construction phase

Project actions	Brief description	Impact factors
Site levelling and grading	Soil removal except for small amounts is not planned as part of the construction phase. However, in unexpected situations during the construction phase, soil removal operations can be performed. Reportedly, if excavation material remains, the remaining excavation material will be transported to a licensed excavation material storage/recovery facility.	Removal of Soil
General onshore engineering/construction works	During construction activities, minor leakage of contaminants can cause soil contamination.	Minor Leakage of Contaminants into Soil

Impacts potentially affecting this component are assessed here below for the construction phase.

- **Removal of Soil**

The onshore part of the Project site that is close to the shore has been used as a stockpile area during the construction of Filyos Port before the area was declared as an industrial zone. With the declaration of the site as an industrial zone, the Ministry of Industry and Trade gave the operator company "Preliminary Use Permit" and soil improvement works were started. After the area was declared as special investment zone and EIA Positive Decision was obtained, pre-easement of this land was granted to TPAO and soil improvement works were taken over.

Excess excavation material from the construction of Filyos Port and Industrial Zone is currently stored as stocks inside the Project boundaries. The amount of material is reported to be 1 million m^3 as of June 2022. Some of this material is currently being transported to be used in the soil improvement works of the industrial zone located on the opposite side of the Filyos River and in the ongoing construction works of Filyos Port. Some part of it is being used in the soil improvement works of the Project area. Also, the waste material originating from the bored pile activities in the OPF site is transferred to this stockpile to dry.

The OPF is divided into 3 blocks. Block 2 is designated as temporary storage of minimal amounts of excavation material used for purchased filling material and Block 3 is designated as construction camp area. There is no topsoil present at the OPF area due to industrial zone construction activities and ongoing soil improvement works.

Soil removal except for small amounts in the OPF and energy transmission line is not planned as part of the construction phase. However, in unexpected situations during the construction phase, soil removal operations can be performed. Reportedly, if excavation material remains, the remaining excavation material will be transported to the licensed excavation material storage/recovery facility by subcontractors. Considering that there is no licensed excavation material storage/recovery facility according to Provincial Environmental Status Report of Zonguldak, as explained in Chapter 3.7.1, the Client will identify parcels, for which usage rights will be obtained from the respective right holders as per the requirements of the applicable legislation.

Land preparation activities will eventually generate disturbances that will make the soil surface more vulnerable to wind and/or rain erosion. The quality of natural water receptors may be impacted by surface drainage caused by soil erosion, which may also cause soil particles to be transported to nearby surface water bodies.

- **Minor Leakage of Contaminants into Soil**

Minor leakage of contaminants into soil can be caused by;

- oil and fuel leakage from vehicles and generators;
- accidental spill of any hazardous materials that are used during the construction;
- runoff from area where chemical, oil and fuel are temporarily stored (i.e. areas where paving and secondary containments are not present);
- pollution caused by temporary storage of hazardous materials and/or wastes;

- disposal of wastes, wastewater and liquid wastes;
- flooding of ponds (i.e., settling pond of concrete wastewater) or secondary containments caused by heavy precipitation;
- accidental spill of wastewater (e.g., domestic, hydrotest) to soil.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Removal of Soil**
  - Project-specific Soil Management and Erosion Control Plan will be implemented.
  - To prevent off-site sediment movement, erosion control measures including geotextile filters, drainage channels, settling structures, etc. will be implemented as needed prior to the start of construction operations.
  - Wherever possible, land preparation and construction activities shall be re-scheduled during extreme weather conditions to avoid risk of erosion.
  - Dikes and drainage channels will be established to prevent loss of soil and runoff to water bodies around the excavated material storage areas.
  - Topsoil (if required) and subsoil removal studies will be completed in compliance with the Regulation on Control of Excavated Soil, Construction and Demolition Wastes issued on March 18, 2004 at Official Gazette no: 25406 and other international practices.
  - Topsoil and subsoil loss will be minimized with appropriate equipment, plan, procedure, and schedule. Also, unnecessary soil stripping will not be carried out during construction activities to minimize disturbance to vegetation, ground species and soils.
  - The topsoil (if required) will be carefully removed up to its determined depth and stored at topsoil storage areas to be used for the closure activities.
  - If some construction areas need to be located onto vegetated and uncontaminated land, the topsoil will be temporarily removed and properly stockpiled to be used for landscaping in the stripped areas upon completion of the works as required by the Regulation on Excavation, Construction and Demolition Wastes issued on March 18, 2004 at Official Gazette no.25406.
  - Filling material will be purchased from licensed quarries.
  - Excess excavated material, if any, will be disposed at licensed storage/recycling facilities as required by the Regulation on Excavation, Construction and Demolition Wastes issued on March 18, 2004 at Official Gazette no.25406. In case a licensed facility cannot be found, the Client will identify parcels, for which usage rights will be obtained from the respective right holders as per the requirements of the applicable legislation. Environmental and social assessment studies as per Management of Change Procedure will be implemented during selection and entry to the off-site excavated material storage sites. Criteria such as selecting brownfields, that are not used for agricultural or grazing

purposes and having a sufficient distance to settlement areas and will be considered in the selection of excavated material storage sites.

- **Minor Leakage of Contaminants into Soil**
  - Project-specific Pollution Prevention Plan and Waste Management Plan will be implemented to ensure that the amount of release and spills can be taken under control before reaching substantial amounts that may potentially affect the quality of soil.
  - The areas, where the hazardous materials (chemicals, liquids etc.) storage tanks located (i.e., hazardous material storage areas), will be designed and constructed to avoid potential contamination into the soil (paved areas with sufficient secondary containment, proper drainage systems, storage as per Safety Data Sheet (SDS) requirements etc.). Also, the Project will comply with relevant legal and project safety requirements to avoid leakages from hazardous materials (chemicals, liquids etc.) storage facilities on-site;
  - The temporary waste storage areas will be constructed based on the requirements listed in the Regulation on Waste Management issued on April 02, 2015 Official Gazette no: 29314 and GIIP.
    - The area will be separate from the facilities and buildings, away from human traffic.
    - There will be a suitable space for the licensed vehicles to receive the wastes.
    - Storage area will have all kinds of precautions against possible fires (fire extinguisher, etc.).
    - Hazardous wastes and non-hazardous wastes will be stored separately, having different entrance doors.
    - In order to protect the compartment where hazardous waste will be stored from precipitation, the top and four sides will be covered. The compartments where non-hazardous wastes will also be covered from precipitation.
    - Storage area will be closed, the entrance door will be lockable (kept locked) and the authorized the staff will have the keys.
    - The contact information of the personnel in charge of the waste storage area and warning signs will be posted at the temporary storage areas.
    - Adequate drainage system will be provided to collect any leakages.
    - The floor will be covered with concrete, the edges of the floor will be raised with concrete walls/parapets for hazardous waste compartment.
    - In order for the concrete to be impermeable; cured concrete with a minimum thickness of 25 cm will be applied or the concrete to be used for this purpose will be in C30 (STS) standard. If this condition is not met, impermeability will be ensured by laying a of at least 1 mm between the concrete and the soil floor.
    - Wastes will be stored separately from each other, in tanks and containers. Labels indicating the type of waste will be placed for each type of waste.
    - Removal of wastes will be ensured in appropriate frequencies so that storage capacities at the temporary waste storage areas/storage compartments are not exceeded. Hazardous wastes (except medical waste) will be temporarily stored at the waste storage areas for a maximum duration of 6 months and non-hazardous waste for a maximum duration of one year.

- Industrial Waste Management Plans for all temporary waste storage area established by contractors (including hazardous and non-hazardous waste) will be submitted to the relevant Provincial Directorate of MoEUCC as per the format defined by the MoEUCC.

- Temporary Waste Storage Permit will be obtained from the related Provincial Directorate of MoEUCC for temporary waste storage sites at the site generating hazardous waste of more than 1,000 kg per month.

- Hazardous Materials and Hazardous Waste Compulsory Liability Insurance will be executed as per the relevant provisions of the Regulation on Waste Management for the hazardous waste temporary storage areas/containers regardless of the amount of hazardous waste stored;

- As per the Circular entitled ‘COVID-19 Measures for the Waste Management of Single Use Masks, Gloves and Other Personal Hygiene Materials’;
  - Masks, gloves and other personal hygiene material wastes generated at the offices, dormitories and work sites will be collected separately.
  - Waste bins will be placed at the entrances and exits of the office buildings, dormitories, cafeterias and at common areas across the accommodation facilities and work sites.
  - The waste bins will be labelled explicitly.
  - Waste bags will not be mixed with other wastes and the waste bags will be transported to a designated temporary storage area by securing them in a second bag via tightly closing.
  - The wastes will be kept at designated temporary storage areas out of reach of other people and animals for at least 72 hours and then will be delivered to the municipality to be managed under ‘other’ domestic waste category.
  - The temporary waste storage areas will be kept closed at all times and secured appropriately.
  - The wastes generated in potential site quarantine/isolation units and at the site infirmaries will be managed as ‘medical waste’ and wastes generated from these areas will not be mixed with other wastes.

- Waste reuse/recycling/recovery/disposal agreements with the Municipality and licensed recovery/disposal firms will be executed for the management of hazardous and non-hazardous waste.

- Official waste declarations for all waste generated will be submitted to the online system of MoEUCC, starting from January each year until the March at least.

- Waste storage out of the designated storage areas will be prohibited. Wastes generated in the interim storage areas will be transferred to the temporary storage area;

- Regular maintenance of vehicles and machinery/equipment will be undertaken to ensure that leakages of oil/fuel or any other hazardous material is prevented;

- Impervious (concrete etc.) surfaces will be designated for the refuelling and maintenance of the machinery/vehicles. If it is not possible according to the nature of the Project, all refuelling tankers and all heavy machinery used at the site will have drip trays, and these trays will be placed under the pipe connection points to prevent accidental leakage to the soil during refuelling operations;

- Generators will be equipped with drip trays and to be checked regularly to prevent soil contamination;

- Secondary containments, ponds and drip trays will be checked regularly, especially during extreme weather conditions;
- Portable spill containment and clean-up materials (spill kits) will be made available and easily accessible at the construction site, instructions on how to use spill containment and clean-up materials will be included in the kits;
- Training on spill response, use of containment and clean-up material (spill kits) will be provided to works (including the subcontractor workers);
- In case of a spill/leakage incident on-site, contamination levels will be identified by means of sampling and analyses studies to be conducted by accredited laboratories and the results will be compared with baseline concentrations of the related parameters to plan corrective actions where necessary;
- No wastewater discharges of any type to land will be allowed. Polluted water (if any generated as a result of accidental leakages) will be properly collected or managed to prevent the soil pollution;
- Pumps and transmixers will be washed only at the concrete plants, concrete slurry will not be discharged into environment;
- Septic tanks will have a leakproof report, and necessary measures will be taken to prevent them from deforming in extreme weather conditions;
- Accidental spills and leakages will be managed through implementation of the Emergency Preparedness and Response Plan.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on the soil and subsoil during the construction phase.

Table 7-2: Residual impact assessment matrix for the soil and subsoil during construction phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Removal of Soil	Duration:	Medium-short	Medium-low	Mid term	**Low**	Medium-high	**Negligible**
	Frequency:	Frequent					
	Geo. Extent:	Project footprint					
	Intensity:	Low					
Minor Leakage of	Duration:	Long	Medium	Mid term	**Medium**	Medium	**Low**
	Frequency:	Frequent					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Contaminants into Soil	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment:		**Low**	Rationale:	Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value			

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the Project on the soil and subsoil during the construction and verify the effectiveness of the mitigation measures.

- Periodic site inspections will be carried out to ensure that the planned construction site boundaries are not expanded, erosion control measures are in place;
- Periodic inspections of subcontractors in order to ensure no uncontrolled dumping of excavated material;
- Periodic visual site inspection of stormwater and wastewater drainage networks, in order to verify their integrity and functionality;
- Periodic site inspections will be carried out and reported to identify any possible leakages;
- Periodic site inspections will be carried out in order to identify any possible damage in the hazardous materials storage areas and waste storage areas;
- Trainings on spill response, use of containment and clean-up material for the workers (including the subcontractors' workers) will be recorded;
- Periodic site inspections will be carried out to ensure adequate amount of spill-response material such as spill-kits and metal trays will be present at the site and in each heavy machinery and records will be kept;
- Routine maintenance programme will be set-up and maintenance records will be kept for all vehicles and machinery/equipment;
- Licenses and permits of quarries and excavation material storage/recycling facilities will be recorded;
- Waste management practices of the subcontractors will be monitored by means of document review (e.g. permits, waste recycling/disposal agreements) and visual checks at the work sites.

7.2.1.1.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting soil and subsoil during operation phase are listed in Table 7-3.

Table 7-3: Project actions and related impact factors potentially affecting soil and subsoil during operation phase

Project actions	Brief description	Impact factors
Plant/infrastructure onshore operation	During operation activities, minor leakage of contaminants can cause soil contamination.	Minor Leakage of Contaminants into Soil

- **Minor Leakage of Contaminants into Soil**

Minor leakage of contaminants into soil can be caused by;

- oil and fuel leakage from vehicles and generators;
- accidental spill of any hazardous materials that are used during the operation;
- runoff from area where chemical, oil and fuel are temporarily stored (i.e. areas where paving and secondary containments are not present);
- pollution caused by temporary storage of hazardous materials and/or wastes;
- disposal of wastes, wastewater and liquid wastes;
- flooding of ponds or secondary containments caused by heavy precipitation;
- accidental spill of wastewater (e.g., domestic, industrial) to soil.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Minor Leakage of Contaminants into Soil**
  - Project-specific Pollution Prevention Plan and Waste Management Plan will be implemented to ensure that the amount of release and spills can be taken under control before reaching substantial amounts that may potentially affect the quality of soil.
  - The areas, where the hazardous materials (chemicals, liquids etc.) storage tanks located (i.e., hazardous material storage areas), will be designed and constructed to avoid potential contamination into the soil (paved areas with sufficient secondary containment, proper drainage systems, storage as per Safety Data Sheet (SDS) requirements etc.). Also, the Project will comply with relevant legal and project safety requirements to avoid leakages from hazardous materials (chemicals, liquids etc.) storage facilities on-site;
  - The temporary waste storage areas will be constructed based on the requirements listed in the Regulation on Waste Management issued on April 02, 2015 Official Gazette no: 29314 and GIIP.
    - The area will be separate from the facilities and buildings, away from human traffic.
    - There will be a suitable space for the licensed vehicles to receive the wastes.
    - Storage area will have all kinds of precautions against possible fires (fire extinguisher, etc.).

- Hazardous wastes and non-hazardous wastes will be stored separately, having different entrance doors.
- In order to protect the compartment where hazardous waste will be stored from precipitation, the top and four sides will be covered. The compartments where non-hazardous wastes will also be covered from precipitation.
- Storage area will be closed, the entrance door will be lockable (kept locked) and the authorized the staff will have the keys.
- The contact information of the personnel in charge of the waste storage area and warning signs will be posted at the temporary storage areas.
- Adequate drainage system will be provided to collect any leakages.
- The floor will be covered with concrete, the edges of the floor will be raised with concrete walls/parapets for hazardous waste compartment.
- In order for the concrete to be impermeable; cured concrete with a minimum thickness of 25 cm will be applied or the concrete to be used for this purpose will be in C30 (STS) standard. If this condition is not met, impermeability will be ensured by laying a membrane of at least 1 mm between the concrete and the soil floor.
- Wastes will be stored separately from each other, in tanks and containers. Labels indicating the type of waste will be placed for each type of waste.
- Removal of wastes will be ensured in appropriate frequencies so that storage capacities at the temporary waste storage areas/storage compartments are not exceeded. Hazardous wastes (except medical waste) will be temporarily stored at the waste storage areas for a maximum duration of 6 months and non-hazardous waste for a maximum duration of one year.

- Industrial Waste Management Plans for all temporary waste storage area established by contractors (including hazardous and non-hazardous waste) will be submitted to the relevant Provincial Directorate of MoEUCC as per the format defined by the MoEUCC.

- Temporary Waste Storage Permit will be obtained from the related Provincial Directorate of MoEUCC for temporary waste storage sites at the site generating hazardous waste of more than 1,000 kg per month.

- Hazardous Materials and Hazardous Waste Compulsory Liability Insurance will be executed as per the relevant provisions of the Regulation on Waste Management for the hazardous waste temporary storage areas/containers regardless of the amount of hazardous waste stored;

- As per the Circular entitled ‘COVID-19 Measures for the Waste Management of Single Use Masks, Gloves and Other Personal Hygiene Materials’;
  - Masks, gloves and other personal hygiene material wastes generated at the offices, dormitories and work sites will be collected separately.
  - Waste bins will be placed at the entrances and exits of the office buildings, dormitories, cafeterias and at common areas across the accommodation facilities and work sites.
  - The waste bins will be labelled explicitly.
  - Waste bags will not be mixed with other wastes and the waste bags will be transported to a designated temporary storage area by securing them in a second bag via tightly closing.

  - The wastes will be kept at designated temporary storage areas out of reach of other people and animals for at least 72 hours and then will be delivered to the municipality to be managed under ‘other’ domestic waste category.
  - The temporary waste storage areas will be kept closed at all times and secured appropriately.
  - The wastes generated in potential site quarantine/isolation units and at the site infirmaries will be managed as ‘medical waste’ and wastes generated from these areas will not be mixed with other wastes.

- Waste reuse/recycling/recovery/disposal agreements with the Municipality and licensed recovery/disposal firms will be executed for the management of hazardous and non-hazardous waste.
- Official waste declarations for all waste generated will be submitted to the online system of MoEUCC, starting from January each year until the March at least.
- Waste storage out of the designated storage areas will be prohibited. Wastes generated in the interim storage areas will be transferred to the temporary storage area;
- Regular maintenance of vehicles and machinery/equipment will be undertaken to ensure that leakages of oil/fuel or any other hazardous material is prevented;
- Impervious (concrete etc.) surfaces will be designated for the refuelling and maintenance of the machinery/vehicles. If it is not possible according to the nature of the Project, all refuelling tankers and all heavy machinery used at the facility will have drip trays, and these trays will be placed under the pipe connection points to prevent accidental leakage to the soil during refuelling operations;
- Generators and chemical tanks will be placed in localised bunded & kerbed areas for containment of drainage, spillages and leaks in order to minimise contaminated surface water routed to the Open Drains;
- Secondary containments, ponds and drip trays will be checked regularly, especially during extreme weather conditions;
- Portable spill containment and clean-up materials (spill kits) will be made available and easily accessible at the facility, instructions on how to use spill containment and clean-up materials will be included in the kits;
- Training on spill response, use of containment and clean-up material (spill kits) will be provided to works;
- In case of a spill/leakage incident on-site, contamination levels will be identified by means of sampling and analyses studies to be conducted by accredited laboratories and the results will be compared with baseline concentrations of the related parameters to plan corrective actions where necessary;
- No wastewater discharges of any type to land will be allowed. Polluted water (if any generated as a result of accidental leakages) will be properly collected or managed to prevent the soil pollution;

- Accidental spills and leakages will be managed through implementation of the Emergency Preparedness and Response Plan.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on the soil and subsoil during the operation phase.

Table 7-4: Residual impact assessment matrix for the soil and subsoil during operation phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Minor Leakage of Contaminants into Soil	Duration:	Long	Medium	Mid term	**Medium**	Medium	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment:		**Low**	Rationale:	The possibility of minor leakage of contaminants into soil is the only impact factor identified for such component in the operation phase.			

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the Project on the soil and subsoil during the construction and verify the effectiveness of the mitigation measures.

- Periodic site inspections will be carried out to ensure that the open drains are free of sediments and accumulation of sediments at the sediment traps does not prevent the run-off flow;
- Periodic visual site inspection of stormwater and wastewater drainage networks, in order to verify their integrity and functionality;
- Periodic site inspections will be carried out and reported to identify any possible leakages;
- Periodic site inspections will be carried out in order to identify any possible damage in the hazardous materials storage areas and waste storage areas;
- Trainings on spill response, use of containment and clean-up material for the workers (including the subcontractors' workers) will be recorded;
- Periodic site inspections will be carried out to ensure adequate amount of spill-response material such as spill-kits and metal trays will be present at the site and in each heavy machinery and records will be kept;
- Routine maintenance programme will be set-up and maintenance records will be kept for all vehicles and machinery/equipment.

7.2.1.2 Air Quality

Based on the information collected for the definition of the baseline (see Ch 6.2.1.2), the physical component *Air Quality* was assigned a **Medium-high** value of sensitivity for high NOx, PM10, and PM2,5 concentrations in the **RSA,** and high PM10, PM2.5, SO_2, and O_3 concentrations in the **AoI**. The AoI is considered to be sensitive for the following reasons:

- The close presence of communities, vulnerable targets, and sensitive ecological receptors potentially exposed to air emissions
- Other ongoing projects (under construction and planning stage) around the Project area.

Potential impacts to air quality associated with construction phase of the Project include;

- Emissions of particulate matter due to vegetation clearing, site levelling and grading, material transportation, onshore construction works,
- Gaseous emissions from vehicles and construction equipment during vegetation clearing, site levelling and grading, material transportation, onshore construction works,
- Gaseous emissions from vessels due to offshore excavation (trenching) and sediment storage, and offshore pipeline laying.

Potential impacts to air quality associated with operation phase of the Project include:

- Emissions of gaseous pollutants and/or greenhouse gases from the onshore processing facility.

Impacts potentially affecting this component are assessed in the following sections for the construction phase and operation phase.

7.2.1.2.1 Construction phase

Impact factors

Heavy construction is a source of dust emissions that may have substantial temporary impact on local air quality. Emissions during the construction activities are associated with land clearing, ground excavation, cut and fill operations, and construction of the facility. Dust emissions often vary substantially over different phases of the construction process. In order to obtain more specific results and to be able to comment on the dust control plan for specific process, dust emissions are considered by breaking down the construction process into phases. The impact factors from the Project activities potentially affecting air quality during construction phase are listed in Table 1.

Table 7-5: Project actions and related impact factors potentially affecting air quality during construction phase

Project actions	Brief description	Impact factors
Onshore construction activities (vegetation clearing, site levelling and grading, material	During land preparation dust will occur due to earthworks including excavation, backfilling, grading, equipment movement, material piling, loading and unloading. Dust emissions will occur due to wind	Dust emissions Exhaust emissions from vehicles and

Project actions	Brief description	Impact factors
transportation, stockpiles, batching plant etc.)	erosion from stockpiles. Fugitive dust emissions will be released from batching plant. Exhaust emissions will be released from the construction machinery and trucks during land preparation activities and material transportation.	construction machinery
Offshore excavation (trenching) and sediment storage, offshore pipeline laying	During offshore activities exhaust emissions will be released from the vessels.	Exhaust emissions from vessels

Impacts potentially affecting this component are assessed here below for the construction phase.

- **Onshore construction activities – Dust Emissions**

Dust emissions from land preparation activities are estimated using the emissions factors given in the Annex 12 of the Regulation on Control of Industrial Air Pollution (see below in Table 7-6). Uncontrolled emission factors represent the situations where activities are carried out without taking any mitigation measures. On the other hand, the controlled factors stand for the cases where activities are carried out with measures in place such sprinkling, using closed haulage systems, keeping materials moist, loading and unloading without skidding, etc.

Table 7-6: Emission Factors used in PM_{10} Emission Estimation

Source of emission	Emission factors		Emission Factor Unit
	Uncontrolled Conditions	Controlled Conditions	
Excavation	0.025	0.0125	kg/ton
Loading	0.010	0.005	kg/ton
Unloading	0.010	0.005	kg/ton
Storage	5.8	2.9	kg/ha.day
Transportation (total distance)	0.7	0.35	kg/km-vehicle

Land preparation activities and corresponding dust emissions are calculated based on the following assumptions on cut and fill amounts, bulk density of soil, duration of earth works, size of the area on which activities take place, working hours per day, capacity of each truck, etc. The calculation of dust emissions are presented in the following table. Considering that the project activities will follow the proposed mitigation measures, dust emissions are calculated based on the controlled condition emission factors.

Table 7-7: PM10 Emission Estimation

Dust Emission due to excavation works:	
Excavation amount	100,000 m^3
Bulk density of soil	1.80 ton/m^3
Mass of excavated soil	100,000 m^3 x 1.80 ton/m^3 = 180,000 ton
Duration of earth works	120 days
Daily working time (3 shifts)	16 h/day
Hourly excavation amount	180,000 ton / (120 days x 16 h/day) = 93.75 ton/h
Dust emission due to excavation (under controlled conditions)	93.75 ton/h x 0.0125 kg/ton = **1.17 kg/h**
Dust Emission due to loading excavated soil to trucks:	
Hourly loading amount	93.75 ton/h
Dust emission due to loading (under controlled conditions)	93.75 ton/h x 0.005 kg/ton = **0.47 kg/h**
Dust Emission due to transportation of excavated material:	
Average transport distance within the project area	600 m (one way), 1.2 km (round trip)
Truck carrying capacity	30 tons/vehicle
Frequency of transports	(93.75 ton/h) / (30 ton/vehicle) = 3.13 vehicle / h
Dust emission due to transportation (under controlled conditions)	3.13 vehicle/h x 0.35 kg/km-vehicle x (1.2 km) = 1.31 **kg/h**
Dust Emission due to unloading backfill material:	
Backfilling amount	70,000 m^3
Bulk density of soil	1.80 ton/m^3
Mass of backfilling material	70,000 m^3 x 1.8 ton/m^3 = 126,000 ton
Duration of earth works	90 days

Daily working time (3 shifts)	16 h/day
Hourly backfilling amount	126,000 ton / (90 days x 16 h/day) = 87.5 ton/h
Truck carrying capacity	30 tons/vehicle
Frequency of transports	(87.5 ton/h) / (30 tons/vehicle) = 2.92 vehicle / hour
Dust emission due to unloading of backfill (under controlled conditions)	87.5 ton/h x 0.005 kg/ton = **0.44 kg/h**
Dust Emission due to transportation of filling material:	
Average transport distance within the project area	500 m (one way), 1 km (round trip)
Dust emission due to transportation (under controlled conditions)	2.92 vehicle/h x 0.35 kg/km-vehicle x (1 km) = 1.02 **kg/h**
Dust Emission due to excavated material storage:	
Dust emission due to material storage	2.9 kg/ha.day x (1 day / 24 h)= **1.21 kg/ha.h**

Dust emission due to excavation, loading and unloading are calculated based on the following formula:

$$\text{Dust Emission}\left(\frac{\text{kg}}{\text{h}}\right) = \text{Emission Factor}\left(\frac{\text{kg}}{\text{ton}}\right)\text{x Production Amount}\left(\frac{\text{m}^3}{\text{h}}\right)\text{x Bulk Density of Soil}\left(\frac{\text{ton}}{\text{m}^3}\right)$$

where:

$$\mathit{Production\ Amount}\ (\text{m}^3) = \frac{\text{Excavation/Loading/Unloading Amount}\ (\text{m}^3)}{\text{Duration of works (days)} * \text{Working hours per day (h/day)}}$$

Dust emission due to transportation are calculated based on the following formula:

$$\text{Dust Emission}\left(\frac{\text{kg}}{\text{h}}\right) = \text{Emission Factor}\left(\frac{\text{kg}}{\text{km} - \text{vehicle}}\right)\text{x Distance}\left(\frac{\text{km}}{\text{vehicle}}\right)\text{x Number of vehicles}\left(\frac{\text{vehicle}}{\text{h}}\right)$$

Dust emission from the concrete batching plant is estimated using US EPA emission factors given in Table 7-8 for uncontrolled and controlled conditions. The capacity of the batching plant will be 90 m^3/h. The average material composition of concrete batch is taken as 849 kg coarse aggregate, 648 kg sand, 223 kg cement and 33 kg cement supplement; 75 L of water is added to this solid material to produce 1826 kg of concrete.

The estimated dust emissions are also presented in Table 7-8 for uncontrolled and controlled emission cases. The batching plant will operate 16 hours per day between May 2022 and January 2023.

Table 7-8: PM10 Emissions from Concrete Batching

Sources	PM10 Emission Factor (kg/ton)		PM10 Emissions (g/sec)	
	Uncontrolled	Controlled	Uncontrolled	Controlled
Aggregate transfer	0.0017	-	0.05	-
Sand transfer	0.00051	-	0.01	-
Cement unloading to elevated storage silo	0.24	0.00017	1.76	0.001
Cement supplement unloading to elevated storage silo (pneumatic)	0.65	0.0024	0.70	0.003
Weigh Hopper Loading	0.0013	-	0.07	0.07
Central Mix - Mixer Loading	0.078	0.0028	4.68	0.17
Total Emission			**7.28**	**0.244**

It is known that loading of concrete and fly ash silos is the greatest source of emissions from batching plants. At the batching plant, special dust collector system called SILOTOP, which includes POLYPEAT dust filter, has been involved at each silo for control of dust emissions. The sand and aggregate is moisturized before being fed to the system and the humid weather conditions help keeping them moist. Therefore, emissions calculated for the controlled conditions are taken into consideration.

In the following, dust emissions to occur during construction phase are summarized:

Table 7-9: PM10 Emissions from site activities

Activity	Dust Emissions (under controlled conditions) (kg/h)	Dust Emissions (under controlled conditions) (g/s)	Activity Period
Excavation	1.17	0.325	June-July-August-September
Loading	0.47	0.131	June-July-August-September
Transportation of excavated material to storage site	1.31	0.364	June-July-August-September
Transportation of filling material to the project site	1.02	0.283	August-September-October
Unloading	0.44	0.122	August-September-October
Storage	1.21 kg/ha.h	$3.36x10^{-5}$ g/m^2.s	June-July-August-September
Concrete batching	0.88	0.244	June 2022-January 2023 (16 hours per day)

- **Onshore construction activities – Exhaust Emissions**

During site preparation activities, heavy duty vehicles (i.e., trucks) will be used to transfer excavated earth to the storage site located on the project site. It is assumed that the excavated earth will be transferred to the soil storage site by trucks having 30 tons of capacity. The transfer frequency is calculated as 3.13 vehicles per hour in one direction (refer to Table 7-7). The filling material will be also transferred to the project site with a transfer frequency of 2.92 vehicle per hour.

For estimation of NOx, VOC, CO, PM and SO2 emissions from on road heavy-duty vehicles, emission factors of European Environment Agency (EEA), EMEP/EEA air pollutant emission inventory guidebook are used[1]. It is assumed that all the heavy-duty vehicles have diesel engine. Tier 2 approach, which is based on detailed machinery classification, is used for estimation of the exhaust emissions from the corresponding emission factors presented in Table 7-10.

Table 7-10: ***Tier 2 Emission Factors for Diesel Heavy-Duty Vehicles***

	NOx	VOC	CO	PM
Emission Factors (g/veh-km)	0.507	0.012	0.121	0.0013

Source: European Environment Agency (EEA), EMEP/EEA air pollutant emission inventory guidebook 2019 – Update Oct. 2021, Table 3-21 EFs for diesel heavy-duty vehicles >32tons and having Euro VI technology.

The generic algorithm for calculating emissions from road transport using the Tier 2 methodology is:

$$E_i = \sum \mathrm{N} \times \mathrm{M} \times \mathrm{EF}_i$$

where:

E_i = mass of emissions of pollutant i (g/hour),

N= number of vehicles,

M = total distance driven by vehicles per time [km/veh],

EF_i = average emission factor for pollutant i [g/veh-km],

i = pollutant type.

SO_2 emissions are estimated by assuming that all sulphur in the fuel is transformed completely into SO_2 using the formula below:

$$E_{SO2} = 2 \sum \mathrm{k}_S \times \mathrm{FC}$$

where:

k_S = weight related sulphur content of fuel [kg/kg] (taken as 400 ppm),

FC = fuel consumption [kg] (FC of heavy-duty trucks > 32ton and having Euro IV technology is 251 g/km).

[1] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i

In the following table, a summary of the total emissions calculated for NOx, VOC, CO, PM and SO_2 due to transfer of excavated material to the storage area located 0.6km south in Block II area is shown.

Table 7-11: ***Emissions during transfer of excavated material to the storage area***

Parameters	NO_x	VOC	CO	PM	SO_2
Emissions in kg/h	1.90E-03	4.54E-04	4.88E-06	7.54E-04	1.90E-03
Emissions in g/s	5.29E-04	1.26E-04	1.36E-06	2.10E-04	5.29E-04

By use of the same approach, emissions from the heavy-duty vehicles to be used for transportation of the fill material to the project site is calculated and given in the following table. 2.42km section of the road up to Zonguldak Çaycuma Road connection is considered in emission calculations.

Table 7-12: ***Emissions during transfer of fill material to the project site***

Parameters	NO_x	VOC	CO	PM	SO_2
Emissions in kg/h	7.17E-03	1.70E-04	1.71E-03	1.84E-05	2.84E-03
Emissions in g/s	1.99E-03	4.71E-05	4.75E-04	5.10E-06	7.88E-04

According to the scheduled construction activities, the peak time of the construction activities will be June to September 2022. Emission estimation is based on the construction machinery that will be operating during this period. For estimation of NOx, CO, VOC, SO2 and PM10 emissions from construction equipment, the emission factors given in Table 7-13 were used. It is assumed that all the NRMM will have diesel engine.

Table 7-13: Emission Factors for Diesel Non Road Mobile Machinery

Engine Power (kWh)	NOx (g/kWh)	VOC (g/kWh)	CO (g/kWh)	PM10 (g/kWh)	Fuel Consumption (g/kWh)
P<8	6.08	0.68	4.8	0.4	270
8<=P<19	6.08	0.68	3.96	0.4	270
19<=P<37	3.81	0.42	2.2	0.015	262
37<=P<56	3.81	0.28	2.2	0.015	260
56<=P<75	0.4	0.13	2.2	0.015	260
75<=P<130	0.4	0.13	1.5	0.015	255
130<=P<560	0.4	0.13	1.5	0.015	250
P>560	3.5	0.13	1.5	0.045	250

Source: European Environment Agency (EEA), EMEP/EEA air pollutant emission inventory guidebook 2016 (Update May 2017), Table 3-6[2].

The generic algorithm used for emission calculation is as follows:

$$E_i = \text{Engine Power } [\text{kW}] \times \text{EF}_i \left[\frac{\text{g}}{\text{kWh}}\right] \times \frac{1\ \text{kg}}{10^3 g}$$

[2] https://www.eea.europa.eu/publications/emep-eea-guidebook-2016/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-4-non-road-1

where:

E_i = mass of emissions of pollutant i [kg/h],

EF_i = average emission factor for pollutant i [g/kWh],

i = pollutant type.

SO_2 emissions are estimated by assuming that all sulphur in the fuel is transformed completely into SO_2 using the formula below:

$$E_{SO2} = 2 \sum \mathrm{k}_S \times \mathrm{FC} \times 10^{-3} kg/g$$

where:

E_{SO2} = mass of SO2 emissions [kg/h],

k_S = weight related sulphur content of fuel [kg/kg] (taken as 400 ppm),

FC = fuel consumption [g/kWh].

The machinery type and number, engine powers and associated emissions are given in Table 7-14 for each contractor work area. The peak time of construction machinery operation period is considered to be between June-October 2022.

Table 7-14: Total Engine Power and Emissions for the Construction Machinery

	Number	Power (kW)	NOx (kg/h)	VOC (kg/h)	CO (kg/h)	PM10 (kg/h)	SO2 (kg/h)
SURF- Landfall Construction							
Dozer Cat	1	197	0.0788	0.0256	0.2955	0.0030	0.0394
Dozer Liebherr	1	184	0.0736	0.0239	0.2760	0.0028	0.0368
Excavator	4	178	0.2848	0.0926	1.0680	0.0107	0.1424
Grader	1	136	0.0544	0.0177	0.2040	0.0020	0.0272
HI-UP	1	175	0.0700	0.0228	0.2625	0.0026	0.0350
Side boom	4	175	0.2800	0.0910	1.0500	0.0105	0.1400
Compressor	2	225	0.1800	0.0585	0.6750	0.0068	0.0900
Generator	2	128	0.1024	0.0333	0.3840	0.0038	0.0522
Generator	4	64	0.1024	0.0333	0.5632	0.0038	0.0532
Truck	2	175	0.1400	0.0455	0.5250	0.0053	0.0700
Tractor	1	77	0.0308	0.0100	0.1155	0.0012	0.0157
SURF- Costal Logistics Center							
HI-UP	1	175	0.0700	0.0228	0.2625	0.0026	0.0350
Side boom	4	175	0.2800	0.0910	1.0500	0.0105	0.1400
Generator	2	128	0.1024	0.0333	0.3840	0.0038	0.0522
OPF							
Dump Truck	12	175	0.8400	0.2730	3.1500	0.0315	0.4200

	Number	Power (kW)	NOx (kg/h)	VOC (kg/h)	CO (kg/h)	PM10 (kg/h)	SO2 (kg/h)
Dozer	1	184	0.0736	0.0239	0.2760	0.0028	0.0368
Grader	1	136	0.0544	0.0177	0.2040	0.0020	0.0272
Excavator 40 ton	1	178	0.0712	0.0231	0.2670	0.0027	0.0356
Excavator 30 ton	1	185	0.0740	0.0241	0.2775	0.0028	0.0370
Tracked excavator 20 ton	1	185	0.0740	0.0241	0.2775	0.0028	0.0370
Tire excavator 20 ton	1	185	0.0740	0.0241	0.2775	0.0028	0.0370
Loader- bucket 20 ton	3	185	0.2220	0.0722	0.8325	0.0083	0.1110
Beko-loader	3	92	0.1104	0.0359	0.4140	0.0041	0.0563
Compactor - roller 16 ton	1	110	0.0440	0.0143	0.1650	0.0017	0.0224
Forklift (10 ton and 2,5 ton)	1	30	0.1143	0.0126	0.0660	0.0005	0.0062
Mini excavator (with crusher)	7	17	0.7235	0.0809	0.4712	0.0476	0.0257
Truck low bed	5	120	0.2400	0.0780	0.9000	0.0090	0.1224
Water tanker 18 ton	3	315	0.3780	0.1229	1.4175	0.0142	0.1890
Water truck	1	223	0.0892	0.0290	0.3345	0.0033	0.0446
Fuel tanker	1	243	0.0972	0.0316	0.3645	0.0036	0.0486
Tractor	3	92	0.1104	0.0359	0.4140	0.0041	0.0563
Generator	19	360	2.7360	0.8892	10.2600	0.1026	1.3680
Light Tower	13	6	0.4742	0.0530	0.3744	0.0312	0.0168
Compressor	5	11	0.3344	0.0374	0.2178	0.0220	0.0119
Compactor -cylinder	3	110	0.1320	0.0429	0.4950	0.0050	0.0673
Compactor -plate	2	110	0.0880	0.0286	0.3300	0.0033	0.0449
Transformer Station & Energy Transmission Line							
Excavator	1	210	0.0840	0.0273	0.3150	0.0032	0.0420
Truck	1	211	0.0844	0.0274	0.3165	0.0032	0.0422
Truck	1	170	0.0680	0.0221	0.2550	0.0026	0.0340
Concrete Mixer	2	155	0.1240	0.0403	0.4650	0.0047	0.0620
Crane	2	205	0.1640	0.0533	0.6150	0.0062	0.0820
Generator (all generators except emergency generators)	2	70	0.0560	0.0182	0.3080	0.0021	0.0291
Wire Pulling and Stopper Machine	1	59.8	0.0239	0.0078	0.1316	0.0009	0.0124
Soil Improvement Works							
Bored pile bauer bg 55	1	570	1.9950	0.0741	0.8550	0.0257	0.1140
Bored pile bauer bg 30	1	298	0.1192	0.0387	0.4470	0.0045	0.0596
Bored pile bauer bg 39	1	433	0.1732	0.0563	0.6495	0.0065	0.0866
Bored pile bauer bg 28	1	354	0.1416	0.0460	0.5310	0.0053	0.0708
Bored pile bauer bg 36	1	433	0.1732	0.0563	0.6495	0.0065	0.0866
Bored pile bauer bg 45	1	433	0.1732	0.0563	0.6495	0.0065	0.0866

	Number	Power (kW)	NOx (kg/h)	VOC (kg/h)	CO (kg/h)	PM10 (kg/h)	SO2 (kg/h)
Crawler crane liebher hs 855	1	450	0.1800	0.0585	0.6750	0.0068	0.0900
Crawler crane texer hc 80	1	185	0.0740	0.0241	0.2775	0.0028	0.0370
Crawler crane sany scc600e	1	129	0.0516	0.0168	0.1935	0.0019	0.0263
Crawler crane texer hc 80	1	185	0.0740	0.0241	0.2775	0.0028	0.0370
Crawler crane liebherr lr 1160	1	230	0.0920	0.0299	0.3450	0.0035	0.0460
Crawler crane xcgm xgc85e	1	183	0.0732	0.0238	0.2745	0.0027	0.0366
Crawler crane sennebogen 3300	1	186	0.0744	0.0242	0.2790	0.0028	0.0372
Crawler crane terex hc 80	1	185	0.0740	0.0241	0.2775	0.0028	0.0370
Crawler crane sany scc900e	1	179	0.0716	0.0233	0.2685	0.0027	0.0358
Crawler crane xcmg quy55e	1	158	0.0632	0.0205	0.2370	0.0024	0.0316
Crawler crane sany scc 500e	1	127	0.0508	0.0165	0.1905	0.0019	0.0259
Excavator sany	1	118	0.0472	0.0153	0.1770	0.0018	0.0241
Excavator komatsu	1	110	0.0440	0.0143	0.1650	0.0017	0.0224
Excavator hidromek 220	1	128	0.0512	0.0166	0.1920	0.0019	0.0261
Loader cat	1	433	0.1732	0.0563	0.6495	0.0065	0.0866
Generator	2	150	0.1200	0.0390	0.4500	0.0045	0.0600
Generator	1	360	0.1440	0.0468	0.5400	0.0054	0.0720
Light tower - generator	6	6	0.2189	0.0245	0.1728	0.0144	0.0078
Concrete Batching Plant							
Concrete Mixer	4	20	0.3048	0.0336	0.1760	0.0012	0.0166
Loader	1	183	0.0732	0.0238	0.2745	0.0027	0.0366
Generator	1	150	0.0600	0.0195	0.2250	0.0023	0.0300

Total emissions for each activity group is given in the following tables in kg/h and g/s.

Table 7-15: Total Emissions for the Construction Machinery in kg/h

Activities	NOx (kg/h)	VOC (kg/h)	CO (kg/h)	PM10(kg/h)	SO2 (kg/h)
SURF- Landfall	1.3972	0.4541	5.4187	0.0524	0.7020
SURF- Costal Logistics Center	0.4524	0.1470	1.6965	0.0170	0.2272
OPF	7.1548	1.9744	21.7859	0.3079	2.822
Transformer Station & Energy Transmission Line	0.6043	0.1964	2.4061	0.0227	0.3038
Soil Improvement Works	4.4527	0.8263	9.4233	0.1243	1.2436
Concrete Batching Plant	0.4380	0.0769	0.6755	0.0062	0.0832

Table 7-16: Total Emissions for the Construction Machinery in g/s

Activities	NOx (g/s)	VOC (g/s)	CO (g/s)	PM10 (g/s)	SO2 (g/s)
SURF- Landfall	0.3881	0.1261	1.5052	0.0146	0.1950
SURF- Costal Logistics Center	0.1257	0.0408	0.4713	0.0047	0.0631
OPF	1.9874	0.5484	6.0516	0.0855	0.7839
Transformer Station & Energy Transmission Line	0.1679	0.0546	0.6684	0.0063	0.0844
Soil Improvement Works	1.2369	0.2295	2.6176	0.0345	0.3454
Concrete Batching Plant	0.1217	0.0214	0.1876	0.0017	0.0231

- **Offshore excavation (trenching) and sediment storage and offshore pipeline laying**

During excavation (trenching) and sediment storage and offshore pipeline laying, exhaust emissions will be released from the vessels. The emissions produced by vessels are a consequence of combusting the fuel in an internal combustion (marine) engine. Consequently, the principal pollutants from internal combustion engines will be NOx, CO, VOC, SO2 and PM.

The emissions from the vessels, which will be active at coastal transition section (to operate within 30km to the coast), will be of concern for the identified receptor network. Therefore, the vessel emissions at the coastal transition section is estimated below. The vessels will be mostly active during the period between April-October 2022. The vessel types and number, engine power, fuel type and activity duration are presented in Table 7-17.

Table 7-17: Total Engine Power and Emissions for the Construction Machinery

Vessel No	Vessel Type	Vessel number	Activity duration (days)	Engine Power (kW)	Fuel Type
1	Near shore dredging to a depth of approximately 30m and post-installation backfilling prior to the commencement of pipe and umbilical laying activities.	1	30	4336	HFO
2	Near shore dredging to a depth of approximately 30m and post-installation backfilling prior to the commencement of pipe and cord laying activities.	1	30	23848	HFO
3	Pre-/post-installation surveys, survey and monitoring activities during installation and seafloor intervention	1	60	1000	Diesel
4	Pipeline barge near the shore for towing the pipe to shore and then laying the gas pipeline and MEG pipeline to a depth of approximately 30 meters	1	60	6900	HFO
5	Anchorage of pipe-laying vessel	3	60	7360	HFO

Vessel No	Vessel Type	Vessel number	Activity duration (days)	Engine Power (kW)	Fuel Type
6	Laying cordon in shallow water and then laying cordon up to 30km open (water depth approx 1900m)	1	210	36610	HFO
7	Laying cordon in shallow water and then laying cordon up to 30km open (water depth approx 1900m)	1	210	2 x 3360	HFO
8	Waste Collection Vessel	1	4	123	Diesel
9	Waste Collection Vessel	1	5	298	Diesel

The EMEP/EEA air pollutant emission inventory guidebook, Chapter 1.A.3.d Navigation[3] is used for estimation of vessel emissions. The emission factors used in emission calculations is given in **Table 7-18** and the Tier-1 emission calculation approach is given below:

$$\mathrm{E}_i = \sum_m (FC_m x \; EF_{i,m})$$

where:

E_i = emission of pollutant i in kg

FC_m = mass of fuel type (tonnes)

EF_i = fuel consumption specific emission factor of pollutant i and fuel type m (kg/tonne)

m = fuel type (bunker fuel oil, marine diesel oil, marine gas oil, LNG, gasoline).

Table 7-18: Tier-1 Emission Factors for ships using bunker fuel oil (BFO) and marine diesel oil / marine gas oil (MDO/MGO)

Fuel Type	Emission Factors (kg/ton fuel)				
	NO_x	CO	VOC	SO_2	PM_{10}
BFO	69.1	3.67	1.67	19.2	5.2
MDO/MGO	72.2	3.84	1.75	1.82	1.07

Based on the average vessel fuel consumption of 134 g/kWh[4], the vessel emissions are calculated as given in Table 7-19. It should be noted that these vessels will be operating within 30 km from the coastline and will be active at different time periods between April-October 2022. The following table presents the emissions

[3] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-d-navigation

[4] Minister of Transport, Maritime Affairs and Communication, http://atlantis.udhb.gov.tr/OTV2/Docs/s44.pdf

calculated for the vessels within 30 km from the coastline. The vessel emissions within 4 km from the coastline was considered in the model to estimate its potential impacts on the land receptors.

Table 7-19: Estimated Emissions for the Vessels to be active at Coastal Crossing Section

Vessel Type	Fuel Consumption (ton fuel / h)	NO_x (kg/h)	CO (kg/h)	VOC (kg/h)	SO_2 (kg/h)	PM_{10} (kg/h)
Near shore dredging to a depth of approximately 30m and post-installation backfilling prior to the commencement of pipe and umbilical laying activities.	0.58	40.15	2.13	0.97	11.16	3.02
Near shore dredging to a depth of approximately 30m and post-installation backfilling prior to the commencement of pipe and cord laying activities.	3.20	220.82	11.73	5.34	61.36	16.62
Pre-/post-installation surveys, survey and monitoring activities during installation and seafloor intervention	0.13	9.26	0.49	0.22	2.57	0.70
Pipeline barge near the shore for towing the pipe to shore and then laying the gas pipeline and MEG pipeline to a depth of approximately 30 meters	0.92	63.89	3.39	1.54	17.75	4.81
Anchorage of pipe-laying vessel	2.96	204.45	10.86	4.94	56.81	15.39
Laying cordon in shallow water and then laying cordon up to 30km open (water depth approx 1900m)	4.91	338.99	18.00	8.19	94.19	25.51
Laying cordon in shallow water and then laying cordon up to 30km open (water depth approx 1900m)	0.90	62.22	3.30	1.50	17.29	4.68
Waste Collection Vessel	0.02	1.14	0.06	0.03	0.32	0.09
Waste Collection Vessel	0.04	2.76	0.15	0.07	0.77	0.21

In order to assess the potential impact of the construction phase activities on the baseline air quality, air dispersion modelling study has been conducted. The methodological approach used for assessment of the air quality impacts is summarized here below.

Methodological Approach for Air Quality Modelling

The United States Environmental Protection Agency (US EPA) regulatory dispersion model AERMOD (American Meteorological Society/Environmental Protection Agency Regulatory Model) (BREEZE AERMOD v9.1.0.18) has been used for this study. AERMOD is one of the US EPA preferred dispersion models for near-field dispersion of emissions for distances up to 50 km. For a wide range of regulatory applications in all types of terrain, and for aerodynamic building downwash, the required model is AERMOD. The AERMOD regulatory modelling system consists of the AERMOD dispersion model, the AERMET meteorological processor, and the

AERMAP terrain processor. AERMOD is a steady-state Gaussian plume model applicable to directly emitted air pollutants that employs best state-of-practice parameterizations for characterizing the meteorological influences and dispersion. The AERMOD modelling system has been extensively evaluated across a wide range of scenarios based on numerous field studies, including tall stacks in flat and complex terrain settings, sources subject to building downwash influences, and low-level non-buoyant sources. [5]

AERMOD can model the dispersion of pollutants over various complex and flat terrains. AERMOD considers surface and elevated releases, and multiple sources including, point, area and volume sources to determine pollutant concentrations at specified receptor points. AERMOD estimates the concentration of pollutants at specified ground-level receptors surrounding an emissions source. AERMOD model can calculate both short-term and long-term averages for any user-defined period. The model forecasts dispersion of the pollutants in the atmosphere, through mathematical formulations[6] which take into account the i) hourly meteorological data (for at least one-year period), ii) local terrain and receptor network, and iii) emission source data, which are described below in detail.

i) <u>Meteorological Data</u>

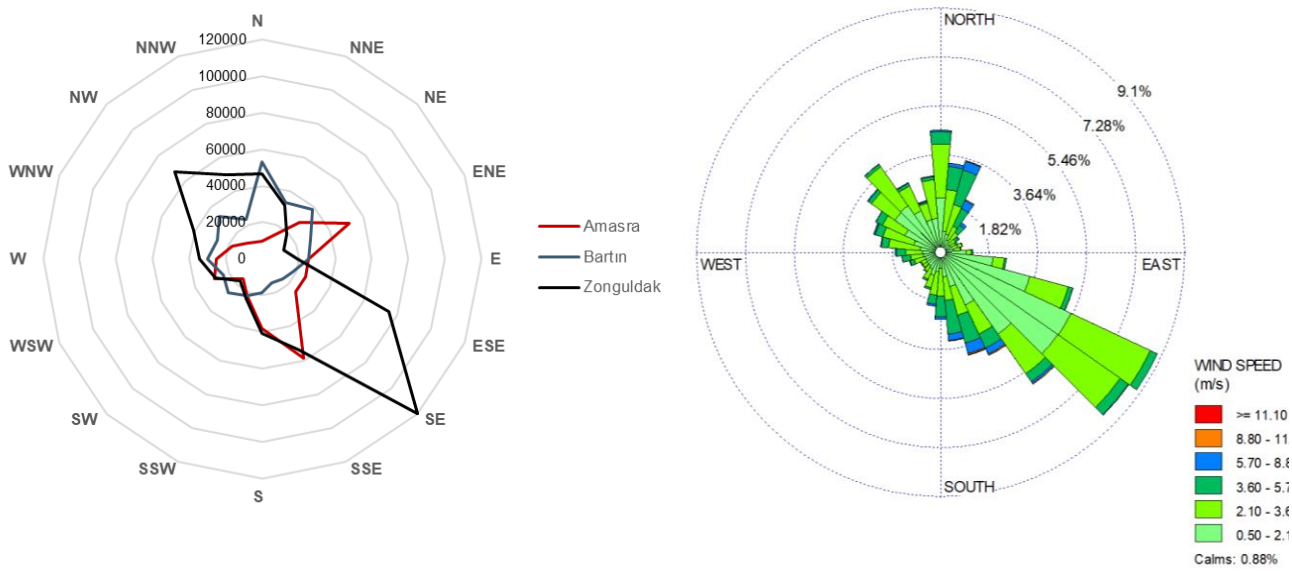
AERMOD model uses “hourly meteorological” data to define rising of the pollutant cloud, movement and accumulation. AERMET, the meteorological pre-processor of AERMOD model, requires two types of meteorological data inputs: hourly surface observations and twice-daily upper air soundings.

For this study, AERMOD-ready meteorological data procured from Trinity Consultants-BREEZE for the year 2019 for Zonguldak - Çaycuma Airport Station, which is the closest station to the Project area (located about 8km south); hence well representing the meteorological conditions at the study area. The model year was selected as 2019 for two reasons; i) the station has good quality data for 2019 (data missing rate was higher for the following two years), ii) 2019 year’s meteorological data is compatible with the long term wind profile for Zonguldak Meteorological Station as can be seen from the following figure.

The frequency distributions of dominant wind directions are shown in Figure 1. The dominant wind direction for the region is North-North-East (NNE) with a frequency of 21.3%. Second and third most frequent wind directions are North (N) with 10.9% frequency and North-East (NE) with 10.3% frequency.

[5] https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf

[6] https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models



a) Wind rose for Amasra, Bartın, and Zonguldak Meteorological Stations (based on long term averages)

b) Wind rose for Zonguldak-Caycuma Airport Meteorological Station (based on 2019 wind data)

Figure 7-1: Wind Rose Diagram

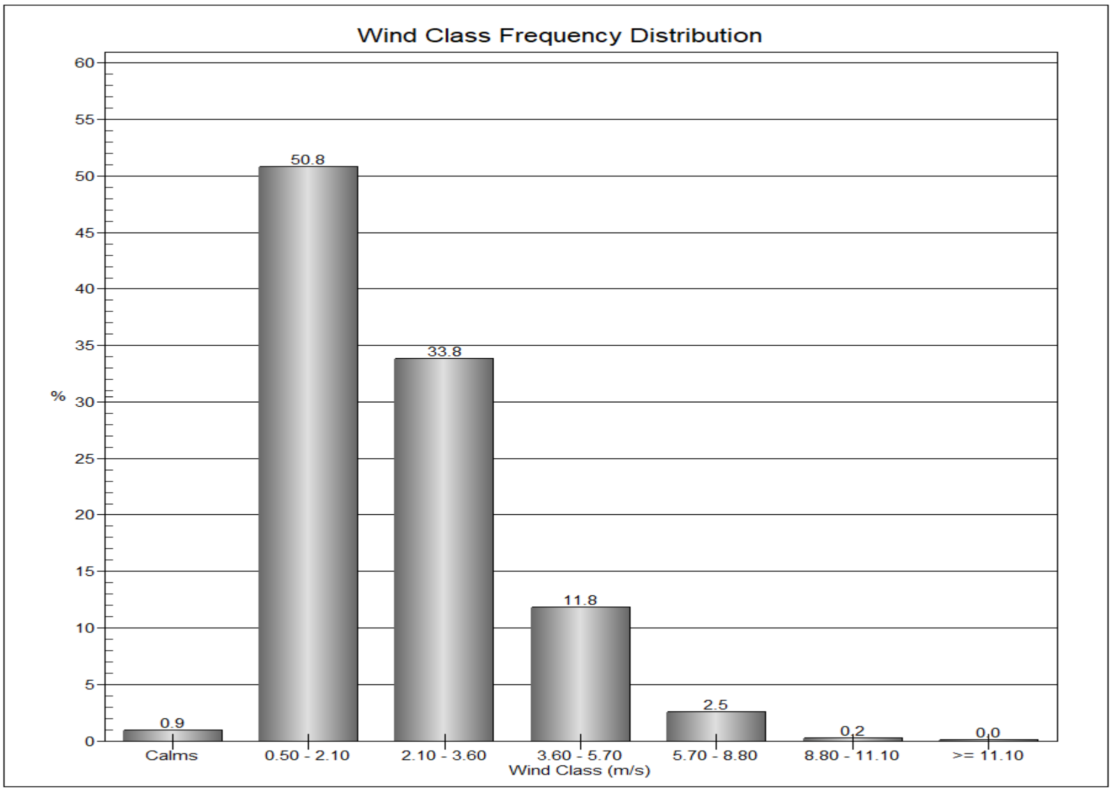


Figure 7-2: Wind Class Frequency Distribution

ii) Local Terrain and Receptor Network

In reference to Section 5, where the area of interest (AoI) has been defined as “5,000 m buffer zone from center of the project area to each direction”, the study area has been set to cover an area of 12 km x 12 km as can be seen in Figure 7-3. The study area covers the nearest settlements and the baseline air quality measurement stations.

The following grid spacing is accounted for the construction phase:

- 250 m spacing from center to 3,000 m
- 500 m spacing from 3000 m to 5,500 m.

In addition to these cartesian grid receptors, the baseline air quality measurement locations have been included in the modelling study as sensitive receptors.

The base elevations for the terrain has been obtained from digital elevation map (DEM) file for the region by running AERMAP processor of AERMOD. The output of AERMAP showing the terrain elevations can be seen in Figure 7-4.

iii) Emission Sources and Characteristics

The construction phase emissions that are estimated in the previous sections were entered in the model. The locations of the emission sources can be seen in Figure 7-5.

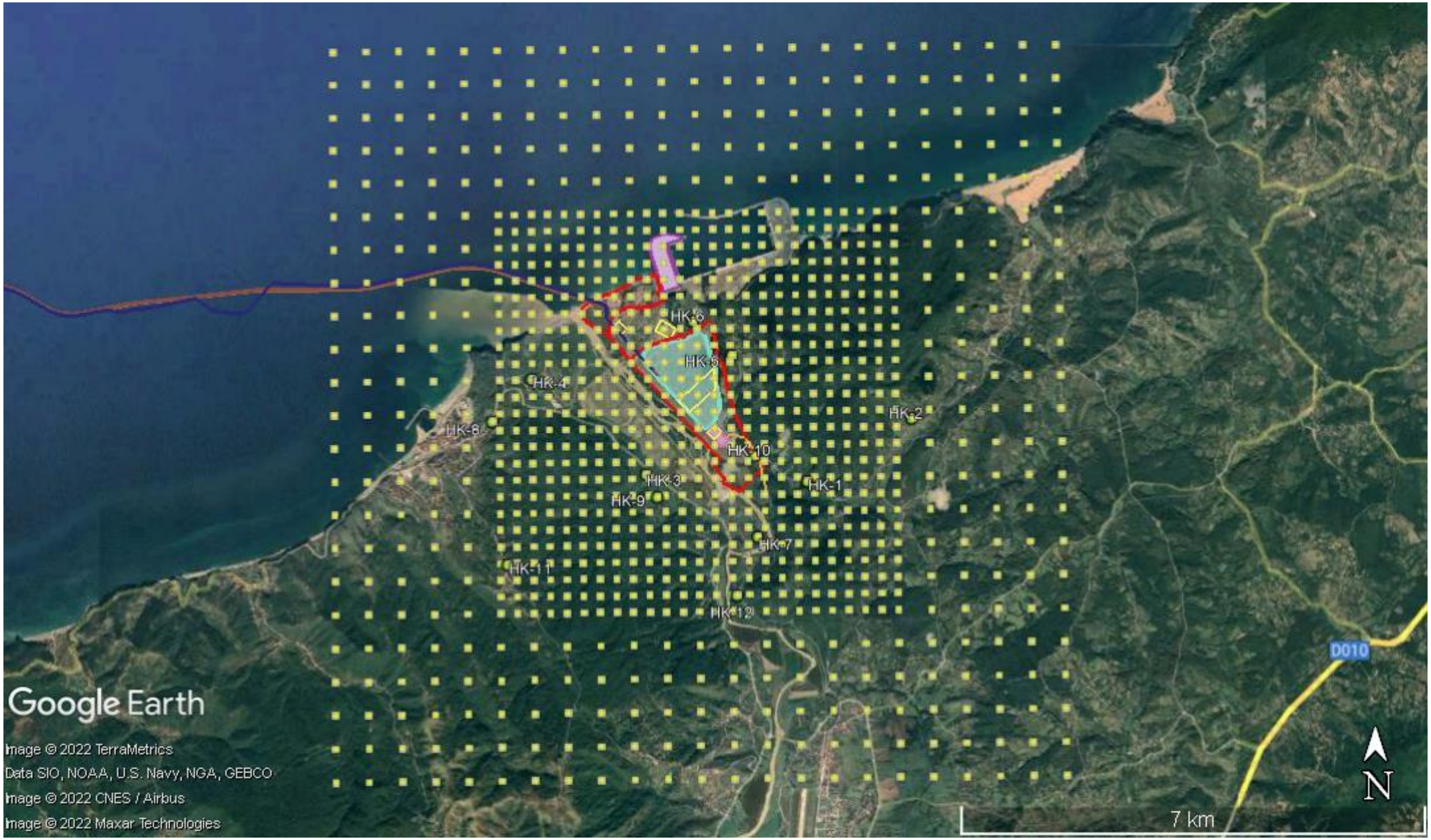


Figure 7-3: Model Domain and the Receptor Grids for Construction Phase

Figure 7-4: Terrain Elevations

Figure 7-5: Emission Sources considered for the Construction Phase Air Quality Modelling

The emissions sources were simulated as follows:

- Storage area was simulated as an area source,

- Site preparation and land grading (excavation and filling) and ground reinforcement activities were simulated as single volume sources,
- Batching plant was simulated as a single volume source,
- Activities at the transformer station was simulated as a single volume source,
- Transfer of excavated material to the storage area was simulated as roadway source,
- Transfer of filling material to the project site was simulated as roadway source, and
- Coastal Transition Vessels were simulated as a series of alternating volume sources.

Since the emissions will not be active throughout the year, variable emission rates were used for the sources depending on their activity period. The model was run only for 1 hour, 8 hours and/or 24 hours averaging periods in line with the averaging periods defined by the applicable limits.

The results are presented in the following tables and figures. The tables present the model calculated ground level concentrations (GLCs) for each receptor and the background concentration for that location. Total pollution value is also presented by summing up the model result with the background concentration for each receptor. For this calculation, the maximum of the measured concentrations was considered to account for the worst case scenario. Total pollution values exceeding the standards are coloured in red. On the other hand, the figures present only the GLCs calculated by the model, and do not include the background concentrations.

Model Results for NO_2

As can be seen from Table 7-20, the highest 1-hour average GLC values for NO_2 are in line with the project standard. The total pollution value for HK-6 (located in the North of the OPF site) and HK-7 (located in the South of the OPF site) are slightly above the project standard of 200 µg/m^3. The total pollution values calculated using the 6th highest 1-hour average GLC values align with the standard.

Figure 7-6 and Figure 7-7 present the contour plots for the 1st and 6th highest GLC values, respectively. As seen from the plots, the NO_2 concentrations would be higher along the route of vessels. Based on Figure 7-7, NO_2 concentration at most sensitive receptors -due to project activities- will be within the 50-100 µg/m^3 range.

Table 7-20: 1st Highest GLC for NO_2 during Construction Phase

Receptor	Easting (m)	Northing (m)	Elev. (m)	Approximate distance from the source (m)	Averaging Period	Model Results (µg/m^3)*	Background Concentration (µg/m^3)*			Total Pollution Value (µg/m^3)	Project Standard (µg/m^3)
							1st	2nd	3rd		
HK-1	424155	4600940	24	1350	1-hour	159.8	10.8	7.25	21.1	180.9	200 (1-hour average)
HK-2	425744	4601871	58	2830	1-hour	92.1	6.85	1.38	8.3	100.4	
HK-3	421717	4601068	7	1100	1-hour	169.3	11.2	20.1	8.9	189.4	
HK-4	419996	4602522	17	1700	1-hour	178.0	11.3	7.89	10.2	189.3	
HK-5	423029	4602850	56	300	1-hour	119.9	10.1	8.18	10.9	130.8	
HK-6	422449	4603370	25	300	1-hour	186.0	7.24	15.6	21.2	207.2	
HK-7	423394	4600118	10	1470	1-hour	187.4	11.3	13.1	16.9	204.3	
HK-8	419395	4601886	47	2470	1-hour	115.1	8.03	17.4	12.2	132.5	

Receptor	Easting (m)	Northing (m)	Elev. (m)	Approximate distance from the source (m)	Averaging Period	Model Results (µg/m³)*	Background Concentration (µg/m³)*			Total Pollution Value (µg/m³)	Project Standard (µg/m³)
							1st	2nd	3rd		
HK-9	421883	4600727	16	1250	1-hour	162.8	6.59	8.33	10.2	173.0	
HK-10	423367	4601334	14	450	1-hour	157.0	11.0	7.25	12.8	169.8	
HK-11	419615	4599735	261	3580	1-hour	99.8	7.57	5.65	7.5	107.3	
HK-12	423072	4599243	10	2250	1-hour	146.8	13.0	10.5	13.4	160.2	

* Maximum of the measured background concentrations is considered in calculating the total pollution value.

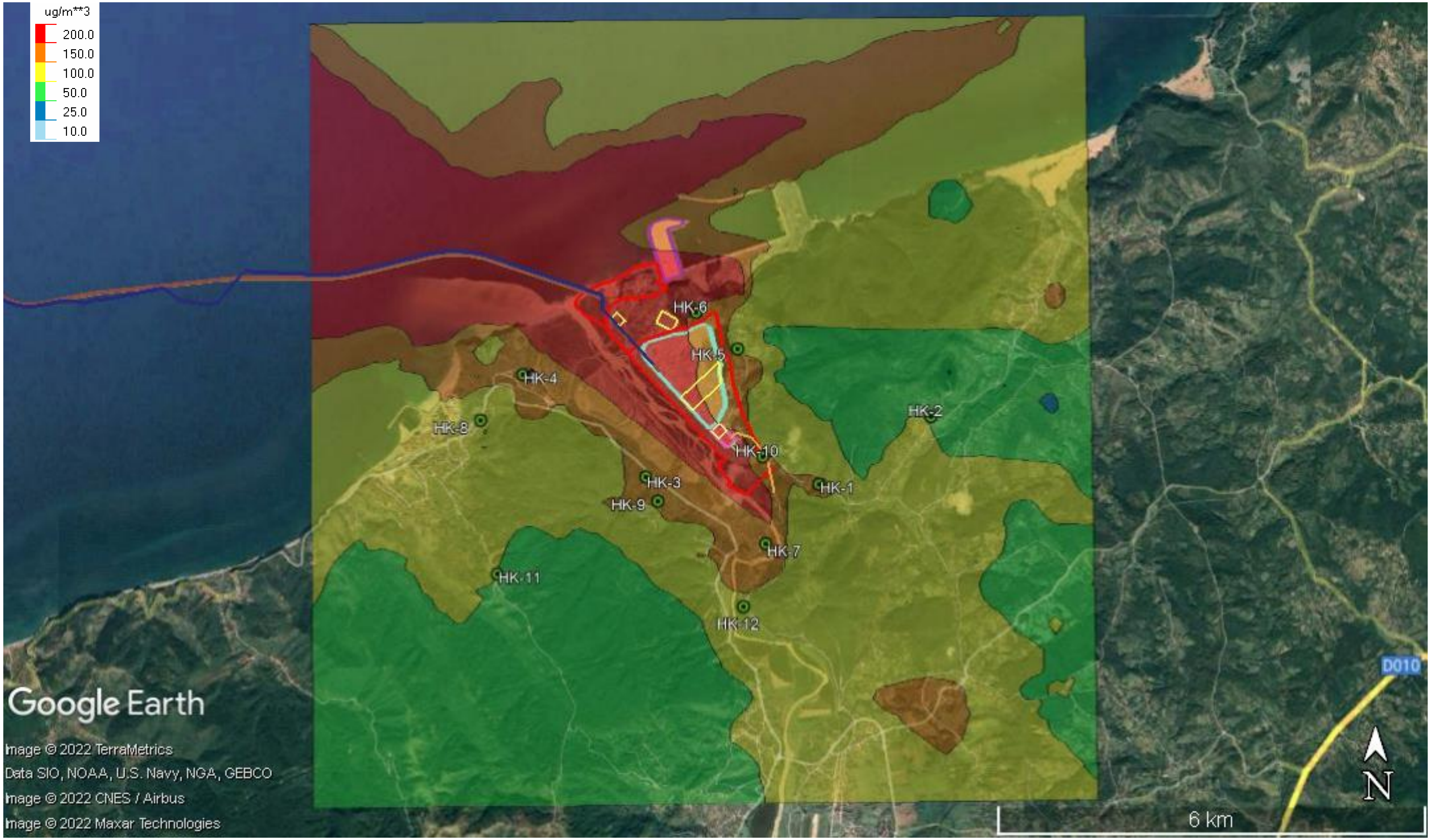


Figure 7-6: 1st Highest 1-Hour Average GLC for NO_2 (μg/m^3)

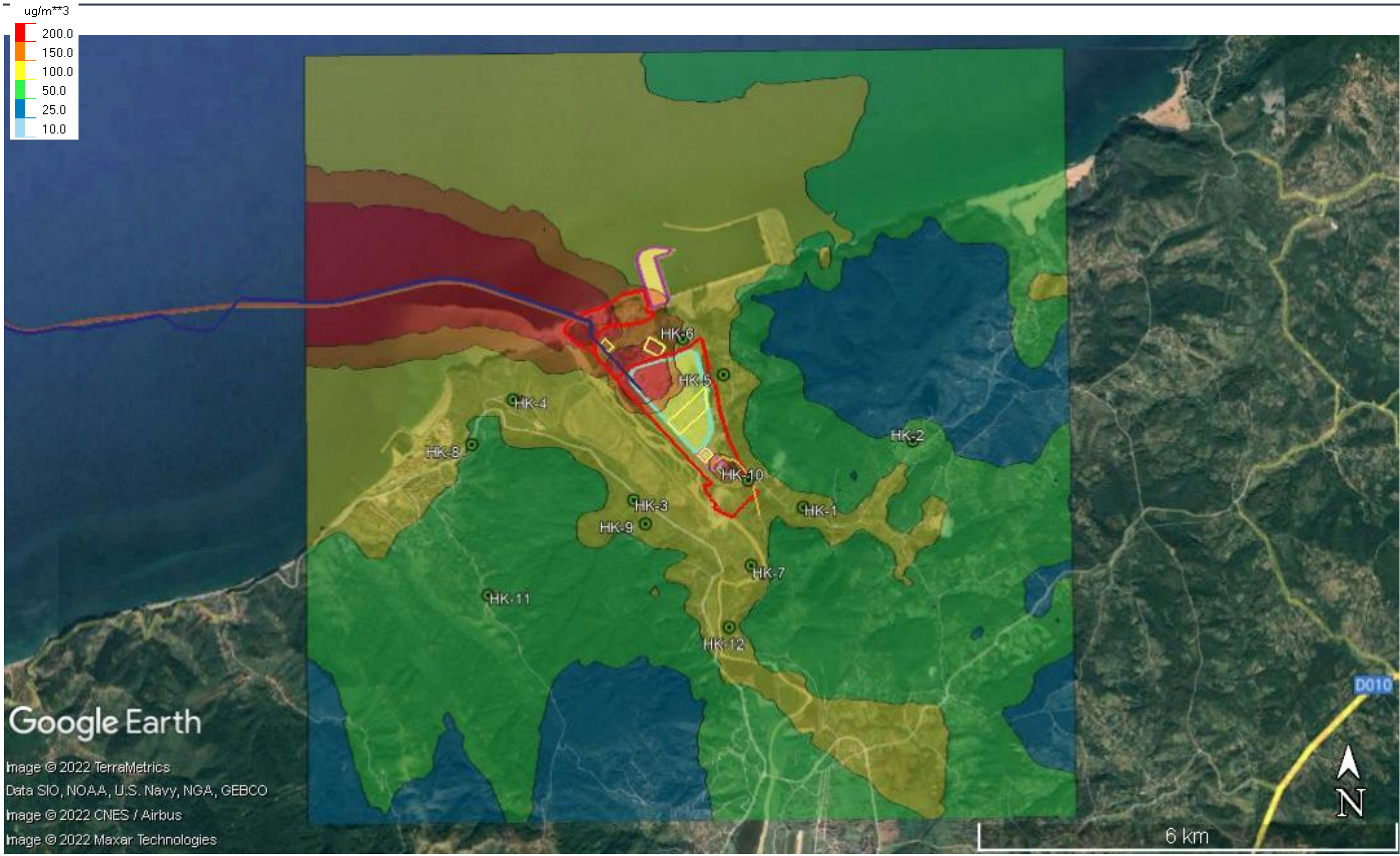


Figure 7-7: 6th Highest 1-Hour Average GLC for NO_2 (µg/m^3)

Model Results for CO

As can be seen from Table 7-21, the highest 8-hours average GLC values for CO are well below the project standard of 10 mg/m^3. The total pollution values calculated using the 1st highest 8-hours average GLC values also align with the standard. Figure 7-8 presents the contour plot for CO. As seen from the plot, the CO concentrations due to project activities are higher within the project site and are less than 100 µg/m^3 at most of the sensitive receptors.

Table 7-21: 1st Highest 8-Hours Average GLC for CO during Construction Phase

Receptor	Easting (m)	Northing (m)	Elev. (m)	Approximate distance from the source (m)	Averaging Period	Model Results (µg/m^3)	Background Concentration (µg/m^3)*	Total Pollution Value (µg/m^3)	Project Standard (µg/m^3)
HK-1	424155	4600940	24	1350	8-hours	44.8	0.6	45.4	10,000 (8-hours average)
HK-2	425744	4601871	58	2830	8-hours	10.8	0.4	11.2	
HK-3	421717	4601068	7	1100	8-hours	71.9	1.7	73.6	
HK-4	419996	4602522	17	1700	8-hours	80.6	2.1	82.7	
HK-5	423029	4602850	56	300	8-hours	27.3	3.3	30.6	
HK-6	422449	4603370	25	300	8-hours	175.2	3.4	178.6	
HK-7	423394	4600118	10	1470	8-hours	28.2	1.9	30.1	
HK-8	419395	4601886	47	2470	8-hours	32.4	1.8	34.2	
HK-9	421883	4600727	16	1250	8-hours	69.1	2.1	71.2	
HK-10	423367	4601334	14	450	8-hours	66.9	0.5	67.4	
HK-11	419615	4599735	261	3580	8-hours	6.8	1.9	8.7	
HK-12	423072	4599243	10	2250	8-hours	35.9	0.5	36.4	

* Maximum of the measured background concentrations is considered in calculating the total pollution value.

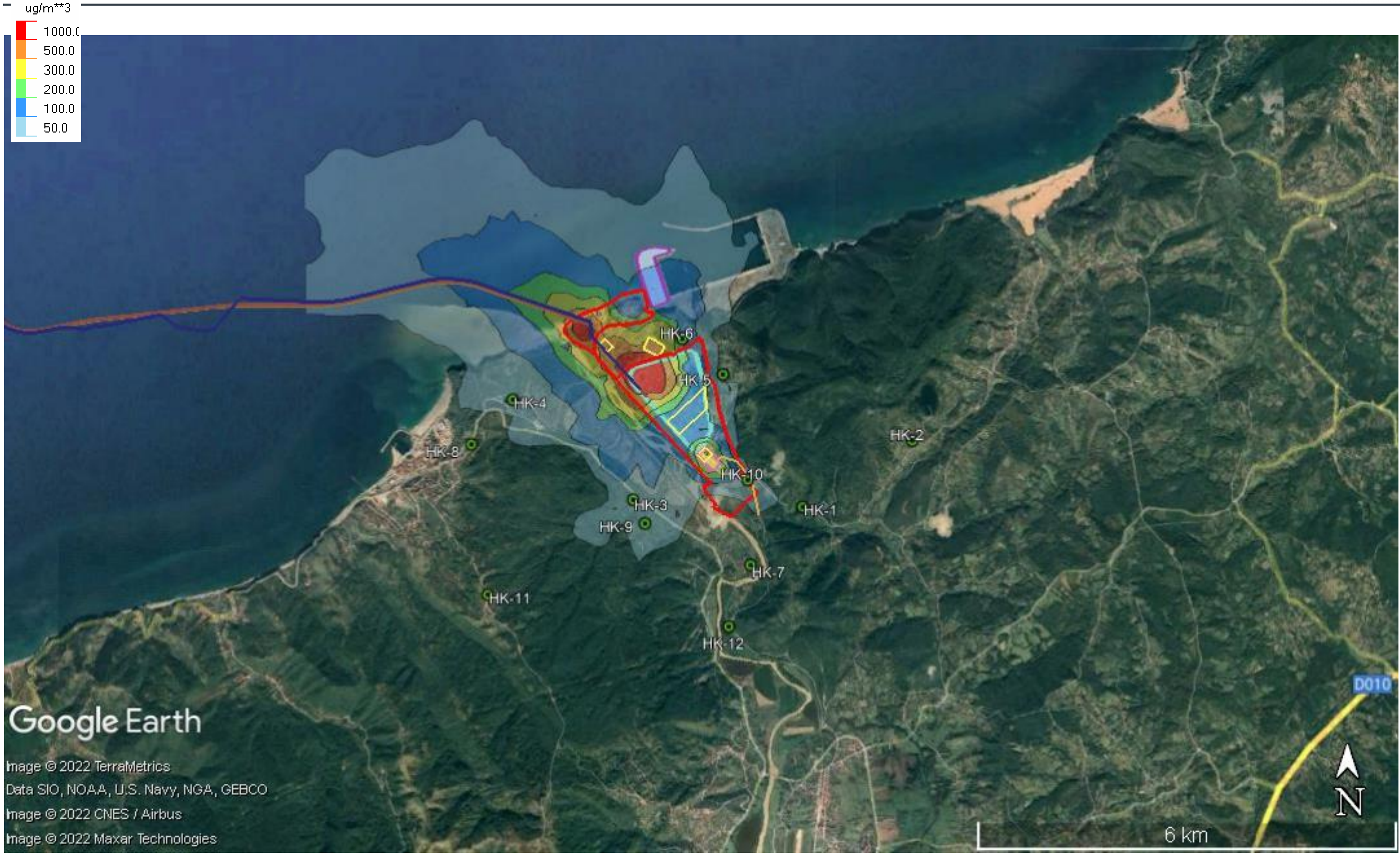


Figure 7-8: 1st Highest 8-Hours Average GLC for CO (μg/m³)

Model Results for VOC

As can be seen from Table 7-22, the highest 1-hour average GLC values for VOC are in line with the project standard of 280 µg/m³. The total pollution values calculated using hourly average GLC values also align with the standard. Figure 7-9 and Figure 7-8 presents the contour plot for VOC. As seen from the plot, the VOC concentrations -due to project activities- are not significant at all of the sensitive receptors.

Table 7-22: 1st Highest 1-Hour Average GLC for VOC during Construction Phase

Receptor	Easting (m)	Northing (m)	Elev. (m)	Approximate distance from the source (m)	Averaging Period	Model Results (µg/m³)	Background Concentration (µg/m³)*		Total Pollution Value (µg/m³)	Project Standard (µg/m³)
							1st	2nd		
HK-1	424155	4600940	24	1350	1-hour	34.9	11.7	16.4	51.3	280 (1-hour average)
HK-2	425744	4601871	58	2830	1-hour	6.9	28.8	9.8	35.7	
HK-3	421717	4601068	7	1100	1-hour	29.9	4.1	24.2	54.1	
HK-4	419996	4602522	17	1700	1-hour	30.6	31.5	16.9	62.1	
HK-5	423029	4602850	56	300	1-hour	15.4	11.4	5.7	26.8	
HK-6	422449	4603370	25	300	1-hour	63.9	16.2	56.5	120.4	
HK-7	423394	4600118	10	1470	1-hour	13.5	39.4	15.3	52.9	
HK-8	419395	4601886	47	2470	1-hour	12.0	91.6	15.1	103.6	
HK-9	421883	4600727	16	1250	1-hour	32.9	4.7	4.8	37.7	
HK-10	423367	4601334	14	450	1-hour	41.4	7.6	13.6	55.0	
HK-11	419615	4599735	261	3580	1-hour	4.9	14.7	9.9	19.6	
HK-12	423072	4599243	10	2250	1-hour	21.4	4.2	14.6	36.0	

* Maximum of the measured background concentrations is considered in calculating the total pollution value.

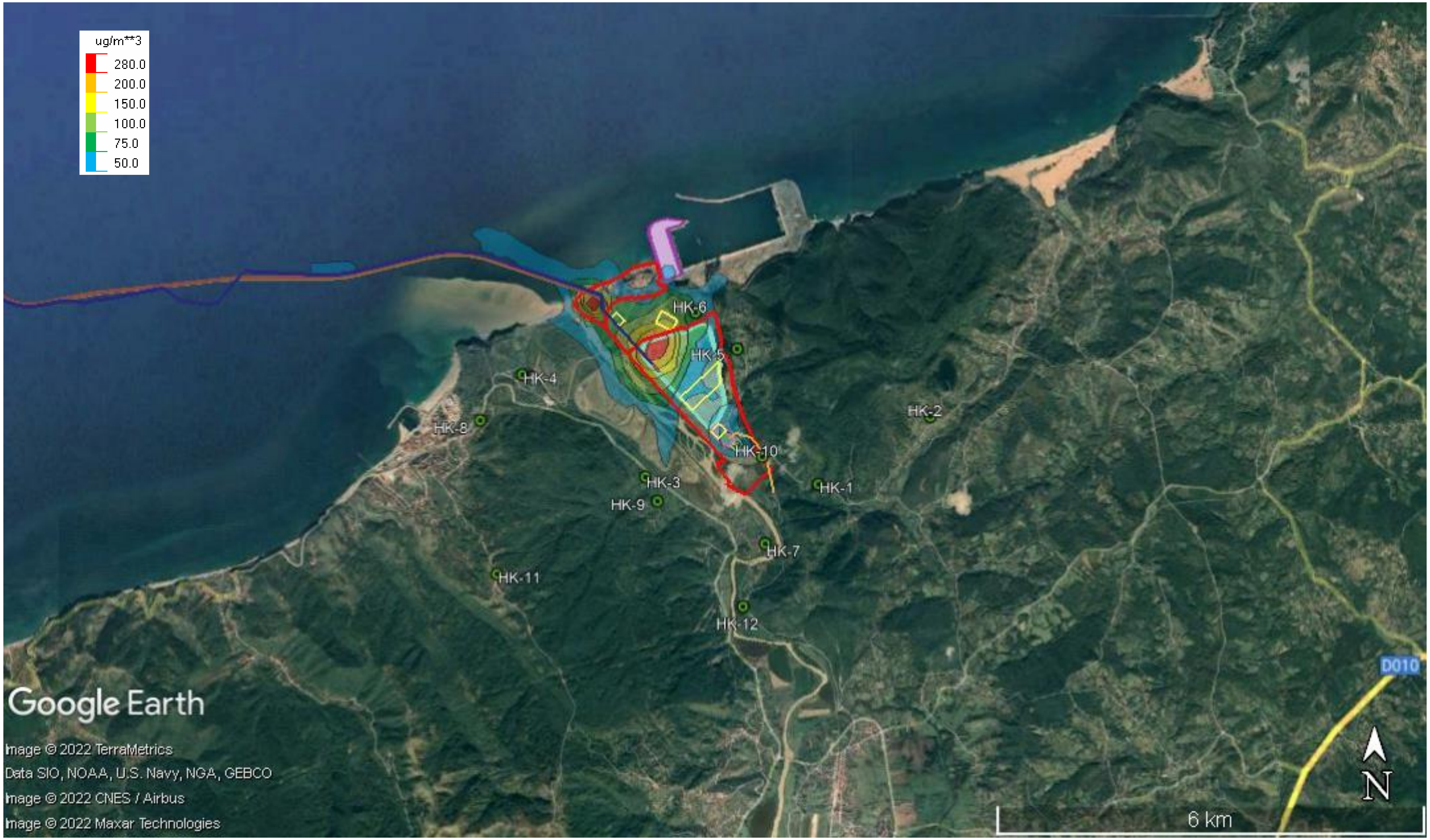


Figure 7-9: 1st Highest 1-Hour Average GLC for VOC (μg/m³)

Model Results for SO_2

As can be seen from Table 7-23, the highest 1-hour and 24-hours average GLC values for SO_2 are in line with the hourly and daily average standards of 350 µg/m³ and 20 µg/m³. However, the total pollution value calculated using daily average GLC values are above the daily average standard of 20 µg/m³ at all sensitive receptors. This is mainly because of the high background SO_2 concentrations at the sensitive receptors.

Figure 7-10 and Figure 7-11 present the contour plots for the 1st highest 1-hour and 24-hours average GLC values, respectively. As seen from the plots, the SO_2 concentrations would be higher along the route of vessels. According to the plots, the hourly SO_2 concentration at the sensitive receptors -due to project activities- are within the range of 30-100 µg/m³ and the daily SO_2 concentration at the receptors are within the range of 1.5-15 µg/m³.

Table 7-23: 1st Highest 1-Hour and 24-Hours Average GLC for SO_2 during Construction Phase

Receptor	Easting (m)	Northing (m)	Elev. (m)	Approximate distance from the source (m)	Averaging Period	Model Results (µg/m³)	Background Concentration (µg/m³)*			Total Pollution Value (µg/m³)	Project Standard (µg/m³)
							1st	2nd	3rd		
HK-1	424155	4600940	24	1350	1-hour	102.8	31.6	23.0	15.6	134.4	350 (1-hour average) 20 (24-hours average)
					24-hours	7.8				39.4	
HK-2	425744	4601871	58	2830	1-hour	30.8	14.5	16.7	12.7	47.5	
					24-hours	4.3				21.0	
HK-3	421717	4601068	7	1100	1-hour	94.2	21.0	15.4	7.7	115.2	
					24-hours	8.1				29.1	
HK-4	419996	4602522	17	1700	1-hour	99.1	19.2	13.0	13.3	118.3	
					24-hours	15.3				34.5	
HK-5	423029	4602850	56	300	1-hour	43.4	20.7	20.2	12.1	64.1	
					24-hours	6.4				27.1	
HK-6	422449	4603370	25	300	1-hour	103.4	18.1	22.4	10.1	125.8	
					24-hours	11.6				34.0	
HK-7	423394	4600118	10	1470	1-hour	104.3	22.1	21.7	7.6	126.4	
					24-hours	6.5				28.6	
HK-8	419395	4601886	47	2470	1-hour	38.6	17.4	24.4	8.6	63.0	
					24-hours	6.4				30.8	
HK-9	421883	4600727	16	1250	1-hour	90.6	21.1	20.2	9.8	111.7	
					24-hours	7.9				29.0	
HK-10	423367	4601334	14	450	1-hour	96.5	26.8	14.7	8.4	123.3	
					24-hours	10.5				37.3	
HK-11	419615	4599735	261	3580	1-hour	30.9	12.4	20.5	10.0	51.4	
					24-hours	1.5				22.0	
HK-12	423072	4599243	10	2250	1-hour	81.7	20.3	19.5	11.2	102.0	
					24-hours	5.5				25.8	

* Maximum of the measured background concentrations is considered in calculating the total pollution value.

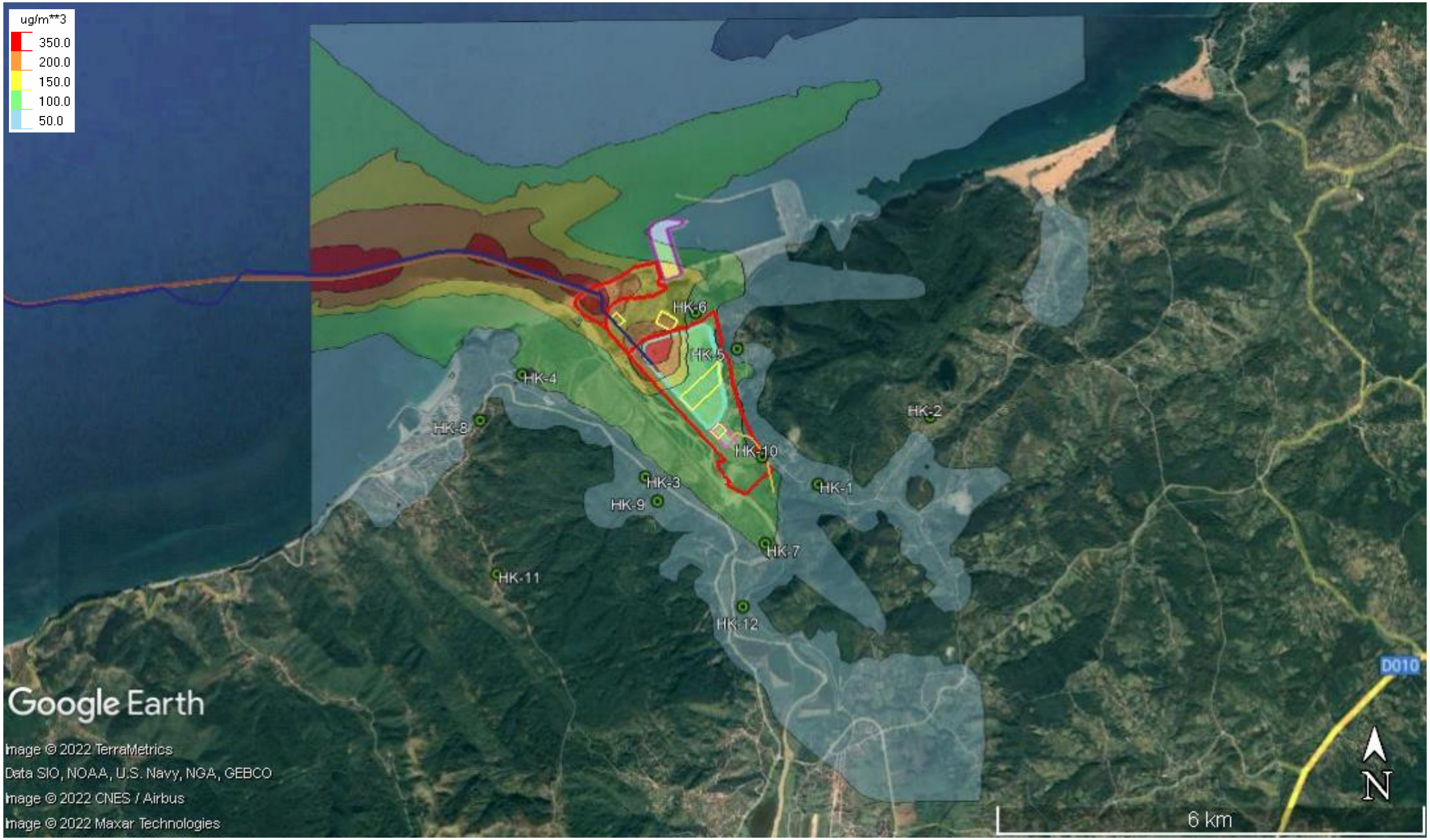


Figure 7-10: 1st Highest 1-Hour Average GLC for SO_2 (μg/m³)

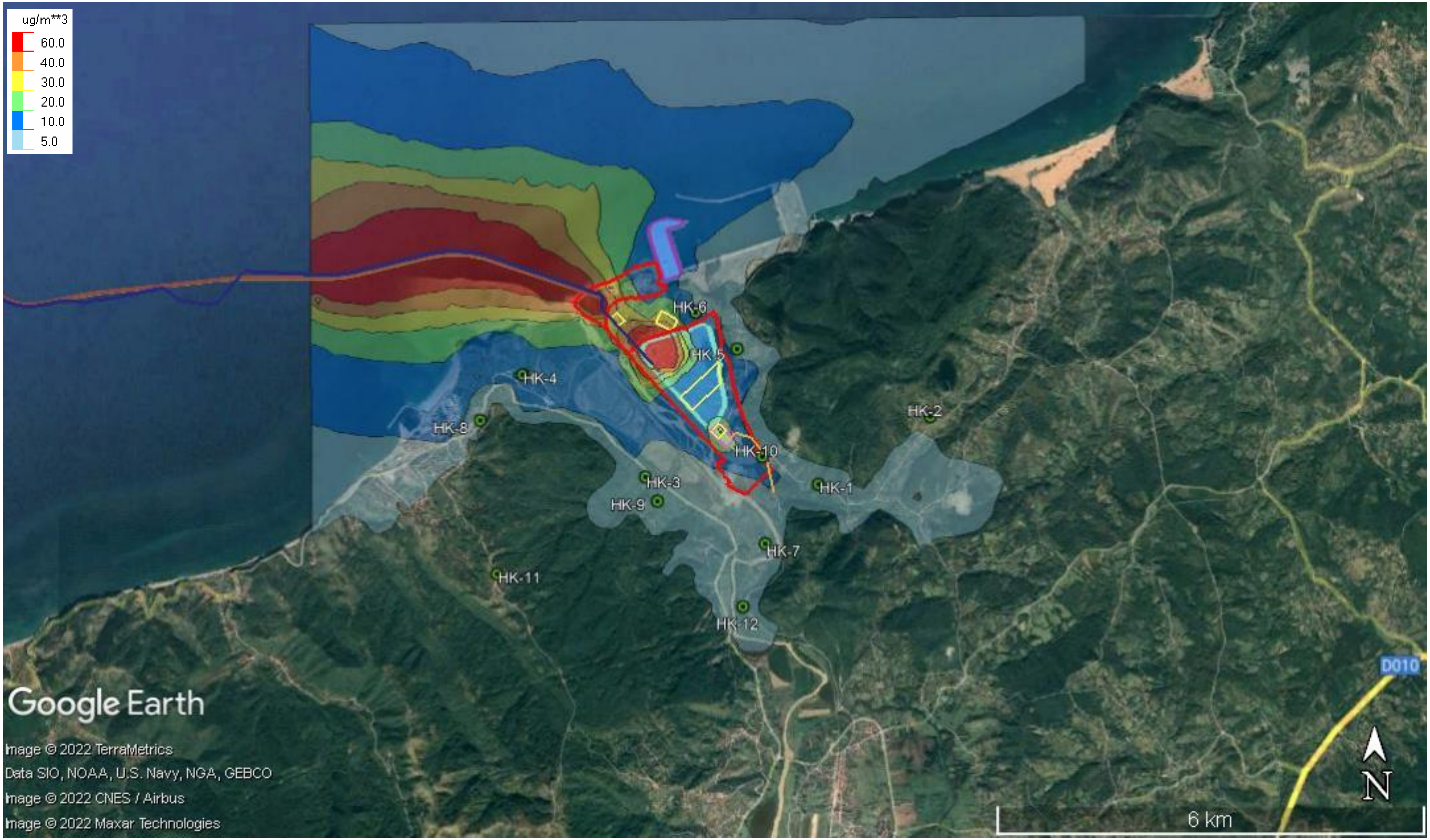


Figure 7-11: 1st Highest 24-Hours Average GLC for SO_2 (μg/m³)

Model Results for PM_{10}

As can be seen from Table 7-24, the highest 24-hours average GLC values for PM_{10} is in line with the daily average standard of 50 µg/m³. However, the total pollution value calculated using daily average GLC values are above the daily average standard of 50 µg/m³ at some of the sensitive receptors. This is mainly because of the high background PM_{10} concentrations at the sensitive receptors, which is considered to be due to earthworks and other construction activities undertaken during the performance of the background measurements.

Figure 7-12 present the contour plot for the 1st highest 24-hours average GLC values. As seen from the plot, the PM_{10} concentrations are highest within the project boundaries and drops below the limit values at the project boundary. According to the plot, the daily PM_{10} concentration at the sensitive receptors -due to project activities- are within the range of 0.65-9.53 µg/m³.

Table 7-24: 1st Highest 24-Hours Average GLC for PM_{10} during Construction Phase

Receptor	Easting (m)	Northing (m)	Elev. (m)	Approximate distance from the source (m)	Averaging Period	Model Results (µg/m³)	Background Concentration (µg/m³)*		Total Pollution Value (µg/m³)	Project Standard (µg/m³)
							1st	2nd		
HK-1	424155	4600940	24	1350	24-hours	3.43	-	92.0	95.4	50 (24-hours average)
HK-2	425744	4601871	58	2830	24-hours	1.18	-	20.1	21.3	
HK-3	421717	4601068	7	1100	24-hours	5.20	45.7	12.0	50.9	
HK-4	419996	4602522	17	1700	24-hours	5.95	66.4	47.0	72.4	
HK-5	423029	4602850	56	300	24-hours	2.32	37.3	18.0	39.6	
HK-6	422449	4603370	25	300	24-hours	9.53	32.8	28.0	42.3	
HK-7	423394	4600118	10	1470	24-hours	3.91	35.1	30.1	39.0	
HK-8	419395	4601886	47	2470	24-hours	2.74	40.1	31.2	42.8	
HK-9	421883	4600727	16	1250	24-hours	5.88	39.1	49.3	55.2	
HK-10	423367	4601334	14	450	24-hours	7.36	44.7	36.1	52.1	
HK-11	419615	4599735	261	3580	24-hours	0.65	13.6	6.3	14.3	
HK-12	423072	4599243	10	2250	24-hours	2.89	-	27.0	29.9	

* Maximum of the measured background concentrations is considered in calculating the total pollution value.

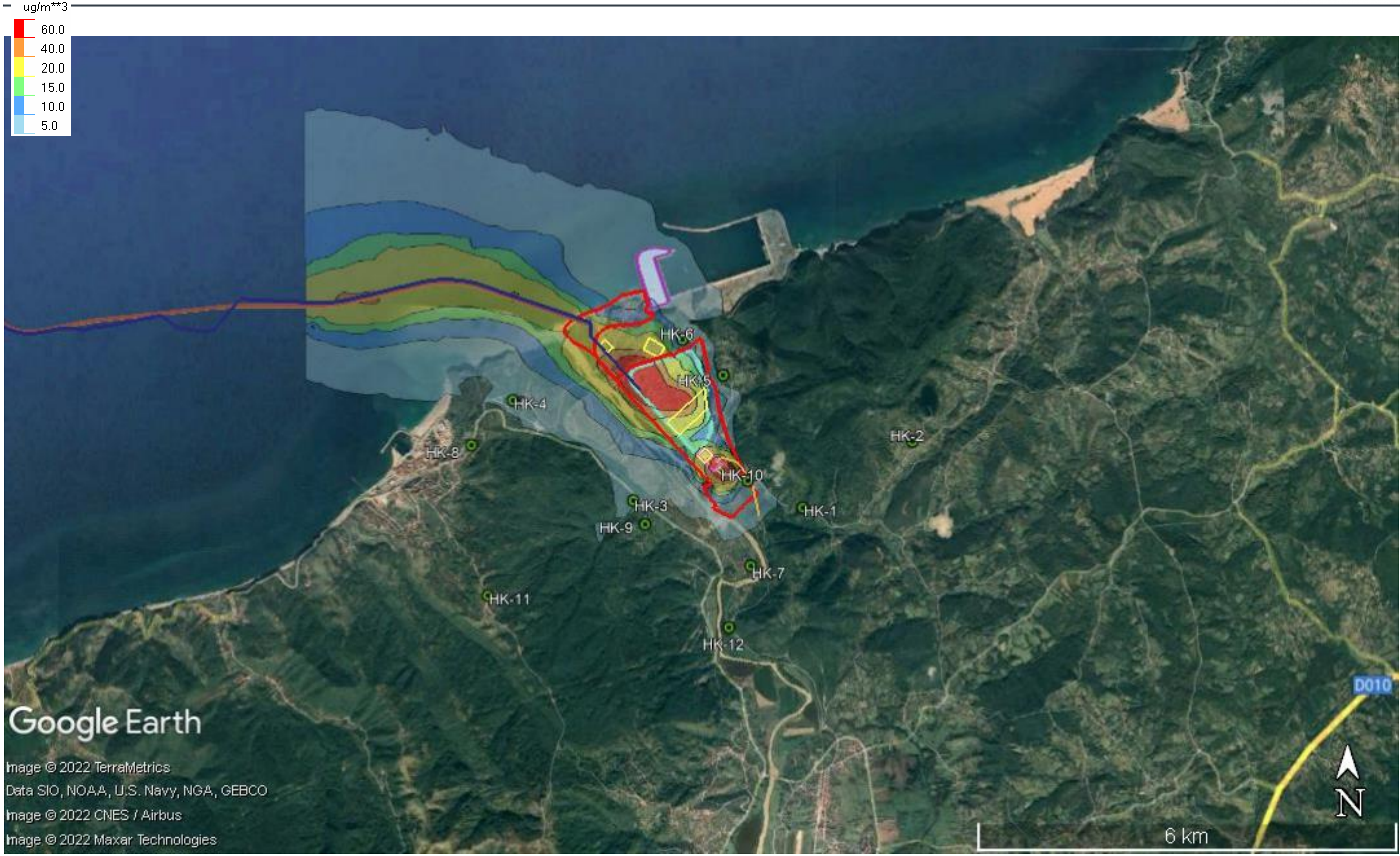


Figure 7-12: 1st Highest 24-Hours Average GLC for PM_{10} ($\mu g/m^3$)

The modelling results showed that the total pollution value, which considers the model computed concentration values and background concentrations, NO_2, SO_2, and PM_{10} concentrations may exceed project standards at some of the sensitive receptors during peak time of construction activities.

In order to ensure the compliance with the standards, NO_2, SO_2, and PM_{10} monitoring will need to be performed at the sensitive receptors, especially during peak time of construction activities that is between June and October 2022.

Mitigation Measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Onshore construction activities – Dust Emissions**

In order to reduce the air emissions from the construction machinery and equipment, the following actions will be implemented during the construction phase:

- Provide PPE to workers on site, such as dust masks where dust levels are likely to be excessive;
- Locate activities and rock / earth stockpiles away from sensitive receptors (natural or residential);
- Moisturize, cover, seed or fence stockpiles to prevent wind whipping;
- Keep stockpiles for the shortest possible time;
- Consider the prevailing wind direction when siting stockpiles to reduce the likelihood of affecting sensitive receptors;
- Slow down or cease the dust generating work under strong winds, such as reducing work activities or using water spray to reduce dust dispersion.
- Minimise amounts of material handling and avoid double handling;
- Seal or re-vegetate completed earthworks as soon as reasonably practicable after completion;
- Ensure all vehicles carrying loose or potentially dusty material to or from the site are fully sheeted;
- Enforce speed limits and reduce vehicle movements and idling on site;
- Use water suppression for control of loose materials on paved or unpaved road surfaces;
- Where dust levels may still cause a nuisance (despite measures above) water or other control measures such as chemical bonding agent (non-toxic), or aggregate may be required as additional measures to control dust.

- **Onshore construction activities – Exhaust Emissions**

The following actions will be implemented to reduce generation of dust in the construction area:

- vehicle engines and other machinery will be kept turned on only if necessary, avoiding any unnecessary emission;
- machinery and equipment will be periodically checked and maintained to ensure their good working condition;

  - all equipment and machinery must be maintained for compliance with standards and technical regulations for the protection of the environment and have appropriate certifications;
  - activities will be conducted trying to use the minimum required number of means at the same time;
  - electric small-scale mechanization and technical tools will be used when available and feasible.

- **Offshore construction activities – Exhaust Emissions from Vessels**

The following air emissions management strategies are recommended relevant to vessel operations[7]:

- Application of air quality management procedures (including for GHG emissions) for ship operations while in port areas, such as:
  - Validate ship engine performance documentation and certification to ensure compliance with combustion emissions specifications (including NOx, SOx, and PM), within the limits established by international regulations (i.e., MARPOL);
  - Comply with the provisions of "1973 The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), Annex VI" amended by 1978 Protocol and the provisions of the "Regulation on Reducing the Sulfur Content in Some Fuel Types" entered into force by being published in the Official Gazette No. 27368 on 06.10.2009.
  - When practical and without affecting the safety of vessel navigation, use reduced ship propulsion power in port access areas.
  - For appropriately configured vessels, including port tugs during idling periods, use shorebased power in port where it is available.
- Application of air quality management procedures to avoid, minimize, and control combustion emissions, including GHG emissions, related to land-based port activities, including:
  - Where practicable, design facilities to minimize travel distances and transfer points, for example from ships' off-loading and on-loading facilities to storage areas, and to avoid/minimize re-storage and re-shuffling of cargo (i.e. pipelines).
  - Where practicable, upgrade land vehicle and equipment fleets with low emission vehicles, including use of alternative energy sources, and fuels/fuel mixtures (e.g., vehicle and equipment fleets powered by electricity or compressed natural gas, hybrid locomotives, etc.).
  - Maintain cargo transfer equipment (e.g., cranes, forklifts, and trucks) in good working condition to reduce air emissions.
  - Encourage reduced engine idling during on- and off-loading activities.
- Ozone Depleting Substances Ozone depleting substances (ODS) such as CFCs and halons may be found on board in refrigeration and fire-fighting equipment and systems. Recommendations to prevent, minimize, and control emissions of ODS include:

[7] https://www.ifc.org/wps/wcm/connect/ddfac751-6220-48e1-9f1b-465654445c18/20170201-FINAL_EHS+Guidelines+for+Ports+Harbors+and+Terminals.pdf?MOD=AJPERES&CVID=lD.CzO9

- Avoiding installation of fire fighting or refrigeration systems containing chlorofluorocarbons (CFCs), in accordance with applicable phase-out requirements;
- Recovery of ODS during maintenance activities and preventing deliberate venting of ODS to the atmosphere.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix x.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low to medium negative impact** is expected on the air quality due to construction activities.

Table 7-25: Residual impact assessment matrix for the air quality during construction phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Dust emissions	Duration:	Medium	Medium-high	Short-term	**Low**	Low	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	High					
Exhaust Emissions from vehicles and construction machinery	Duration:	Medium	Medium-high	Short-term	**Low**	Low	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	High					
Vessel exhaust emissions	Duration:	Medium-short	Medium-high	Short-mid-term	**Medium**	Low	**Medium**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	High					
Overall assessment:		**Low to Medium**	Rationale:	Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value			

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the Project on the air quality during the construction and verify the effectiveness of the mitigation measures.

- Regular (daily) visual monitoring to ensure that the dust mitigation measures are in place;

- Routine maintenance programme will be set-up and maintenance records will be kept for all vehicles, machinery/equipment, and vessels;
- Periodic inspection of subcontractors to ensure that all vehicles, construction machinery and vessels used on site evidence regular maintenance schedule in line with regulatory requirements;
- Maintaining a logbook by recording any exceptional incidents that cause extra dust or gas emissions, either on- or offsite, and the action taken to resolve the situation in the log book; and
- Air quality monitoring of NOx, SO_2 and PM_{10} at the closest sensitive receptors during peak time of construction activities and earthworks, and also in case of grievance.

7.2.1.2.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting air quality during operation phase are listed in Table 7-26.

Table 7-26: Project actions and related impact factors potentially affecting air quality during operation phase

Project actions	Brief description	Impact factors
Plant/infrastructure onshore operation	Emissions from OPF can be categorized as *fugitive, combusted,* and *associated emissions* including several different kinds of air pollutants, such as methane, VOC, CO_2, CO, NOx, and trace amounts of SO_2 and PM.	Emission of gaseous pollutants and/or greenhouse gases

- <u>**Emission of gaseous pollutants and/or greenhouse gases**</u>

Emissions from OPF can be categorized as *fugitive, combusted,* and *associated emissions* as explained below:

i) Fugitive emissions refer to the natural gas vapors that are released to the atmosphere during OPF operations. Fugitive emissions can be either intentional (i.e., vented emissions to guard against over pressuring) or unintentional (i.e., leaked emissions from routine wear, tear, and corrosion; improper installation or maintenance of equipment). Fugitive emissions can contain several different kinds of air pollutants, including methane, VOCs, and HAPs (Hazardous Air Pollutants, including n-hexane, the BTEX compounds, and H_2).

ii) Combustion emissions refers to the by-products that are formed from the burning of natural gas during OPF operations. Combusted emissions are commonly released through either the flaring of natural gas for safety and health precautions or the combustion of natural gas for process heat, power, and electricity in the system (e.g., for compressors and other machinery). The chemical process of combusting natural gas releases several different kinds of air pollutants, including CO_2, carbon monoxide (CO), nitrogen oxides (NOx), and trace amounts of sulfur dioxide (SO_2) and particulate matter (PM).

iii) Associated refers to secondary sources of emissions that arise from associated operations in natural gas systems. Associated emissions may result from the combustion of other fossil fuels (i.e., other than the natural gas stream) to power equipment and machinery.

Fugitive Emissions

Hydrocarbon containing vertical fixed roof tanks (Rich MEG, Lean MEG and Slop Oil tanks) will be kept under positive pressure with nitrogen breathing system. The storage tanks have been designed with pressure/vacuum relief valves (PVRVs) and blanketed with an inert gas (nitrogen). Tank vent lines will be connected to the LLP flare. As a consequence, fugitive VOC emissions from storage tanks is not expected.

Fugitive VOC emissions that may be associated with the connection equipment (e.g. valves, flanges, open-ended lines, pump seals, compressor seals, etc.) have been estimated by use of the emission factors provided in Annex 12 of the Regulation on Control of Industrial Air Pollution. The estimated fugitive VOC emissions from the connection equipment are given in Table 7-27.

Table 7-27: Fugitive VOC Emissions from Connection Equipment

Equipment Type	Service	Emission Factor (kg/h.source)	Number of Onshore Equipment	Estimated VOC Emission (kg/h)
Valve	Gas	0.0045	567	2.5515
	Heavy Oil	0.0000084	928	0.0078
	Light Oil	0.0025	N/A	N/A
Pump	Gas	0.0024	N/A	N/A
	Light Oil	0.013	N/A	N/A
Flange	Gas	0.00039	810	0.3159
	Heavy Oil	0.00000039	1328	0.0005
	Light Oil	0.00011	N/A	N/A
Open-Ended Lines	Gas	0.002	N/A	N/A
	Heavy Oil	0.00014	N/A	N/A
	Light Oil	0.0014	N/A	N/A
Pressure Relief Devices	Gas	0.0002	36	0.0072
	Heavy Oil	0.0000075	24	0.0002
	Light Oil	0.00021	N/A	N/A
Compressor	Gaz	0.0088	N/A	N/A
	Heavy Oil	0.000032	N/A	N/A
	Light Oil	0.0075	N/A	N/A
			Total VOC Emission	**2.8831**

* TEG & MEG are considered as heavy oil according to their volatility.

The total fugitive VOC emission is estimated as 2.88 kg/h, which is lower than the limit (3 kg/h) given in the Regulation on Control Industrial Air Pollution, Annex 2, Table 2.1. Therefore, fugitive VOC emissions have not been included in the modelling.

Combustion Emissions

Due to combustion of natural gas and auxiliary fuel for process heat, power, and electricity for the OPF and due to flaring of natural gas during normal operating conditions and emergency conditions, combustion gases air pollutants, including CO, NOx, and trace amounts of SO_2 and PM_{10} will release to the atmosphere.

The air dispersion modelling study focused on the following three scenarios:

Table 7-28: Emission Scenarios considered in the Modelling Study

Code	Scenario	Included Sources	Source Type	Notes
S1	Normal operation	Gas Engine Generator	Continuous	
		LP Steam Boiler	Continuous	
		Indirect Fired Heaters (IFH)	Intermittent	Used to raise the fluid temperature when arrival temperatures are below 10 ˚C. It is assumed that two IFHs will be in operation during winter time (releasing emissions through 4 stacks) and only one IFH (releasing emissions through 2 stacks) will be active during the rest of the year.
		HP Ground Flare (pilot flame)	Continuous	
S2	Abnormal operation	Sources considered in S1	Continuous	In addition to the sources included in normal operation scenario, 4 emergency diesel generators are included in this scenario.
		Four Emergency Diesel Generators	Emergency - In case of power outage / Intermittent	
S3	Emergency operation	HP (Ground) Flare	Emergency venting	This scenario is based on full load of the flares in the event of all untreated emissions are directed to the flares. HP flare will be operated in case of emergency venting/blowdown. The most governing case of emergency venting foresees 70 minutes of depressurization and flaring duration.
		LP (Enclosed) Flare	Emergency venting	

During the start-up, the production fluids from wells will be delivered to OPF with 16" production line that length is 150 km. Well operation pressures are considerably higher than OPF operation pressure so, production line pressure will be more than OPF inlet pressure and pipeline need to be depressurized before OPF start-up. Instead of flaring, inlet by-pass arrangement with choke valves provided to decrease pressure and they will be operated at start-up operation. Downstream pressure will be adjusted with choke valve and process will be taken in operation with slowly increase inlet flowrate. At the end of the choke valve operation, production line pressure will be as same as with facility inlet pressure without flaring or any flaring emission.

The model has been run with the following assumptions:

- Emissions from the plant are the maximum possible (concentrations and flow rate).

- Pollutants are not subject to dry or wet precipitation.
- Pollutants are not subject to any chemical reaction in the atmosphere and there is no depletion in pollutant concentrations.
- Ambient Ratio Model Version 2 (ARM2) has been used for estimation of ground level concentrations in terms of NO_2.
- Due to high combustion efficiency (99.8%) and high total hydrocarbon (THC) destruction efficiency, THC emissions are considered to be insignificant for normal operation conditions.
- The composition of natural gas and fuels did not indicate any significant presence of sulphur. Flame-out case has been considered in the HAZOP Analysis and it has been concluded that relevant safeguards are in place. Hence, H_2S emission release due to flame out has not been considered as a probable scenario.

The emission sources and their characteristics are summarized in the following table.

Table 7-29: Inventory of Air Pollution Sources and Emission Characteristics

Source Type	Stack Name	Main/ Backup	Source Type	Fuel Type	Stack Name	UTM Coordinate (m)		Stack Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Exit Velocity (m/s)	Exit Temperature (ºK)	Emission Rate (g/s)	
						Easting	Northing						NOx	CO
Point	Gas Engine Generator Stack - 1	Main	Continuous	Natural Gas	81-G-1002A	421776.39	4602856.09	7.5	30	0.813	18.2	617	1.540	2.003
Point	Gas Engine Generator Stack - 2	Main	Continuous	Natural Gas	81-G-1002B	421781.98	4602861.04	7.5	30	0.813	18.2	617	1.540	2.003
Point	Gas Engine Generator Stack - 3	Backup*	Backup	Natural Gas	81-G-1002C			7.5	30	0.813	18.2	617	1.540	2.003
Point	LP Boiler Stack -1	Main	Continuous	Fuel gas	55-Q-1110 A	422533.94	4602945.08	7.5	40	1.812	6.7	381	3.114	2.075
Point	LP Boiler Stack -2	Backup*	Backup	Fuel gas	55-Q-1110 B			7.5	40	1.812	6.7	381	3.114	2.075
Point	Indirect Fired Heater Stack-1	Main	Intermittent	Natural Gas	20-Q-1101	422096.00	4602636.00	7.5	30	0.914	8.2	660	0.311	0.104
Point	Indirect Fired Heater Stack-2	Main	Intermittent	Natural Gas	20-Q-1111	422098.42	4602633.49	7.5	30	0.914	8.2	660	0.311	0.104
Point	Indirect Fired Heater Stack-3	Main	Intermittent	Natural Gas	20-Q-1102	422098.40	4602638.14	7.5	30	0.914	8.2	660	0.311	0.104
Point	Indirect Fired Heater Stack-4	Main	Intermittent	Natural Gas	20-Q-1112	422100.62	4602635.46	7.5	30	0.914	8.2	660	0.311	0.104
Point	Diesel Generator Stack - 1 (380 V)	Main	Emergency - In case of power outage / Intermittent	Diesel	84-G-1001	421894.53	4602752.82	7.5	3.93	0.315	62.3	730	2.714	0.365
Point	Diesel Generator Stack- 2 (380 V)	Main	Emergency - In case of power outage / Intermittent	Diesel	84-G-1002	422170.57	4602908.46	7.5	3.675	0.171	44	702	2.474	0.060
Point	Diesel Generator Stack- 3 (380 V)	Main	Emergency - In case of power outage / Intermittent	Diesel	84-G-1003	422538.27	4603119.58	7.5	3.563	0.221	82.3	702	2.325	0.183

Source Type	Stack Name	Main/ Backup	Source Type	Fuel Type	Stack Name	UTM Coordinate (m)		Stack Base Elevation (m)	Stack Height (m)	Exit Diameter (m)	Exit Velocity (m/s)	Exit Temperature (ºK)	Emission Rate (g/s)	
						Easting	Northing						NOx	CO
Point	Diesel Generator Stack - 4 (690 V)	Main	Emergency - In case of power outage / Intermittent	Diesel	84-G-1004	422194.36	4602884.42	7.5	3.863	0.276	18.5	682	1.916	0.141
N/I	Firewater Pump Diesel Engine Stack - 1	Main	In case of fire	Diesel	71-P-001 A			7.5	2	0.25	18	746	0.24	0.05
N/I	Firewater Pump Diesel Engine Stack - 2	Main	In case of fire	Diesel	71-P-001 B			7.5	2	0.25	18	746	0.24	0.05
N/I	Firewater Pump Diesel Engine Stack - 3	Backup	In case of fire	Diesel	71-P-001 C			7.5	2	0.25	18	746	0.24	0.05
N/I	Firewater Pump Diesel Engine Stack - 4	Main	In case of fire	Diesel	71-P-003 A			7.5	2	0.25	18	746	0.24	0.05
N/I	Firewater Pump Diesel Engine Stack - 5	Main	In case of fire	Diesel	71-P-003 B			7.5	2	0.25	18	746	0.24	0.05
N/I	Firewater Pump Diesel Engine Stack - 6	Backup	In case of fire	Diesel	71-P-003 C			7.5	2	0.25	18	746	0.24	0.05

Source Type	Stack Name	Main/ Backup	Source Type	Fuel Type	Unit Name	UTM Coordinate (m)		Stack Base Elevation (m)	Stack Height (m)	Exit Velocity (m/s)	Exit Temperature (ºK)	Heat Release (cal/s)	Radiation Loss (%)	Release Height (m)	Initial Lateral Dim. (σ_{yo})	Initial Vertical Dim. (σ_{zo})	Emission Rate (g/s)	
						Easting	Northing										NOx	CO
Volume	HP (Ground) Flare	Main	Pilot flame - continuous	Flare Gas	43-Q-1002	422130	4602438	7.5	-	-	-	-	-	13.72	11.63	3.19	0.001	0.005
			Emergency venting														262	1,195
Flare	LP (Enclosed) Flare**	Main	Emergency venting	Flare Gas	44-Q-1001	422303	4602879	7.5	25.44	20	485	2.95×10^{7}	55				6.94	31.63

* Backup units are not included in the modelling study.
** LP Flare pilot flame will release negligible amounts of emission.
*** SO2 and PM10 emissions will be released at negligible amounts.

****Flare gases are expected to have negligible hydrocarbon emissions under normal operating conditions.[8]
***** Source coordinates are based on WGS 84 / UTM zone 36N.
N/I: Not included in the modelling study.

[8] AP-42 Section 5.3 Natural Gas Processing https://www.epa.gov/sites/default/files/2020-09/documents/5.3_natural_gas_processing.pdf

Mass flow rates (kg/h) of the main emission sources are summarized in the following table with comparison to the Regulation on Control of Industrial Air Pollution limits. The Regulation states that air dispersion model need to be run in case these limits are exceeded. Nevertheless, modelling study is performed for NOx and CO to understand the dispersion of pollutants in the AoI under different operation conditions.

Table 7-30: Main Stack Emissions in comparison to National Standards

Parameters	Gas Engine Emission (kg/h)	LP Boiler Emission (kg/h)	Indirect Fired Heater Emission (kg/h)	Stack Emission Limits given by Regulation (kg/h)
NOx (as NO_2)	16.63	11.21	1.12	40
CO	21.63	7.47	0.37	500
PM_{10}	0.023	0.041	-*	10
SO_2	0.40	0.52	-*	60

* PM_{10} and SO_2 emissions will be released at negligible amounts.

The compliance of the design stack heights has been assessed by Schlumberger with regards to the Good International Industry Practice (GIIP) Stack Height requirements that is defined in the IFC Environmental Health and Safety (EHS) General Guidelines (see Appendix B for GIIP stack height calculation method). All stack heights have been determined in line with the GIIP requirements.

AERMOD Simulation Results

AERMOD model has been run using the meteorological and topography data described in “the Methodological Approach for Air Quality Modelling” section given under Section 7.2.1.2.17.2.1.2.

The following grid spacing is accounted for the operation phase:

- 50 m spacing from center to 2,000 m
- 100 m spacing from 2,000 m to 3000 m
- 250 m spacing from 3000 m to 5,500 m.

The grid receptors are placed close enough to capture the maximum pollutant concentration and good resolution of the dispersion profile. The locations of the emission sources can be seen in Figure 7-13.

Figure 7-13: Location of the Emission Sources

In the following, the model resulting ambient air ground level concentrations for NO_X and CO are provided together with the background concentrations and total pollution values that have been calculated by adding up the model results with the background concentrations. For this calculation, the maximum of the measured concentrations was considered to account for the worst case scenario. Total pollution values exceeding the standards are coloured in red. On the other hand, the figures present only the GLCs calculated by the model, and do not include the background concentrations. The estimated ambient air concentrations have been compared with the Project Standards.

Scenario 1: Normal Operation

Model Results for NO_2

As can be seen from Table 7-31, the highest 1-hour average GLC value for NO_2 is 191.87 µg/m^3 and the total pollution value (201.97 µg/m^3) is slightly above the project standard of 200 µg/m^3. Figure 7-14 presents the contour plot for the 1st highest GLC values. As seen from the plots, the highest hourly concentration occurs at 710m east of the OPF boundary due to the reflection of the plume on the hills at 103m altitude.

The highest annual average GLC (3.04 µg/m^3) is well below the annual standard of 40 µg/m^3. The annual average GLC plot can be seen in Figure 7-15. The hourly and annual average GLCs at all of the sensitive receptors are all well below the standards.

Table 7-31: 1st Highest 1-Hour Average and Annual Average GLCs for NO_2 during Normal Operation

Receptor	Easting	Northing	Elev. (m)	Distance from the source (m)	Averaging Period	Model Results (µg/m³)	Background Concentration (µg/m³)*	Total Pollution Value (µg/m³)	Project Standard (µg/m³)
Highest Value Calculated by the Model*	423350	4603200	103	710	Hourly	191.87	10.1	201.97	200
	422450	4602600	7.5	within fenceline	Yearly	1.64		11.74	40
HK-1	424155	4600940	24	1350	Hourly	11.78	21.1	32.88	200
					Yearly	0.39		21.49	40
HK-2	425744	4601871	58	2830	Hourly	22.91	6.85	29.76	200
					Yearly	0.26		7.11	40
HK-3	421717	4601068	7	1100	Hourly	11.15	20.1	31.25	200
					Yearly	0.42		20.52	40
HK-4	419996	4602522	17	1700	Hourly	13.62	11.3	24.92	200
					Yearly	0.17		11.47	40
HK-5	423029	4602850	56	300	Hourly	26.17	10.1	36.27	200
					Yearly	1.00		11.10	40
HK-6	422449	4603370	25	300	Hourly	14.78	21.2	35.98	200
					Yearly	0.54		21.74	40
HK-7	423394	4600118	10	1470	Hourly	13.70	16.9	30.60	200
					Yearly	0.31		17.21	40
HK-8	419395	4601886	47	2470	Hourly	14.58	17.4	31.98	200
					Yearly	0.18		17.58	40
HK-9	421883	4600727	16	1250	Hourly	11.58	10.2	21.78	200
					Yearly	0.38		10.58	40
HK-10	423367	4601334	14	450	Hourly	10.99	12.8	23.79	200
					Yearly	0.47		13.27	40
HK-11	419615	4599735	261	3580	Hourly	6.18	7.57	13.75	200
					Yearly	0.08		7.65	40
HK-12	423072	4599243	10	2250	Hourly	10.57	13.4	23.97	200
					Yearly	0.23		13.63	40

* Maximum of the measured background concentrations is considered in calculating the total pollution value.

Figure 7-14: 1st Highest 1-Hour Average GLCs for NO_2 during Normal Operation (μg/m³)

Figure 7-15: Annual Average GLCs for NO_2 during Normal Operation (μg/m³)

Model Results for CO

As can be seen from Table 7-32, the highest 8-hours average GLC value for CO is in line with the project standard of 10 mg/m^3. The GLCs at all receptors are also well below the standard. Figure 7-16 presents the contour plot for the highest 8-hour average GLCs.

Table 7-32: 1st Highest 8-Hour GLCs for CO during Normal Operation

Receptor	Easting	Northing	Elev. (m)	Distance from the source (m)	Averaging Period	Model Results (µg/m^3)	Background Concentration (µg/m^3)	Total Pollution Value (µg/m^3)*	Project Standard (µg/m^3)
Highest Value Calculated by the Model*	423250	4603250	84.30	670	8 hours	76.12	3.3	80.18	10,000 (8-hours average)
HK-1	424155	4600940	24	1350	8 hours	4.04	0.6	4.64	
HK-2	425744	4601871	58	2830	8 hours	3.81	0.4	4.21	
HK-3	421717	4601068	7	1100	8 hours	6.92	1.7	8.62	
HK-4	419996	4602522	17	1700	8 hours	2.64	2.1	4.74	
HK-5	423029	4602850	56	300	8 hours	8.20	3.3	11.50	
HK-6	422449	4603370	25	300	8 hours	5.92	3.4	9.32	
HK-7	423394	4600118	10	1470	8 hours	3.55	1.9	5.45	
HK-8	419395	4601886	47	2470	8 hours	4.66	1.8	6.46	
HK-9	421883	4600727	16	1250	8 hours	5.78	2.1	7.88	
HK-10	423367	4601334	14	450	8 hours	4.21	0.5	4.71	
HK-11	419615	4599735	261	3580	8 hours	1.48	1.9	3.38	
HK-12	423072	4599243	10	2250	8 hours	3.24	0.5	3.74	

* Maximum of the measured background concentrations is considered in calculating the total pollution value.

Figure 7-16: 1st Highest 8-Hour Average GLCs for CO during Normal Operation (μg/m^3)

Scenario 2: Abnormal Operation

Abnormal operation scenario is based on operation of the four emergency diesel generators (EDGs) in addition to the Scenario 1 sources. As the EDGs will be active in case of power outage, only short-term average GLCs were evaluated.

Model Results for NO_2

As can be seen from Table 7-33, the highest 1-hour average GLC value for NO_2 is above the project standard of 200 µg/m³. Figure 7-17 and Figure 7-18 present the contour plots for the 1st and 6th highest GLC values, respectively. As seen from the plots, the highest hourly concentration occurs within the OPF boundary and on the east of OPF site. Together with the background concentrations, the total pollution value at HK-5, HK-6, and HK-8 approach to the limit value.

Figure 7-19 and Figure 7-20**Error! Reference source not found.** shows the distribution of 1- hour GLCs over the receptors. According to these figures, the hourly average standard is exceeded at 2.99% and 1.78% of the receptors based on 1st and 6th highest hourly average GLCs, respectively.

Table 7-33: 1st Highest 1-Hour Average GLCs for NO_2 during Abnormal Operation

Receptor	Easting	Northing	Elev. (m)	Distance from the source (m)	Averaging Period	Model Results (µg/m³)	Background Concentration (µg/m³)*	Total Pollution Value (µg/m³)	Project Standard (µg/m³)
Highest Value Calculated by the Model*	422150	4602950	4.93	within fenceline	Hourly	735.24	21.2	756.44	(1-hour average)
HK-1	424155	4600940	24	1350	Hourly	100.64	21.1	121.74	
HK-2	425744	4601871	58	2830	Hourly	115.54	6.85	122.39	
HK-3	421717	4601068	7	1100	Hourly	113.24	20.1	133.34	
HK-4	419996	4602522	17	1700	Hourly	114.28	11.3	125.58	
HK-5	423029	4602850	56	300	Hourly	175.90	10.1	186.00	
HK-6	422449	4603370	25	300	Hourly	169.54	21.2	190.74	
HK-7	423394	4600118	10	1470	Hourly	95.59	16.9	112.49	
HK-8	419395	4601886	47	2470	Hourly	172.08	17.4	189.48	
HK-9	421883	4600727	16	1250	Hourly	106.93	10.2	117.13	
HK-10	423367	4601334	14	450	Hourly	101.92	12.8	114.72	
HK-11	419615	4599735	261	3580	Hourly	27.20	7.57	34.77	
HK-12	423072	4599243	10	2250	Hourly	90.98	13.4	104.38	

Figure 7-17: 1st Highest 1-Hour Average GLC for NO_2 during Abnormal Operation (μg/m³)

Figure 7-18: 6th Highest 1-Hour Average GLC for NO_2 during Abnormal Operation (μg/m^3)

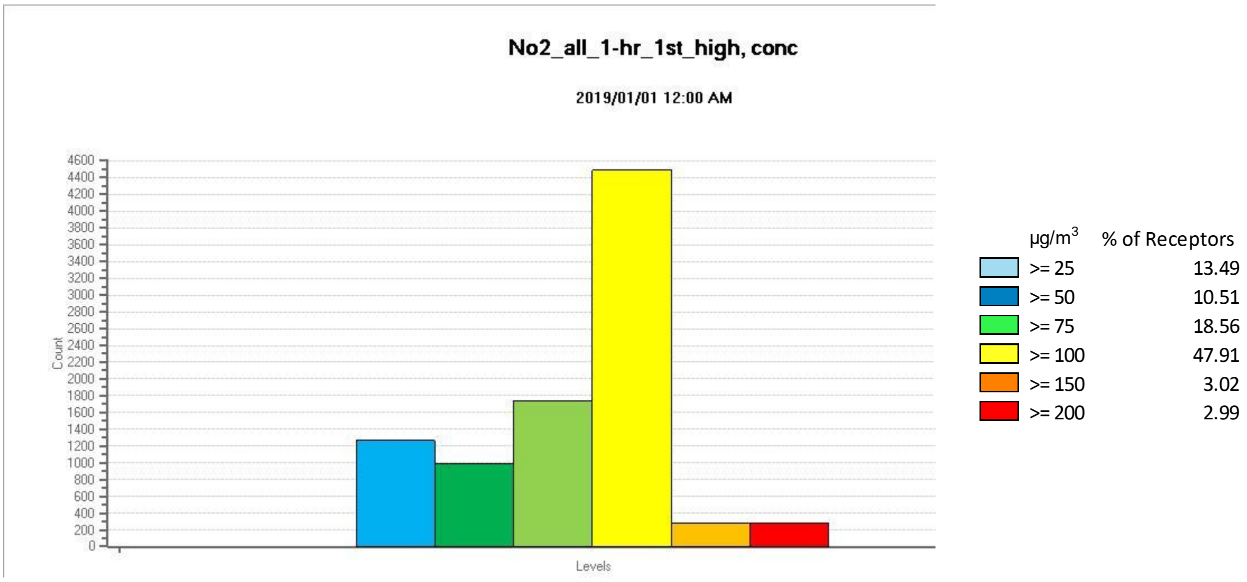


Figure 7-19: Distribution of 1st Highest 1-Hour Average GLCs for NO_2 during Abnormal Operation

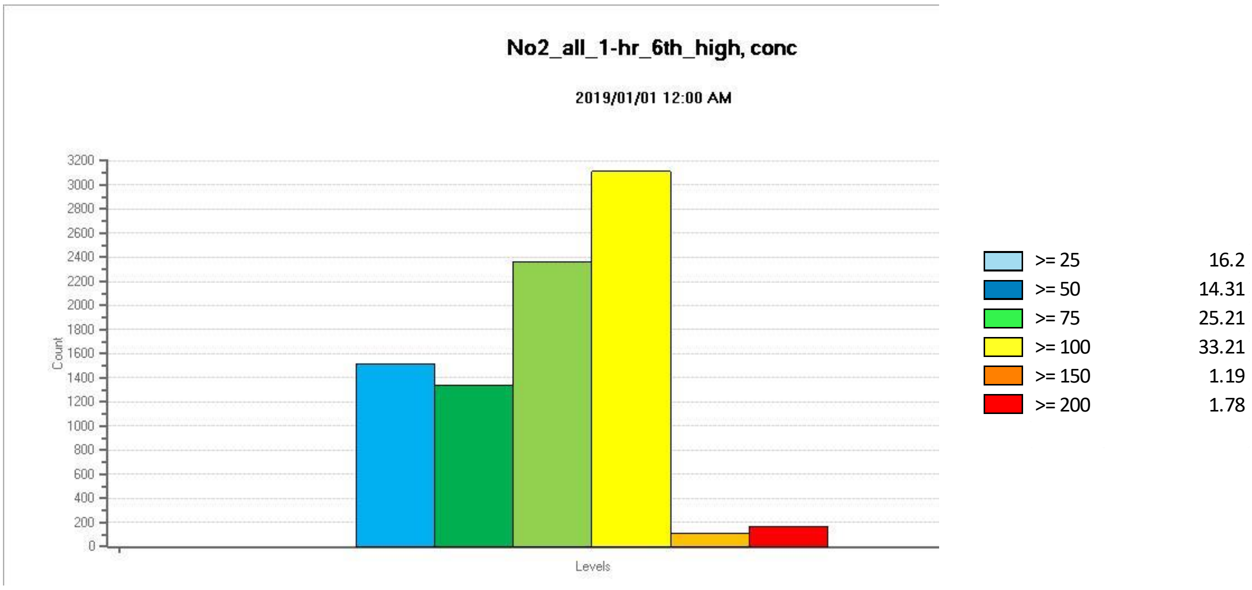


Figure 7-20: Distribution of 6th Highest 1-Hour Average GLCs for NO_2 during Abnormal Operation

Model Results for CO

As can be seen from Table 7-34, the highest 8-hours average GLC value for CO is in line with the project standard of 10 mg/m^3. The GLCs at all receptors are also well below the standard. Figure 7-21 presents the contour plot for the highest 8-hour average GLCs.

Table 7-34: 1st Highest 8-Hour GLCs for CO during Abnormal Operation

Receptor	Easting	Northing	Elev. (m)	Distance from the source (m)	Averaging Period	Model Results (µg/m^3)	Background Concentration (µg/m^3)	Total Pollution Value (µg/m^3)*	Project Standard (µg/m^3)
Highest Value Calculated by the Model*	423250	4603250	84	640	8 hours	76.90	3.4	80.30	10,000 (8-hours average)
HK-1	424155	4600940	24	1350	8 hours	5.20	0.6	5.80	
HK-2	425744	4601871	58	2830	8 hours	4.71	0.4	5.11	
HK-3	421717	4601068	7	1100	8 hours	8.46	1.7	10.16	
HK-4	419996	4602522	17	1700	8 hours	3.41	2.1	5.51	
HK-5	423029	4602850	56	300	8 hours	13.71	3.3	17.01	
HK-6	422449	4603370	25	300	8 hours	11.00	3.4	14.40	
HK-7	423394	4600118	10	1470	8 hours	4.48	1.9	6.38	
HK-8	419395	4601886	47	2470	8 hours	6.63	1.8	8.43	
HK-9	421883	4600727	16	1250	8 hours	7.20	2.1	9.30	
HK-10	423367	4601334	14	450	8 hours	5.30	0.5	5.80	
HK-11	419615	4599735	261	3580	8 hours	1.95	1.9	3.85	
HK-12	423072	4599243	10	2250	8 hours	3.80	0.5	4.30	

* Maximum of the measured background concentrations is considered in calculating the total pollution value.

Figure 7-21: 8hr Average GLC for CO during Abnormal Operation (µg/m³)

Scenario 3: Emergency Operation

As noted in Table 7-28, emergency venting foresees 70 minutes of depressurization and flaring duration. The amount of natural gas to be flared will decrease within this duration until it reaches to zero at the 70th minute. Accordingly, the amount of emissions will decrease in time in proportion to the amount of the gas inventory.

Model Results for NO_2

This scenario was modelled with regard to the maximum emission rate (262 g/s of NOx) at full capacity. Because AERMOD allows to enter variable emission rates for one hour intervals (not possible to input emissions for shorter intervals), it is assumed the maximum emission rate will last for 1 hour duration. Therefore, actual GLC levels can be expected to be lower. In order to see how low the GLC would be, the model run also for the emission rate at 60th to 70th time interval, which corresponds to 14% of the maximum emission rate that is 37.5g/s.

For this scenario only short-term average (1-hour average) GLC values were evaluated, as emergency flaring will be a short-term event.

As seen from Table 7-35, the highest 1-hour average GLC values for NO_2 exceed the hourly standard of 200µg/m³. Figure 7-22 and Figure 7-23 present the contour plots for the 1st and 6th highest GLC values, respectively. As seen from the plots, the highest hourly concentration occurs at the center of the OPF site.

Table 7-35: 1st and 6th Highest 1-Hour Average GLCs for NO_2 during Emergency Operation

Receptor	Easting	Northing	Elev. (m)	Distance from the source (m)	Averaging Period	Model Results for 262g/s of NOx emission rate (µg/m³)		Model Results for 262g/s of NOx emission rate (µg/m³)		Project Standard (µg/m³)
						1st Highest	6th Highest	1st Highest	6th Highest	
Highest Value Calculated by the Model*	422100	4602450	7.5	within fenceline	1-hour	171,624	149,797	24,543	21,421	200 (1-hour average)
HK-1	424155	4600940	24	1350	1-hour	5,361	5,011	767	717	
HK-2	425744	4601871	58	2830	1-hour	2,128	1,623	304	232	
HK-3	421717	4601068	7	1100	1-hour	10,889	7,672	1,557	1,097	
HK-4	419996	4602522	17	1700	1-hour	8,323	7,092	1,190	1,014	
HK-5	423029	4602850	56	300	1-hour	5,939	4,691	849	671	
HK-6	422449	4603370	25	300	1-hour	16,585	15,167	2,372	2,169	
HK-7	423394	4600118	10	1470	1-hour	5,499	3,257	786	466	
HK-8	419395	4601886	47	2470	1-hour	3,252	2,743	465	392	
HK-9	421883	4600727	16	1250	1-hour	9,712	7,833	1,389	1,120	
HK-10	423367	4601334	14	450	1-hour	8,421	6,934	1,204	992	
HK-11	419615	4599735	261	3580	1-hour	1,591	1,040	228	149	

Receptor	Easting	Northing	Elev. (m)	Distance from the source (m)	Averaging Period	Model Results for 262g/s of NOx emission rate (μg/m³)		Model Results for 262g/s of NOx emission rate (μg/m³)		Project Standard (μg/m³)
						1st Highest	6th Highest	1st Highest	6th Highest	
HK-12	423072	4599243	10	2250	1-hour	4,777	3,224	683	461	

Figure 7-22: 1st Highest 1-Hour Average GLC for NO_2 during Emergency Operation (µg/m³)

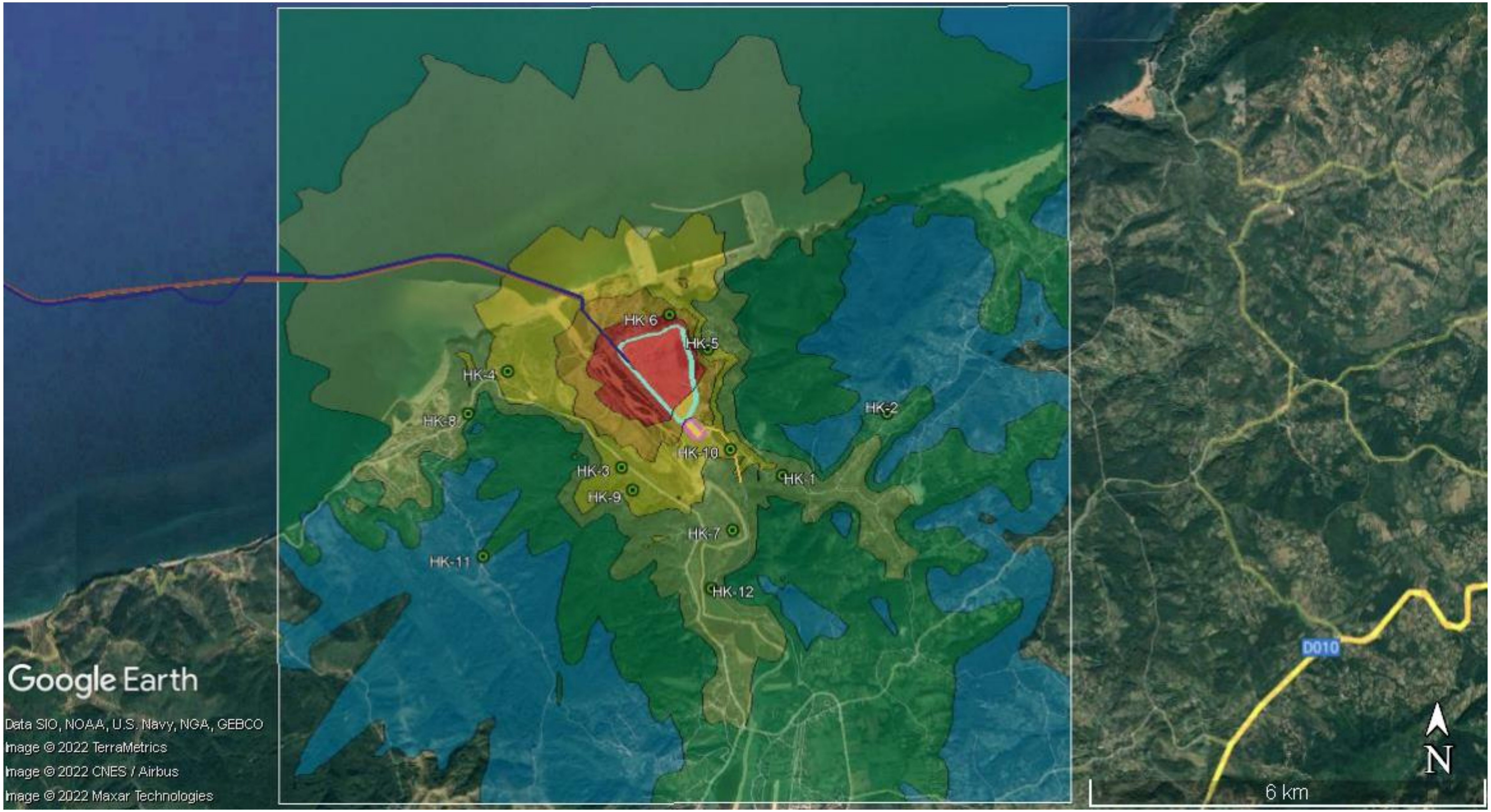


Figure 7-23: 6th Highest 1-Hour Average GLC for NO_2 during Emergency Operation (μg/m³)

Model Results for CO

This scenario was modelled in regard to the maximum emission rate (1,195 g/s of CO) at full flaring capacity. AERMOD allows to input variable emission rates with one hour intervals (not possible to input emission rates for shorter time intervals). Therefore, it was assumed that the emission will last for 1 hour (instead of 70 mins) at a constant rate (at full capacity, not with a decreasing rate). It was also considered that the emergency flaring will occur during the most unfavourable meteorological conditions (when the wind speed is 0.5-1.0 m/s), which gives the worst case GLCs. For this purpose, the date and time giving the highest concentration was identified for each sensitive receptor, and the maximum CO emission rate for a duration of 1 hour is input for that time of the day. The model is run to obtain short-term average (8-hour average) GLC values to compare the results with the short-term limit for CO.

As seen from Table 7-36, the highest 8-hour average GLC values for CO exceed the hourly standard of 10,000μg/m^3 at most of the receptors. Figure 7-24 presents the contour plots for the highest 8-hour average GLC values. As seen from the plots, the highest concentration occurs at the center of the OPF site.

Table 7-36: 1st Highest 8-Hour Average GLC for CO during Emergency Operation

Receptor	Easting	Northing	Elev. (m)	Distance from the source (m)	Averaging Period	Model Results (μg/m^3)	Project Standard (μg/m^3)
Highest Value Calculated by the Model*	422100	4602450	7.5	within fenceline	8 hours	518,278	10,000 (8-hours average)
HK-1	424155	4600940	24	1350	8 hours	10,296	
HK-2	425744	4601871	58	2830	8 hours	3,539	
HK-3	421717	4601068	7	1100	8 hours	30,517	
HK-4	419996	4602522	17	1700	8 hours	16,064	
HK-5	423029	4602850	56	300	8 hours	8,856	
HK-6	422449	4603370	25	300	8 hours	37,027	
HK-7	423394	4600118	10	1470	8 hours	9,590	
HK-8	419395	4601886	47	2470	8 hours	6,348	
HK-9	421883	4600727	16	1250	8 hours	21,198	
HK-10	423367	4601334	14	450	8 hours	15,070	
HK-11	419615	4599735	261	3580	8 hours	1,815	
HK-12	423072	4599243	10	2250	8 hours	7,233	

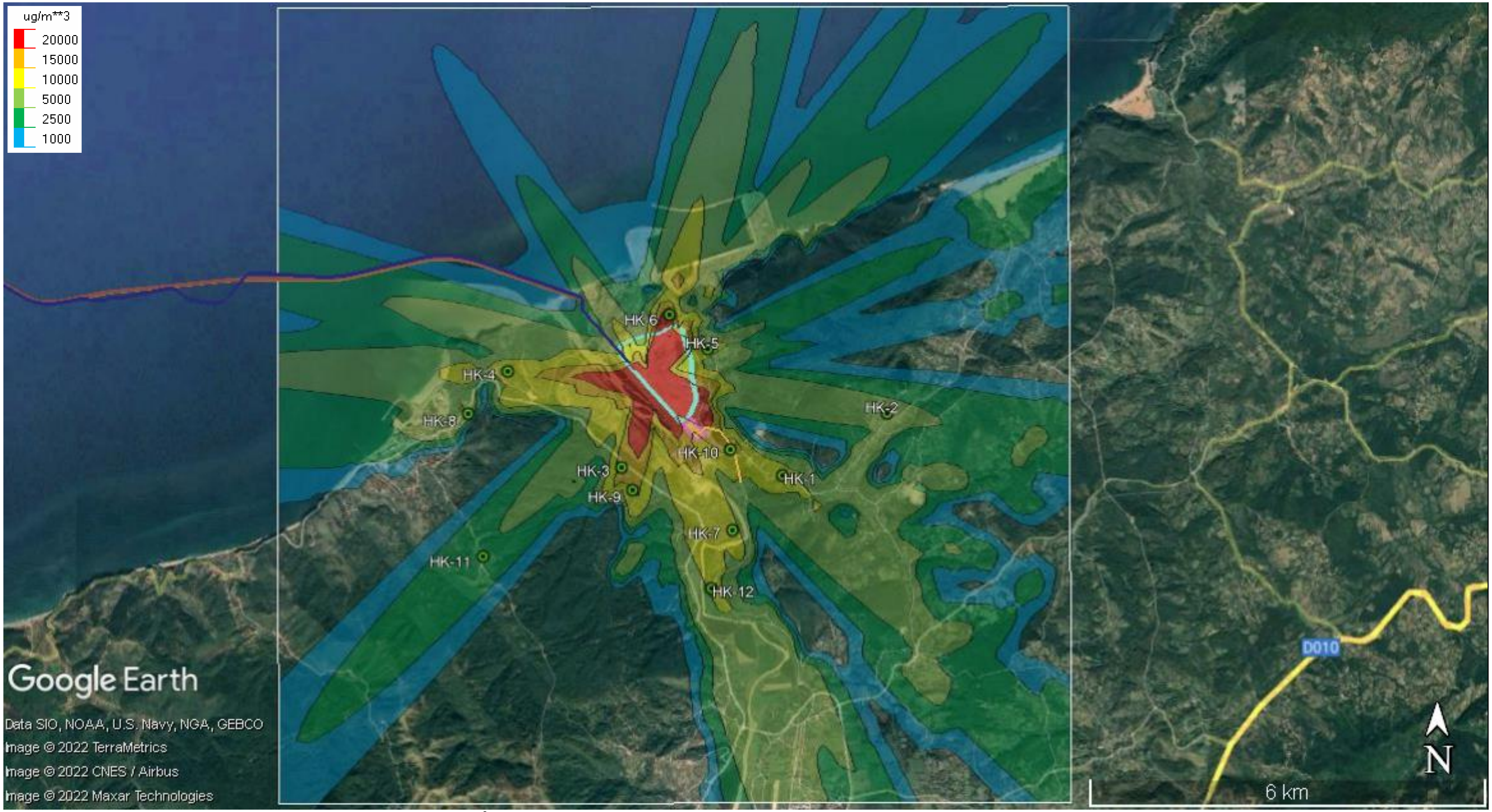


Figure 7-24: 8hr Average GLC for CO during Emergency Operation (μg/m³)

Overall Discussion of the Model Results

Based on the model results, the following conclusions can be drawn:

- During the normal operation, the annual and hourly average NO_2 GLCs are in line with the project standards.
- During abnormal operation, the highest hourly average concentration for NO_2 exceeds the project standard at certain locations (within OPF site and on the east of OPF site) which do not correspond to sensitive receptors. At three of the sensitive receptors, the total pollution value approaches to the limit value.
- None of the sensitive receptors are expected to be significantly impacted during normal or abnormal scenarios as the predicted CO concentration is well within the regulatory limit.
- During emergency operation, the hourly average NO_2 GLCs and 8-hours average CO GLCs are quite above the limit values and likely to adversely impact most sensitive receptors. However, this operating condition is not expected to persist for a long duration. According to the process design team, emergency flaring mainly happens during the first three months of start-up, approximately 15 times, with an average of 70 minutes. Subsequently, the flaring incidents reduce drastically to about 10 shut-downs with an average time 30 mins in 2 years. Moreover, the flaring usually does not happen at the complete rate, as customer will choke the wells and flares are operated with partial opening to maintain pressure in the 180km pipeline.

Mitigation Measures

Fugitive emissions

The following design measures have been considered for the reduction of potential atmospheric leaks from components and instruments, and releases to atmosphere from vessels and inspection points during maintenance:

- Flanged manual valves will have flanges integral with valve body and no welding on valve flanges permitted
- Swing check valves will be provided with limit stops to prevent disc from remaining in open position
- By-pass valves will be globe type
- All (pipeline) fittings will be seamless in construction unless otherwise specified
- In accordance with API 622 all control valves will undergo fugitive testing to the standard ISO 15848 (2015)
- Project places upper permissible leak limit of 100 ppm at stem package flange
- All fillet welds for by-pass installation shall be 100% examined by DP/MO tested and butt weld joints shall be 100% examined by radiography or ultrasonic examination
- The Project will utilise isolation for the following:
  - Valve – Single Block and Bleed (SBB): A single block valve with bleed valve (vent/drain) installed on the same side as the isolated section
  - Valve – Double Block and Bleed (DBB): Double block valve with single bleed valve installed
  - Spectacle Blind: Two discs are attached to each other by section of steel similar to the nose piece of a pair of glasses. One of the discs is a solid plate, and the other is a ring, whose inside diameter is

equal to that of a flange. Either can be rotated into the pipe stream. When ring is in stream there is flow; when solid plate is moved in place flow is prevented

  - Line Blind: Solid plate that is installed in pipeline which completely prevents flow through pipe
  - Spade Solid plate used to cut off flow in pipeline.

- All hydrocarbon handling equipment will have facility for spectacle blind, spade/spacer or removable spool. Spectacle blinds shall be used in preference to spaces whenever design allows. Pumps will be fitted with isolation valves (SBB/DBB) on both suction and discharge ends as close to pump inlet/outlet as possible to minimise vapor build up. Eccentric type flat side up reducers will be used to avoid accumulation of gas pockets.
- Control valves, relief valves, pressure instrumentation, and flow instrumentation will be used as an isolation method for the components on the service lines.
- Project vessels/tanks requiring entry, i.e., for inspection/maintenance purposes will have facility for isolation of the vessel from the main process lines. Isolation of the vessel from both inlet and outlet flows will be achieved through installation of valve isolation (single block and bleed or double block and bleed), spectacle blind, line blind, removable nozzle, or spade.
- For closed and open drainage from the vessels/tanks, the following isolation will be used:
  - Vessels with Hazardous (Closed) drains will be isolated using manual isolation valve (NC) followed by spectacle blind and then ball valve (NC) arrangement.
  - Non-hazardous (open) drains will use single block valve followed by U-bend and connected to the common open drain header.
- Isolation equipment will be installed as close as possible to the vessel/tank to minimise amount of gas between isolation point and vessel. Positive isolation will be achieved prior to depressurisation of tank/vessel.
- Pig receiver will use DBB isolation. Each receiver will be fitted with flanged purge connection with isolation valve and check valve.
- The following design considerations have been put forth as given in the Piping design philosophy:
  - Protective coating will be applied to pipeline to reduce risk of fracture and accidental releases.
  - Threaded connections will not be used for process connections (except instrument take-offs after the process isolation valve).
  - Use of flanges on pipe will be kept to a minimum, limited to connecting lines to equipment.
- Hydrocarbon containing vertical fixed roof tanks' (Rich MEG, Lean MEG and Slop Oil tanks) vent lines will be connected to the LLP flare. .
- Leak Detection and Repair (LDAR) programs will be developed and will be implemented as a part of the management system.

Flaring emissions

The following mitigation measures have been considered in the design of flares:

- Multiple tips ensure smokeless burning under all flow conditions.
- Operating flare to control odor and visible smoke emissions (no visible black smoke).
- Flare pilots are of a robust design that have been proven to remain lit in extreme wind and rain conditions.
- Backup supply of pilot fuel via propane bottles to supply up to 8 hours of uninterrupted pilot operation should the fuel gas supply fail.
- Redundant pilots on every stage of the flare.
- Redundant ignition system (high energy ignition/flame front generator) with automatic pilot relight capability.

The following pollution prevention and control measures should also be considered for gas flaring:

- Implementation of source gas reduction measures[9] to the maximum extent possible;
- Use of efficient flare tips, and optimization of the size and number of burning nozzles;
- Maximizing flare combustion efficiency by controlling and optimizing flare fuel / air stream flow rates to ensure the correct ratio of assist stream to flare stream;
- Minimizing flaring from purges and pilots, without compromising safety, through measures including installation of purge gas reduction devices, flare gas recovery units, inert purge gas, soft seat valve technology where appropriate, and installation of conservation pilots;
- Minimizing risk of pilot blow-out by ensuring sufficient exit velocity and providing wind guards;
- Use of a reliable pilot ignition system;
- Installation of high integrity instrument pressure protection systems, where appropriate, to reduce over pressure events and avoid or reduce flaring situations;
- Minimizing liquid carry-over and entrainment in the gas flare stream with a suitable liquid separation system;
- Minimizing flame lift off and / or flame lick;Locating flare at a safe distance from local communities and the workforce including workforce accommodation units;
- Implementation of burner maintenance and replacement programs to ensure continuous maximum flare efficiency;
- Metering flare gas;

[9] As per IFC EHS Guideline on Onshore Oil and Gas Development, measures consistent with the Global Gas Flaring and Venting Reduction Voluntary Standard (part of the World Bank Group's Global Gas Flaring Reduction Public-Private Partnership (GGFR program) should be adopted for flaring and venting options. The standard provides guidance on how to eliminate or achieve reductions in the flaring and venting of natural gas.

- In the event of an emergency or equipment breakdown, or plant upset conditions, excess gas shall not be vented but shall be sent to the flare gas system;
- Flaring volumes should be estimated during the initial commissioning period so that fixed volume flaring targets can be developed.

Hydrogen sulfide (H_2S) emissions

- The gas composition did not indicate any significant presence of sulphur and flame-out case has been considered by the HAZOP Analysis to be unlikely because relevant safeguards are in place. Nevertheless, a hydrogen sulfide gas monitoring network has been installed within the OPF site to facilitate early detection and warning. The location of monitoring stations takes into account the location of emissions sources and areas of community use and habitation.
- Emergency Preparedness and Response Plan (EPRP) involves effective responses to monitoring system warnings and accounts for community health.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix x.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low to medium negative impact** is expected on the air quality during the operation phase.

Table 7-37: Residual impact assessment matrix for the air quality during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Emission of gaseous pollutants during normal operation	Duration:	Long	Medium-high	Short-term	**Low**	Low	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Low					
Emission of gaseous pollutants during abnormal operation	Duration:	Long	Medium-high	Short-term	**Low**	Low	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of gaseous pollutants during emergency operation	Duration:	Long	Medium-high	Short-mid-term	**Medium**	None	**Medium**
	Frequency:	Infrequent					
	Geo. Extent:	Regional					
	Intensity:	Very high					
Overall assessment:		**Low to Medium**	Rationale:	Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value			

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the Project on the air quality during the operation and verify the effectiveness of the mitigation measures.

- Continuous Emission Monitoring Systems (CEMS) will be installed at Indirect Fired Heater, Diesel Generator, LP Steam Boiler and Reciprocating Gas Engine units;
- Routine maintenance programme will be set-up and maintenance records will be kept for all units, machinery/equipment, and vessels;
- The volumes of gas flared for all flaring events should be recorded and reported;
- A logbook should be maintained and any exceptional incidents should be recorded;
- Periodical ambient air quality monitoring at the sensitive receptors: Monthly monitoring during the first 4 months of operation (including testing & commissioning), to be followed by quarterly monitoring until the first 2 years of operation. The monitoring plan would then be revised in accordance with the measurement results. Parameters to be monitored: NO_x, SO_2, H_2S, VOC, O_3.

7.2.1.2.3 Greenhouse Gas Emissions Estimation

As a part of this ESIA, a GHG Inventory has been prepared in line with the Equator Principles 4 (EP4). This GHG Inventory is intended to serve as documentation and a basis for providing background on the procedures for estimation of GHG emissions at the Facility, particularly from the stationary combustion sources. This GHG Inventory provides a description of the Facility's GHG sources and the quantification procedures used to calculate GHG emission estimates. It presents reference material which provides the framework for developing the inventory boundary and lists the emission factors and approaches that were used.

Review of Applicable GHG Estimation Guidelines

EP4 requires GHG emissions to be calculated in line with the GHG Protocol (GHG Protocol, n.d.). However, based on EP4, projects can use national reporting methodologies if they are consistent with the GHG Protocol. The GHG inventory for the Project has been developed based on Tier 1 methods from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006). The IPCC Guidelines provides differing "tiers" of calculation methods for estimating emissions, with each subsequent tier requiring a higher level of detail and accuracy. Tier 1 methods typically require the least amount of detailed information and are calculated based default emission factors. The Tier 2 method is similar to Tier 1, however country-specific emission factors are used in place of the IPCC default factors. Finally, Tier 3 method requires the most detailed information, but provides the highest level of accuracy. For GHG emissions from each source, the tier methodology used in the calculations will be provided.

Identification of GHG Emission Sources

EP4 requires estimation of Scope 1 and Scope 2 emissions for GHG inventories. Table 7-38 presents the GHG sources identified at the Facility. Scope 1 emissions includes emissions associated from fugitive sources, stationary combustion, and on-site transportation. Fugitive emissions includes emissions associated with venting emissions (blowdown vent emissions), flaring emissions, emissions from equipment leaks (including metering stations, pipeline mains, service lines, and damage events) and other fugitive sources (including farm taps and customer meter sets). Stationary combustion emissions includes emissions from combustion of natural gas at the facility including operations associated with electricity generation. Lastly, emissions from on-site transportation includes combustion emissions from transportation of vehicles and marine vessels. To be consistent with the air quality assessment inventory summarized in this ESIA, only emissions from stationary combustion sources have been considered for the assessment, as summarized in Table 7-38.

Scope 2 emissions includes emissions from purchase of electricity. The Project will produce its own electricity from natural gas. As the Project will not purchase electricity, there are no Scope 2 emissions associated with the operations phase of the Project, and hence Scope 2 emissions are not considered for the GHG assessment.

Table 7-38: GHG Emission Sources from the Project Facility

Activity	Emission Source	Source Category	Considered for GHG Assessment[1]
Fugitive emissions	Fugitive natural gas emissions from above ground meter-regulating stations, pipeline mains, service lines, pipeline flaring, damage events, residential and commercial meter sets	Scope 1 (Direct emissions)	Yes
General stationary combustion	Natural gas combustion at the Facility	Scope 1 (Direct emissions)	Yes
On-site transportation	Combustion emissions from any on-site transportation vehicles and marine vessels.	Scope 1 (Direct emissions)	No
Purchase of electricity	Emissions associated with electricity purchase.	Scope 2 (Indirect emissions)	N/A

Note: Emission sources considered in the GHG Assessment are selected to be consistent with the Air Quality Assessment. N/A = Not Applicable.

GHG Emissions Calculation Methodology

This section describes the methodology used for calculating GHG emissions for the GHG Inventory. GHG emissions were only calculated for the stationary combustion sources and fugitive sources. The stationary combustion sources were divided into upset and maintenance emissions, power generation, process emissions, and emergency equipment. As a first step, data required for the calculation was obtained from an information request provided to TP-OTC and is summarized in Table 7-39. Data requirements to calculate GHG emissions at the Project site was associated with site-specific fuel consumption data resulting in GHG emissions.

Table 7-39: Fuel Usage Data from Client

Emission Source	Activity	Fuel Type	Unit of Measure	Annual Estimate
Upset and Maintenance	HP Flare package	Fuel Gas	$MMSm^3$	0.3
	LP/LLP Flare Package	Fuel Gas	$MMSm^3$	0.1
	HP Flare purge	Fuel Gas	$MMSm^3$	1.8

Emission Source	Activity	Fuel Type	Unit of Measure	Annual Estimate
Power Generation	Gas Engine Generator Package	Fuel Gas	$MMSm^3$	28.5
Process Emissions	LP Steam Boiler Package	Fuel Gas	$MMSm^3$	38.0
	Indirect Fired Heaters	Fuel Gas	$MMSm^3$	5.8
	TEG package	Fuel Gas	$MMSm^3$	1.2
Emergency Equipment	EDG test runs	Diesel	m^3	30.6
	Fire Water pumps test runs	Diesel	m^3	7.65

Stationary combustion emissions were reported using the methodology described by the IPCC Guidelines, Chapter 2 Stationary Combustion. Equations 2.1 and 2.2 from the IPCC Guideline were used to estimate the annual total emissions of GHGs from stationary combustion sources. The IPCC Guideline provides the following equations (Equation 1 and Equation 2) for the calculation of stationary combustion, as directed in Chapter 2.

Equation 1 (Equation 2.1 in the IPCC Guideline)

$$Emissions_{GHG,fuel} = Fuel\ Consumption_{fuel} \times Emission\ Factor_{GHG,fuel} \times HHV \times 0.001$$

Where:

$Emissions_{GHG,\ fuel}$ = emissions of a given GHG by type of fuel (kg GHG)
$Fuel\ Consumption_{fuel}$ = amount of fuel combusted (TJ)
$Emissions\ Factor_{GHG,\ fuel}$ = default emission factor of a given GHG by type of fuel (kg gas/TJ). For CO_2, it includes the carbon oxidation factor, assumed to be 1.

This methodology is based on fuel consumption, default HHV, and default fuel specific emission factor (kg CO_2/GJ). The following equation was used to calculate the total CO_2 emissions from stationary fuel combustion.

Equation 2 (Equation 2.2 in the IPCC Guideline)

$$E_{CH_4/N_2O} = \sum_{p=1}^{n} Fuel_i \times HHV \times EF \times 0.000001$$

Where:

$E_{CH4/N2O}$ = Annual CH_4 or N_2O emissions from combustion of fuel in stationary sources (tonnes CH_4 or N_2O)
$Fuel_i$ = Volume of the fuel combusted in the calendar year (m^3)
HHV= Default high heat value of the fuel (GJ/m^3)

EF = Fuel-specific default CO_2 emission factor
0.000001 = Conversion factor from g to tonnes

Emission factors were taken from Environmental Protection Agency (EPA 2021) and are summarized in Table 7-40. Use of these emission factors is consistent with applicable GHG Protocol guidance document.

Table 7-40: Emission Factors (EPA 2021)

Activity	Fuel Type	CO_2 Emission Factor	CH_4 Emission Factor	N_2O Emission Factor
Stationary Combustion	Natural Gas	53.060 kg CO_2 per mmBtu	1.0 g CH_4 per mmBtu	0.1 g N_2O per mmBtu
	Diesel	73.96 kg CO_2 per mmBtu	3.0 g CH_4 per mmBtu	0.6 g N_2O per mmBtu

The fugitive emission sources were calculated assuming that all emissions would be methane emissions. Data required for the calculation of GHG emissions from fugitive sources is summarized in Table 7-41. Consistent with the air quality section, methane emissions were calculated by multiplying number of onshore equipment data with the emission factors from Regulation on Control Industrial Air Pollution, Annex 2, Table 2.1.

Table 7-41: Onshore Equipment Data

Equipment Type	Service	Number of Onshore Equipment
Valve	Gas	567
	Heavy Oil	928
Flange	Gas	810
	Heavy Oil	1328
Pressure Relief Devices	Gas	36
	Heavy Oil	24

The GHG emissions estimates for CO_2, CH_4, and N_2O, were then multiplied by their respective Global Warming Potential (GWP) to estimate the carbon-di-oxide equivalent (CO_{2e}) GHG emissions. The GWP for these Greenhouse gases were derived from IPCC Fifth Assessment Report (AR5) (IPCC 2014) and are summarized in Table 7-42.

Table 7-42: Global Warming Potential (GWP) for Greenhouse Gases (IPCC 2014)

Greenhouse Gas	Formula	GWP
Carbon Dioxide	CO_2	1
Methane	CH_4	28

Greenhouse Gas	Formula	GWP
Nitrous Oxide	N_2O	265

GHG Emissions from the Project

The direct annual GHGs from the stationary combustion and fugitive emissions sources associated with the project are presented in Table 7-43. Emissions associated with electricity production from the power plant are included in the stationary combustion. These annual emissions were calculated for the maximum operating scenario. The GHG emissions from the direct sources represent 100% of the project GHG emissions.

Table 7-43: Annual GHG Emissions from the Project (Scope 1)

Source	Activity	Emissions (kt)				
		CO_2	CH_4	N_2O	CO_2e	% of Project Total
Stationary Combustion	Upset and Maintenance	4.1	0.0	0.0	4.1	2.8
	Power Generation	54.7	0.03	0.03	54.7	54.7
	Process Emissions	86.4	0.05	0.05	59.5	59.5
	Emergency Equipment	<0.001	<0.001	<0.001	<0.001	0.0
Fugitive Emissions	Connection Equipment Losses	0.0	0.03	0.0	0.7	0.5
	Total Emissions				**146**	**100%**

GHG Emissions Intensity

The emissions intensity measurement consists of the amount of GHG emitted per tonne of compressed LNG produced on an annual basis. Emissions intensity was calculated using Equation 3.

Equation 3

$$Emissions\ Intensity = \frac{Total\ Annual\ GHG\ Emissions(tonnes\ CO_2e)}{Total\ Annual\ LNG\ Production\ (tonnes\ LNG)}$$

Based on the equation above, the Scope 1 emissions intensity of the Project was estimated to be 0.04 $tCO_2e/tLNG$ produced annually. Emissions associated with fugitive sources and on-site transportation have not been included in the estimation of GHG intensity.

Comparison of Project GHG Totals to Sector, Country, and Global Emissions

Turkey's total annual GHG emissions reported for 2019 were 506.1 megatonnes of carbon dioxide equivalent (Mt CO2e) (Turkish Statistical Institute 2021). Based on the available emissions reported globally for 2018, Turkey represented approximately 1% of the total global GHG emissions, which were 47,552 Mt CO2e in 2018 (Government of Canada 2022). The Project would contribute 0.03% to Turkey's national annual emissions (see Table 6).

The sector that contributes the most to Turkey's national GHG emissions is the energy sector, which the Project is a part of (Turkish Statistical Institute 2021). In 2019, the energy sector contributed 364.4 Mt CO2e, which accounts for 72% of Turkey's emissions that year (Turkish Statistical Institute 2021). Turkey's emissions in 2019 by sector, compared to the Project's total emissions can be seen in Table 7-44.

Table 7-44: Turkeys 2019 Emissions by Sector Compared to Project Emissions

Sector	Emissions (Mt CO_2e)	Sector % of Total Country Emissions	Project % of emissions
Energy	364.4	72%	0.04%
IPPU	56.4	11%	N/A
Agriculture	68.0	13%	N/A
Waste	17.2	3%	N/A
Total Country Emissions	**506.1**	N/A	0.03%
Project Emissions	**0.15**	**N/A**	**N/A**

* Information in this table regarding Turkeys overall emissions was taken from Turkey's 2021 National Inventory Report (Turkish Statistical Institute 2021).

It is important to note that the Project will contribute to the growing nature of Turkey's economy, and it can be assumed that energy demand will continue to increase as the economy grows. There will be a demand for the energy that is provided by the Project continually until project completion as energy demands increases with economic growth.

Summary

The GHG emissions from stationary combustion sources and fugitive emission sources of the Project were estimated to be 145.3 $ktCO_{2e}$ annually and 0.7 $ktCO_{2e}$ annually, respectively. The Scope 1 emissions intensity of the Project was estimated to be 0.04 tCO_{2e}/t LNG produced annually. The annual GHG emissions and the GHG emissions intensity has been calculated considering the stationary combustion sources and fugitive emission sources. GHG emissions from on-site transportation sources have not been considered for this assessment, to be consistent with the air quality section. Inclusion of GHG emissions from these sources could lead to higher annual emissions intensity from the Project.

The emissions from the Project are estimated to be above 100 $ktCO_{2e}$ annually. EP4 required projects with emissions above 100 $ktCO_{2e}$ annually to conduct an alternatives assessment to identify the best practicable environmental options and consideration of alternative fuel or energy sources that were considered for the project. An alternatives assessment has been conducted for the Project and has been summarized in Chapter 4.

7.2.1.3 Noise and Vibration

Based on the information collected for the definition of the baseline (see Chapter 6.2.1.3), the physical component *Noise and Vibration* was assigned a **Medium-High** value of sensitivity for the following reasons:

- High noise levels in the AoI
- Close presence of communities, vulnerable targets and sensitive ecological receptors potentially exposed to noise and vibration emissions
- Other ongoing projects (under construction and planning stage) around the Project area.

Potential impacts to noise and vibration associated with construction and operation phases of the Project include;

- Emission of aerial noise and vibrations;

The project actions related to the abovementioned impact factors are the following:

- Vegetation clearing
- Site levelling and grading;
- Material transportation
- General onshore engineering/construction works;
- Plant/infrastructure onshore operation.

Methodology

For the assessment of the noise and vibration to be generated during the construction and operation phases of the Project, a noise modelling study and a vibration assessment study have been conducted by a specialist company (Frekans Acoustics & Environmental Laboratory, "Frekans") as part of the ESIA in order to determine the potential impacts. The methodology used and the noise and vibration calculations are summarized in this chapter. Noise and Vibration Report prepared by Frekans is presented in Appendix P. It should be noted that the methodology used by Frekans was incorporated into Golder's methodology for coherency.

For the construction phase, environmental noise and vibration levels were calculated by using appropriate methods taking account of construction equipment, dredging and piling activities (see Chapter 3.7.2.3 for equipment list used in the modelling). It is assumed that the machines given for each construction area will work with a homogeneous distribution in the relevant regions. Operational noise and vibration levels were calculated with taking account of operation equipment.

Noise levels around the AoI will increase during the construction temporarily and operation phase of the Project. The difference between the baseline noise levels and the noise levels during Project implementation will determine the impact and its significance. The sections below detail the impact and mitigations for the noise and vibration in the construction phase and operation phase of the Project.

A noise model was developed using commercial noise modeling software CadnaA from Datakustik. The calculation parameters and sound source levels for the modeling and the methods are described in this section.

Since sound propagation is hugely affected by terrain which can act as an obstacle to noise, information on ground topography was considered in the noise model. Ground topography data for the project area was used to develop the model. Topographical data for the noise propagation pathway was obtained from client.

Ground sound absorption (G) varies between 0 for hard - reflective surfaces and 1 for soft - absorptive surfaces. When calculating noise propagation, G was considered as 0.9 for rural areas due to the substrate being soil.

Meteorological data (average relative humidity, average temperature, wind frequencies) were included in the noise mapping software to calculate the most suitable sound propagation conditions. Meteorological attenuation parameters – Cmet - are considered as 1.5, 0.7 and 0 for day, evening and night periods respectively.[10]

Buildings were introduced to prepare 3D noise propagation model where relevant data exists.

To evaluate the background noise climate of the existing conditions, in the area of influence, noise level measurement results were conducted (see Chapter 6.2.1.3).

The receiver locations were selected depending on the sections of the possibility of having potential noise impact from the Project construction and operation activities. Along the project field, 13 different receiver locations were selected to conduct noise impact assessment to predict the potential impact of the Project.

Identified receiver locations are representing a cluster of receivers which have the same or similar background characteristics in terms of environmental noise levels. Moreover, receivers to be evaluated can be defined as representative points which have the highest possibility to expose to noise due to project operations. Receiver locations are presented in Table 7-45 and Figure 7-25.

Table 7-45: Receiver Points Information

Receiver Points	Comments	Distance to Project Border (Special Investment Zone) (m)
Sefercik 1	Residential	1255
Sefercik 2	Residential	1220
Gökçeler	Residential	770
Derecikören 1	Residential	440
Derecikören 2	Residential	240
Aşağıihsaniye 1	Residential	15
Aşağıihsaniye 2	Residential	90
Aşağıihsaniye 3	Residential	0
Sazköy 1	Residential	170
Sazköy 2	Residential	45
Sazköy 3	Residential	220
Sazköy 4	Residential	130
Sazköy 5	Residential	120

[10] Adaptation and revision of the interim noise computation methods for the purpose of strategic noise mapping, EUROPEAN COMMISSION DG Environment, 2003.

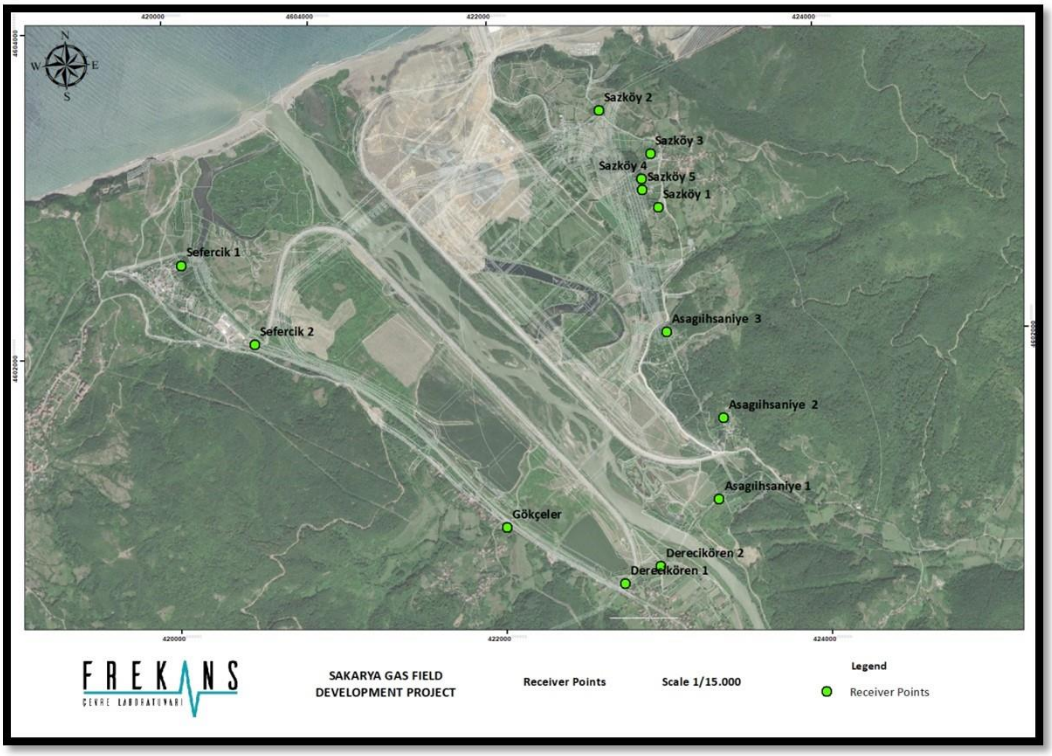


Figure 7-25: Receiver Locations

7.2.1.3.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting in terms of noise and vibration during construction phase are listed in Table 7-46.

Table 7-46: Project actions and related impact factors during construction phase

Project actions	Brief description	Impact factors
Vegetation clearing	Removal of natural and farmed vegetation from the pole areas along the ETL, and from coastal dune area within the Project's footprint.	Emission of aerial noise and vibrations
Site levelling and grading;	Removal of the first 300 mm of soil from ETL pole locations and dune habitat in the landfall area. Earthwork equipment will operate during ground reinforcement, excavation, filling works at the onshore section and offshore vessels will operate during excavation of the trench in shallow water (up to 2 km) in correspondence of the land approach.	Emission of aerial noise and vibrations

Project actions	Brief description	Impact factors
Material transportation	Removed soil and construction material will be transported out and in the construction area using trucks and heavy machinery. Building material will include crushed rocks and gravel for both the landfall area and the ETL. Sediment will be transported between storage area and pipeline route. Pipe loading and transportation works will be carried out at the Coastal Logistics Center. Offshore vessels will operate during material and sediment transportation.	Emission of aerial noise and vibrations
General onshore engineering/construction works;	Heavy machinery and concrete batching plant will be operating on the onshore construction areas including landfall, OPF, transformer station and ETL.	Emission of aerial noise and vibrations

All the impact factors identified above are described below and assessed in the matrix that follows.

- **Emission of aerial noise and vibrations**

Increased noise and vibration levels are expected due to operation of generators, heavy machinery, bored piles, concrete batching plant etc. during;

- vegetation clearing and site levelling and grading on the ETL route (pole locations)),
- site levelling, grading and ground reinforcement works of onshore construction areas,
- material transportation including excavation material, equipment in and out in the onshore construction areas;
- pipe loading transportation between Coastal Logistics Center and pipeline route by vessels;
- sediment transportation between temporary storage area and pipeline route;
- operation of vessels during excavation of the trench in shallow water (up to 2 km);
- general onshore construction works.

As a result of examination of construction schedule of different Project components,

Noise Modelling

Most logical way to express constructional noise is to create area noise sources with the noise modelling software. Since a variety of constructional equipment will be used during the entire construction phase, it may be complicated to mirror the real noise case into the modelling software. Logic used while modelling constructional noise is determining the reasonable and necessary amount of constructional equipment in a reasonable area.

As a result of the examination of the construction schedule of the different Project components, the period with the highest noise and vibration impact was determined as the June-August 2022 period when the construction works of landfall, OPF, transformer station and ETL overlapped. Accordingly, modeling was carried out according to the areas where construction will commence on, and the equipment list provided by TP-OTC.

Construction zones and total sound power levels are presented in Table 7-47.

The sound power levels of the related construction machines/equipment, which provided by TP-OTC, are defined in the "BS 5228-1:2009+A1:2014 - Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise" standard. The total sound power level is distributed over the construction area with using formula below.

Lw''=Lw-10*log(S1/S0)

where;
Lw'': Total Sound Power Level / Area (dBA/m^2)
Lw: Sound Power Level (dBA)
S1: Construction Area (m^2)
S0: Reference Area, 1 m^2

Table 7-47: Construction Zones –Total Sound Power Levels

Construction Zone	Total L_w (dBA)	Construction Area (m^2)	Total L_w'' $(dBA/m2)$
Coastal Transition Section	-	-	70.0
Coastal Logistics Center	93.8	277,800	39.4
Landfall	105.7	256,700	51.6
OPF	125.6	58,530	77.9
Transformer Station and Energy Transmission Line	83.8	38,200	38.0
Concrete Batching Plant	109.9	6210	72.0

While the construction modelling, it was assumed that all equipment were working simultaneously in the June-August 2022 period for Phase 1 construction works. Piling activities which are expected to contribute the most to the noise to be generated were located at the locations specified by TP-OTC (Figure 7-26).

Noise modelling results at selected receiver points are presented in Table 7-48 for Regulation on Assessment and Management of Environmental Noise (RAMEN) Limits and Table 7-49 for IFC Limits. The construction noise maps are presented in Figure 7-26 for daytime and Figure 7-27 for night-time. The larger sizes of the maps are submitted in Appendix P.

Table 7-48: Construction Phase Noise Assessment Results, RAMEN Limits

Receiver Point	Model Result L_{eq} (dBA)			Limit Value L_{eq} (dBA)			Limit Exceedance Max (dBA)
	L_{day}	L_{eve}	L_{night}	L_{day}	L_{eve}	L_{night}	
Sefercik 1	38.3	39.1	39.7	70.0	65.0	60.0	0.0
Sefercik 2	39.1	39.9	40.6	70.0	65.0	60.0	0.0
Gökçeler	39.3	40.1	40.7	70.0	65.0	60.0	0.0
Derecikören 1	41.1	41.9	42.6	70.0	65.0	60.0	0.0
Derecikören 2	41.7	42.5	43.1	70.0	65.0	60.0	0.0
Aşağıihsaniye 1	43.3	44.1	44.8	70.0	65.0	60.0	0.0
Aşağıihsaniye 2	42.5	43.3	43.9	70.0	65.0	60.0	0.0
Aşağıihsaniye 3	57.1	57.8	58.4	70.0	65.0	60.0	0.0
Sazköy 1	46.9	47.6	48.3	70.0	65.0	60.0	0.0
Sazköy 2	51.6	52.4	53.0	70.0	65.0	60.0	0.0
Sazköy 3	47.9	48.6	49.3	70.0	65.0	60.0	0.0
Sazköy 4	52.4	53.1	53.8	70.0	65.0	60.0	0.0
Sazköy 5	52.3	53.0	53.7	70.0	65.0	60.0	0.0

L_{day}: Equivalent continuous sound pressure level for reference time interval day (07:00-19:00).
L_{eve}: Equivalent continuous sound pressure level for reference time interval evening (19:00-23:00).
L_{night}: Equivalent continuous sound pressure level for reference time interval night (23:00-07:00).

Table 7-49: Construction Phase Noise Assessment Results, IFC Limit

Receiver Point	Model Result L_{eq} (dBA)		Baseline L_{eq} (dBA)		Cumulative (dBA)		Limit Value (dBA)*		Limits Exceedance Max
	L_d	L_n	L_d	L_n	L_d	L_n	L_d	L_n	
Sefercik 1	38.3	39.7	50.5	49.4	50.7	49.9	55.0	52.4	0.0
Sefercik 2	39.1	40.6	51.4	46.6	51.7	47.6	55.0	49.6	0.0
Gökçeler	39.3	40.7	61.3	54.2	61.3	54.4	64.3	57.2	0.0
Derecikören 1	41.1	42.6	58.7	54.4	58.8	54.6	61.7	57.4	0.0
Derecikören 2	41.7	43.1	58.7	54.4	58.8	54.7	61.7	57.4	0.0
Aşağıihsaniye 1	43.3	44.8	50.8	46.1	51.5	48.5	55.0	49.1	0.0
Aşağıihsaniye 2	42.5	43.9	50.8	46.1	51.4	48.1	55.0	49.1	0.0
Aşağıihsaniye 3	57.1	58.4	52.2	43.1	58.3	58.5	55.0	45.0	**13.5**
Sazköy 1	46.9	48.3	47.2	44.3	50.1	49.8	55.0	45.0	**4.8**
Sazköy 2	51.6	53.0	51.1	47.7	54.3	54.1	55.0	50.7	**3.5**
Sazköy 3	47.9	49.3	47.2	44.3	50.6	50.5	55.0	45.0	**5.5**
Sazköy 4	52.4	53.8	47.2	44.3	53.6	54.3	55.0	45.0	**9.3**
Sazköy 5	52.3	53.7	47.2	44.3	53.5	54.2	55.0	45.0	**9.2**

L_d: Equivalent continuous sound pressure level for reference time interval day (07:00-22:00).
L_n: Equivalent continuous sound pressure level for reference time interval night (22:00-07:00).
Limit exceedances (above 3 dBA) are presented in **red**.
*3 dBA (limit exceedance) is added to Limit Values where baseline noise levels exceed IFC limits.

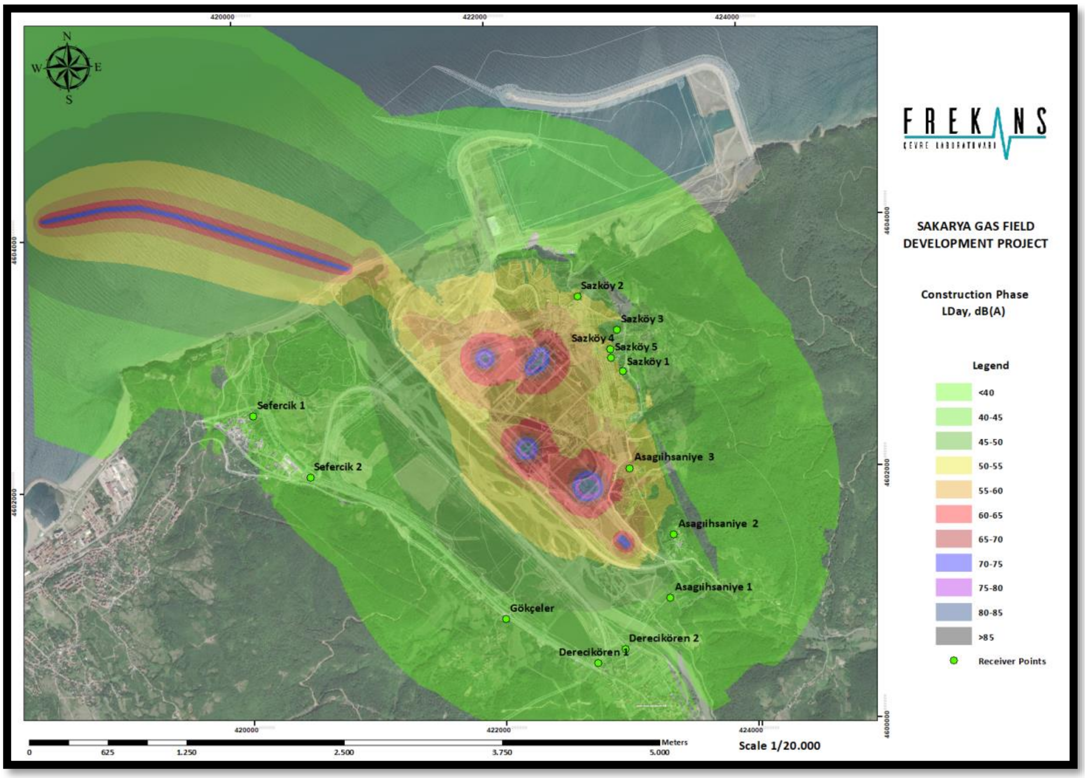


Figure 7-26: Construction Noise Map - Day

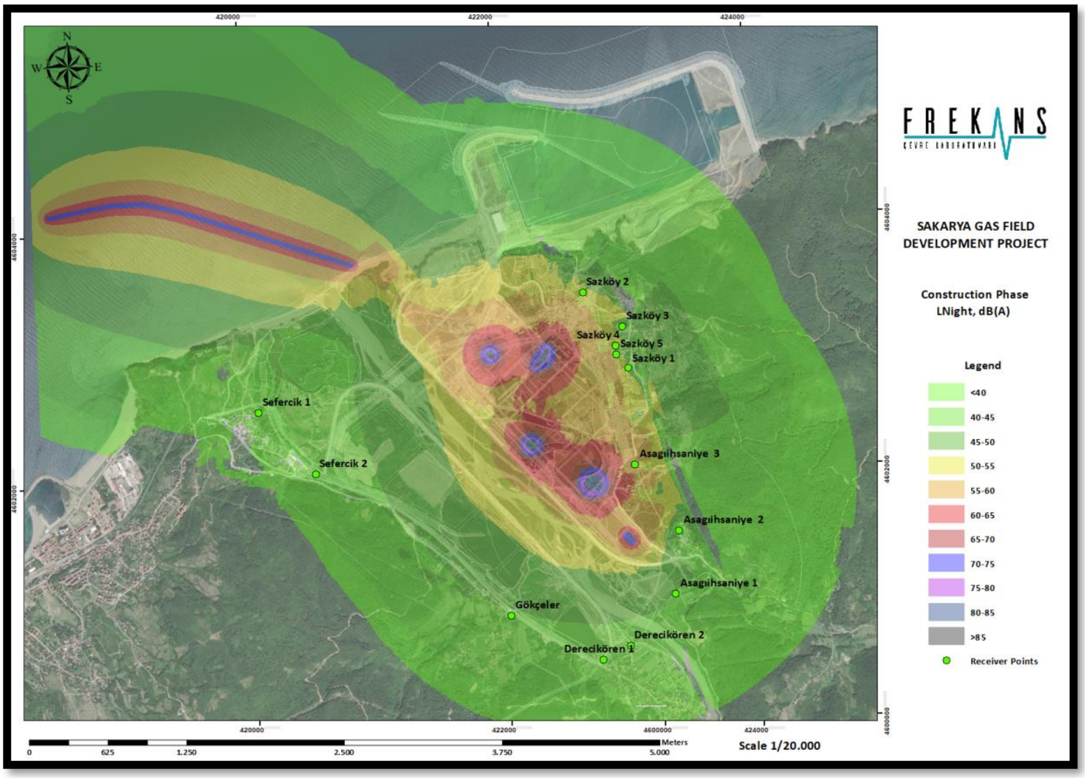


Figure 7-27: Construction Noise Map - Night

As it can be seen from assessment tables related with the construction phase of the Project, all receiver points comply with Turkish RAMEN limit values whereas Aşağıihsaniye 3 receiver point and all Sazköy receiver points exceeds maximum 3 dBA exceedance criteria defined by IFC EHS Guidelines.

Vibration Assessment

During construction period regarding to the distances of the main construction area major vibration source for receptors are pile driving activities.

In order to simulate maximum vibration that may occur at receptors, calculations and assessment will be conducted in terms of environmental vibration sourced from pile driving activities. No blasting activity is defined for the Project.

The major vibration interaction is pile-driving activities for the construction phase. Therefore, the reference vibration value is accepted as pile driver (impact) – typical.

Table 12-2. Vibration Source Levels for Construction Equipment (From measured data.[7,8,9,10])			
Equipment		**PPV at 25 ft (in/sec)**	**Approximate L_v† at 25 ft**
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (sonic)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory Roller		0.210	94
Hoe Ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58
† RMS velocity in decibels (VdB) re 1 micro-inch/second			

Figure 7-28: Reference Vibration Levels of Construction Equipment – FTA Document[11]

The peak particle velocities at the identified receivers are calculated with reference vibration velocities and distances in between the working area and receiving bodies as shown in the equation below.

$$PPVreceiver = PPVreferance \times (dref/drec)^{1.5}$$

PPV: peak particle velocity (mm/s),

dref: reference distance (m),

drec: receiver distance (m)

Calculations were conducted according to the information and reference vibration levels gathered from FTA document. The major vibrational activity is pile-driving for the construction phase. Therefore, the reference vibration value is accepted as pile driver (impact) – typical according to the FTA.

Critical distances from the construction zone are calculated as 10 meter according to the RAMEN limit and 100 meters according to the BS 5225-2:2009 document. As can be seen from Figure 7-29, construction activity closer than this distance to the receiving bodies will have impact.

[11] Quagliata, 2018

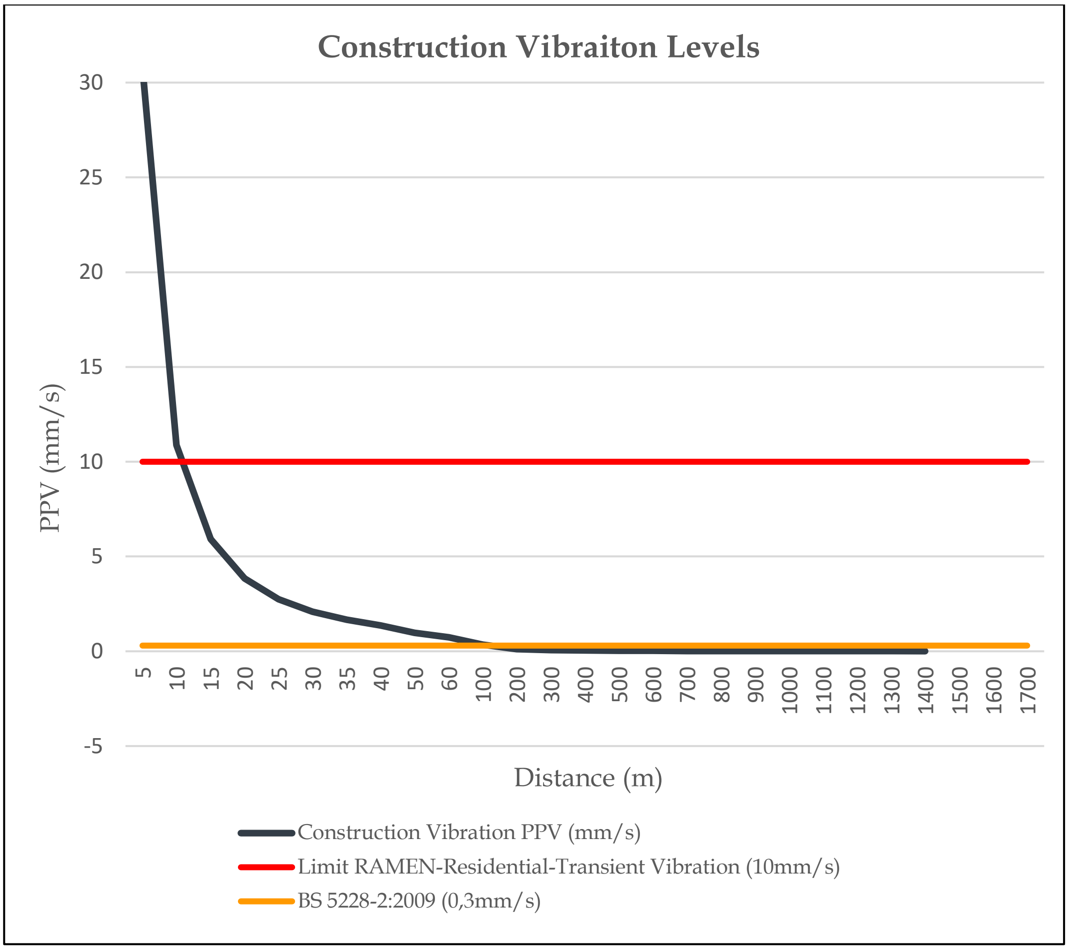


Figure 7-29: Construction Vibration Levels and Limit Values [12]

Calculated construction vibration levels at receiver points are presented in Table 7-50. As it can be seen from the table, none of receiving body is within the critical distance.

Table 7-50: Construction Vibration Results

Receiver Points	Distance (m)	Limit Values (mm/s)		Construction Vibration Value (mm/s)
		RAMEN	BS5228-2	
Sefercik 1	1620	10	100	0.005
Sefercik 2	1385	10	100	0.007
Gökçeler	1030	10	100	0.010

[12] Antoinette Quagliata, Transit Noise and Vibration Impact Assessment Manual, FTA, 2018.

Receiver Points	Distance (m)	Limit Values (mm/s)		Construction Vibration Value (mm/s)
		RAMEN	BS5228-2	
Dereciören 1	1230	10	100	0.008
Dereciören 2	1190	10	100	0.008
Aşağıihsaniye 1	1015	10	100	0.011
Aşağıihsaniye 2	720	10	100	0.018
Aşağıihsaniye 3	215	10	100	0.109
Sazköy 1	280	10	100	0.073
Sazköy 2	250	10	100	0.087
Sazköy 3	350	10	100	0.053
Sazköy 4	255	10	100	0.084
Sazköy 5	250	10	100	0.087

Mitigation measures

Sazköy locations and Aşağıihsaniye – 3 location will be under impact of the construction noise. In order to overcome construction noise related problems, possible alternative mitigation should be applied by each contractor which suits best the practical dynamics of the construction activities;

- Speed limit applications should be applied throughout site for the Project vehicles that will transport construction materials/equipment.
- Machinery, equipment and vehicles with lower sound power levels and sound reduced models will be preferred.
- Properly refurbished and/or new machinery, equipment and vehicles will be used to the extent possible.
- Maintenance of construction vehicles will be conducted regularly by means of a regular vehicle maintenance and repair program as per the recommendations of the manufacturer.
- Where applicable, silencers will be installed on the exhaust of vehicles.
- Portable barriers and acoustic enclosures will be put around equipment where necessary.
- Where practical, temporary noise barriers will be deployed near sensitive receptors.
- Natural topography will be used to create a barrier against noise where feasible.
- Construction traffic through the settlements will be avoided, whenever alternative routes and/or service roads are available.
- Idling of construction vehicles will be avoided.
- Night-time activities will be avoided where possible.

Monitoring results will be taken into account in the extent of implementation of mitigation measures.

Since there is no vibration impact observed at the receiving locations for the construction phase, mitigation is not required.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the Project characteristics, and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low impact** is expected in terms of the noise and vibration during the construction phase.

Table 7-51: Residual impact assessment matrix for the noise during construction phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Noise	Duration:	Medium	Medium-high	Short/Mid-term	**Medium**	Medium	**Low**
	Frequency:	Highly Frequent					
	Geo. Extent:	Local					
	Intensity:	High					
Vibration	Duration:	Medium	Medium-high	Short/Mid-term	**Low**	Medium	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Overall assessment:		**Low**	Rationale:	Mitigation measures proposed are expected to decrease the noise emission to meet with Project standards leaving with low residual impact. Since constructional activities has limited time extent, along with the completion of the Project no residual impact expected at any kind of receiving bodies in terms of noise and vibration.			

Monitoring measures

The following monitoring measure shall be implemented to assess the true impacts of the Project in terms of the noise and vibration during the construction and verify the effectiveness of the mitigation measures.

- Inspection of vehicle/machinery/equipment maintenance records.
- Site inspections to be conducted to check the construction activities.
- Monthly noise monitoring at noise sensitive receptors where noise limits are exceeded and additional monitoring in case complaints are received. Monitoring will be carried out specifically at locations and frequency depending on the specific construction schedule, for two consecutive nights where the noisiest

activities take place at the most impacted settlements Monitoring frequency can be decreased if 3 consecutive monitoring results comply with Project standards.

7.2.1.3.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting noise and vibration during operation phase are listed in Table 7-52.

Table 7-52: Project actions and related impact factors during operation phase

Project actions	Brief description	Impact factors
Plant/infrastructure onshore operation	During operations, the main sources of noise and vibration impact will be produced by gas engines and rotating equipment. Other noise sources include flares, pumps, compressors, generators, and heaters.	Emission of aerial noise and vibrations

All the impact factors identified above are described below and assessed in the matrix that follows.

- **Emission of aerial noise and vibrations**

The emission of noise is expected to decrease during operation phase compared to construction phase, but it will be still above the baseline levels due to the expected activities from the OPF. Noise emissions will occur frequently during operation phase as the OPF will be fully operative. Main noise sources are gas engines, rotating equipment, flares, pumps, compressors, generators, and heaters. It is expected that there will not be a vibration impact that can occur at the receiving locations for the equipment that will work in the operation phase.

Noise Modelling

In the modelling study, noise sources were modelled according to the project layout render and unit information. The given sound power levels were used for the gas engine. It was assumed that; apart from the gas engine, all the remaining machine and equipment's sound pressure level is 85 dBA at 1 meter of the distance according to the health and safety regulations' highest allowed noise level.

For the noise sources located in the building, the sound transmission loss due to the building walls was modelled as 20 dBA.

Generally, the modelled noise sources of the Project operation phase are as follows:

- Pipe racks
- Gas Engine
- MEG Units
- Boiler Unit
- Flare Units
- TEG Units

- Sludge Catcher
- Transformer Units

Operation phase 3D noise model view is presented in Figure 7-30.

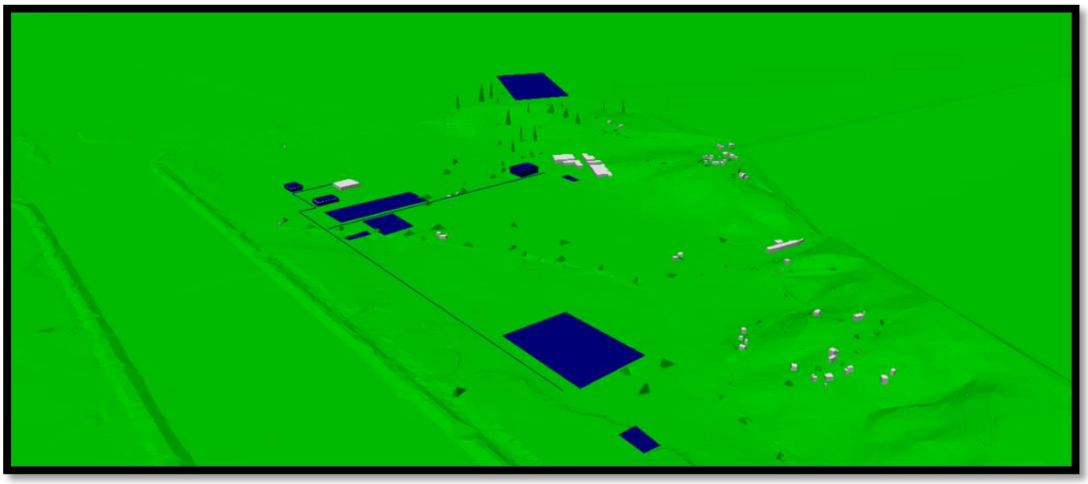


Figure 7-30: Operation Noise Model 3D View

Noise modelling results at selected receiver points are presented in Table 7-53 for RAMEN Limits and Table 7-54 for IFC Limits. The noise maps are presented in Figure 7-31 for daytime and Figure 7-32 for night-time. The larger sizes of the maps are submitted in Appendix P.

Table 7-53: Operation Phase Noise Assessment Results, RAMEN Limits

Receiver Point	Model Result L_{eq} (dBA)			Limit Value L_{eq} (dBA)			Limit Value L_{eq} (dBA) Baseline +5 dBA			Limit Exceedance Max (dBA)
	L_{day}	L_{eve}	L_{night}	L_{day}	L_{eve}	L_{night}	L_{day}	L_{eve}	L_{night}	
Sefercik 1	27.0	27.8	28.4	65.0	60.0	55.0	56.2	55.9	54.3	0.0
Sefercik 2	32.5	33.3	33.9	65.0	60.0	55.0	57.4	54.7	51.6	0.0
Gökçeler	35.9	36.7	37.3	65.0	60.0	55.0	66.5	65.0	58.9	0.0
Derecikören 1	36.1	36.9	37.5	65.0	60.0	55.0	64.7	61.7	58.8	0.0
Derecikören 2	36.9	37.7	38.4	65.0	60.0	55.0	64.7	61.7	58.8	0.0
Aşağıihsaniye 1	39.4	40.1	40.8	65.0	60.0	55.0	54.4	56.7	50.6	0.0
Aşağıihsaniye 2	40.0	40.8	41.4	65.0	60.0	55.0	54.4	56.7	50.6	0.0
Aşağıihsaniye 3	47.4	48.1	48.7	65.0	60.0	55.0	57.9	50.9	49.6	0.0
Sazköy 1	40.9	41.6	42.3	65.0	60.0	55.0	52.2	51.4	49.5	0.0
Sazköy 2	46.6	47.2	47.8	65.0	60.0	55.0	57.0	49.7	53.0	0.0
Sazköy 3	45.2	45.8	46.4	65.0	60.0	55.0	52.2	51.4	49.5	0.0
Sazköy 4	49.5	50.2	50.7	65.0	60.0	55.0	52.2	51.4	49.5	1.2
Sazköy 5	49.1	49.7	50.3	65.0	60.0	55.0	52.2	51.4	49.5	0.8

L_{day}: Equivalent continuous sound pressure level for reference time interval day (07:00-19:00).
L_{eve}: Equivalent continuous sound pressure level for reference time interval evening (19:00-23:00).
L_{night}: Equivalent continuous sound pressure level for reference time interval night (23:00-07:00).

Table 7-54: Operation Phase Noise Assessment Results, IFC Limits

Receiver Point	Model Result L_{eq} (dBA)		Baseline L_{eq} (dBA)		Cumulative (dBA)		Limit Value (dBA)*		Limits Exceedance Max
	L_d	L_n	L_d	L_n	L_d	L_n	L_d	L_n	
Sefercik 1	27.0	28.4	50.5	49.4	50.5	49.5	55.0	52.4	0.0
Sefercik 2	32.5	33.9	51.4	46.6	51.5	46.8	55.0	49.6	0.0
Gökçeler	35.9	37.3	61.3	54.2	61.3	54.3	64.3	57.2	0.0
Derecikören 1	36.1	37.5	58.7	54.4	58.8	54.5	61.7	57.4	0.0
Derecikören 2	36.9	38.4	58.7	54.4	58.8	54.5	61.7	57.4	0.0
Aşağıihsaniye 1	39.4	40.8	50.8	46.1	51.1	47.2	55.0	49.1	0.0
Aşağıihsaniye 2	40.0	41.4	50.8	46.1	51.2	47.4	55.0	49.1	0.0
Aşağıihsaniye 3	47.4	48.7	52.2	43.1	53.5	49.8	55.0	45.0	**4.8**
Sazköy 1	40.9	42.3	47.2	44.3	48.1	46.4	55.0	45.0	1.4
Sazköy 2	46.6	47.8	51.1	47.7	52.4	50.7	55.0	50.7	0.1
Sazköy 3	45.2	46.4	47.2	44.3	49.3	48.5	55.0	45.0	**3.5**
Sazköy 4	49.5	50.7	47.2	44.3	51.5	51.6	55.0	45.0	**6.6**
Sazköy 5	49.1	50.3	47.2	44.3	51.3	51.3	55.0	45.0	**6.3**

L_d: Equivalent continuous sound pressure level for reference time interval day (07:00-22:00).
L_n: Equivalent continuous sound pressure level for reference time interval night (22:00-07:00).
*Limit exceedances (above 3 dBA) are presented in **red**.*

**3 dBA (limit exceedance) is added to Limit Values where baseline noise levels exceed IFC limits.*

As it can be seen from assessment tables related with the operation phase of the Project, all receiver points comply with Turkish RAMEN limit values whereas Asağıihsaniye 3 receiver point and all Sazköy 3, Sazköy 4 and Sazköy 5 receiver points exceed maximum 3 dBA exceedance criteria defined by IFC EHS Guidelines.

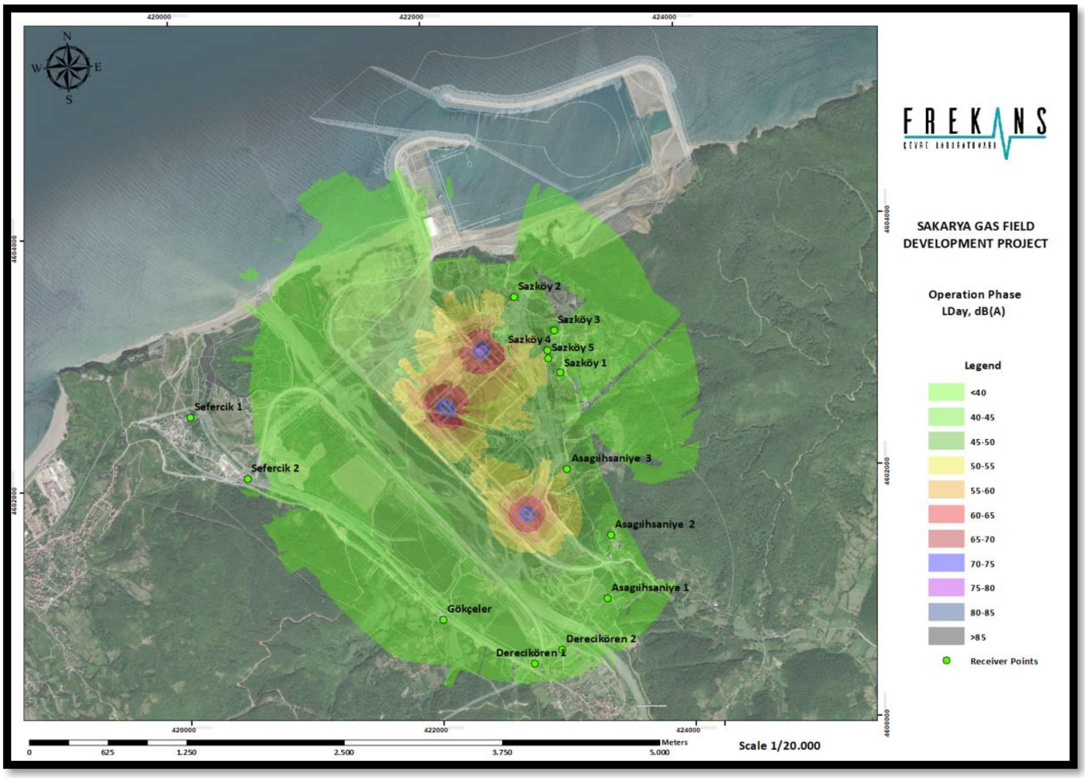


Figure 7-31: Operation Noise Map - Day

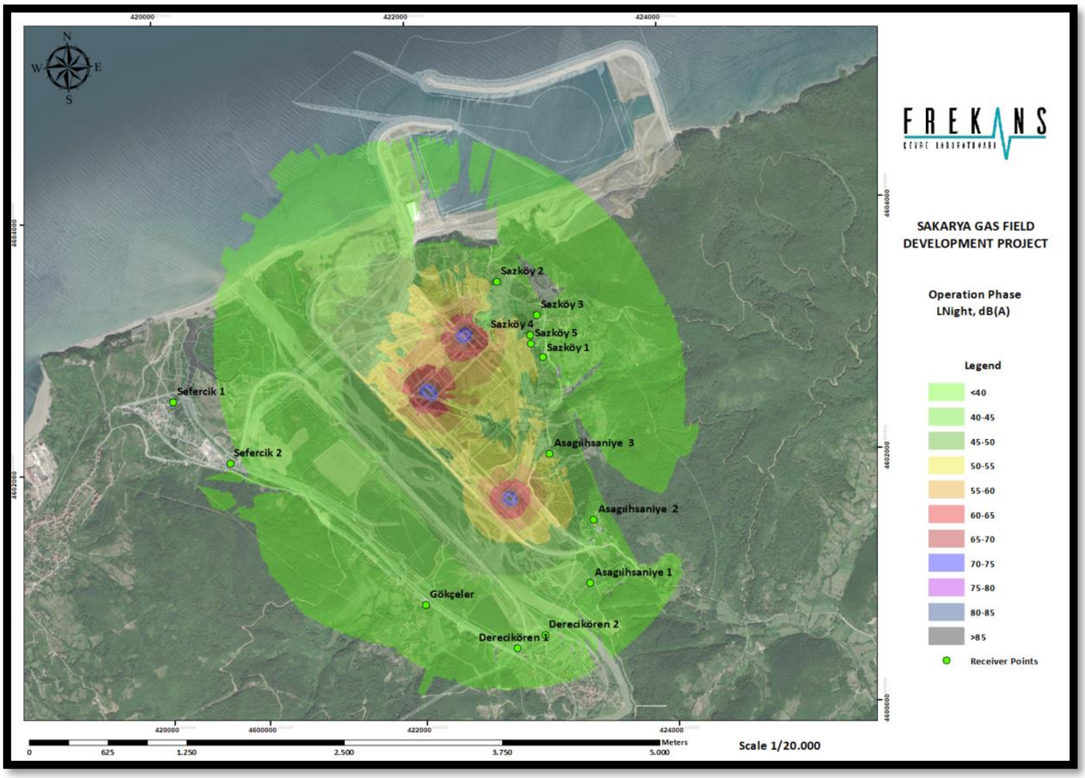


Figure 7-32: Operation Noise Map - Night

Vibration Assessment

It is expected that there will not be a vibration impact that can occur at the receiving locations for the equipment that will work in the operation phase. Therefore, vibration assessment was not performed for this phase.

Mitigation measures

According to modelling study results, the dominating noise impact is due to MEG unit in accordance with the partial noise levels at the receiving locations. Mitigation measures should be taken into account for this unit. A minimum noise mitigation need is 6 dBA. A shield installation to the outer layer of the MEG Unit would mitigate the noise levels down to limits. A single layer of aluminium / steel composite panels would provide needed mitigation.

The results of impact assessment after mitigation are presented in Table 7-55.

Table 7-55: Operation Phase Noise Assessment Results, After Mitigation, IFC Limits

Receiver Point	Model Result L_{eq} (dBA)		Baseline L_{eq} (dBA)		Cumulative (dBA)		Limit Value (dBA)*		Limits Exceedance Max
	L_d	L_n	L_d	L_n	L_d	L_n	L_d	L_n	
Sefercik 1	21.0	22.4	50.5	49.4	50.5	49.4	55.0	52.4	0.0
Sefercik 2	26.5	27.9	51.4	46.6	51.5	46.7	55.0	49.6	0.0
Gökçeler	29.9	31.3	61.3	54.2	61.3	54.3	64.3	57.2	0.0
Derecikören 1	30.1	31.5	58.7	54.4	58.8	54.4	61.7	57.4	0.0

Receiver Point	Model Result L_{eq} (dBA)		Baseline L_{eq} (dBA)		Cumulative (dBA)		Limit Value (dBA)*		Limits Exceedance Max
	L_d	L_n	L_d	L_n	L_d	L_n	L_d	L_n	
Derecikören 2	30.9	32.4	58.7	54.4	58.8	54.4	61.7	57.4	0.0
Aşağıihsaniye 1	33.4	34.8	50.8	46.1	50.9	46.4	55.0	49.1	0.0
Aşağıihsaniye 2	34.0	35.4	50.8	46.1	50.9	46.4	55.0	49.1	0.0
Aşağıihsaniye 3	41.4	42.7	52.2	43.1	52.6	45.9	55.0	45.0	0.9
Sazköy 1	34.9	36.3	47.2	44.3	47.5	44.9	55.0	45.0	0.0
Sazköy 2	40.6	41.8	51.1	47.7	51.4	48.7	55.0	50.7	0.0
Sazköy 3	39.2	40.4	47.2	44.3	47.9	45.8	55.0	45.0	0.8
Sazköy 4	43.5	44.7	47.2	44.3	48.8	47.5	55.0	45.0	2.5
Sazköy 5	43.1	44.3	47.2	44.3	48.6	47.3	55.0	45.0	2.3

L_d: Equivalent continuous sound pressure level for reference time interval day (07:00-22:00).
L_n: Equivalent continuous sound pressure level for reference time interval night (22:00-07:00).
Limit exceedances (above 3 dBA) are presented in ***red****.*

**3 dBA (limit exceedance) is added to Limit Values where baseline noise levels exceed IFC limits.*

General noise reduction options that should be considered in the design include: ·

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, apply sound insulation;
- Reducing project traffic routing through community areas wherever possible;

Since there is no vibration impact observed at the receiving locations for the operation phase, mitigation is not required.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the Project characteristics, and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected in terms of the noise and **negligible impact** in terms of the vibration during the operation phase.

Table 7-56: Residual impact assessment matrix for the noise and vibration during operation phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Noise	Duration:	Long	Medium-high	Short-Midterm	**Medium**	Medium	**Low**
	Frequency:	Highly frequent					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment:		**Low**	Rationale:	Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value.			

Monitoring measures

The following monitoring measure shall be implemented to assess the true impacts of the Project in terms of the noise and vibration during the operation phase and verify the effectiveness of the mitigation measures.

- Inspection of vehicle/machinery/equipment maintenance records.
- Site inspections to be conducted to check the operational activities.
- Monthly noise monitoring during the first quarter, quarterly during the first year and annually for the rest of the operation phase will be conducted at noise sensitive receptors where noise limits are exceeded and additional monitoring in case complaints are received.

7.2.1.4 Hydrology and Surface Water Quality

Based on the information collected for the definition of the baseline (see Chapter 6.2.1.6), the physical component *Hydrology and Surface Water Quality* was assigned a **high** value of sensitivity for the following reasons:

- Presence of waterbody (Filyos River) in AoI.
- Presence of water/sediment pollution.
- Presence of hydrological changes in sub-catchments of Creeks in AoI.

Potential impacts to hydrology and surface water quality associated with construction and operation phases of the Project include;

- Demand for freshwater;
- Changes in flow/circulation in natural water bodies;
- Discharge of wastewater.

The project actions related to the abovementioned impact factors are the following:

- General onshore engineering/construction works;
- Plant/infrastructure onshore operation.

7.2.1.4.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting hydrology and surface water quality during construction phase are listed in following Table 7-57.

Table 7-57. Project actions and related impact factors potentially affecting hydrological features during construction phase

Project actions	Brief description	Impact factors
General onshore engineering/construction works	During construction activities, treated wastewater will be discharged into Filyos River and Black Sea. Also, groundwater abstractions will have an impact on the baseflow of Filyos River.	Changes in flow/circulation in natural water bodies Discharge of wastewater Minor leakage of contaminants into water

All the impact factors identified above are assessed below for the construction phase.

- **Changes in Flow/Circulation in Natural Water Bodies**

Within the scope of Filyos Port and Industrial Area Projects the natural flow regime/streambed of Filyos River was already altered by diversion channels which was built to prevent erosion risk and to ensure flood control. The streambeds of the ephemeral streams, which are the smallest channels feeding the Filyos River, were already disturbed and diverted to stormwater collection channels as discussed in Chapter 6.2.1.6. As a result, no major impact on the recharge of Filyos River is expected, and this impact factor can be considered as negligible. In addition, groundwater abstractions in the construction phase are expected to affect the baseflow of the Filyos River. The changes in baseflow rates are discussed in detail in Chapter 7.2.1.5.1.

- **Discharge of Wastewater**

Sources of wastewater to be produced during the construction phase are listed below.

Domestic Wastewater / Sewage Wastewater due to Personnel

It is assumed that all the domestic water to be used by the Project personnel will be converted to domestic wastewater. Domestic wastewater generated by personnel at the camp site will be collected by sewage infrastructure and treated in package wastewater treatment plants that have been established by contractors and subcontractors exceeding the legal limit (84 people). Wastewater collected in septic tanks or the tanks of the mobile WCs will be transported to the package wastewater treatment plants of the construction camp sites.

As of June 2022, there are three (3) Sewage Treatment Plants (STP) operated by each contractor. Domestic wastewaters have been pumped to the STP where it will be biologically treated. As such, the wastewater capacity per day during the as of June 2022 is 540 m^3/day.

Two (2) of the plants discharge to Filyos River while one (1) of the plant discharges into shoreline of Black Sea as shown in Table 7-58 and Figure 7-33. A contractor having personnel number below 84 stores wastewater in non-leaking septic tanks and transfers to licensed WWTP of the Municipality via vacuum trucks for treatment. Until the wastewater treatment plants were commissioned, wastewater was transported to the urban wastewater treatment plant in Çaycuma District by vacuum trucks. With the commissioning of WWTPs, treated wastewaters will be discharged to the receiving environment (Filyos River or Black Sea) in line with the environmental permit to be secured from the Provincial Directorate of Environment, Urbanization and Climate Change as per the Regulation on Environmental Permits and Licenses.

Table 7-58. Domestic Wastewater to be Generated during the Construction Phase and Management Methods

Contractor/Subcontractor	Daily Amount/Outlet Flowrate	Discharge Location	Discharge Permit
Kolin	100 m^3/day for 500 people	Sea shore	Required
Schlumberger-RNS	400 m^3/day for 2000 people	Filyos River	Required
Subsea7-ACD	40 m^3/day for 200 people	Filyos River	Required
Güngör Elektrik	Personnel number below 84	Transferred to licensed WWTP by vacuum trucks	Not required

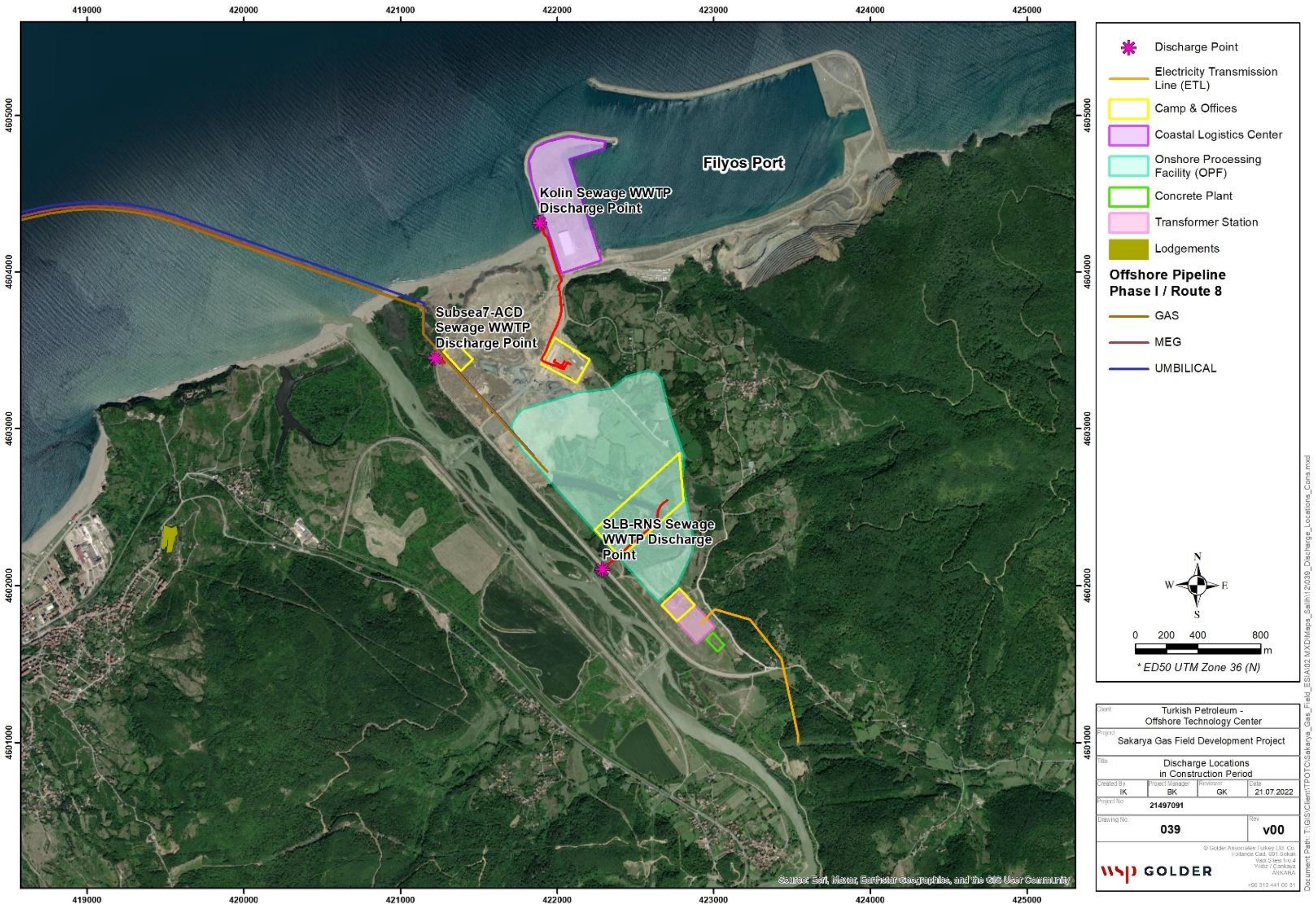


Figure 7-33. Water Discharge Locations in Construction Period

Wastewater Generated by Backwashing of Filters in the Potable Water Treatment Plants

Potable water treatment plants operated for treating groundwater for personnel needs generate backwash wastewater of approximately 400 m^3/day calculated according to 3,524 people of camp capacity. The capacities of potable water treatment plants can be increased with the increasing number of people during the peak construction period. Backwash wastewaters will be discharged to Filyos River in line with the environmental permit to be secured from the Provincial Directorate of Environment, Urbanization and Climate Change as per the Regulation on Environmental Permits and Licenses.

Stormwater Discharge

The drainage system within the construction camp and construction facilities area will be designed to collect the runoff water and discharge it into the Filyos River. Filyos River annually carries 4.18x106 tons of suspended materials and 0.9x106 tons of bed load (Donders, 2010). For this reason, a proper outlet structures will be constructed to prevent off-site sediment transport.

Wastewater Generated from Pre-commissioning Activities

After the completion of the construction phase and before the pipelines are put into operations, all the pipes will be hydrotested to detect possible faults in the junctions and prevent leakage. The hydrotest (pre-commissioning activities) of the onshore part of the SURF pipeline (1.4 km) will be carried out separately from the offshore SURF, as described in Chapter 3.3.2, groundwater will be used as the water source, and it will not include chemical additives. Approximately, 200 m^3 groundwater will be supplied from wells by tankers. The testing process will take 3-4 days in total. For pre-commissioning activities of the OPF, 3,500 m^3 groundwater will be supplied from wells by tankers. The water will be kept in the pipe at the end of the hydrotest, a sample will be taken, and if appropriate, it will be discharged to Filyos River. If the analysis results are not compliant, the water will be sent to licensed WWTPs by vacuum trucks.

To sum up, based on the information provided by TP-OTC, total amount of water needed for all hydrotest line is 3,700 m^3. Accordingly, 3,700 m^3 will be discharged to Filyos River intermittently within 5 months (between August 2022 and December 2022). In addition to hydrotesting, backwash wastewater discharge volume was estimated as 400 m^3 per day, while domestic sewage discharge volume was about 440 m^3 per day according to the STP capacities as of June 2022. The number of daily discharges related to hydrotesting is negligible. For this reason, water used for hydrotesting was not included in runoff assessments because discharges will be infrequent within 5 months. Accordingly, the discharge of treated wastewater (840 m^3 per day in total) to Filyos River is about 2 of the minimum flow rate of Filyos River which is approximately 28 m^3/sec in August. Since the water budgets of the receiving environments (Filyos & Black Sea) are much larger than the discharged amounts, no quantity impact is expected or very limited in the amount discharged to the Filyos River. Therefore, the impact can be considered as low. Impact assessment on discharge to Black Sea is addressed in Chapter 7.3.1.3.

Based on the baseline conditions as discussed in Chapter 6.2.1.6, the water quality of Filyos River is assessed as Class III in May 2021 due to high concentrations of Suphide and Class II in March 2022 due to high concentrations of TKN, BOD, Ammonium and Total N-N as per Surface Water Quality Regulation. Also, Total Suspended Solids (TSS) of the Filyos River were above the IFC Effluent Discharge Limits. Even if STPs will treat sewage wastewater and all effluents including stormwater, backwash wastewater and hydrotest water will be compliant with Project Standards, they may still affect the river water quality.

- **Minor Leakage of Contaminants into Water**

Leakages of contaminants into the water would be mainly expected to occur due to runoffs from areas in proximity of freshwater bodies that have experienced:

- Oil and fuel leakage from vehicles and generators;
- Accidental spill of any hazardous materials that are used during the construction;
- Runoff from area where chemical, oil and fuel are temporarily stored (i.e. areas where paving and secondary containments are not present);
- Pollution caused by temporary storage of hazardous materials and/or wastes;
- Disposal of wastes, wastewater and liquid wastes;
- Flooding of ponds (i.e., settling pond of concrete wastewater) or secondary containments caused by heavy precipitation;
- Accidental spill of wastewater (e.g., domestic, hydrotest).

Chemical contamination of freshwater could have a variety of adverse effect on the quality of surface water, depending on the contaminant and its concentration. Despite the potential for even severe impacts, this factor is predicted to be infrequent at best, and of a low intensity and therefore spills, leakages, and accidental discharges would have to originate from the OPF footprint or the connecting roads which are generally located at a certain distance from the nearby water bodies.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Changes in Flow/Circulation in Natural Water Bodies**

No mitigation measures are identified for the impact factor potentially affecting the hydrology and surface water quality during construction.

- **Discharge of Wastewater**

  - The drainage system within the construction camp and construction facilities area will be designed to collect the runoff water and discharge it into the Filyos River after proper outlet structures to prevent off-site sediment transport.
  - The wastewater from onshore pre-commissioning activities will be discharged to Filyos River by vacuum trucks or through rainwater drainage channels if analyses results are compliant with the Project Standards. If the results are not aligned with the Project standards, the produced wastewater will be transferred to licensed WWTPs by vacuum trucks.
  - The hydrotesting lines shall be depressurized immediately after the successful in disposing the test water, maximum care shall be taken not to damage any other structure and/or equipment, etc. Excessive erosion of the temporary back fill materials on the access roads, road itself and/or soil shall be avoided.
  - Project-specific Pollution Prevention Plan will be implemented for the management of hydrotest water, backwash wastewater, sewage wastewater, wastes and hazardous materials and implemented during the construction phase of the Project.

- All discharge points would utilize discharge dispersion methods(e.g., controlled rate of discharge and use of energy dissipaters, displacement of geotextile mats or other physical erosion prevention measures) to mitigate erosion. Measures to minimise scour and reduce sediment load will be implemented at locations where hydrotest water is discharged to Filyos River and discharge velocities will be regulated to prevent erosion (e.g. controlled rate of discharge and use of energy dissipaters, displacement of geotextile mats or other physical erosion prevention measures).
- Where possible, water used in one section of the pipeline will be transferred to adjacent sections upon completion of the hydrostatic test section in order to minimize discharge volume.
- Discharge of wastewater to surface waters will be in compliance with the applicable regulatory requirements given in Appendix C.
- Fueling/refilling and chemical handling activities in close vicinity of the watercourses will be restricted.

- **Minor Leakage of Contaminants into Water**
  - Project-specific Pollution Prevention Plan and Waste Management Plan will be implemented to ensure that the amount of release and spills can be taken under control before reaching substantial amounts that may potentially affect the quality of soil and potentially that of the nearby water bodies.
  - Detailed information on spills and leakages mitigation procedures are provided in Chapter 7.2.1.1.
  - Particular care will be taken on spill containment procedures and materials, and spill/leakage response training of personnel in order to avoid any contamination reaching the freshwater habitats where containment and clean-up procedures would become significantly more complex.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the Project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, **low negative impact** is expected on the hydrology and surface water quality during the construction phase.

Table 7-59: Residual impact assessment matrix for the hydrology and surface water quality during construction phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Discharge of Wastewater	Duration:	Medium	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Changes in Flow/Circulatio	Duration:	Medium	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
n in Natural Water Bodies	Geo. Extent:	Local					
	Intensity:	Medium					
Minor Leakage of Contaminants into Water	Duration:	Medium	High	Short-mid-term	**Medium**	High	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Overall assessment:		**Low**	Rationale:	Due to the compliance with relevant standards of the impact factors, even using a precautionary approach, the residual impact values are not expected to cumulate to a higher impact value. Therefore, the average residual impact value may be considered as a reference for the overall impact.			

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the Project on the hydrology and surface water quality during the construction and verify the effectiveness of the mitigation measures.

- Periodic visual site inspection of stormwater and wastewater drainage networks, in order to verify their integrity and functionality;
- Periodic site inspections will be carried out and reported to identify any possible leakages;
- Periodic site inspections will be carried out in order to identify any possible damage in the hazardous materials storage areas and waste storage areas;
- Trainings on spill response, use of containment and clean-up material for the workers (including the subcontractors' workers) will be recorded;
- Sampling and analysis of hydrotest water by accredited laboratories to check whether water quality is suitable for discharge;
- Monthly monitoring of discharge water quality with chemical analysis;
- Monthly monitoring of Filyos River water quality in terms of Flow (Low/med/high), Conductivity (µS/cm), Turbidity (NTU), Temperature (°C), pH, Dissolved Oxygen (mg/L) at the upstream and downstream of the wastewater discharge locations;
- Water samplings and analyses to be performed at the hydrotest discharge point immediately after the hydrotesting activities and by one month after them (i.e., a time interval from a week after to a month after is accepted).

7.2.1.4.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting hydrology and surface water quality during operation phase are listed in following Table 7-60.

Table 7-60. Project actions and related impact factors potentially affecting hydrological features during operation phase

Project actions	Brief description	Impact factors
Plant/infrastructure onshore operation	During operation activities, wastewater will be treated and discharged to Filyos River.	Discharge of wastewater

- **Discharge of Wastewater**

Sources of wastewater to be produced during the operation phase are listed below.

Domestic Wastewater / Sewage Wastewater due to Personnel

The wastewater generation per day is calculated as 27 m^3/day (according to 120 individuals). A Sanitary Sewage Treatment System (ETP-B) having capacity of 75 m^3/day (3 m^3/h) will be provided to treat the sanitary water collected in the facility. Treated wastewater as per Project Standards will be discharged to Filyos River in line with the environmental permit to be secured from the Provincial Directorate of Environment, Urbanization and Climate Change as per the Regulation on Environmental Permits and Licenses.

Effluent Wastewater from MEG Regeneration and Reclamation Unit

The water that has been decomposed by the MEG regeneration and reclamation unit from the MEG will be transferred to the Produced Water Treatment Package (PWT). Wastewater treatment system will have a total capacity of 440 m^3/day (22 m^3/h). Treated wastewater as per Project Standards will be discharged to Filyos River through a pipe routed to the river running adjacent to the OPF in line with the environmental permit to be secured from the Provincial Directorate of Environment, Urbanization and Climate Change as per the Regulation on Environmental Permits and Licenses. Re-routing flow back to the system will be available if water samples do not comply with discharge limits.

Wastewater Generated by Backwashing of Filters in the Demineralized and Potable Water Generation Package

Wastewater resulting from backwashing and regeneration of activated carbon filter, multimedia filter and ultrafiltration system will be directed to Demineralized and Potable Water Generation Package - Sedimentation Package where the residues and trace heavy metals will be settled and processed in sludge thickener and filter press and finally disposed. Wastewater treatment system will have a total capacity of 175 m^3/day (17 m^3/h). Resulting wastewater as per Project Standards will be discharged to Filyos River in line with the environmental permit to be secured from the Provincial Directorate of Environment, Urbanization and Climate Change as per the Regulation on Environmental Permits and Licenses.

Discharge from Effluent Treatment Plant-A

This wastewater contains minimal quantities of organics e.g., lube oil, diesel, heat transfer oil, MEG, TEG, corrosion inhibitor and solids (e.g., sand, corrosion products and salts). The flow to the ETP-A unit will not be continuous and will be intermittent depending on demand. Moreover, Boiler Effluents (High TDS Effluents) (app. 0.65 m^3/h (15.6 m^3/day) will be collected on concrete curbed area and routed towards Effluent Treatment Package-A (ETP-A) for further processing before discharge into Filyos River.

Water from ETP-A will be routed to Filyos River for discharge in line with the environmental permit to be secured from the Provincial Directorate of Environment, Urbanization and Climate Change as per the Regulation on Environmental Permits and Licenses or to Produced Water Treatment Package (PWT) for further processing. In case ETP-A does not meet river discharge limits, wastewater will be routed to Produced Water Treatment Package. Skimmed oily content from ETP-A will be directed to the Slop Storage Tank for disposal via vacuum truck.

Stormwater Discharge

Open drain system will collect stormwater from the paved areas (open spaces, buildings, roadways, and uncontaminated places) and from ETP-A after treatment, and will discharge it into Filyos River. Stormwater shall also be collected in open trapezoidal ditches routed at the sides and parallel to the plant roads. To protect the environment from accidental contaminated water flowing into the river, manually operated sluice gate will be provided before the outfall location of the ditch for examination of stormwater for any contamination.

During the operation period, the wastewater from the four (4) treatment plants would converge at a single point and discharged in the river as shown in Figure 7-34. Since the water budgets of the receiving environments (Filyos & Black Sea) are much larger than the discharged amounts, no quantity impact is expected or very limited in the amount discharged to the Filyos River. Therefore, the impact can be considered as low.

Based on the baseline conditions as discussed in Chapter 6.2.1.6, the water quality of Filyos River is assessed as Class III in May 2021 due to high concentrations of Suphide and Class II in March 2022 due to high concentrations of TKN, BOD, Ammonium and Total N-N as per Surface Water Quality Regulation. Also, Total Suspended Solids (TSS) of the Filyos River were above the IFC Effluent Discharge Limits. Considering that the WWTPs will collect hazardous and non-hazardous compounds, as well as the drains from the paved areas, their effluents, even if compliant with the national and international regulations illustrated in Appendix C may still affect the river water quality.

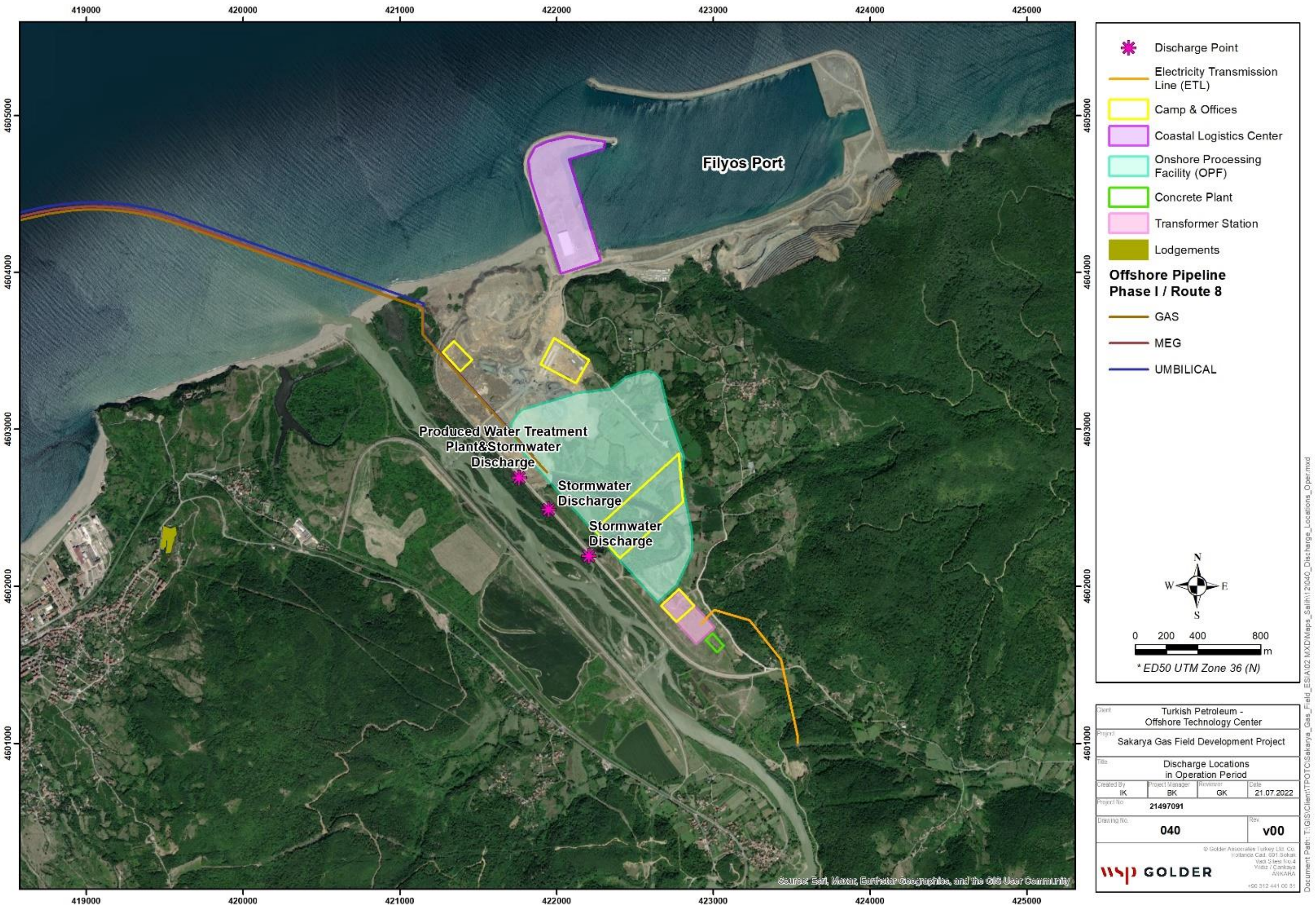


Figure 7-34. Discharge Locations in Operation Period

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Discharge of Wastewater**
  - The drainage system (including closed drain and open drain) within the facility will be designed to collect the runoff water and discharge it into Filyos River after proper outlet structures to prevent off-site sediment transport. The wastewaters from sanitary facilities, lodging premises, and kitchens, if any, will not be discharged into the open drain.
  - To protect the environment from accidental contaminated water flowing into the river, manually operated sluice gate will be provided before the outfall location of the ditch for examination of stormwater for any contamination.
  - All discharge points would utilize discharge dispersion methods to mitigate erosion (e.g., controlled rate of discharge and use of energy dissipaters, displacement of geotextile mats or other physical erosion prevention measures). Discharge of wastewater to surface waters will be in compliance with the applicable regulatory requirements given in Appendix C.
  - Fuelling/refilling and chemical handling activities in close vicinity of the watercourses will be restricted.
  - Project-specific Pollution Prevention Plan and Waste Management Plan will be implemented for the management of wastewater, waste and hazardous materials and implemented throughout the operation.

In addition, as recommended in the Flood Risk Analysis Report of the Project dated January 2022 (Appendix L), increasing berms at the Project Site can provide additional safety to avoid flood that can be occurred in situations where flooding is more than specified from spillways of dams in operation, dam breaking or not cleaning sedimentation from river channels. This can be considered in future according to safety level requested by related institution. Also, in case spreading of flood in the upstream of the Project site is restricted in the possible future studies, the flood risk assessment analysis should need to be renewed. As a result, the suggestions specified in the updated Flood Risk Analysis Report of the Project (Appendix L) should be put into practice.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on the hydrology and surface water quality during the operation phase.

Table 7-61: Residual impact assessment matrix for the hydrology and surface water quality during operation phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Discharge of Wastewater	Duration:	Long	High	Short-mid-term	**High**	Medium-high	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment:		**Low**	Rationale:	Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value			

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the Project on the hydrology and surface water quality during the operation and verify the effectiveness of the mitigation measures.

- Periodic site inspections will be carried out to ensure that the open drains are free of sediments and accumulation of sediments at the sediment traps does not prevent the run-off flow;
- Periodic visual site inspection of stormwater and wastewater drainage networks, in order to verify their integrity and functionality;
- Periodic site inspections will be carried out and reported to identify any possible leakages;
- Periodic site inspections will be carried out in order to identify any possible damage in the hazardous materials storage areas and waste storage areas;
- Trainings on spill response, use of containment and clean-up material for the workers (including the subcontractors' workers) will be recorded.
- Analyzes will be carried out quarterly for the treated wastewater at the respective outlet points prior to discharge by accredited laboratories to check compliance with Project standards. Analyzes will also be carried out at the frequency specified in the Communique on Water Pollution Control Regulation Sampling and Analysis Metho and in the environmental permit document to be obtained from the Provincial Directorate of Environment, Urbanization and Climate Change in accordance with the Environmental Permit and License Regulation. As per the IFC EHS Guidelines, wastewater monitoring should take into consideration the discharge characteristics from the process over time. If the effluent is observed to be highly variable or discharge standards are exceeded, monitoring can be carried out more frequently or through composite methods.
- Treatment plants having a flow rate of 200-500 m^3/day will have a sampling manhole and automatic sampling device at the outlet point of the wastewater treatment plant according to the "Regulation on Water Pollution Control.

7.2.1.5 Hydrogeology and Groundwater Quality

Based on the information collected for the definition of the baseline (see Chapter 6.2.1.7), the physical component *Hydrogeology and Groundwater Quality* was assigned a **High** value of sensitivity for the following reasons:

- Presence of shallow aquifer in AoI.
- Presence of groundwater exploitation (exploited aquifer) in AoI.
- Presence of high rock permeability in AoI.
- Presence of aquifer vulnerability in AoI.

Potential impact factors to hydrogeology and groundwater quality associated with construction and operation phases of the Project include;

- Demand for freshwater;
- Changes in flow/circulation in natural water bodies;
- Discharge of wastewater.

The project actions related to the abovementioned impact factors are the following:

- General onshore engineering/construction works;
- Plant/infrastructure onshore operation.

Groundwater Modelling Methodology

Hydrogeological data used for development of conceptual groundwater model which representing the AoI has been collected from Waterwell Drilling and Testing reports (Toker, 2021) with the additional secondary data sources which were defined in baseline section in Chapter 6.2.1.7.

Based on the conceptual understanding of the hydrogeological conditions, numerical groundwater flow model was developed for the onshore Project site and AoI. The hydrogeological model has been calibrated using the site monitoring data representing the baseline conditions.

Hydrostratigraphic Units & Hydraulic Conductivity & Hydraulic Heads

The Project Site and its surroundings mainly consist of Quaternary aged Alluviums and Upper Createse aged Yemişliçay formation, the upper parts of which are composed of very fine-grained materials. The Project Site is mainly located on Quaternary aged alluvium.

Quaternary aged alluvium, which covers a large part of the RSA, is considered a permeable unit. The Upper Cretaceous Yemişliçay formation, which occupies less space in and around the Project Site compared to the alluvium unit, consists of volcanic sandstone, siltstone, claystone, shale and pyroclastic rocks and pelagic-semi-pelagic limestones, and it is defined as semi-permeable.

The number of 5 water wells were drilled in order to understand the groundwater potential of alluvium aquifer in the scope of water supply studies as a part of the Onshore Processing Facility (Toker, 2021).

Well logs and step discharge pumping test results were examined and imported to the conceptual hydrogeological model to define the hydrostratigraphy and physical properties of alluvium aquifer. Apart from the alluvium, older deposits of claystone-sandstone and shale formation, called Yemisliçay was imported to the model by considering a representative literature property considering this unit is semi-permeable in shallow to impermeable in deeper zones, relatively.

Groundwater level measurements at five monitoring wells (Waterwell-1 to Waterwell-5) were used in the calibration process.

Water Budget

Discharges

Surface water in the onshore AoI generally originates from ephemeral flows resulting from precipitation, and from groundwater discharge directly to the streams both as baseflow and as springs.

The hydrogeological model was calibrated using site data collected during February 2022 to March 2022.

Since long-term data collection studies for the estimation of the baseflow observations could not be carried out, calibration of the hydrogeological model was processed through the hydraulic heads and quantitative proportional ratio between the surface flow observations in dates between February to March, 2022.

Recharge

Meteorological data used for recharge estimation were obtained from the Amasra, Bartın and the Zonguldak Automatic Meteorological Observation Stations located around the Project Site. The recorded data is available for long periods at the Amasra Station between 1970 and 2021, at the Bartin Station between 1961 and 2021 and at the Zonguldak Station between 1939 and 2021.

By interpolating the data obtained from these three stations, site-specific precipitation, temperature and evaporation data were calculated. The CN coefficient, which is given in the Project site Flood Risk Assessment Report given in Appendix L, has been taken as 83. The site-specific hydrological water budget was built with the obtained CN value and the generated site-specific precipitation, temperature, and evaporation data (Thornthwaite-Mather, 1955). According to the result from the hydrological water budget, the infiltration amount was used as the recharge value in the groundwater flow model and minor adjustments were made according to the hydrostratigraphic units and the topographical conditions in the model during model calibration and sensitivity analysis studies.

Numerical Groundwater Model

The numerical groundwater model for the Project Site and AoI was constructed using FEFLOW, a finite element modelling package developed by the Institute for Water Resources Planning and Systems Research Ltd. (WASY) in Germany (Finite-Element Simulation System for Subsurface Flow and Transport Processes). FEFLOW can simulate transient groundwater flow, solute, and heat transport in three-dimensional heterogeneous and isotropic media under a variety of hydrogeologic boundaries and stresses. Selected as the modelling code for this project with the ability of FEFLOW to combine complex hydrostratigraphy and boundary conditions using finite elements.

The numerical model was used to estimate distribution of the hydraulic head and pressures in the area of influence, to assess groundwater flow paths & particle tracks for any leakages or contamination and the impact of water demands from the groundwater on the water table.

Model Extents and Finite Element Mesh

The mesh in the model area consisted of approximately 93,500 triangular elements with a uniform spacing of 15 m - 20 m in the Onshore Facility Area where major hydraulic gradients are expected to develop during groundwater extraction from the wells in construction and operation phases, and 20 m - 40 m in other areas of model extent.

The model was vertically discretized into five layers. The top of layer one was assigned the ground surface elevation, based on the DEM (digital elevation model). Ground surface ranged from 313 masl in Sarıgazel Hill in the east of the model to approximately 0 masl at the northwest model boundary (Blacksea). Model layers were set equally in thickness between layer top and bottom, and the thickness of these layers ranged from ~2 m to ~100 m. 3D layer configuration of the model is presented in Figure 7-35.

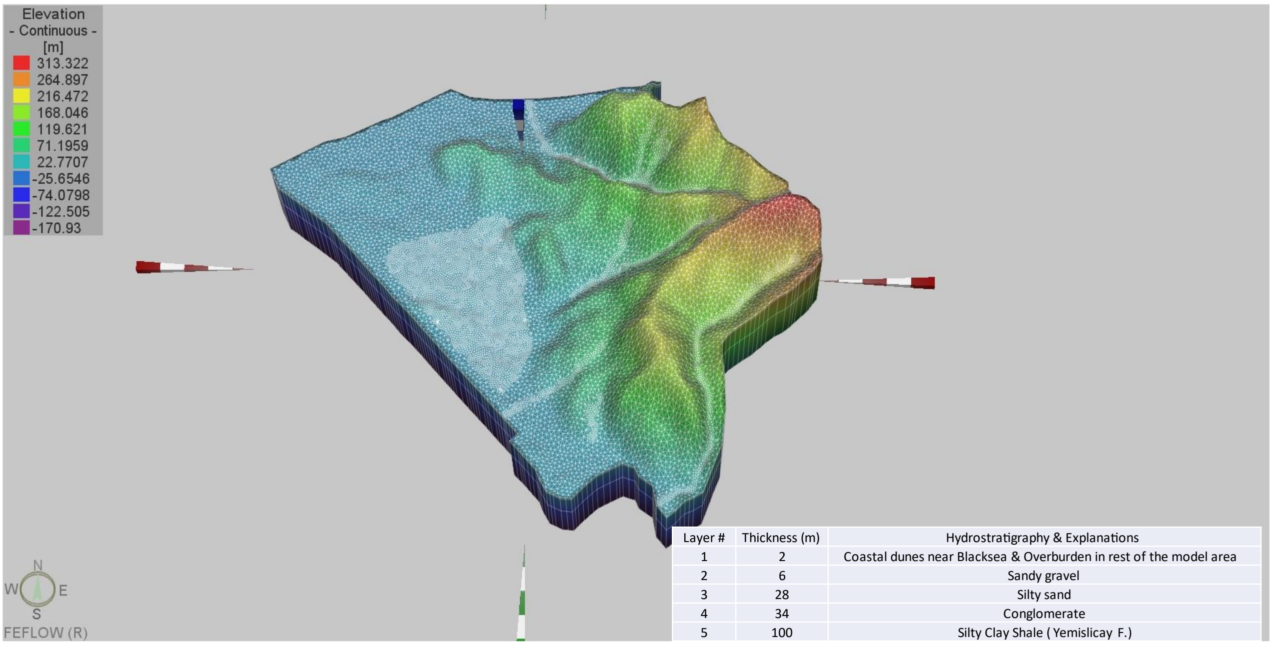


Figure 7-35 3D Layer Configuration of the Numerical Model

Model Boundaries

Three types of boundary conditions were used in the model: specified head, specified flux, and no-flow.

Specified head boundaries were used to represent all watercourses and springs within the model domain. These boundaries were assigned along the model top based on surface water elevations derived from the site DEM Specified head boundaries constrained to outflow only were assigned to represent seepage faces where seepage faces were interpreted to exist. Specified head boundaries without seepage face constraint were used to represent Filyos River along the western model boundary and Blacksea along the northwestern model boundary in order to simulate the discharge to the streams and the sea from the aquifer systems.

Specified flux boundaries were used to represent recharge from precipitation. Initially, a uniform rate of 64 mm/yr (approximately 6% of average annual precipitation) was applied to where its elevation is higher than 100masl and 35mm/yr where its elevation is lower than 100masl along the top of the model. The recharge rate was later adjusted during model calibration considering the precipitation and strong topographic relief throughout the area.

No-flow boundaries were used to represent inferred groundwater flow divides. The locations of these divides were assumed to correspond to the surface water divides. A no-flow boundary was also assigned along the bottom of the model.

The water table was simulated as a free surface that was allowed to move vertically in response to imbalances in the inflows and outflows of the model.

Model boundaries are shown in 3D model extent in Figure 7-36.

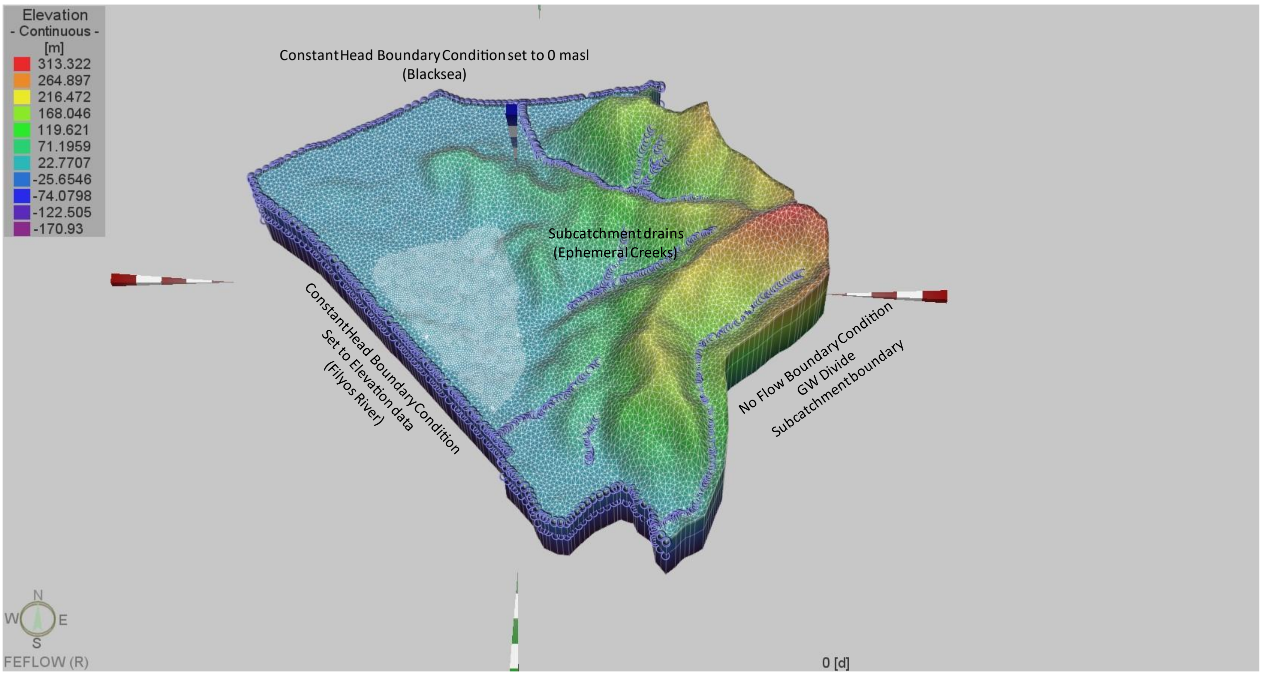


Figure 7-36: Groundwater Model Boundary Conditions

Model Parameters and Calibration

In the groundwater flow model, the physical parameters of the alluvial aquifer were assigned considering the test results performed in the field, and sensitivity analysis was performed according to the calibrated results and minor adjustments were made until the final hydraulic conductivity (K) values were reached.

K values assigned for each layer in groundwater flow model is presented in Figure 7-37 below.

Porosity values assigned for each hydrostratigraphic unit have been determined for their sand and clay matrices according to the empirical literature values of unconsolidated deposits for gravel, sand, silt, and clays (Cheery and Freeze, 1979) and they are given in Table 7-62 below.

Table 7-62: Porosity (n) values for GW model units

Hydrostratigrahic Unit	Assigned porosity (n) value
Overburden & Coastal Dunes	0.5
Sandy gravel	0.5
Silty sand	0.5

Hydrostratigrahic Unit	Assigned porosity (n) value
Conglomerate	0.4
Silty Claystone & Shale	0.7

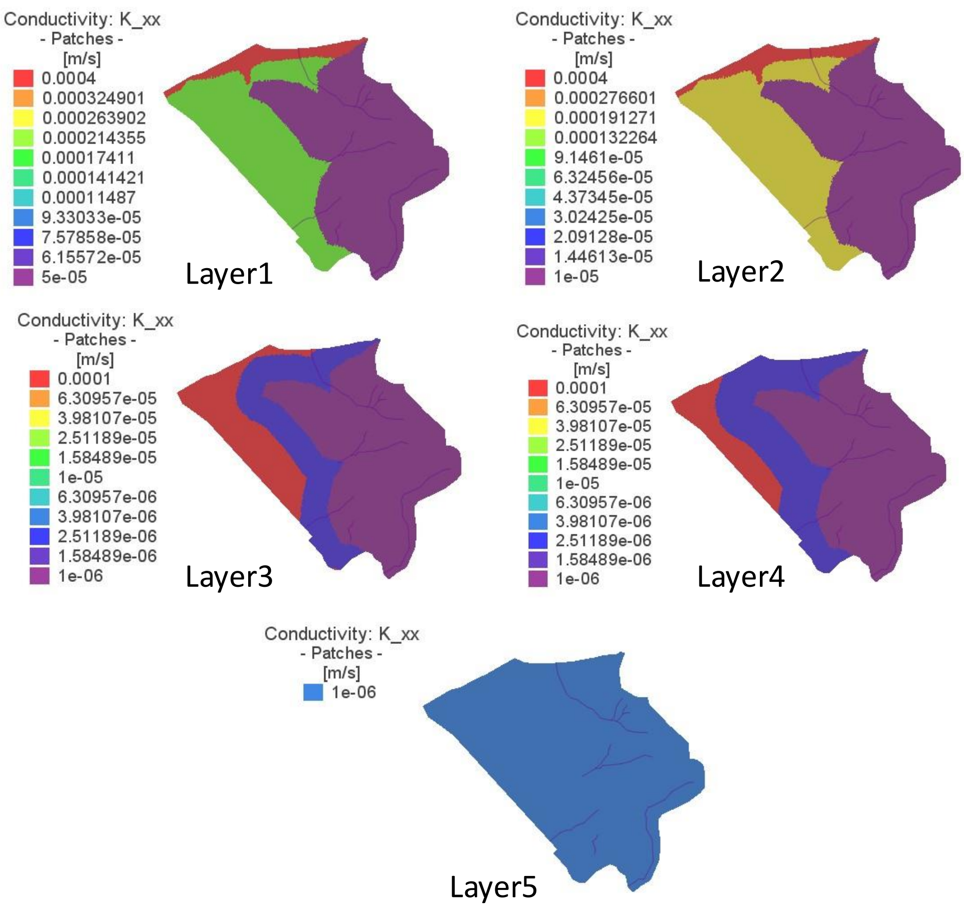


Figure 7-37: Hydraulic Conductivity (K) values assigned for each layer

Considering the aquifer test results and overall understanding of groundwater and hydrological conditions at the site, the adjustments in hydraulic conductivity values and recharge rates made during calibration are compatible. Figure 7-38 presents a comparison between the hydraulic heads simulated by the model and those estimated from measurement data at 5 monitoring locations (Waterwell-1 to Waterwell-5). The root-mean-square (RMS) error was 2.3 % suggesting that overall, a good match has been achieved between the simulated and measured hydraulic heads in these installations.

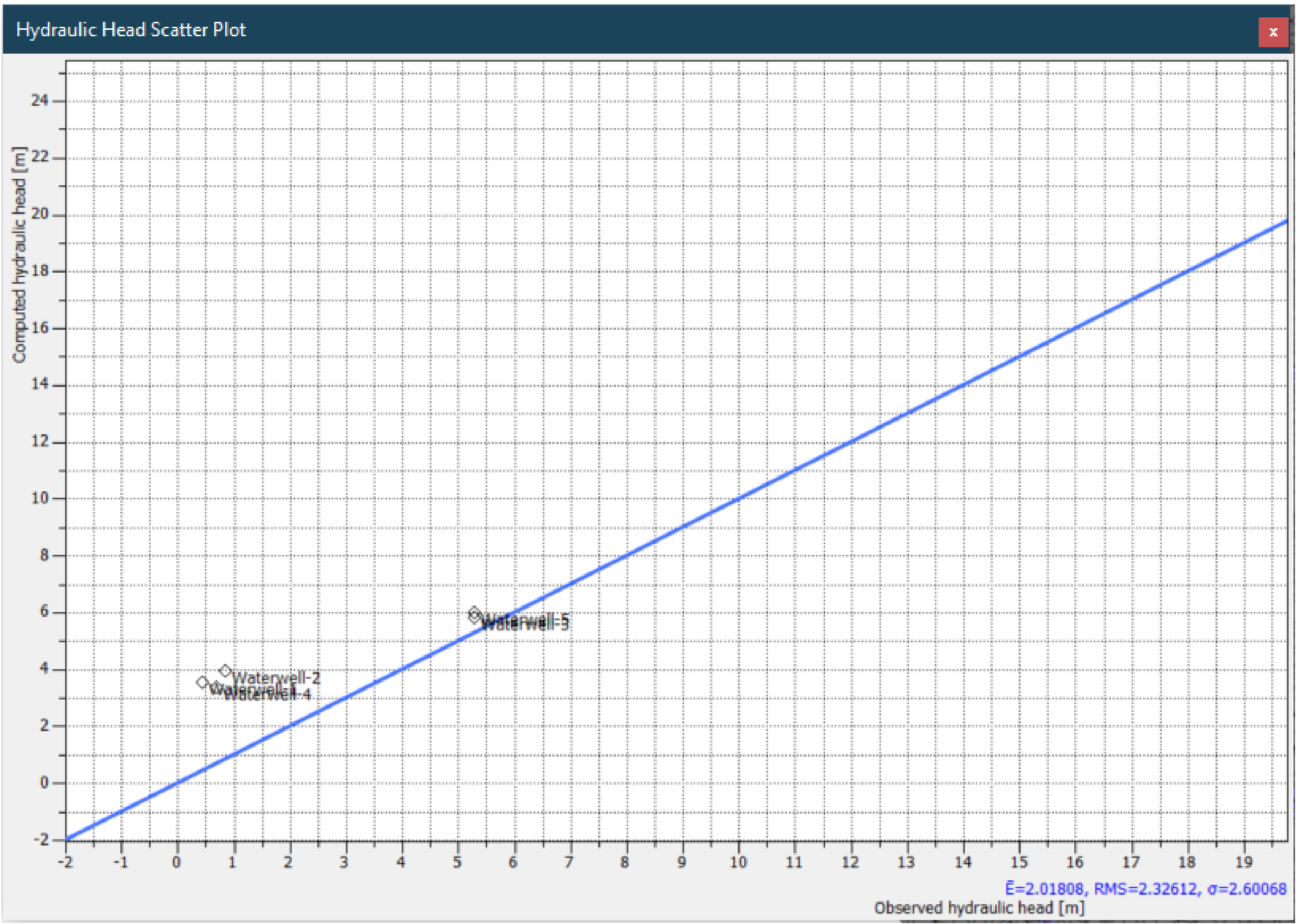


Figure 7-38: Steady-state Calibration Based on the Hydraulic Heads (Measured vs Modeled) in Groundwater Model Area

Transient Calibration on Waterwell-2 Step Drawdown Data

The model was calibrated according to hydraulic heads in steady-state conditions as the results are presented in abovementioned figure. In order to calibrate the model in transient conditions, and to increase the reliability of the impact assessment model results, Waterwell-2 step-drawdown test results were used as real data, which can be considered as time-dependent variable data. In this context, a 1-day pumping was simulated in the model with 13.25 L/sec, which is the draw amount performed at the last stage of the step-drawdown test at the Waterwell-2 point, and the obtained model results were compared with the actual test results. It has been determined that the artificial test data modelled according to the comparison result and the test results of the real system are very close to each other. The graphical presentation of the actual step-drawdown data and the transient modelled pumping test data is given in Figure 7-39.

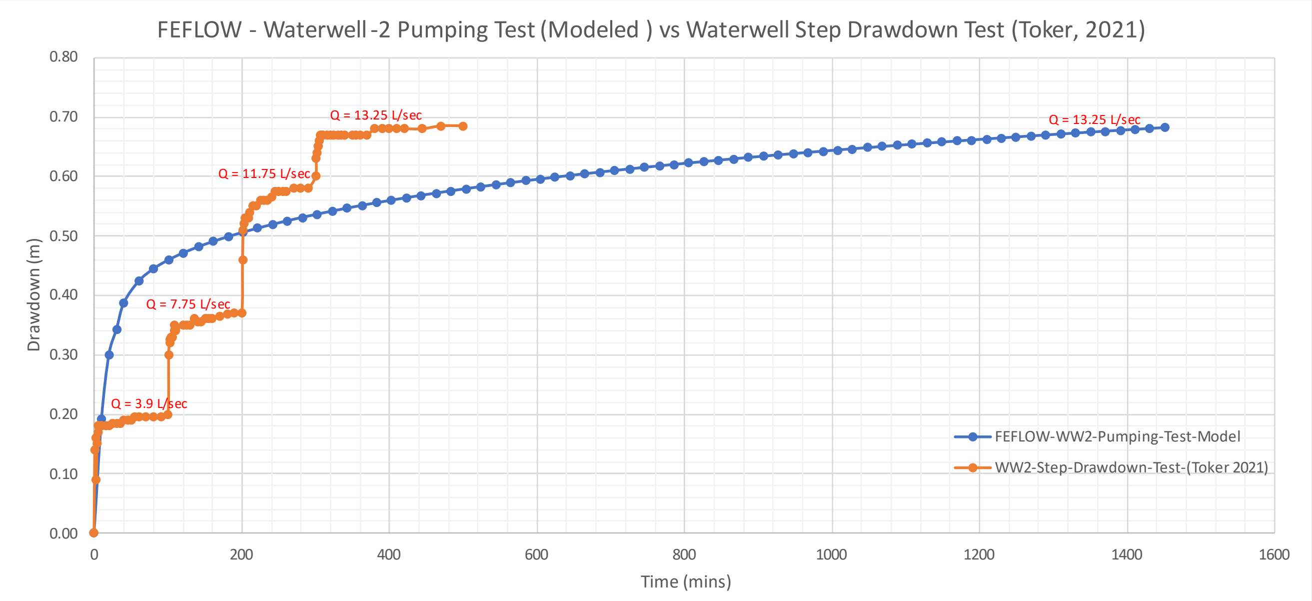


Figure 7-39: Groundwater Model Transient Calibration According to the Waterwell-2 Step Drawdown Test Results

7.2.1.5.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting hydrogeology and groundwater quality during construction phase are listed in following Table *7-63*.

Table 7-63. Project actions and related impact factors potentially affecting hydrological features during construction phase

Project actions	Brief description	Impact factors
General onshore engineering/construction works	During construction activities, treated wastewater will be discharged into Filyos River and Black Sea. Also, groundwater abstractions will have an impact on the baseflow of Filyos River.	Demand for freshwater Changes in flow/circulation in natural water bodies Discharge of wastewater

All the impact factors identified above are assessed below for the construction phase.

- **Demand for freshwater**

The demand for freshwater as a result of the Project activities are discussed in this section in terms of quantity and quality, and how the surface water - groundwater interaction is affected considering the baseline hydrogeological characteristics of Area of Influence (AoI).

Water Supply Plan During Construction: Based on a verbal information gathered from TP-OTC team on the site; water need is planned to be supplied from groundwater wells, namely Waterwell-2 and Waterwell-4, in the Project Site.

It is foreseen that the main water supply well will be Waterwell-2 with a maximum discharge rate of 2,400 m^3/day. Waterwell-4 will be the backup supply with its discharge rate 672 m^3/day.

Impacts on groundwater resources due to groundwater abstraction from Waterwell-2 and Waterwell-4

Construction period is considered as 16 months between December 2021 and March 2023. During this period, two different scenarios were imported to the groundwater model and two different simulations were run for the impacts of the water demand from groundwater resources. The inputs for these scenarios are detailed in Table 7-64 below.

Table 7-64: Inputs for Groundwater Abstraction Scenarios (Construction Phase)

Input Type	Assumptions	Groundwater Supply from	Groundwater Abstraction rate (m^3/day)	Duration
Scenario 1	Water will be supplied only from Waterwell-2, no backup needs	Waterwell-2	2,400	16 months
Scenario 2	Water will be supplied from both Waterwell-2 and Waterwell-4	Waterwell-2 + Waterwell-4	3,072	16 months

Changes in Groundwater Levels and Filyos River Baseflow in Scenario-1

According to the Scenario-1; water will be supplied from Waterwell-2 with a daily rate of 2,400 m^3 during construction phase which its duration is expected to be 16 months.

Filyos River's flowrate budget during the Scenario-1 in the groundwater model is given in Figure 7-40.

The cone of depression in water table as a result of water abstraction with Scenario-1 inputs is presented in Figure 7-41.

Based on the flowrate budget graph in Figure 7-40; an approximately 1,700 m^3/day groundwater discharge rate to Filyos is minimized to zero within 2 months of abstraction from Waterwell-2 and Filyos River is recharging the groundwater with a rate of 400-500 m^3/day between month 2 – month 16.

During the last 6 months period; an approximately 2,200 m^3/day reduction is expected in Filyos River's baseflow in Scenario-1.

As a result of water abstraction from the Waterwell-2, a cone of depression is expected to be occurred where its borders are staying almost in Onshore Project Facility Area.

It appears that SK-3 well, which is the water source of Sazköy Village, is being in the area of cone of depression, and it is expected to be impacted by groundwater abstractions during the construction phase. Beside this well, no other groundwater sources in and near the Project site is expected to be impacted by the cone of depression.

As mentioned in "Mitigation measures" below; since SK-3 is in a location affected by Project activities, SK-4 well was constructed by TP-OTC instead of SK-3 well as Sazköy Village's water resource, and Sazköy's water resource will be SK-4 in the next period.

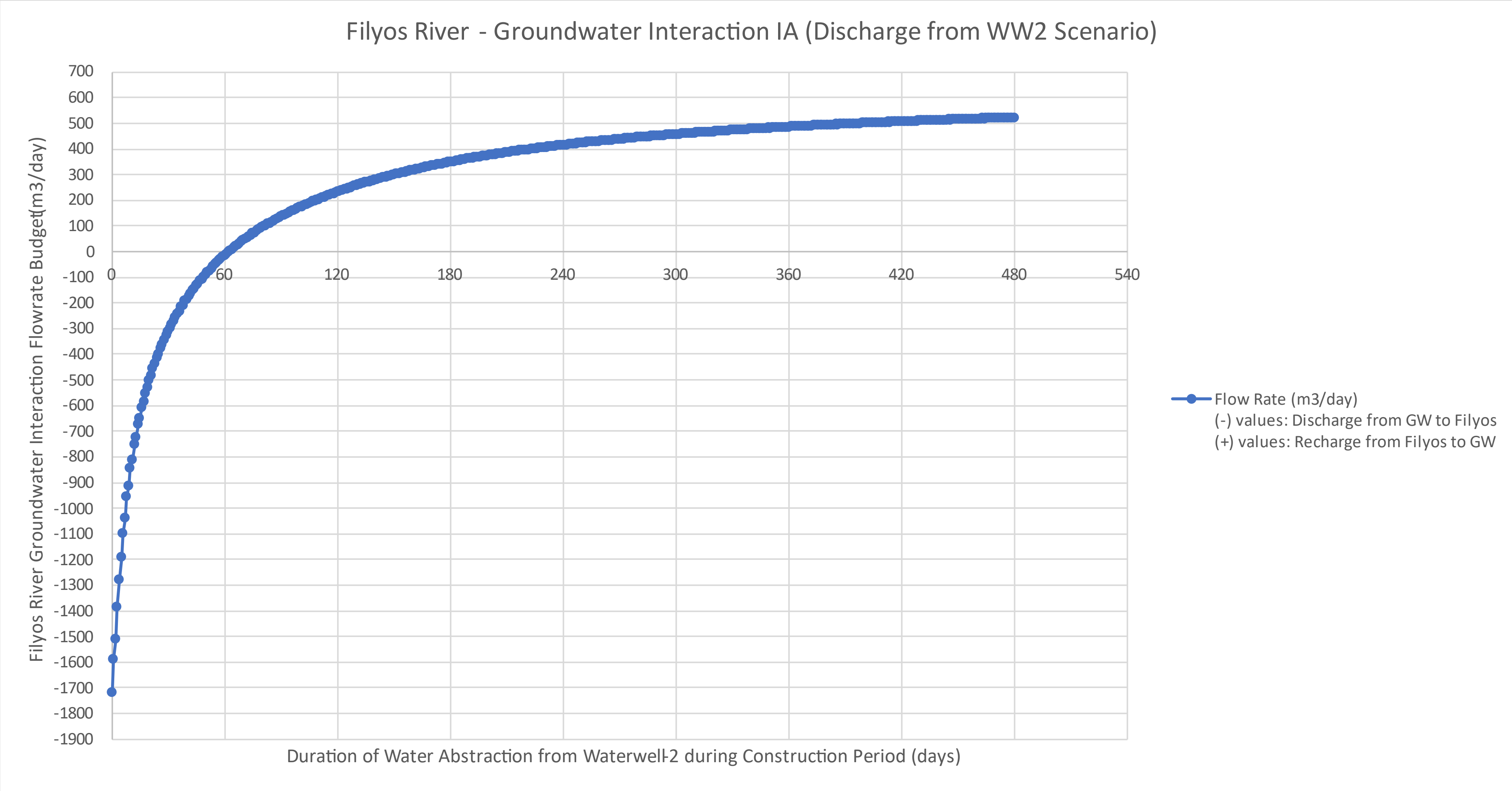


Figure 7-40: Filyos River Baseflow - Groundwater Interaction Budget (Scenario-1)

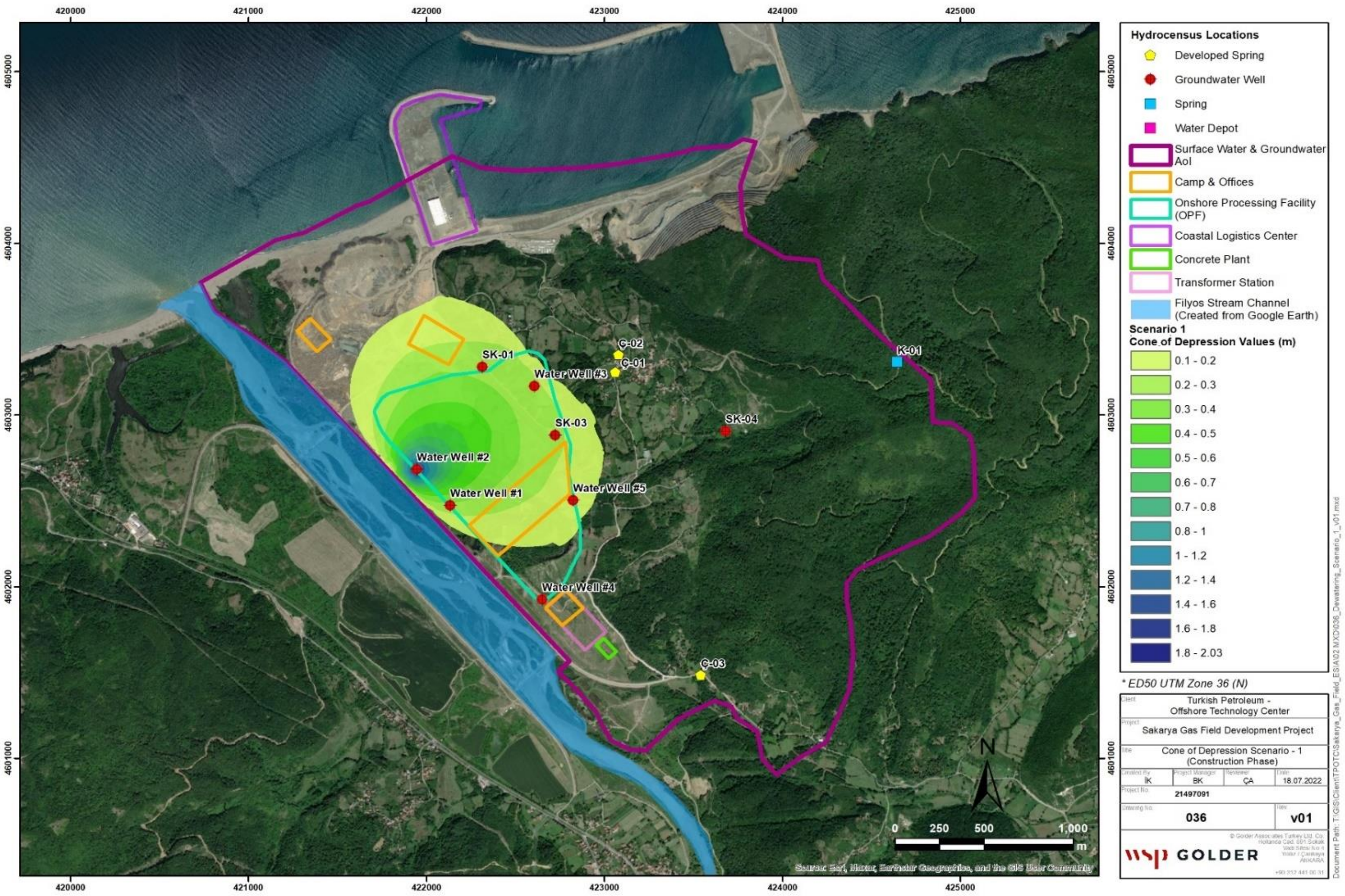


Figure 7-41: Cone of Depression Map (Scenario-1)

Changes in Groundwater Levels and Filyos River Baseflow in Scenario-2

According to the Scenario-2; water will be supplied from Waterwell-2 with a daily rate of 2, 400m^3, plus from Waterwell-4 with a daily rate of 672 m^3, during construction phase which its duration is expected to be 16 months.

Filyos River's flowrate budget during the scenario-2 in the groundwater model is given in Figure 7-42.

The cone of depression in water table as a result of water abstraction with scenario-2 inputs is presented in Figure 7-43.

Based on the flowrate budget graph in Figure 7-42; an approximately 1,700 m^3/day groundwater discharge rate to Filyos River is minimized to zero within a month of abstraction from Waterwell-2 & Waterwell-4 together, and Filyos River is recharging the groundwater with a rate of 900-1,000 m^3/day between month 1 – month 16.

During the last 6 months period; an approximately 2,700 m^3/day reduction is expected in Filyos River's baseflow in Scenario-2.

As a result of water abstraction from the Waterwell-2 and Waterwell-4, a cone of depression is expected to be occurred where its borders are staying almost in onshore Project area.

It appears that SK-3 well, which is the water source of Sazköy Village, is being in the area of cone of depression, and it is expected to be impacted by groundwater abstractions during the construction phase. Beside this well, no other groundwater sources in and near the Project site is expected to be impacted by the cone of depression.

As mentioned in "Mitigation measures" below; Since SK-3 is in a location affected by Project activities, SK-4 well will be constructed instead of SK-3 well as Sazköy Village's water resource, and Sazköy's water resource will be SK-4 in the next period.

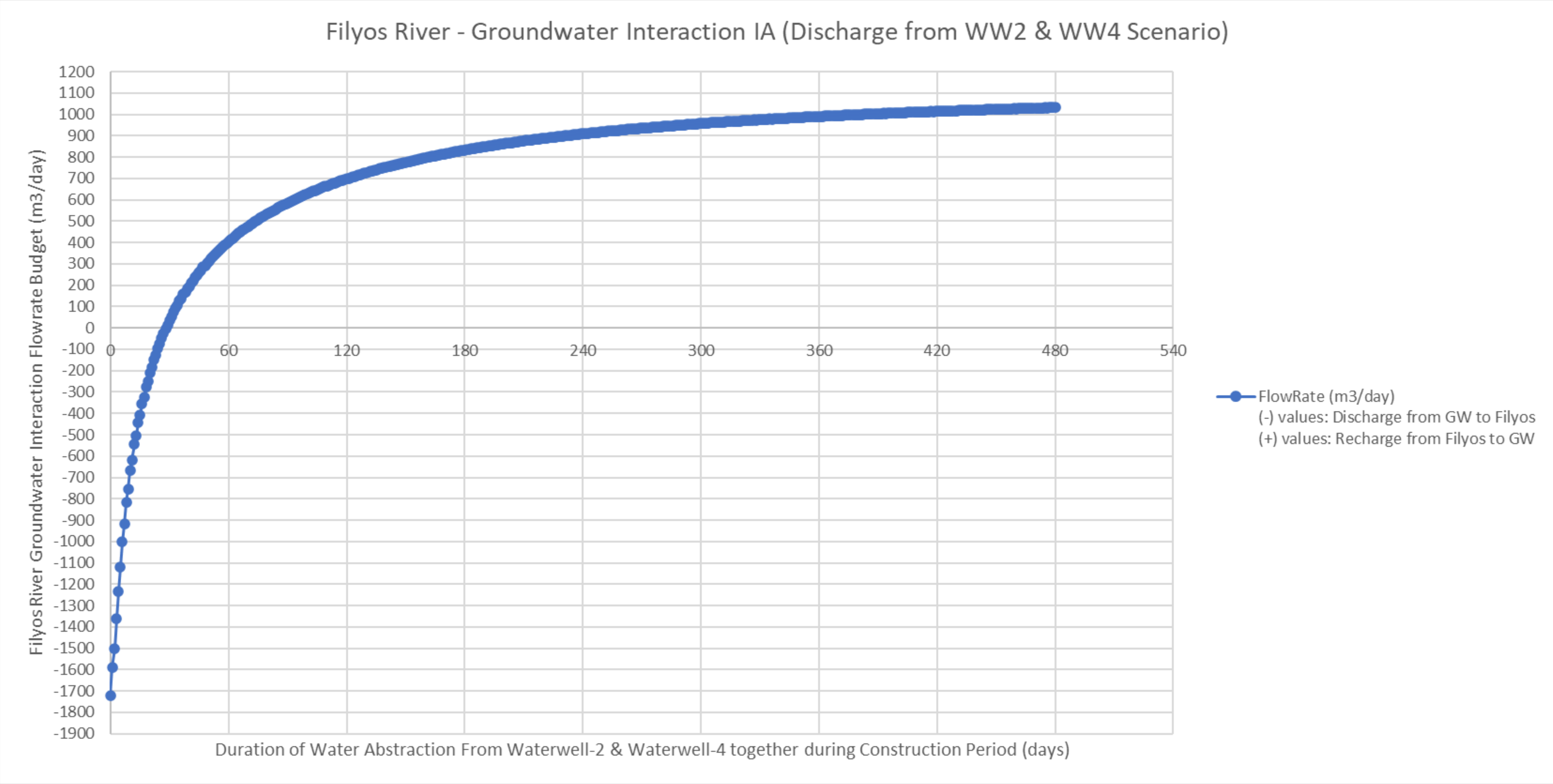


Figure 7-42: Filyos River Baseflow - Groundwater Interaction Budget (Scenario-2)

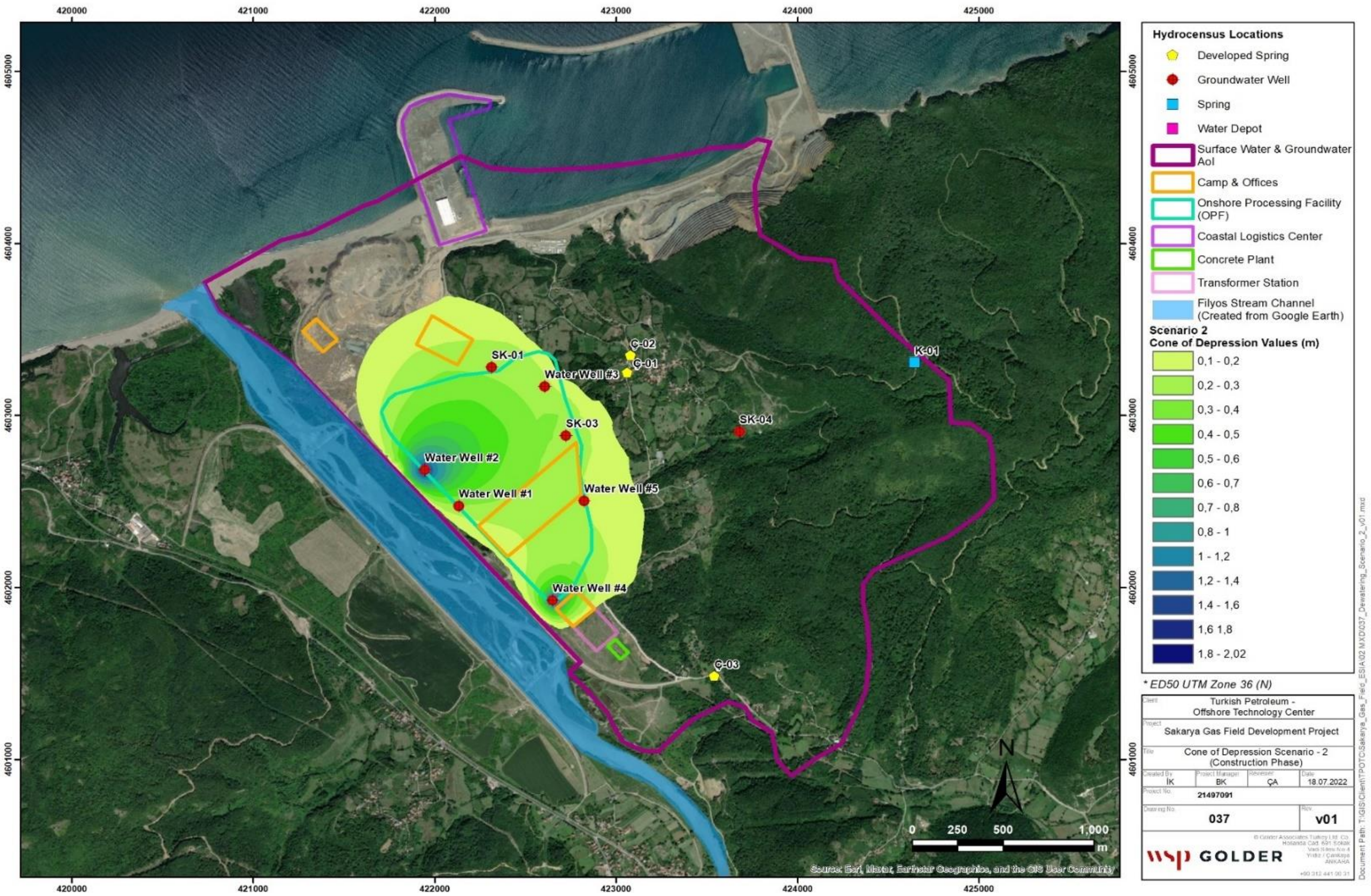


Figure 7-43: Cone of Depression Map (Scenario-2)

- **Changes in flow/circulation in natural water bodies**

There are ephemeral streams in the onshore project construction site, and there is no major water body that will be potentially impacted by the construction activities.

Therefore, no major impact on the groundwater resources is expected, and this impact factor can be considered as negligible.

- **Wastewater and stormwater discharges**

The wastewater and stormwater produced during the construction phase is discharged to Filyos River and Blacksea accordingly. Since the water budgets of the receiving environments (Filyos & Blacksea) are much larger than the discharged amounts, no quality impact is expected or very limited in the amount recharged to the groundwater due to the dilution of the water quality. Therefore, the impact can be considered as negligible.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the Project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **medium negative impact** is expected on the hydrogeology and groundwater quality during the construction phase.

Table 7-65. Impact Assessment Matrix for Hydrogeology and Groundwater Quality During Construction Phase After Mitigation Measures

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Demand for freshwater	Duration:	Medium	High	Short-mid-term	**Medium**	Low	**Medium**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Changes in flow/circulation in natural water bodies	Duration:	Medium	High	Mid term	**High**	Medium-high	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Low					
Discharge of Wastewater	Duration:	Medium	High	Short-term	**Low**	Medium-high	**Negligible**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Overall assessment:		**Medium**	Rationale:	Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value			

Since the mitigation and monitoring measures are same measures for both the construction and operation periods, they are listed together after operation phase impact assessment.

7.2.1.5.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting hydrogeology and groundwater quality during operation phase are listed in following Table 7-66.

Table 7-66. Project actions and related impact factors potentially affecting hydrogeology and groundwater during operation phase

Project actions	Brief description	Impact factors
Plant/infrastructure onshore operation	During operation activities, wastewater will be treated and discharged to Filyos River. Also, groundwater will be abstracted for the potable and process water need.	Demand for freshwater Discharge of wastewater

- **Demand for freshwater**

The demand for freshwater as a result of the Project activities are discussed in this section in terms of quantity and quality, and how the surface water - groundwater interaction is affected considering the baseline hydrogeological characteristics of Area of Influence (AoI).

Water Supply Plan During Operation: Based on a verbal information gathered from TP-OTC team on the site; water need is planned to be supplied from groundwater wells, namely Waterwell-2, in the Project Site and from the potable water system.

It's foreseen that the main water supply well will be Waterwell-2 with an average discharge rate of 218 m^3/day. The main sources of water supply can be changed according to the aquifer tests conducted in the wells drilled at the west side of the facility and in the wells that are planned to be drilled. For this reason, the study of water sustainability should be repeated accordingly.

Impacts on groundwater resources due to groundwater abstraction from Waterwell-2

Operation period is considered as 480 months between March 2023 and March 2063. During this period, one scenario was imported to the groundwater model and the simulation was run for the impacts of the water demand from groundwater resources. The input for the scenario is detailed in Table 7-67 below.

Table 7-67: Inputs for Groundwater Abstraction Scenario (Operation Phase)

Input Type	Assumptions	Groundwater Supply from	Groundwater Abstraction rate (m3/day)	Duration
Scenario 3	Water will be supplied only from Waterwell-2, no backup needs	Waterwell-2	218	480 months

Changes in Groundwater Levels and Filyos River Baseflow in Scenario-3

According to the Scenario-3; water will be supplied from Waterwell-2 with a daily rate of 218 m^3 during operation phase which its duration is expected to be 480 months.

Filyos River's flowrate budget during the Scenario-3 in the groundwater model is given in Figure 7-44.

The cone of depression in water table as a result of water abstraction with scenario-3 inputs is presented in Figure 7-45.

Based on the flowrate budget graph in Figure 7-44; an approximately 1,700 m^3/day groundwater discharge rate to Filyos is reduced to 1,510 m^3/day within 18 months of abstraction from Waterwell-2.

During the operation period; an approximately 200 m^3/day reduction is expected in Filyos River's baseflow in Scenario-3.

As a result of water abstraction from the Waterwell-2 during the operation phase, a cone of depression is expected to be occurred where its borders are staying almost in Onshore Project facility area.

It appears that SK-3 well, which is the water source of Sazköy Village, is being in the area of cone of depression, and it is expected to be impacted by groundwater abstractions during the operation phase. Beside this well, no other groundwater sources in and near the Project site is expected to be impacted by the cone of depression.

As mentioned in "Mitigation measures" below; Since SK-3 is in a location affected by Project activities, SK-4 well will be constructed instead of SK-3 well as Sazköy Village's water resource, and Sazköy's water resource will be SK-4 in the next period. In case of drilling new groundwater wells, water sustainability study should be redone to comply with IFC PS3.

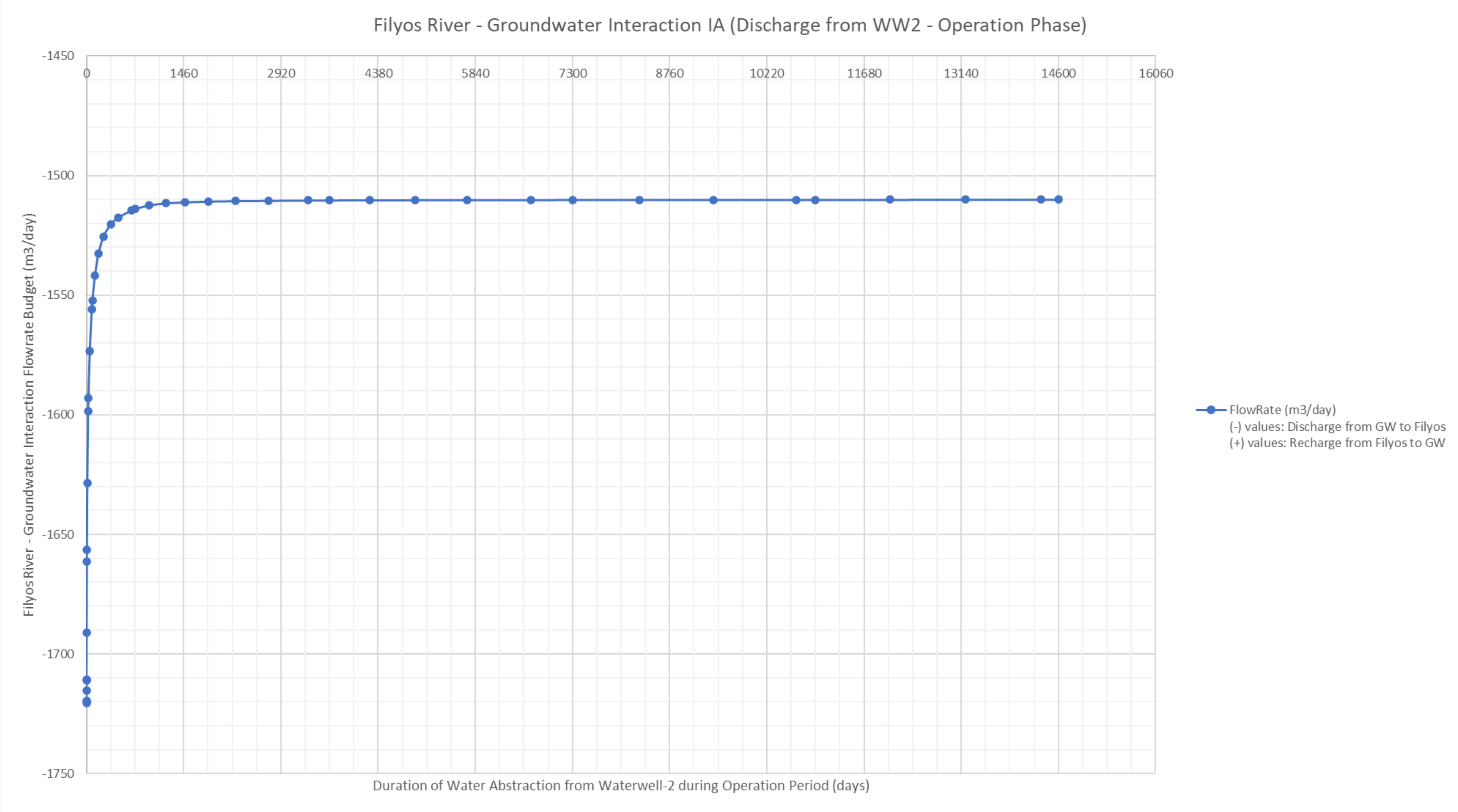


Figure 7-44: Filyos River Baseflow - Groundwater Interaction Budget (Scenario-3)

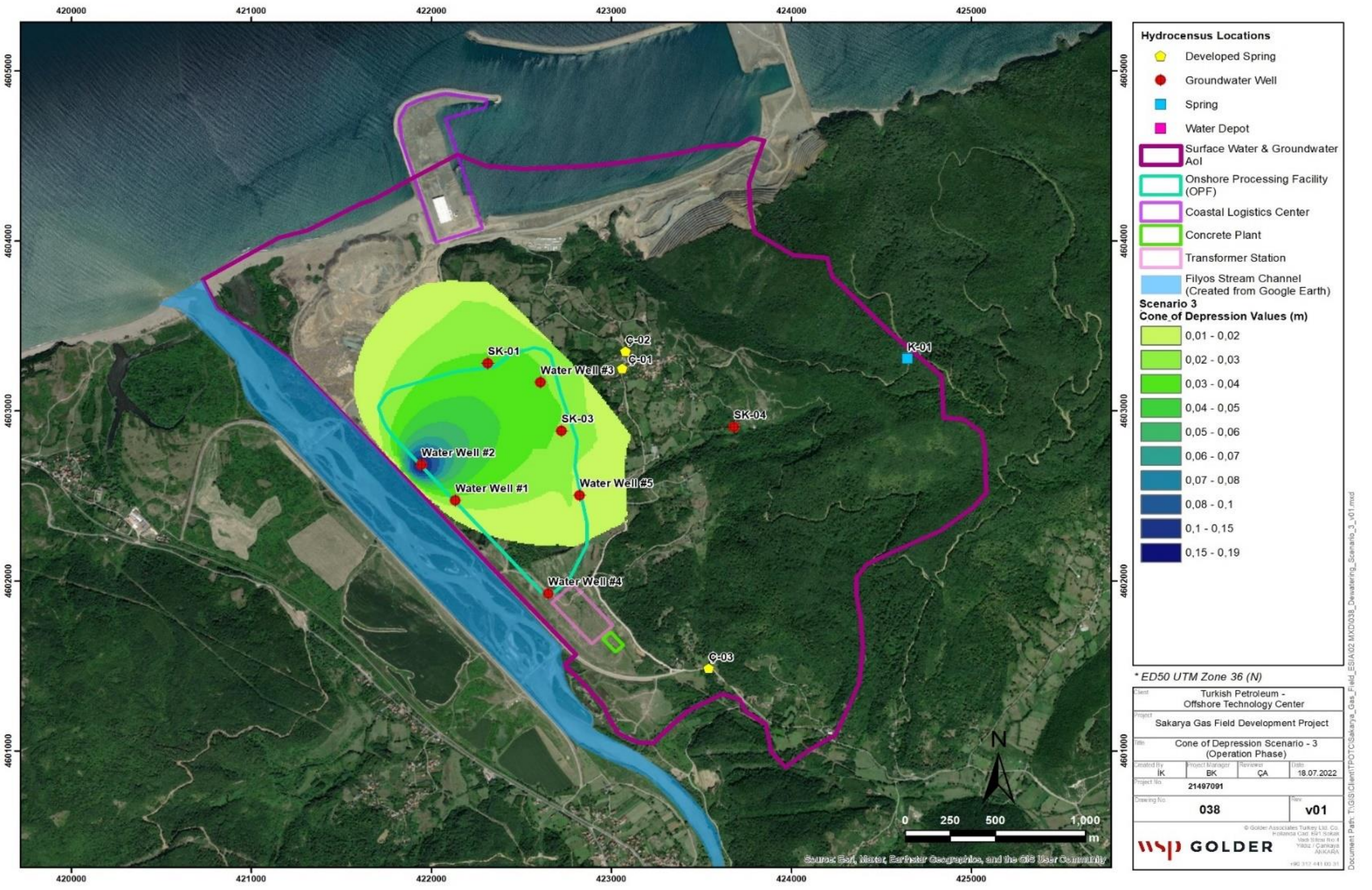


Figure 7-45: Cone of Depression Map (Scenario-3)

Mitigation Measures

The mitigation measures related to hydrogeology and groundwater quality for the construction and operation phases are as follow:

Measures incorporated in the Project Design:

- Since SK-3 is in a location affected by Project activities, SK-4 well was constructed instead of SK-3 well as Sazköy's water resource, and Sazköy's water resource will be SK-4 in the next period.
- The main sources of water supply can be changed according to the aquifer tests conducted in the wells drilled at the west side of the facility and in the wells that are planned to be drilled. For this reason, the study of water sustainability should be repeated accordingly.
- Worksite will be minimized to the smallest extent possible in order to meet Project's works and activities.
- The foundations' footprints and depths have been properly dimensioned; hence the excavations and the consequent physical-mechanical disturbances will be minimized.
- The Project will comply with safety requirements to avoid leakages from hazardous chemicals/materials and liquids stored on-site.
- The areas, where the diesel/fuel storage tanks located (can be named as hazardous material storage areas), will be designed and constructed to avoid potential contamination into the soil (paved areas with sufficient secondary containment, proper drainage systems etc.).
- Project-specific Pollution Prevention Plan and Waste Management Plan will be implemented to ensure that the amount of release and spills can be taken under control before reaching substantial amounts that may potentially affect the quality of groundwater.
- The areas, where the hazardous materials (chemicals, liquids etc.) storage tanks located (i.e., hazardous material storage areas), will be designed and constructed to avoid potential contamination into the soil (paved areas with sufficient secondary containment, proper drainage systems, storage as per Safety Data Sheet (SDS) requirements etc.). Also, the Project will comply with relevant legal and project safety requirements to avoid leakages from hazardous materials (chemicals, liquids etc.) storage facilities on-site.
- The temporary waste storage areas will be constructed based on the requirements listed in the Regulation on Waste Management issued on April 02, 2015 Official Gazette no: 29314 and GIIP. Details are Given in Chapter 7.2.1.1.

General mitigation measures are listed below:

- Consultations will be held with State Hydraulic Works and General Directorate of Water Management regarding the hydrogeological studies and groundwater quality and any additional studies will be conducted upon the opinions of these institutions prior to the construction phase.
- Using the monitored seasonal flowrates and any additional groundwater well data to be drilled in and/or near the Project site, the hydrogeological model should be re-calibrated (if necessary) to re-evaluate groundwater abstraction related consequences prior to the operation period.

- Maintenance of the vehicles and machinery/equipment (if needed) will be conducted in designated area where there is impermeable surface (concrete floor etc.) and if needed secondary containment system present;
- Portable spill containment and clean-up materials (spill kits) will be made available and easily accessible at the construction site, instructions on how to use spill containment and clean-up materials will be included in the kits;
- Training on spill response, use of containment and clean-up material (spill kits) will be provided to works (including the subcontractor workers);
- Adequate and properly maintained tanks, paved ground, spill containment materials and proper secondary containment systems with sufficient volume will be provided for fuel/oil storage and for the storage of other fluids and hazardous substances to prevent loss into the soil;
- Wastewater flows from any field activities (i.e., excavations, drillings, re-fuelling and vehicle/equipment washing) will be properly managed;
- Polluted water (if any generated as a result of accidental leakages) will be properly collected or managed to prevent mixing with any water body and the topsoil/soil pollution.
- Discharge of untreated wastewater, residues or other waste into groundwater or into surface water will be avoided.

Residual Impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the Project characteristics, and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on the hydrogeology and groundwater quality during the operation phase.

Table 7-68: Impact Assessment Matrix for Hydrogeology and Groundwater Quality During Operation Phase After Mitigation Measures

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Demand for freshwater	Duration:	Long	High	Short-term	**Low**	Low	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Discharge of Wastewater	Duration:	Long	High	Short-term	**Low**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Overall assessment:		**Low**	Rationale:	Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value			

Monitoring Measures

Since the monitoring measures written in this section are same measures for both the construction and operation periods, they are listed together here. Both the construction and operation period monitoring measures are as follows.

- Groundwater levels should be continuously and automatically measured by water level loggers that should be inserted within the groundwater wells which should be selected based on the representability of the AoI and in addition to these wells, in the SK-4 (Sazköy water supply well) well. Moreover, the water quality in these wells will be monitored seasonally and trend analyzes will be developed. The data should be reviewed periodically (at least on an annual basis) by TP-OTC and/or an independent supervisor to establish current site conditions and to detect any trends in groundwater quality or levels. If significant trends are observed, then potential causes should be investigated, and corrective measures should be taken, as necessary. During monitoring, the groundwater levels will be monitored continuously by internal transmitters and the monitoring and sampling operations at the monitoring wells based on the EIA commitments will be conducted by an independent company or an accredited laboratory by the Ministry of Environment, Urbanization and Climate Change (MoEUCC) in Turkey.
- With the monitoring to be carried out within the scope of the project, the established groundwater flow model can be recalibrated, the impact assessment studies can be updated and the monitoring program can be expanded with additional points.
- Periodic site inspections will be carried out to ensure that the open drains are free of sediments and accumulation of sediments at the sediment traps does not prevent the run-off flow;
- Periodic visual site inspection of stormwater and wastewater drainage networks, in order to verify their integrity and functionality;
- Periodic site inspections will be carried out and reported to identify any possible leakages;
- Periodic site inspections will be carried out in order to identify any possible damage in the hazardous materials storage areas and waste storage areas;
- Trainings on spill response, use of containment and clean-up material for the workers (including the subcontractors' workers) will be recorded.
- Analyzes will be carried out quarterly for the treated wastewater at the respective outlet points prior to discharge by accredited laboratories to check compliance with Project standards. Analyzes will also be carried out at the frequency specified in the environmental permit document to be obtained from the Provincial Directorate of Environment, Urbanization and Climate Change in accordance with the Environmental Permit and License Regulation. As per the IFC EHS Guidelines, wastewater monitoring should take into consideration the discharge characteristics from the process over time. If the effluent is observed to be highly variable or discharge standards are exceeded, monitoring can be carried out more frequently or through composite methods.
- Treatment plants having a flow rate of 200-500 m^3/day will have a sampling manhole and automatic sampling device at the outlet point of the wastewater treatment plant according to the "Regulation on Water Pollution Control.

7.2.2 Biological

7.2.2.1 Flora

Based on the information collected for the definition of the baseline (see Chapter 6.2.2.1), the biological component *Flora* was assigned a **Medium** value of sensitivity for the following reasons:

- Limited Presence (1) of threatened species of flora;
- Limited Presence (1) of protected species; and
- Limited Presence of endemic or restricted-range species of flora.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.2.2.1.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting flora during construction phase are listed in the following table.

Table 7-69: Project actions and related impact factors potentially affecting flora during construction phase.

Project actions	Brief description	Impact factors
Vegetation clearing	Removal of natural and farmed vegetation from the area along the ETL for the installation of poles, and from coastal dune area within the Project's footprint.	■ Removal of natural vegetation ■ Emission of dust and particulate matter ■ Possible introduction of alien species
Site levelling and grading	Removal of the first 300 mm of soil from dune habitat in the landfall area	■ Removal of natural vegetation ■ Emission of dust and particulate matter ■ Removal of soil
Material transportation	Removed soil and construction material will be transported out and in the construction area using trucks and heavy machinery. Building material will include crushed rocks and gravel for both the landfall area and the ETL.	■ Emission of dust and particulate matter ■ Possible introduction of alien species
General engineering / Construction works	Heavy machinery will be operating on the landfall area and the ETL poles installation	■ Emission of dust and particulate matter ■ Possible introduction of alien species

The impact factors identified above are described below and assessed in the matrix that follows.

- **<u>Removal of natural vegetation</u>**

About 78.5% of the Project footprint consists of highly modified area, corresponding to the preexisting Filyos Industrial Area, with only a 16% of natural habitat and a 5.5% of highly artificial forestry, which includes a 4% of Eucalyptus trees, an introduced flora species.

The natural vegetation within the Project' footprint is present only in the following two areas:

- The landfall area located in the dune habitat on the coast section where the offshore pipeline will be connected to the OPF.
- The ETL area where poles and electrical lines will be installed.

The area directly impacted by the landfall construction works corresponds to approximately 5 ha, including about 3 ha of riparian and gallery woodland vegetation east of the coastal pond with the remaining 2 ha area of sand dune grassland.

The removal of vegetation in these areas will cause habitat loss and habitat fragmentation, however, the sand dune area hosting a CH triggering flora species (*Centaurea kilaea*) was subjected to an early mitigation program before site preparation commenced (Appendix M), which consisted the translocation of all individuals from the two main species characterizing the habitat (including *C. kilaea*) as per the Biodiversity Action Plan and Biodiversity Management Plan for the Onshore Dune Area Construction Phase.

The ETL construction works are expected to impact an area of about 5 m on each side along 1.3 km route crossing natural woodland and a small area of fruit and nut tree orchards, for a total of nearly 1.3 ha. Trees and vegetation will be removed from the ETL route to clear the preexisting access roads and install pole stands and towers, causing habitat loss and habitat fragmentation.

As a preliminary mitigation measure the individuals of one sensible flora species, *Cyclamen coum var. coum*, present along the ETL working area have also been translocated to a suitable nearby undisturbed area.

The area affected by this impact factor will be limited to part of the natural habitat within the Project footprint, it will be carried on in a three-months period (ETL), on one or more events evenly distributed in this period, the changes to the environment, although, fairly evident, will be in accordance with the current legal regulations.

- **Removal of soil**

Topsoil removal will be carried out as a consequent step of the natural vegetation clearance discussed above and therefore, it will affect the same areas (i.e, Landfall and ETL).

This could have an impact on roots and bulbs from dune vegetation and the removed riparian woodland.

The removed soil from the landfall area will be stored in a dedicated area and reinstated at the end of the construction work. In the ETL the soil will be used for backfilling the poles installation areas.

The removal of soil, as per the vegetation removal, will be limited to part of the natural habitat within the Project footprint, it will be carried on in the medium-short term (ETL), on one or more events evenly distributed in this period, and the evident changes to the environment will be in accordance with the current legal regulations.

- **Emission of dust and particulate matter**

Emission of dust and particulate matter and its consequent fall to the ground has been proven to negatively impact flora. Dust emissions can impact vegetation directly by covering leaf surface and indirectly through impacts on soil composition and structure (Farmer, 1993). Dust can block stomata on the leaf surface, affect photosynthesis, respiration, transpiration, and may cause leaf injury symptoms. Possibly, resulting in a loss of productivity, and the consequent reduction in vegetation growth, vegetation cover and species loss.

The impact is expected to be stronger in the immediate vicinity of the construction site and vehicle decline with the distance within the 100 m precautionary buffer. About 1 ha of natural and seminatural vegetation could be indirectly impacted by pollutant and dust emission during construction.

This impact is expected to be discontinuous during construction (depending on wind conditions and vehicle and machinery activity vehicle), localized and limited to the immediate surroundings of the project footprint. The intensity of the impact is expected to be low within the Project Area. The impact is considered reversible in the short term since a rain event, even if rare, could clean the leaf surface from dust and pollutant. The probability of occurrence of this impact is expected to be high.

- **Possible introduction of alien species**

Removal of vegetation and topsoil could facilitate the introduction and proliferation of alien flora species. In particular, vehicles, machinery and materials utilized in other sites and entering the construction area may also carry seeds and bulbs non-native flora species.

Construction operations in natural habitats such as in the landfall and ETL areas carry the potential for such accidental introductions during the entire phase of works within each area but with an infrequent frequency and possibly negligible intensity.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Removal of natural vegetation**
  - Biological pre-construction surveys will be implemented in the areas still to be cleared in order to identify and relocate flora species;
  - Limits of clearing and construction areas will be clearly marked or fenced in order to avoid impacts outside this area;
  - All vehicles will drive on designated routes unless otherwise authorized, and off-road driving will be strictly prohibited;
  - Specialist training shall be provided to plant operators and key personnel involved in activities which involve land clearance, materials handling and transport activities which may impact terrestrial biodiversity (e.g. vegetation, clearing, restoration activities);
  - To allow for vegetation recovery those structures and service roads built for construction purposes only in previously vegetated areas should be removed after construction activities are terminated;
  - Monitoring of flora species and their recovery in the landfall and ETL construction area to inform if further mitigation is needed.
- **Removal of soil**
  - Topsoil to be stored in designated stockpile areas;
  - Reinstatement of topsoil in the landfall construction area to enhance natural habitat restoration.
- **Emission of dust and particulate matter**

  - Dust management control measures will be implemented as described in Chapter 7.2.1.2 – Air Quality.
- **Possible introduction of alien species**
  - Check of vehicles and machinery for evident foreign plant material, soil and seeds on their first entry on site.
  - Trucks coming from the outside the Project area covered with visible amounts of dirt will be washed in a controlled site, where residues will be managed as waste;
  - If spreading of invasive species is observed, an appropriate eradication program will be developed and implemented.
  - It was also noticed that within the main TPAO Special -Investment Zone rehabilitation was conducted using planting of eucalyptus trees in rows. Since eucalyptus is considered an invasive alien species in Turkey, it is strongly recommended that further rehabilitation (if any) or restorations of deceased plants (if any) will be carried out with mixed tree species typical of local floodplain woodlands, (e.g., Platanus, Populus, Salix, Ulmus, etc.), in order to align with IFC PS6. A more natural planting scheme is suggested alternating areas with higher density of mixed trees, open areas and depressions in the terrain where temporary ponds could form. An appropriate mix of seeds should be sowed after tree planning in order speed up the revegetation process and ensure ground cover to minimize erosion and sediment runoff.

A comprehensive mitigation strategy for the landfall (dune) area has been prepared separately and can be found in the dedicated BAP reported in Appendix M.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative residual impact** is expected on flora during the construction phase.

Table 7-70: Residual impact assessment matrix for flora during construction phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Removal of natural vegetation	Duration:	Medium-short	Medium	Long term	**Medium**	Medium	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Removal of soil	Duration:	Medium-short	Medium	Long term	**Medium**	Medium-high	**Low**
	Frequency:	Infrequent					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
	Geo. Extent:	Project site					
	Intensity:	Medium					
Emission of dust and particulate matter	Duration:	Medium	Medium	Short-mid-term	**Low**	Medium-high	**Negligible**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Possible introduction of alien species	Duration:	Medium-short	Medium	Long term	**Medium**	High	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Overall assessment:		**Low**	Rationale:	Removal of vegetation will interest a minor part of the Project Area, interesting mostly the landfall dune and riparian vegetation, and the mitigation measures proposed, which are outlined on a specific BAP, are expected to offer a substantial recovery leaving a negligible to low residual impact			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on flora during the construction and verify the effectiveness of the mitigation measures.

- Monitoring for vegetation cover and recovery of construction areas and the 100 m AoI around the general Project area to be carried out at completion of works and in the following two years, annually.
- Monitoring of landfall area should follow the indications provided in the relative BAP (Appendix M).
- If detected, presence and spreading of invasive flora, including eucalyptus species, within and around the construction site will be monitored every three months by experts, and, if necessary, extirpation campaign will be put in place in order to avoid the spreading of the invasive species.

7.2.2.1.2 Operation phase

Impact factors

Impacts on flora generated by the operation phase of the Project are expected to be limited to the emission of dust and particulate matter. Impacts and mitigation measures are, therefore, applied as per the construction phase (Chapter 7.2.2.1.1).

Table 7-71: Project actions and related impact factors potentially affecting the flora during operation phase.

Project actions	Brief description	Impact factors
Plan/Infrastructure onshore operation	Site activities and vehicle traffic within the Project's Area	■ Emission of dust and particulate matter

The impact factors identified above are described below and assessed in the matrix that follows.

- **Emission of dust and particulate matter**

As reported in the previous section emission of dust and particulate matter and its consequent fall to the ground has been proven to negatively impact flora.

The impact is expected to be stronger in the 1 ha of total area consisting of the 100 m surrounding the Project Area.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Emission of dust and particulate matter**
  - Dust management control measures will be implemented as described in Chapter 7.2.1.2 – Air Quality.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a **negligible residual impact** is expected on flora during the operation phase.

Table 7-72: Residual impact assessment matrix for the flora during operation phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Enhancement effectiveness	Residual impact value
Emission of dust and particulate matter	Duration:	Long	Medium	Short-term	**Low**	Medium-high	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Low					
Overall assessment:		**Negligible**	Rationale:	During the operation phase no further direct impact on vegetation is expected and any negative effect from site activities will be promptly mitigated and monitored leading to an expected negligible residual impact.			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on flora during the operation and verify the effectiveness of the mitigation measures.

- Inadvertent impacts on natural habitats present around the project area will be monitored annually in order to assess eventual footprint creep outside designated areas, including signs of erosion or stagnant water accumulation, functioning of the water run-off management system, dust deposition on vegetation, presence of waste or hazardous substances spill.
- Areas progressively restored (dune area) will be inspected annually during the vegetative season, in order to allow for prompt corrective actions, if needed. The monitoring will aim to assess the development of the planted/seeded species, the vegetation cover and the presence of stress or erosion signs.
- If detected, presence and spreading of invasive flora, including eucalyptus species within and around the construction site will be monitored once a year by experts, and, if necessary, extirpation campaign will be put in place in order to avoid the spreading of the invasive species.

7.2.2.2 Freshwater Fauna

Based on the information collected for the definition of the baseline (see Chapter 6.2.2), the biological components included in the *Freshwater Fauna* were assigned a **Medium** value of sensitivity for the following reasons:

- Absence of threatened amphibians and fish species;
- Limited number of threatened species of freshwater aquatic invertebrates (1);
- Limited presence of endemic amphibian (1) and fish species (3);
- Absence of endemic or restricted range species of freshwater aquatic invertebrates;
- Presence of protected amphibian species (8);
- Presence of introduced fish species (2); and
- Presence of areas, within the Project's AoI, deemed suitable for the spawning of the amphibian

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.2.2.2.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting freshwater fish during construction phase are listed in the following table.

Table 7-73: Project actions and related impact factors potentially affecting the freshwater fauna during construction phase.

Project actions	Brief description	Impact factors
Vegetation clearing	Removal of natural and farmed vegetation from the area along the ETL for installation of poles, and from coastal dune area within the Project's footprint.	■ Emission of dust and particulate matter ■ Emission of aerial noise and vibrations
Site levelling and grading	Removal of the first 300 mm of soil from ETL and dune habitat in the landfall area	■ Emission of dust and particulate matter ■ Emission of aerial noise and vibrations
Material transportation	Removed soil and construction material will be transported out and in the construction area using trucks and heavy machinery. Building material will include crushed rocks and gravel for both the landfall area and the ETL.	■ Emission of dust and particulate matter ■ Emission of aerial noise and vibrations ■ Increase and modification of traffic onshore
General engineering / construction works	Heavy machinery will be operating on the landfall area, for the ETL poles installation and the general OPF construction. Water will be withdrawn form groundwater wells within the Project's footprint, used for construction-related activities, and then discharged back into the river.	■ Discharge of wastewater ■ Changes in flow/circulation in natural water bodies ■ Minor leakage of contaminants into water ■ Emission of dust and particulate matter ■ Emission of aerial noise and vibrations ■ Emission of light ■ Possible introduction of alien species ■ Increase and modification of traffic onshore

The impact factors identified above are described below and assessed in the matrix that follows.

- Filyos**Discharge of wastewater**

It is expected an intermitted discharge of treated and untreated wastewater for up to 540 m^3/day from sewage and 400 m^3/day from backwashing of potable water treatment plant filters, plus an additional maximum total of 3,700 m^3 from the pre-commissioning of the onshore pipeline section and OPF. In case analysis results of pre-commissioning wastewaters are not compliant, wastewater will be transferred to licensed WWTPs by vacuum trucks

The discharge outlets will be present at two different points along the Project's riverside. The sewage discharge points will be placed in its mid-section, while the one-off event of water discharge for the pre-commissioning of the pipeline has been planned in a prevalently stagnant water section surrounded by riparian vegetation.

This factor will have a frequent impact during the construction phase although the intensity is considered to be low.

- **Changes in flow/circulation in natural water bodies**

Changes in water flow/circulation will be due mainly to discharges from wastewater treatment facilities into Filyos River.

The expected volumes and discharge outlets detailed in the previous point may produce an impact on the flow and circulation of freshwater in proximity of the discharge points.

The discharge in the faster flowing section of the river is expected to have a negligible impact on flow/circulation of the receiving water body, on the contrary, the discharge of water in proximity of a stagnant water body could have a flash-flood effect on the habitat, resulting in fauna being washed away from the area, possibly causing loss of biodiversity in that area.

This factor would have a negligible intensity impact, and a short-term reversibility. The generated impacts will be infrequent over time.

- **Minor leakage of contaminants into water**

Leakages of contaminants into the water would be mainly expected to occur due to runoffs from areas in proximity of freshwater bodies that have experienced:

- oil and fuel leakage from vehicles and generators;
- accidental spill of any hazardous materials that are used during the construction;
- runoff from area where chemical, oil and fuel are temporarily stored (i.e. areas where paving and secondary containments are not present);
- pollution caused by temporary storage of hazardous materials and/or wastes;
- disposal of wastes, wastewater and liquid wastes;
- flooding of ponds (i.e., settling pond of concrete wastewater) or secondary containments caused by heavy precipitation;
- accidental spill of wastewater (e.g., domestic, hydrotest).

Chemical contamination of freshwater could have a variety of adverse effect on aquatic fauna, depending on the contaminant and its concentration. Oil and fuel, for example, could be lethal for many aquatic invertebrates linked to the water surface but also for amphibians and fish, while sewage water could promote eutrophication and even algal blooms with a consequent reduction of oxygen and even production of harmful toxins.

Despite the potential for even severe impacts this factor is predicted to be infrequent at best, and of a low intensity as there are no construction activities directly in freshwater habitats and therefore spills, leakages, and accidental discharges would have to originate from the OPF footprint or the connecting roads which are generally located at a certain distance from the nearby water bodies.

- **Emission of dust and particulate matter**

Dust and particulate depositing along the river sides and in the water could cause alterations in the biological and chemical characteristics of the water environment. Dust deposition can also produce negative effects on vegetation, in case of freshwater environments this could cause a loss of riparian vegetation and important feeding and nesting habitats. Also, direct effects to fauna species could be through inhalation or ingestion of soil particles. Amphibians are also particularly susceptible to dust and air pollution due to their characteristic cutaneous respiration.

The impacts due to the dispersion of dust and particular matter, which is considered to be highly frequent and of low intensity, are possible around the Project footprint, involving a geographic extent defined as local (within 100 m buffer). The reversibility from this impact factor is considered to be short/mid-term.

- **Emission of aerial noise and vibrations**

The emission of noise and vibrations is expected to increase during construction phase compared to baseline levels due to construction activities such as vegetation clearance, soil excavation, surface levelling and grading, soil improvement activities, mobilization of vehicles, workers and equipment, temporary stockpiling of material, transport of materials and waste, construction of the facilities and paved areas.

Noise and vibration emission could cause indirect habitat degradation due to temporary avoidance of surrounding areas by fauna species. In freshwater habitats amphibians may prefer to move further away from the Project Area to avoid the increased noise from construction site activities.

Noise and vibrations can also have a negative effect on feeding behavior of freshwater fish (Popper and Hawkins, 2019; Pieniazek et al., 2020).

The emission of noise and vibration is expected to be of medium intensity during construction activities, and to have a highly frequency and a local geographic extent (within 300 m buffer). The impact is considered to be reversible in a short-term time.

- **Emission of light**

Aquatic ecosystems can be very sensitive to light and are often severely affected by artificial light at night. Exposure to artificial light at night can affect the productivity of freshwater ecosystems and interfere with predator-prey relationships. Some freshwater fish have been shown to avoid areas with artificial light (Kim and Mandrak, 2017) or even to increase risk-taking behaviors (Kurvers et al., 2018) increasing the chance of being predated.

Some amphibians (e.g., tree frogs), may also lessen their mating call in areas with intense artificial light, practically reducing the mating success and consequently negatively influencing local populations.

Light pollution is expected to be continuous during construction operations, and of a medium intensity.

- **Possible introduction of alien species**

The possibility of introduction of alien freshwater fauna species is limited to the import of water or moist soil into the Project Area and its discharge in or in proximity of water bodies within the Project footprint. Alien species tend to have an advantage in disturbed ecosystems, and if they penetrate into a habitat, they can potentially change its functionality and species composition, and compete with other species including endemic ones.

Such event is expected to be rare, and to be infrequent in its occurrence and of negligible intensity, its reversibility is classified as long-term.

- **Increase and modification of traffic onshore**

During construction, an increase in vehicular traffic is expected along all road network of the present Project Area, this could cause a higher risk of accidental collisions with wildlife, especially in areas crossing or in proximity of natural habitats. Roads are known to attract some fauna species for a variety of reasons (e.g., water, humidity, heat, presence of roadkill and preys), this can increase the impact on local populations of specific fauna groups and individual species.

Amphibians might be attracted by stagnant water that forms at roadside or within the construction area increasing the risk of collisions with traffic. During the construction phase, most fauna species may temporarily avoid construction areas and their immediate vicinities, and this behaviour is mainly due to the increase in human activity.

This impact factor is considered to have a local geographic extent classified, and a potential medium intensity with a frequency defined as "frequent", since the events are evenly or randomly distributed over time. Since the biodiversity components can restore themselves in a short period after the end of this impact, depending on species' biology, the reversibility of the vehicular traffic factor is classified as mid-term.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Discharge of wastewater**
  - Discharges of water into the natural water habitats should follow the indications of Chapter 7.2.1.4 – Hydrology and Surface Water Quality.
  - Treated wastewater should be analyzed in accordance with national and international guidelines listed in Appendix B;
  - In case of any parameter exceeding its concentration limit the discharge output should be immediately closed until the issue is properly assessed and resolved.
- **Changes in flow/circulation in natural water bodies**
  - Discharges of water into the natural water habitats should follow the indications of Chapter 7.2.1.4 – Hydrology and Surface Water Quality.
  - In particular, the discharge from the pre-commissioning pipeline should be done at a reduced discharge flow to allow for the soil to absorb the majority of the water preventing any wash-off effect on the freshwater fauna in the area.
- **Minor leakage of contaminants into water**
  - Project-specific Pollution Prevention Plan and Waste Management Plan will be implemented to ensure that the amount of release and spills can be taken under control before reaching substantial amounts that may potentially affect the quality of soil and potentially that of the nearby water bodies.
  - Detailed information on spills and leakages mitigation procedures are provided in Chapter 7.2.1.1 – Soil and Subsoil and Chapter 7.2.1.4 – Hydrology and Surface Water Quality Hydrology and Surface Water Quality.
  - Particular care will be taken on spill containment procedures and materials, and spill/leakage response training of personnel in order to avoid any contamination reaching the freshwater habitats where containment and clean-up procedures would become significantly more complex.

- **Emission of dust and particulate matter**
  - Dust from material handling, such as conveyors, trucks processing equipment, including storage piles, will be minimized by using covers and/or control equipment (water suppression, bag house, or cyclone) and increasing the moisture content by water spraying.
  - Speed limit for all vehicles will be implemented so as not to generate dust emissions, and all trucks will be properly maintained and travel with covers when carrying material, at all times.
  - Any unpaved internal and access roads will be adequately compacted and periodically graded and maintained, and sprayed with water on an as needed basis to minimize dust from vehicle movements. If water spraying is deemed insufficient, other means of surface treatment (e.g. hygroscopic media, such as calcium chloride, and soil natural–chemical binding agents) of unpaved internal and access roads, and exposed stockpiles using a sprinkler system or a ”water-mist cannon” will be implemented.
  - If the topsoil and stockpiles are stored for a long period of time (more than 2 years), they shall be planted with appropriate methods in order to avoid erosion from wind and rain, and to protect the organic matter content.
- **Emission of aerial noise and vibrations**
  - Emissions of aerial noise and vibrations should follow the indications of Chapter 7.2.1.3 – Noise and Vibration.
  - Care will be taken to select machines and equipment with low noise emissions;
  - Night works will be avoided (from 8 pm to 6 am at least), as far as practicable, to reduce impacts to nocturnal freshwater fauna species;
  - Particularly noisy activities will be performed during the day and at regular times to promote the habituation of the local fauna to noise and avoid disturbances during critical hours for many species (dusk and dawn).
- **Emission of light**
  - Light emissions will be focused within the Project Area boundaries.
  - As far as practicable, no intense light has to be aimed directly towards the freshwater habitats within and in proximity of the Project Area.
  - Lights will be mounted as low as practicable.
  - Downward-facing lights will be used to manage horizon glow. Louvered bollards, low height flat beam technology luminaires, poles and structure mounted fittings are acceptable.
  - Shielded light fittings and directional lights will be used to manage light spill.
  - Use of artificial light will be limited to what required to maintain a safe working environment during construction activities past sunset and before sunrise.
  - Unnecessary lighting will not be used, including lights in unused areas, decorative lighting, or lighting that is brighter than needed for the task being carried out.

  - Where practicable, timers and motion sensors will be used to turn off lights when not in use (e.g., sunset switch on, timer off for lighting used for walkways, car parks, and roads).
- **Possible introduction of alien species**
  - No freshwater or moist soil is to be discharged to the Project Area without a proper inspection from the Site Environmental Officer (environmental specialist/ecologist).
  - No freshwater procured outside of the Project Area will be discharged into Filyos River or any other nearby natural freshwater habitat.
  - If spreading of invasive species is observed, an appropriate eradication program will be developed and implemented.
- **Increase and modification of traffic onshore**
  - Speed limits and animal crossing signs will be installed on the access road. If necessary, speed limit along the site access road will enforce installing speed bumps and noise stripes on straight sections;
  - Appropriate design elements aimed at modifying the behavior of animals (e.g., crossing structures, dry ledges, fencing, right-of way jump outs, etc.) could be installed on the road;
  - Avoid the accumulation of stagnant water and organic waste within the construction site and on the roads, that could attract wildlife, properly dispose of waste in a timely and secure manner including animal carcasses;
  - Awareness among employees and contractors working on site about the protected species/habitats potentially present in the area will be developed, in order to ensure constant monitoring and promote actions to be taken if wildlife is encountered;
  - If freshwater fauna species are encountered (amphibians), employees and contractors will wait until it moves on by itself or they will ask the assistance of the Environmental technician for its safe removal and relocation in a suitable environment;
  - Hunting and collection of any wild animal, including fish and invertebrates, by employees and contractors will be strictly prohibited within the Project area.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **negligible residual negative impact** is expected on freshwater fish during the construction phase.

Table 7-74: Residual impact assessment matrix for the freshwater fauna during construction phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Discharge of wastewater	Duration:	Medium	Medium	Short-mid-term	**Low**	High	**Negligible**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Changes in flow/circulation in natural water bodies	Duration:	Medium	Medium	Short-term	**Negligible**	Medium-high	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Minor leakage of contaminants into water	Duration:	Medium	Medium	Short-mid-term	**Low**	High	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Emission of dust and particulate matter	Duration:	Medium	Medium	Short-mid-term	**Low**	Medium-high	**Negligible**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of aerial noise and vibrations	Duration:	Medium	Medium	Short-mid-term	**Low**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Medium	Medium	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Possible introduction of alien species	Duration:	Medium-short	Medium	Long term	**Medium**	High	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Increase and modification of traffic onshore	Duration:	Medium	Medium	Mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment:		**Negligible**	Rationale:	During the construction phase some low to medium intensity impacts are expected on freshwater fauna. Mostly reversible in the short-term and with a medium to high efficiency of the reported mitigation measures. Consequently, there is an expected negligible residual impact on this component.			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on freshwater fauna during the construction and verify the effectiveness of the mitigation measures.

- Discharge water quality should be monitored monthly with chemical analysis.
- Inadvertent impacts on natural freshwater habitats present around the construction site will be monitored monthly in order to assess eventual footprint creep outside designated areas, including signs of habitat loss or stagnant water accumulation, functioning of the water run-off management system, dust deposition on vegetation, presence of waste or hazardous substances spill.
- Accidents involving freshwater wildlife (amphibians) or the observation of live animal or carcasses along the access road or on the construction site will be recorded. Additional mitigation measures to discourage wildlife presence on site and to avoid roadkill will be taken if needed.
- The monitoring program for aquatic ecosystems and their living organisms, especially endemic species, should be planned twice a year in May and October during construction activities. Monitoring of possible effects on the availability and population status of benthic macroinvertabrates, fish, and amphibians species should be carried out by a Hydrobiologist.
- For freshwater ecosystems, the monitoring program should include water quality, flow and freshwater biodiversity.

7.2.2.2.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting freshwater fish during operation phase are listed in the following table.

Table 7-75: Project actions and related impact factors potentially affecting the freshwater fauna during operation phase.

Project actions	Brief description	Impact factors
Plan/Infrastructure onshore operation	Several site activities during operational phase will require the use of water, wastewater generated from these activities will be treated on site in dedicated treatment plants and discharged in Filyos River, unless discharge quality requirements are not met. Vehicle traffic within the Project's Area will continue to be intense.	■ Discharge of wastewater ■ Emission of aerial noise and vibrations ■ Emission of light ■ Increase and modification of traffic onshore

The impact factors identified above are described below and assessed in the matrix that follows.

- **Discharge of wastewater**

During the operation phase, five different sources of wastewater (i.e., demineralization process, open drains, sewage, MEG reclamation Unit, and Boiler effluent) are expected to be discharging into Filyos River, through a single discharge point (see Chapter 7.2.1.4 – Hydrology and Surface Water Quality). Before discharge, wastewater will be treated to satisfy national and international limits given in Appendix B. Approximatively up to 780 m^3 /day will be discharged into Filyos River, which could have the potential for impacting the receiving freshwater habitat and fauna. High volumes of treated wastewater could, in time, still contribute to the eutrophication of the freshwater environment causing a general avoidance of the area from aquatic species and a potential loss of biodiversity.

This factor would have a medium intensity impact, and a short-term reversibility. The generated impacts will be continuous over time.

- **Emission of aerial noise and vibrations**

The emission of noise and vibrations is expected to decrease during operation phase compared to construction phase, but it will be still above the baseline levels due to the expected activities from the OPF and the other associated facilities within the Project Area. Noise and vibrations emissions will occur frequently during operation phase as the OPF will be fully operative, However, in general, the effects of noise disturbance from human activity on wildlife are mostly perceived over short distances in a species- specific way (up to ~ 300 m, Reijnen et al., 1995; Canaday and Rivadeneyra, 2001). The emission of noise and vibrations is relevant during the operational phase, but in the long term it also can be defined more usual and "predictable" in time and space. In fact, animals exposed to prolonged or repeated human disturbance may eventually adapt both behaviorally and physiologically and become "habituated" (Petrinovich et Peeke, 1973). Additionally, the fact that the noise from the Project Area is not associated with an immediate risk suggests that the animals are able to habituate to the sound.

In general, once animals become habituated to noise, especially when it is steady and associated with clearly non-threatening activity, they suffer very little adverse response. During the operations phase the following effects are expected on local fauna:

- likely change in species composition in the study area, with less noise-tolerant species moving further away to avoid areas of high noise;
- selection for more noise tolerant individuals within the population of species closed to the project; and
- habituation of some species and individuals to the noise impacts.

During operation phase, the emission of noise and vibrations will be highly frequent and with a medium intensity impact. So that, the geographic extent of this factor is defined as local and its reversibility is considered to occur in a mid-term time.

- **Emission of light**

Light emissions during operation phase will be probably increasing in number of sources as the OPF, roads, and all the associated facilities will be fully operational and will require proper illumination to maintain safe working conditions.

The impact on freshwater fauna present around the Project Area will be in line with what discussed for the construction phase (Chapter 7.2.2.2.1),

This factor would have a medium intensity impact, and a short-term reversibility. The generated impacts will be continuous over time.

- **Increase and modification of traffic onshore**

An increase in vehicular traffic is expected during the operation phase compared to baseline conditions. The potential impact deriving from this impact factor are the same as described for the construction phase (Chapter 7.2.2.2.1).

This factor would have a medium intensity impact in a local geographic extent, and a short-term reversibility. The generated impacts will be frequent over time.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Discharge of wastewater**
    - Treated wastewater should be analyzed in accordance with national and international guidelines listed in Appendix B;
    - In case of any parameter exceeding its concentration limit the discharge output should be immediately closed until the issue is properly assessed and resolved.
- **Emission of aerial noise and vibrations**
    - No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.2.1.
- **Emission of light**
    - No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.2.1.
- **Increase and modification of traffic onshore**

- No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.2.1.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low residual negative impact** is expected on freshwater fish during the operation phase.

Table 7-76: Residual impact assessment matrix for the freshwater fauna during operation phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Discharge of wastewater	Duration:	Long	Medium	Mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of aerial noise and vibrations	Duration:	Long	Medium	Short-mid-term	**Medium**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Long	Medium	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Increase and modification of traffic onshore	Duration:	Long	Medium	Mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment:		**Low**	Rationale:	In the operation phase the main impact identified originates from wastewater discharge into FilyosFilyos River. The continuous frequency and long duration of the impact are expected to be counterbalanced by the medium-high effectiveness of the mitigation measures suggested resulting (considering also all the other factors) in a low residual impact.			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on freshwater fauna during the operation and verify the effectiveness of the mitigation measures.

- Discharge wastewater quality will be monitored quarterly by accredited laboratories.
- The monitoring program for freshwater fauna, especially endemic species, should be planned twice a year (May and October) for at least two years during operation phase. Monitoring of possible effects on the availability and population status of benthic macroinvertabrates, fish and amphibian species should be carried out by a Hydrobiologist.
- Inadvertent impacts on natural freshwater habitats present around the operation site will be monitored monthly in order to assess eventual footprint creep outside designated areas, including signs of habitat loss or stagnant water accumulation, functioning of the water run-off management system, dust deposition on vegetation, presence of waste or hazardous substances spill.
- Accidents involving freshwater wildlife (amphibians) or the observation of live animal or carcasses along the access road or on the construction site will be recorded. Additional mitigation measures to discourage wildlife presence on site and to avoid roadkill will be taken if needed.

7.2.2.1 Terrestrial Fauna

Based on the information collected for the definition of the baseline (see Chapter 6.2.2), the biological components included in the *Terrestrial Fauna* were assigned a **Medium** value of sensitivity for the following reasons:

- Absence of threatened terrestrial invertebrate, reptile and mammal species;
- Presence of protected reptile species (17);
- Limited Presence of endemic reptile species (2);
- Absence of endemic terrestrial invertebrate and mammal species;
- Presence of protected mammal species (24) including bat species, predators, scavengers, and European otter;

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.2.2.1.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting amphibians during construction phase are listed in the following table.

Table 7-77: Project actions and related impact factors potentially affecting the terrestrial fauna during construction phase.

Project actions	Brief description	Impact factors
Vegetation clearing	Removal of natural and farmed vegetation from the area along the ETL with installation of poles, and from coastal dune area within the Project's footprint.	▪ Removal of natural vegetation ▪ Emission of aerial noise and vibrations ▪ Possible introduction of alien species
Site levelling and grading	Removal of the first 300 mm of soil from ETL and dune habitat in the landfall area	▪ Removal of soil ▪ Emission of aerial noise and vibrations
Material transportation	Removed soil and construction material will be transported out and in the construction area using trucks and heavy machinery. Building material will include crushed rocks and gravel for both the landfall area and the ETL.	▪ Emission of aerial noise and vibrations ▪ Possible introduction of alien species ▪ Increase and modification of traffic onshore
General engineering / construction works	Heavy machinery will be operating on the landfall area and the ETL poles installation and the general OPF construction.	▪ Emission of aerial noise and vibrations ▪ Emission of light ▪ Increase and modification of traffic onshore ▪ Possible introduction of alien species

The impact factors identified above are described below and assessed in the matrix that follows.

- **Removal of natural vegetation**

Vegetation clearing will be performed along the Energy Transmission Line (ETL) and in the landfall area located in the dune habitat on the coast section.

The removal of vegetation in these areas will cause direct habitat loss and habitat fragmentation. Fauna species will be both directly and indirectly impacted by this activity. The removal of vegetation could cause the destruction of suitable habitats for fauna species that use the vegetation present as food, shelter or nesting site. Furthermore, fauna species characterized by low mobility (such as reptiles) may not be able to move ahead of construction. Species with a hiding strategy to escape predators might also be accidentally killed during the construction operations. Nesting sites could be destroyed by vegetation clearing with different effects depending on timing and the species reproduction strategy.

The area affected by this impact factor will be limited to part of the natural habitat within the Project footprint, it will be carried on in a three-months period (ETL), on one or more events evenly distributed in this period, the changes to the environment, although, fairly evident, will be in accordance with the current legal regulations.

- **Removal of soil**

Topsoil removal will be carried out as a consequent step of the natural vegetation clearance discussed above and therefore, it will affect the same areas (i.e, Landfall and ETL route).

This activity could have an impact on the soil fauna (such as terrestrial invertebrates) and on the terrestrial species characterized by a hiding strategy to escape predators.

The removed soil from the landfall area will be stored in a dedicated area and reinstated at the end of the construction work. In the ETL the soil will be used for backfilling as previously natural habitat will be cleared for poles installation.

The removal of soil, as per the vegetation removal, will be limited to part of the natural habitat within the Project footprint, it will be carried on in the medium-short term (ETL), on one or more events evenly distributed in this period, and the evident changes to the environment will be in accordance with the current legal regulations.

- **Emission of aerial noise and vibrations**

The emission of noise and vibrations is expected to increase during construction phase compared to baseline levels due to construction activities such as vegetation clearance, soil excavation, surface levelling and grading, mobilization of vehicles, workers and equipment, temporary stockpiling of material, transport of materials and waste, construction of the facilities and paved areas.

Noise and vibration emission, related to the increase in human activities, could cause indirect habitat degradation due to temporary avoidance of surrounding areas by fauna species. In fact, in terrestrial habitats, animals may prefer to move further away from the Project Area to avoid the increased noise from construction site activities.

Noise has the greatest effect on wildlife that relies heavily on auditory signals for survival and especially on mammals. The effects of noise disturbance from human activity on wildlife are mostly perceived over short distances in a species- specific way.

Reptiles are highly sensitive to vibration (e.g., Shen, 1983), which low-frequency noise can be a source of information about approaching predators and prey.

The emission of noise and vibration is expected to be of medium intensity during construction activities, with a highly frequency and a geographic extent around the Project footprint (within 300 m buffer). The impact is considered to be reversible in a short-term time.

- **Emission of light**

Terrestrial ecosystems can be very sensitive to light and are often severely affected by artificial light at night. Light pollution can negatively affect the biological processes of many organisms and cause cascading effects on the entire ecosystem.

Among animals, the first to suffer from the problem of light pollution are those with nocturnal or crepuscular habits and those who use light sources to orient themselves. Exposure to artificial light at night can interfere with predator-prey relationships.

Invertebrates, and in particular insects, are the animals most affected: artificial light sources can attract them, deceive their sense of orientation and increase the risk of predation. Repeated collisions, stunning and disorientation are stressful, often fatal, and make survivors easy prey.

The emission of light during construction phases is expected to be of medium intensity and duration, with a frequency defined as "continuous" and a geographic extent around the Project footprint. The impact is considered to be reversible in a short-term time.

- **Possible introduction of alien species**

Removal of natural vegetation cover and soil disturbance could facilitate within and around the Project site the spreading of invasive alien (non-native) species accidentally introduced by cars, trucks and other heavy machinery used during construction phases. These species tend to have an advantage in disturbed ecosystems, and if they penetrate into a habitat, they can potentially change its functionality and species composition, including priority biodiversity species.

The habitats around the construction site could experience a decrease in biodiversity, with a consequent trivialization (potential appearance of more dominant species) of the ecosystem in a small area close to the Project site. Local fauna that depends on those ecosystems could also be indirectly affected by the habitat degradation.

Although unlikely to occur and usually localized to areas of disturbed soil and vegetation, this impact could have a potential long-term duration on habitats. Even if such event is expected to be rare, and to have a sporadic frequency and a negligible intensity, its reversibility is classified as long-term. In accordance with the vehicular traffic factor, the geographic extent of this impact factor is classified as local.

- **Increase and modification of traffic onshore**

During construction, an increase in vehicular traffic is expected along all road network of the present Project Area, this could cause a higher risk of accidental collisions with wildlife, especially in areas crossing or in proximity of natural habitats.

Traffic can have an important influence on the behavior and distribution, thus the use of the space, of local wildlife populations (St. Clair and Forrest, 2009). Some birds use roadside gravel to aid their digestion of seeds or come to dust bathe on dirt roads, where they are vulnerable to vehicles as well as predators. Crows and other scavengers seek out roadkill and often become roadkill themselves.

This impact factor is considered to have a local geographic extent classified, and a potential medium intensity with a frequency defined as "highly frequent", since the high number of events are evenly or randomly distributed over time. Since the biodiversity components can restore themselves in a short period after the end of this impact, depending on species' biology and ecology, the reversibility of the vehicular traffic factor is classified as mid-term.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Removal of natural vegetation**
  - Biological pre-construction surveys will be implemented in the areas still to be cleared in order to identify and relocate fauna species;
  - Limits of clearing and construction areas will be clearly marked or fenced in order to avoid impacts outside this area;

- All vehicles will drive on designated routes unless otherwise authorized, and off-road driving will be strictly prohibited;
- Specialist training shall be provided to plant operators and key personnel involved in activities which involve land clearance, materials handling and transport activities which may impact terrestrial fauna (e.g. vegetation, clearing, restoration activities);

- **Removal of soil**
  - Topsoil to be stored in designated stockpile areas;
  - Reinstatement of topsoil in the landfall construction area to enhance natural habitat restoration;
  - Specialist training shall be provided to plant operators and key personnel involved in activities which involve land clearance, materials handling and transport activities which may impact terrestrial fauna.

- **Emission of aerial noise and vibrations**
  - Care will be taken to select machines and equipment with low noise emissions;
  - Night works will be avoided (from 8 pm to 6 am at least), as far as practicable, to reduce impacts to nocturnal fauna species;
  - Particularly noisy activities will be performed during the day and at regular times to promote the habituation of the local fauna to noise and avoid disturbances during critical hours for many species (dusk and dawn).

- **Emission of light**
  - Light emissions will be focused within the Project Area boundaries;
  - Lights will be mounted as low as practicable;
  - Downward-facing lights will be used to manage horizon glow. Louvered bollards, low height flat beam technology luminaires, poles and structure mounted fittings are acceptable;
  - Shielded light fittings and directional lights will be used to manage light spill;
  - Use of artificial light will be limited to what required to maintain a safe working environment during construction activities past sunset and before sunrise;
  - Unnecessary lighting will not be used, including lights in unused areas, decorative lighting, or lighting that is brighter than needed for the task being carried out;
  - Where practicable, timers and motion sensors will be used to turn off lights when not in use (e.g., sunset switch on, timer off for lighting used for walkways, car parks, and roads).

- **Possible introduction of alien species**
  - Check of vehicles and machinery for evident foreign plant material, soil and seeds on their first entry on site;

- Trucks coming from the outside the Project area covered with visible amounts of dirt will be washed in a controlled site, where residues will be managed as waste;
- If spreading of invasive species is observed, an appropriate eradication program will be developed and implemented.

- **Increase and modification of traffic onshore**
  - Wire fences should be used to prevent wildlife to enter the Project Area.
  - In locations within the Project Area where wire fencing is not a feasible option entry-exit of terrestrial fauna should be detected via cameratraps to be activated in the night hours during construction.
  - Speed limits and animal crossing signs will be installed on the access road. If necessary, speed limit along the site access road will enforce installing speed bumps and noise stripes on straight sections;
  - Appropriate design elements aimed at modifying the behavior of animals (e.g., crossing structures, dry ledges, fencing, right-of way jump outs and other one-way structures that allow animals to leave the right-of-way, noise barriers, olfactory repellents) could be installed on the road;
  - Avoid the accumulation of stagnant water and organic waste within the construction site and on the roads, that could attract wildlife, properly dispose of waste in a timely and secure manner including animal carcasses;
  - Feeding of wildlife or stray cats and dogs will be prohibited on-site and organic waste will be carefully managed and disposed of in order to avoid attraction of wildlife or stray cats and dogs;
  - Awareness among employees and contractors working on site about the protected species/habitats potentially present in the area will be developed, in order to ensure constant monitoring and promote actions to be taken if wildlife is encountered;
  - If fauna species are encountered, employees and contractors will wait until it moves on by itself or they will ask the assistance of the environmental Specialist/ecologist for its safe removal and relocation in a suitable environment;
  - Hunting and collection of wild animals, by employee and contractors will be strictly prohibited within the Project area and the 300 m radius around it.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low residual negative impact** is expected on amphibians during the construction phase.

Table 7-78: Residual impact assessment matrix for the terrestrial fauna during construction phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Removal of natural vegetation	Duration:	Medium-short	Medium	Long term	**Medium**	Medium	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Removal of soil	Duration:	Medium-short	Medium	Long term	**Medium**	Medium-high	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Emission of aerial noise and vibrations	Duration:	Medium	Medium	Short-mid-term	**Low**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Medium	Medium	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Possible introduction of alien species	Duration:	Medium-short	Medium	Long term	**Medium**	High	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Increase and modification of traffic onshore	Duration:	Medium	Medium	Mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment:		**Low**	Rationale:	Impacts on terrestrial fauna during construction activities is expected to be of medium to negligible intensity, this is because most impacts are expected to induce the local fauna to move away from the Project's AoI, and despite the mid to long-term needed to reverse some of these impacts a medium to high effectiveness of the proposed mitigation measures indicate a general low residual impact for terrestrial fauna.			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on terrestrial fauna during the construction and verify the effectiveness of the mitigation measures.

- Accidents involving wildlife or the observation of live animal or carcasses along the access road or on the construction site will be recorded. Additional mitigation measures to discourage wildlife presence on site and to avoid roadkill will be taken if needed.
- Cameratraps will serve also as monitoring of fauna within the Project Area, detection records will be analysed regularly and will be used to decide on the implementation of further mitigation measures

7.2.2.1.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting amphibians during operation phase are listed in the following table.

Table 7-79: Project actions and related impact factors potentially affecting the terrestrial fauna during operation phase.

Project actions	Brief description	Impact factors
Plan/Infrastructure onshore operation	Site activities and vehicle traffic within the Project's Area	■ Emission of aerial noise and vibrations ■ Emission of light ■ Increase and modification of traffic onshore

The impact factors identified above are described below and assessed in the matrix that follows.

- <u>**Emission of aerial noise and vibrations**</u>

The emission of noise and vibrations is expected to decrease during operation phase compared to construction phase, but it will be still above the baseline levels due to the expected activities from the OPF and the other associated facilities within the Project Area. Noise and vibrations emissions will occur frequently during operation phase as the OPF will be fully operative, However, in general, the effects of noise disturbance from human activity on wildlife are mostly perceived over short distances in a species- specific way (up to ~ 300 m, Reijnen et al., 1995; Canaday and Rivadeneyra, 2001). The emission of noise and vibrations is relevant during the operational phase, but in the long term it also can be defined more usual and "predictable" in time and space. In fact, animals exposed to prolonged or repeated human disturbance may eventually adapt both behaviorally and physiologically and become "habituated" (Petrinovich et Peeke, 1973). Additionally, the fact that the noise from the Project Area is not associated with an immediate risk suggests that the animals are able to habituate to the sound.

In general, once animals become habituated to noise, especially when it is steady and associated with clearly non-threatening activity, they suffer very little adverse response. During the operations phase the following effects are expected on local fauna:

- likely change in species composition in the study area, with less noise-tolerant species moving further away to avoid areas of high noise;

- selection for more noise tolerant individuals within the population of species closed to the project; and
- habituation of some species and individuals to the noise impacts.

During operation phase, the emission of noise and vibrations will be highly frequent and with a medium intensity impact. So that, the geographic extent of this factor is defined as local and its reversibility is considered to occur in a mid-term time.

- **Emission of light**

Light emissions during operation phase will be probably increasing in number of sources as the OPF, roads, and all the associated facilities will be fully operational and will require proper illumination to maintain safe working conditions.

The impact on terrestrial fauna present around the Project Area will be in line with what discussed for the construction phase (Chapter 7.2.2.1.1), generally inducing individual to move away from light sources. It can be also expected that a limited number of species, in particular invertebrates, could be attracted to lighted areas and due to their presence other predatory specie may frequent these areas too.

This factor would have a medium intensity impact, and a short-term reversibility. The generated impacts will be continuous over time.

- **Increase and modification of traffic onshore**

An increase in vehicular traffic is expected during the operation phase compared to baseline conditions. The potential impact deriving from this impact factor are the same as described for the construction phase (Chapter 7.2.2.1.1).

In addition, a constant presence of people may generate organic and food waste that if not properly stored could attract wildlife within the Project Area and therefore increase the chance of wildlife-vehicles interactions.

This impact factor is considered to have a local geographic extent classified, and a potential medium intensity with a frequency defined as “highly frequent”, since the high number of events are evenly or randomly distributed over time. Since the biodiversity components can restore themselves in a short period after the end of this impact, depending on species’ biology and ecology, the reversibility of the vehicular traffic factor is classified as mid-term.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Emission of aerial noise and vibrations**
  - No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.1.1.
- **Emission of light**
  - No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.1.1.

- **Increase and modification of traffic onshore**
  - In addition to the mitigation measures mentioned in the Chapter 7.2.2.1.1, attention should also be given to properly store and dispose of organic and food waste on-site. During the operation phase cameratraps will be activated in the night hours for a 30-days period in each season.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low residual negative impact** is expected on amphibians during the operation phase.

Table 7-80: Residual impact assessment matrix for terrestrial fauna during operation phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Emission of aerial noise and vibrations	Duration:	Long	Medium	Short-mid-term	**Medium**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Long	Medium	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Increase and modification of traffic onshore	Duration:	Long	Medium	Mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment:		**Low**	Rationale:	Impacts on terrestrial fauna during operation phase will be limited to a general disturbance inducing mostly avoidance of the area, although, in some cases (e.g., light emissions) these could produce the opposite effect. All impacts have a medium intensity and a mid to short-term reversibility, which with the medium to high effectiveness of the proposed mitigation measures produce a low residual impact on this component.			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on terrestrial fauna during the operation and verify the effectiveness of the mitigation measures.

- Accidents involving wildlife or the observation of live animal or carcasses along the access road or on the construction site will be recorded. Additional mitigation measures to discourage wildlife presence on site and to avoid roadkill will be taken if needed.
- Cameratraps will also serve as monitoring of fauna within the Project Area, detection records will be analysed regularly and will be used to decide on the implementation of further mitigation measures.

7.2.2.2 Birds

Based on the information collected for the definition of the baseline (see Chapter 6.2.2.6), the biological component *Birds* was assigned a **Medium-high** value of sensitivity for the following reasons:

- Presence of threatened bird species (2 confirmed, 1 potential);
- Presence of protected species (175); and
- Absence of endemic species.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.2.2.2.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting birds during construction phase are listed in the following table.

Table 7-81: Project actions and related impact factors potentially affecting birds during construction phase.

Project actions	Brief description	Impact factors
Vegetation clearing	Removal of natural and farmed vegetation from the area along the ETL with installation of Right-of-Ways and poles, and from coastal dune area within the Project's footprint.	▪ Removal of natural vegetation ▪ Emission of aerial noise and vibrations
Site levelling and grading	Removal of the first 300 mm of soil from ETL and dune habitat in the landfall area	▪ Emission of aerial noise and vibrations
Material transportation	Removed soil and construction material will be transported out and in the construction area using trucks and heavy machinery. Building material will include crushed rocks and gravel for both the landfall area and the ETL.	▪ Emission of aerial noise and vibrations ▪ Increase and modification of traffic onshore
General engineering / construction works	Heavy machinery will be operating on the landfall area, the ETL construction and	▪ Emission of light ▪ Minor leakage of contaminants into water ▪ Emission of aerial noise and vibrations

Project actions	Brief description	Impact factors
	poles installation, and the general OPF construction	▪ Increase and modification of traffic onshore

The impact factors identified above are described below and assessed in the matrix that follows.

- **Removal of natural vegetation**

Vegetation clearing will be performed along the Energy Transmission Line (ETL) and in the landfall area located in the dune habitat on the coast section.

The removal of vegetation in these areas will cause direct habitat loss and habitat fragmentation. Flora species present in the area will be directly impacted by vegetation clearing while birds will be both directly and indirectly impacted by this activity. The removal of vegetation could cause the destruction of suitable habitats for birds that use the vegetation present as food, shelter or nesting site. Nesting sites could be destroyed by vegetation clearing with different effects depending on timing and the species reproduction strategy.

The area affected by this impact factor will be limited to part of the natural habitat within the Project footprint, it will be carried on in a three-months period (ETL), on one or more events evenly distributed in this period, the changes to the environment, although, fairly evident, will be in accordance with the current legal regulations.

- **Emission of aerial noise and vibrations**

The emission of noise and vibrations is expected to increase during construction phase compared to baseline levels due to construction activities such as vegetation clearance, soil excavation, surface levelling and grading, mobilization of vehicles, workers and equipment, temporary stockpiling of material, transport of materials and waste, construction of the facilities and paved areas.

Noise and vibration emission, related to the increase in human activities, could cause indirect habitat degradation due to temporary avoidance of surrounding areas by fauna species. In fact, in terrestrial habitats, animals may prefer to move further away from the Project Area to avoid the increased noise from construction site activities.

Noise has the greatest effect on wildlife that relies heavily on auditory signals for survival and especially on birds. The effects of noise disturbance from human activity on wildlife are mostly perceived over short distances in a species- specific way.

Disturbance from anthropogenic noise, for example, is known to be correlated with reduced densities of breeding birds (Reijnen et al., 1995; Canaday and Rivadeneyra, 2001). The effects of vibration on wildlife is poorly studied, however avoidance behaviour around the source of vibration is likely to exist for birds. Birds are highly sensitive to vibration (e.g., Shen, 1983), which low-frequency noise can be a source of information about approaching predators and prey.

The emission of noise and vibration is expected to be of medium intensity during construction activities, with a highly frequency and a geographic extent around the Project footprint (within 300 m buffer). The impact is considered to be reversible in a short-term time.

- **Emission of light**

Terrestrial ecosystems can be very sensitive to light and are often severely affected by artificial light at night. Light pollution can negatively affect the biological processes of many organisms and cause cascading effects on the entire ecosystem.

Among animals, the first to suffer from the problem of light pollution are those with nocturnal or crepuscular habits and those who use light sources to orient themselves. Exposure to artificial light at night can modify the rivalry interactions, can interfere with predator-prey relations and cause physiologic damage. Therefore, the disturbance of these patterns can affect the ecologic dynamics.

Light pollution mainly affects the singing and the times of reproductive behavior of birds, with consequences that have not yet been determined for the populations.

The emission of light during construction phases is expected to be of medium intensity and duration, with a frequency defined as “continuous” and a geographic extent around the Project footprint. The impact is considered to be reversible in a short-term time.

- **Minor leakage of contaminants into water**

Contamination of water bodies within and around the Project Area as described in Chapter 7.2.1.4 – Hydrology and Surface Water Quality can have a detrimental effect on birds that may use that habitat for feeding, drinking or resting.

Birds could be affected directly, for example by drinking, but also indirectly, for example by eating contaminated prey. Furthermore, the potential reduction of prey due to contamination in the frequented habitat could result in the displacement of birds from the area.

Despite the potential for even severe impacts this factor is predicted to be infrequent at best, and of a low intensity as there are no construction activities directly in freshwater habitats and therefore spills, leakages, and accidental discharges would have to originate from the OPF footprint or the connecting roads which are generally located at a certain distance from the nearby water bodies.

- **Increase and modification of traffic onshore**

During construction, an increase in vehicular traffic is expected along all road network of the present Project Area, this could cause a higher risk of accidental collisions with wildlife, especially in areas crossing or in proximity of natural habitats.

Traffic can have an important influence on the behaviour and distribution, thus the use of the space, of local wildlife populations (St. Clair and Forrest, 2009). Some birds use roadside gravel to aid their digestion of seeds or come to dust bathe on dirt roads, where they are vulnerable to vehicles as well as predators. Crows and other scavengers seek out roadkill and often become roadkill themselves.

This impact factor is considered to have a local geographic extent classified, and a potential medium intensity with a frequency defined as “highly frequent”, since the high number of events are evenly or randomly distributed over time. Since the biodiversity components can restore themselves in a short period after the end of this impact, depending on species’ biology and ecology, the reversibility of the vehicular traffic factor is classified as mid-term.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Removal of natural vegetation**
  - Biological pre-construction surveys will be implemented in the areas still to be cleared in order to identify and relocate fauna species;
  - Limits of clearing and construction areas will be clearly marked or fenced in order to avoid impacts outside this area;
  - All vehicles will drive on designated routes unless otherwise authorized, and off-road driving will be strictly prohibited;
  - Specialist training shall be provided to plant operators and key personnel involved in activities which involve land clearance, materials handling and transport activities which may impact birds (e.g. vegetation, clearing, restoration activities);
  - Monitoring of bird species and their presence in the landfall and ETL construction area at completion of works and in the following one and two years.

- **Emission of aerial noise and vibrations**
  - Care will be taken to select machines and equipment with low noise emissions;
  - Night works will be avoided (from 8 pm to 6 am at least), as far as practicable, to reduce impacts to nocturnal birds species;
  - Particularly noisy activities will be performed during the day and at regular times to promote the habituation of the local fauna to noise and avoid disturbances during critical hours for many species (dusk and dawn).

- **Emission of light**
  - Light emissions will be focused within the Project Area boundaries;
  - Downward-facing lights will be used to manage horizon glow. Louvered bollards, low height flat beam technology luminaires, poles and structure mounted fittings are acceptable;
  - Shielded light fittings and directional lights will be used to manage light spill;
  - Use of artificial light will be limited to what required to maintain a safe working environment during construction activities past sunset and before sunrise;
  - Unnecessary lighting will not be used, including lights in unused areas, decorative lighting, or lighting that is brighter than needed for the task being carried out;
  - Where practicable, timers and motion sensors will be used to turn off lights when not in use (e.g., sunset switch on, timer off for lighting used for walkways, car parks, and roads).

- **<u>Minor leakage of contaminants into water</u>**
  - Project-specific Pollution Prevention Plan and Waste Management Plan will be implemented to ensure that the amount of release and spills can be taken under control before reaching substantial amounts that may potentially affect the quality of soil and potentially that of the nearby water bodies.
  - Detailed information on spills and leakages mitigation procedures are provided in Chapter 7.2.1.1 – Soil and Subsoil and Chapter 7.2.1.4 – Hydrology and Surface Water Quality;
  - Particular care will be taken on spill containment procedures and materials, and spill/leakage response training of personnel in order to avoid that any contamination reaches the freshwater habitats where containment and clean-up procedures would also be significantly more complex.

- **<u>Increase and modification of traffic onshore</u>**
  - Speed limits and animal crossing signs will be installed on the access road. If necessary, speed limit along the site access road will enforce installing speed bumps and noise stripes on straight sections;
  - Avoid the accumulation of stagnant water and organic waste within the construction site and on the roads, that could attract wildlife, including birds, properly dispose of waste in a timely and secure manner including animal carcasses;
  - Feeding of wildlife or stray cats and dogs will be prohibited on-site and organic waste will be carefully managed and disposed of in order to avoid attraction of wildlife or stray cats and dogs;
  - Awareness among employees and contractors working on site about the protected species/habitats potentially present in the area will be developed, in order to ensure constant monitoring and promote actions to be taken if wildlife is encountered;
  - If fauna species are encountered, employees and contractors will wait until it moves on by itself or they will ask the assistance of the Environmental technician for its safe removal and relocation in a suitable environment;
  - Hunting and collection of wild animals, by employee and contractors will be strictly prohibited within the Project area and the a 300 m radius around it.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The whole matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **<u>low negative residual impact</u>** is expected on birds during the construction phase.

Table 7-82: Residual impact assessment matrix for birds during construction phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectivenes s	Residual impact value
	Duration:	Medium-short	Medium-high	Long term	**Medium**	Medium	**Medium**

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Removal of natural vegetation	Frequency:	Infrequent					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Emission of aerial noise and vibrations	Duration:	Medium	Medium-high	Short-mid-term	**Medium**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Medium	Medium-high	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Minor leakage of contaminants into water	Duration:	Medium	Medium-high	Shot-mid-term	**Low**	High	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Increase and modification of traffic onshore	Duration:	Medium	Medium-high	Mid-term	**High**	Medium-high	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment:		**Low**	Rationale:	Impacts on bird species during construction activities are expected to mainly result in the avoidance or a reduced use of the Project Area. The main impact consisting in the loss of natural habitat for bird species to use for resting and/or feeding (vegetated areas) although, the residual impact for his factor is expected to be medium the overall residual impact for the component is low, given the efficiency of the mitigation measures and the reversibility of most impacts.			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on birds during the construction and verify the effectiveness of the mitigation measures.

- Accidents involving birds or the observation of live individuals or carcasses along the access road or on the construction site will be recorded. Additional mitigation measures to discourage bird presence on site and to avoid roadkill will be taken if needed.
- Monitoring for bird species during construction phase should be carried out twice a year in breeding (May-June) and migration (October-November) months.

7.2.2.2.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting birds during operation phase are listed in the following table.

Table 7-83: Project actions and related impact factors potentially affecting birds during operation phase.

Project actions	Brief description	Impact factors
Plan/Infrastructure onshore operation	Site activities and vehicle traffic within the Project's Area	■ Presence of new onshore infrastructures ■ Discharge of wastewater ■ Emission of aerial noise and vibrations ■ Emission of light ■ Increase and modification of traffic onshore

The impact factors identified above are described below and assessed in the matrix that follows.

- **<u>Presence of new onshore infrastructures</u>**

During operation phase, the presence of permanent energy transmission line (ETL) and, in particular, the presence of vertical and linear infrastructures, such as the new powerline, could affect especially bird species, by causing habitat fragmentation and by increasing individuals' mortality due to collision and electrocution especially for medium-sized and large birds. It is also true that there may be some partially beneficial effects such as the use of ETL and poles as safe nesting and roaming sites in areas where there are natural alternatives suitable for many birds, including transmission lines, larger species such as vultures and eagles (Jenkins 2005). Although, it may also expose these birds to a greater risk of colliding with power lines.

Birds of prey are vulnerable to mortality due to overhead power lines (Van Rooyen 2008). Bird species, including ducks and herons, have a higher risk of death from electric shock than other species such as storks and crows due to their morphology and behavior (Janss and Ferrer, 1998). These birds are at risk of distortion due to their relatively large wingspan and the risk of hunting, which they tend to use the pole as nesting platforms (Lehmann 2000).

Birds could also be occasionally entering the buildings of the OPF and the other facilities which could result in individuals being trapped inside and/or being injured or killed.

The expected impact from this factor is infrequent and of negligible intensity.

- **<u>Discharge of wastewater</u>**

Such as already stated in the Chapter 7.2.2.2.2, wastewaters produced by the OPF are expected to be discharged in the Filyos river, after being properly treated. Such discharges concern the industrial wastewater, civil sewage and rain drainages.

Considering that the Wastewater Treatment Plants will collect hazardous and non-hazardous compounds, as well as the drains from the paved areas, their effluents, even if compliant with the national and international regulations illustrated in Appendix B may still affect the river water quality and, consequently, impact directly (e.g., drinking) and indirectly (e.g., eating contaminated prey - biomagnification) the birds present in the area.

This factor will have a long duration and a continuous frequency during the operation phase although the intensity is considered to be medium.

- **<u>Emission of aerial noise and vibrations</u>**

The emission of noise and vibrations is expected to decrease during operation phase compared to construction phase, but it will be still above the baseline levels due to the expected activities from the OPF and the other associated facilities within the Project Area.

Noise and vibrations emissions will occur frequently during operation phase as the OPF will be fully operative, However, in general, the effects of noise disturbance from human activity on wildlife are mostly perceived over short distances in a species- specific way (up to ~ 300 m, Reijnen et al., 1995; Canaday and Rivadeneyra, 2001). The emission of noise and vibrations is relevant during the operational phase, but in the long term it also can be defined more usual and "predictable" in time and space. In fact, animals exposed to prolonged or repeated human disturbance may eventually adapt both behaviorally and physiologically and become "habituated" (Petrinovich et Peeke, 1973). Additionally, the fact that the noise from the Project Area is not associated with an immediate risk suggests that the animals are able to habituate to the sound.

In general, once animals become habituated to noise, especially when it is steady and associated with clearly non-threatening activity, they suffer very little adverse response. During the operations phase the following effects are expected on local fauna:

- likely change in species composition in the study area, with less noise-tolerant species moving further away to avoid areas of high noise;
- selection for more noise tolerant individuals within the population of species closed to the project; and
- habituation of some species and individuals to the noise impacts.

During operation phase, the emission of noise and vibrations will be highly frequent and with a medium intensity impact. So that, the geographic extent of this factor is defined as local and its reversibility is considered to occur in a mid-term time.

- **<u>Emission of light</u>**

Light emissions during operation phase will be probably increasing in number of sources as the OPF, roads, and all the associated facilities will be fully operational and will require proper illumination to maintain safe working conditions.

The impact on birds present around the Project Area will be in line with what discussed for the construction phase (Chapter 7.2.2.2.1),

This factor would have a medium intensity impact, and a short-term reversibility. The generated impacts will be continuous over time.

- **<u>Increase and modification of traffic onshore</u>**

An increase in vehicular traffic is expected during the operation phase compared to baseline conditions. The potential impact on birds deriving from this impact factor are the same as described for the construction phase (Chapter 7.2.2.2.1).

This impact factor is considered to have a local geographic extent classified, and a potential medium intensity with a frequency defined as "highly frequent", since the high number of events are evenly or randomly distributed over time. Since the biodiversity components can restore themselves in a short period after the end of this impact, depending on species' biology and ecology, the reversibility of the vehicular traffic factor is classified as mid-term.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **<u>Presence of new onshore infrastructures</u>**
  - Line marking devices (e.g., marker balls, spirals, and other hanging devices) of the earth wire is recommended to increase its visibility of the line;
  - Windows and other wide accesses points to the buildings should be kept closed. If not possible, dissuasion devices should be utilized (e.g., acoustic devices, bird of prey shapes applied on windows, etc.).
- **<u>Discharge of wastewater</u>**
  - Treated wastewater should be analyzed in accordance with national and international guidelines listed in Chapter 2;
  - In case of any parameter exceeding its concentration limit the discharge output should be immediately closed until the issue is properly assessed and resolved.
- **<u>Emission of aerial noise and vibrations</u>**
  - No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.2.1.
- **<u>Emission of light</u>**
  - No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.2.1.

- **Increase and modification of traffic onshore**
  - No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.2.1.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative residual impact** is expected on birds during the operation phase.

Table 7-84: Residual impact assessment matrix for birds during operation phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Discharge of wastewater	Duration:	Long	Medium-high	Short-term	**Low**	High	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of aerial noise and vibrations	Duration:	Long	Medium-high	Short-mid-term	**Medium**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Long	Medium-high	Short-term	**Low**	Medium	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Increase and modification of traffic onshore	Duration:	Long	Medium-high	Mid-term	**High**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Presence of new onshore infrastructures	Duration:	Long	Medium-high	Mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Project site					
	Intensity:	Negligible					

Impact Factor	Impact Factor Features	Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Overall assessment:	**Low**	Rationale:	The factors affecting bird presence and abundance during the operation phase have a general long duration and a variable frequency resulting in low to high impact values. The medium to high effectiveness of the mitigation measures proposed allowed for a final low residual impact on this component			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on birds during the operation and verify the effectiveness of the mitigation measures.

- Accidents involving birds or the observation of live individuals or carcasses along the access road or on the project site will be recorded. Additional mitigation measures to discourage bird presence on site and to avoid roadkill will be taken if needed.
- Monitoring for bird species during operation phase should be carried out twice a year in breeding (May-June) and migration (October-November) months for the duration of the operation phase.

7.2.2.3 Habitats

Based on the information collected for the definition of the baseline (see Chapter 6.2.2.8), the biological component *Habitats* was assigned a **Medium-high** value of sensitivity for the following reasons:

- Presence of threatened and/or protected habitats (Grey Dunes Habitat, B1.4).

The approach adopted for this component involves the inclusion of several impact factors form previously discussed components. The different habitats, including the threatened B1.4, are, in fact, susceptible to any impact on freshwater and terrestrial flora and fauna, including birds, that could alter their ecological equilibrium.

For this reason, this component directly refers to previous sections for impact descriptions, mitigation and monitoring measures. Residual impacts are then calculated for construction and operation phases including and averaging all impacts across the different components.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.2.2.3.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting habitats during construction phase are listed in the following table.

Table 7-85: Project actions and related impact factors potentially affecting habitats during construction phase.

Project actions	Brief description	Impact factors
Vegetation clearing	Removal of natural and farmed vegetation from the area along the ETL with installation of Right-of-Ways and poles, and from coastal dune area within the Project's footprint.	■ Removal of natural vegetation ■ Emission of aerial noise and vibrations ■ Possible introduction of alien species
Site levelling and grading	Removal of the first 300 mm of soil from ETL and dune habitat in the landfall area	■ Removal of natural vegetation ■ Emission of dust and particulate matter ■ Removal of soil
Material transportation	Removed soil and construction material will be transported out and in the construction area using trucks and heavy machinery. Building material will include crushed rocks and gravel for both the landfall area and the ETL.	■ Emission of dust and particulate matter ■ Emission of aerial noise and vibrations ■ Possible introduction of alien species
General engineering / construction works	Heavy machinery will be operating on the landfall area and the ETL poles installation	■ Emission of light ■ Emission of aerial noise and vibrations ■ Changes in flow/circulation in natural water bodies ■ Minor leakage of contaminants into water ■ Possible introduction of alien species

The impact factors identified above have been already described in detail in Chapters 7.2.2.1.1, 7.2.2.2.1, 7.2.2.1.1, and 7.2.2.2.1. For each factor the impacts were averaged across the different components affected and the selected value inserted in the matrix that follows.

Mitigation measures

The mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Removal of natural vegetation**
- No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.1.1, 7.2.2.1.1, and 7.2.2.2.1.
- **Removal of soil**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.1.1, 7.2.2.2.1, 7.2.2.1.1, and 7.2.2.2.1.
- **Emission of dust and particulate matter**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.1.1, 7.2.2.1.1, and 7.2.2.2.1.
- **Emission of aerial noise and vibrations**

No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.2.1, 7.2.2.1.1, and 7.2.2.2.1.

- **Emission of light**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.2.1, 7.2.2.1.1, and 7.2.2.2.1.

- **Changes in flow/circulation in natural water bodies**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.2.1.

- **Minor leakage of contaminants into water**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.2.1 and 7.2.2.2.1.

- **Possible introduction of alien species**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.1.1, 7.2.2.2.1, 7.2.2.1.1, and 7.2.2.2.1.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative residual impact** is expected on habitats during the construction phase.

Table 7-86: Residual impact assessment matrix for habitats during construction phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Removal of natural vegetation	Duration:	Medium-short	Medium	Long term	**Medium**	Medium	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Removal of soil	Duration:	Medium-short	Medium	Long term	**Medium**	Medium-high	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Emission of dust and particulate matter	Duration:	Medium	Medium	Short-mid-term	**Low**	Medium-high	**Negligible**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
	Intensity:	Medium					
Emission of aerial noise and vibrations	Duration:	Medium	Medium	Short-mid-term	**Low**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Medium	Medium	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Changes in flow/circulation in natural water bodies	Duration:	Medium	Medium	Short-term	**Negligible**	Medium-high	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Minor leakage of contaminants into water	Duration:	Medium	Medium	Short-mid-term	**Low**	High	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Possible introduction of alien species	Duration:	Medium-short	Medium	Long term	**Medium**	High	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Overall assessment:		**Low**	Rationale:	The mitigation strategy for the impacted habitats reported in this section is expected to offer a medium to high recover from construction phase, producing an expected low residual impact mostly due to the habitat loss for the RoW of the ETL.			

Monitoring measures

No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.1.1, 7.2.2.2.1, 7.2.2.1.1, and 7.2.2.2.1.

7.2.2.3.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting habitats during operation phase are listed in the following table.

Table 7-87: Project actions and related impact factors potentially affecting habitats during operation phase.

Project actions	Brief description	Impact factors
Plan/Infrastructure onshore operation	Site activities and vehicle traffic within the Project's Area. The operation phase will also require freshwater for several applications and processes, as a consequence wastewater will be produced, treated on-site and discharged mostly in Filyos River.	■ Discharge of wastewater ■ Emission of dust and particulate matter ■ Emission of aerial noise and vibrations ■ Emission of light ■ Increase and modification of traffic onshore ■ Presence of new onshore infrastructures

The impact factors identified above have been already described in detail in Chapters 7.2.2.1.2, 7.2.2.2.2, 7.2.2.1.2, and 7.2.2.2.2. For each factor the impacts were averaged across the different components affected and the selected value inserted in the matrix that follows.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Discharge of wastewater**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.2.2 and 7.2.2.2.2.

- **Emission of dust and particulate matter**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapter 7.2.2.1.2.

- **Emission of aerial noise and vibrations**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.2.2, 7.2.2.1.2, and 7.2.2.2.2.

- **Emission of light**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.2.2, 7.2.2.1.2, and 7.2.2.2.2.

- **Increase and modification of traffic onshore**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.2.2, 7.2.2.1.2, and 7.2.2.2.2.

- **Presence of new onshore infrastructures**

  No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapter 7.2.2.2.2.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative residual impact** is expected on habitats during the operation phase.

Table 7-88: Residual impact assessment matrix for habitats during operation phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Discharge of wastewater	Duration:	Long	Medium	Mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of aerial noise and vibrations	Duration:	Long	Medium	Short-mid-term	**Medium**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Long	Medium	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Increase and modification of traffic onshore	Duration:	Long	Medium	Mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Presence of new onshore infrastructures	Duration:	Long	Medium-high	Mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Project site					
	Intensity:	Negligible					
Overall assessment:		**Low**	Rationale:	Operation phase activities will influence the aquatic and terrestrial habitats through discharge of wastewaters and various emissions. These impacts are mitigated and monitored with medium to high efficiency leaving a low residual impact.			

Monitoring measures

No additional mitigation measures for construction phase are proposed in addition to those mentioned in the Chapters 7.2.2.1.2, 7.2.2.2.2, 7.2.2.1.2, and 7.2.2.2.2.

7.2.2.4 Legally Protected Areas and Internationally Protected Areas

Based on the information collected for the definition of the baseline (see Chapter 6.2.2.9), the biological component *Legally Protected Areas and Internationally Protected Areas* was assigned a **Medium** value of sensitivity for the following reasons:

- Absence of protected areas within the Project's AoI;
- Presence of two Key Biodiversity Areas (KBAs) and one relevant area for bird biodiversity, Important Bird Area (IBA), according to national/local regulations.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.2.2.4.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting legally protected areas and internationally protected areas during construction phase are listed in the following table.

Table 7-89: Project actions and related impact factors potentially affecting legally protected areas and internationally protected areas during construction phase.

Project actions	Brief description	Impact factors
Vegetation clearing	Removal of natural and farmed vegetation from the area along the ETL with installation of poles, and from coastal dune area within the Project's footprint.	▪ Removal of natural vegetation ▪ Emission of dust and particulate matter ▪ Emission of aerial noise and vibrations ▪ Possible introduction of alien species
Site levelling and grading	Removal of the first 300 mm of soil from ETL and dune habitat in the landfall area	▪ Emission of dust and particulate matter ▪ Emission of aerial noise and vibrations
Material transportation	Removed soil and construction material will be transported out and in the construction area using trucks and heavy machinery. Building material will include crushed rocks and gravel for both the landfall area and the ETL.	▪ Emission of dust and particulate matter ▪ Emission of aerial noise and vibrations ▪ Possible introduction of alien species
General engineering / construction works	Heavy machinery will be operating on the landfall area and the ETL poles installation	▪ Emission of dust and particulate matter ▪ Emission of light ▪ Emission of aerial noise and vibrations ▪ Possible introduction of alien species

The impact factors identified above are described below and assessed in the matrix that follows.

- **<u>Removal of natural vegetation</u>**

The removal of vegetation during the construction phase as described in Chapter 7.2.2.1.1 could affect habitat availability within the Important Bird Area. The removal of vegetation could cause the destruction of suitable habitats for fauna species, including birds, that use the vegetation present as food, shelter or nesting site. This could lead to a reduction of biodiversity in the impacted areas and therefore, on consequences on the KBA status.

This impact factor will affect part of the natural habitat within the Project footprint, it will have a medium-short duration, medium intensity and reversible in the long term.

- **Emission of dust and particulate matter**

Dust emission, as discussed in previous sections, can affect the health of vegetation within a 100 m from the Project Area boundaries, with adverse effects on the fauna using those habitats and consequently impacting the biodiversity within and in the vicinity of the Project Area.

The impacts due to the dispersion of dust and particular matter, which is considered to be highly frequent and of medium intensity, are possible around the Project footprint, involving a geographic extent defined as local (within 100 m buffer). The reversibility from this impact factor is considered to be short/mid-term.

- **Emission of aerial noise and vibrations**

Emissions of noise and vibration would affect the general biodiversity (i.e., freshwater and terrestrial fauna and birds) of the KBA and IBA as per the details reported in Chapters 7.2.2.2.1, 7.2.2.1.1, and 7.2.2.2.1.

The impacts due to the emissions of aerial noise and vibrations are considered to be highly frequent and of medium intensity with a short-mid-term reversibility.

- **Emission of light**

Similarly to noise and vibration, light emissions will also affect the fauna within the Project's AoI and consequently the KBA and IBA. Te details are again discussed in previous components at Chapters 7.2.2.2.1, 7.2.2.1.1, and 7.2.2.2.1.

The impacts due to light emissions are considered to be continuous and of medium intensity with a short-term reversibility.

- **Possible introduction of alien species**

The possible introduction of alien species (flora or fauna alike) could have a cascade effect on local biodiversity by changing the species compositions (invasive fauna and flora), the habitats morphology (invasive flora) and even some physical parameters (invasive microalgae) of the different habitats. A spill off effect from the Project's AoI to the KBAs could threaten the biodiversity value of these areas.

The impacts due to light emissions are considered to be continuous and of medium intensity with a short-term reversibility.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Removal of natural vegetation**
  - Biological pre-construction surveys will be implemented in the areas still to be cleared in order to identify and relocate fauna species;

  - Limits of clearing and construction areas will be clearly marked or fenced in order to avoid impacts outside this area;
  - All vehicles will drive on designated routes unless otherwise authorized, and off-road driving will be strictly prohibited;
  - Specialist training shall be provided to plant operators and key personnel involved in activities which involve land clearance, materials handling and transport activities which may impact natural habitats (e.g. vegetation, clearing, restoration activities);
- **Emission of dust and particulate matter**
  - Dust management control measures will be implemented as described in Chapter 7.2.1.2 – Air quality.
- **Emission of aerial noise and vibrations**
  - Care will be taken to select machines and equipment with low noise emissions;
  - Night works will be avoided (from 8 pm to 6 am at least), as far as practicable, to reduce impacts to nocturnal birds species;
  - Particularly noisy activities will be performed during the day and at regular times to promote the habituation of the local fauna to noise and avoid disturbances during critical hours for many species (dusk and dawn).
- **Emission of light**
  - Light emissions will be focused within the Project Area boundaries;
  - Keep glare to a minimum by ensuring that the main beam angle of all lights directed towards any potential observer is not more than 70°;
  - Downward-facing lights will be used to manage horizon glow. Louvered bollards, low height flat beam technology luminaires, poles and structure mounted fittings are acceptable;
  - Shielded light fittings and directional lights will be used to manage light spill;
  - Use of artificial light will be limited to what required to maintain a safe working environment during construction activities past sunset and before sunrise;
  - Unnecessary lighting will not be used, including lights in unused areas, decorative lighting, or lighting that is brighter than needed for the task being carried out;
  - Where practicable, timers and motion sensors will be used to turn off lights when not in use (e.g., sunset switch on, timer off for lighting used for walkways, car parks, and roads).
- **Possible introduction of alien species**
  - Check of vehicles and machinery for evident foreign plant material, soil and seeds on their first entry on site:

- Trucks coming from the outside the Project area covered with visible amounts of dirt will be washed in a controlled site, where residues will be managed as waste;
- If spreading of invasive species is observed, an appropriate eradication program will be developed and implemented.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **negligible negative residual impact** is expected on legally protected areas and internationally protected areas during the construction phase.

Table 7-90: Residual impact assessment matrix for legally protected areas and internationally protected areas during construction phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Removal of natural vegetation	Duration:	Medium-short	Medium	Long term	**Medium**	Medium	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Emission of dust and particulate matter	Duration:	Medium	Medium	Short-mid-term	**Low**	Medium-high	**Negligible**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of aerial noise and vibrations	Duration:	Medium	Medium	Short-mid-term	**Low**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Medium	Medium	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Possible introduction	Duration:	Medium-short	Medium	Long term	**Medium**	High	**Negligible**
	Frequency:	Infrequent					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
of alien species	Geo. Extent:	Local					
	Intensity:	Negligible					
Overall assessment:		**Negligible**	Rationale:	The impacts affecting the KBA and IBA status on biodiversity during construction activities will be mitigated and monitored as described in the previous components, in particular for birds, resulting in a negligible residual impact.			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on legally protected areas and internationally protected areas during the construction and verify the effectiveness of the mitigation measures.

- Inadvertent impacts on natural habitats present around the construction site will be monitored monthly in order to assess eventual footprint creep outside designated areas, including signs of erosion or stagnant water accumulation, functioning of the water run-off management system, dust deposition on vegetation, presence of waste or hazardous substances spill.
- Monitoring of birds and flora species and their recovery in the landfall and ETL construction area at completion of works and in the following one and two years.
- Monitoring of landfall area (grey dunes habitat) should follow the indications provided in the relative BAP (Golder, 2022a).
- If detected, presence and spreading of invasive flora and fauna species within and around the construction site will be monitored every three months by experts, and, if necessary, extirpation campaign will be put in place in order to avoid the spreading of the invasive species.

7.2.2.4.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting legally protected areas and internationally protected areas during operation phase are listed in the following table.

Table 7-91: Project actions and related impact factors potentially affecting legally protected areas and internationally protected areas during operation phase.

Project actions	Brief description	Impact factors
Plan/Infrastructure onshore operation	Site activities within the Project’s Area	■ Emission of aerial noise and vibrations ■ Emission of light

The impact factors identified above are described below and assessed in the matrix that follows.

- **Emission of aerial noise and vibrations**

The impact due to aerial noise and vibrations emissions present around the Project Area will be in line with what discussed for the construction phase (Chapter 7.2.2.4.1).

The impacts due to the emissions of aerial noise and vibrations are considered to be highly frequent and of medium intensity with a short-mid-term reversibility.

- **Emission of light**

The impact due to light emissions present around the Project Area will be in line with what discussed for the construction phase (Chapter 7.2.2.4.1).

This factor would have a medium intensity impact, and a short-term reversibility. The generated impacts will be continuous over time.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Emission of aerial noise and vibrations**
  - No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.4.1.

- **Emission of light**
  - No specific mitigation measures for operation phase are proposed in addition to the that mentioned in the Chapter 7.2.2.4.1.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed. The complete matrix used for the assessment, including all scores, is available in Appendix K.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **negligible negative residual impact** is expected on legally protected areas and internationally protected areas during the operation phase.

Table 7-92: Residual impact assessment matrix for legally protected areas and internationally protected areas during operation phase.

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Emission of aerial noise and vibrations	Duration:	Long	Medium	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation effectiveness	Residual impact value
Emission of light	Duration:	Long	Medium	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project site					
	Intensity:	Medium					
Overall assessment:		**Negligible**	Rationale:	The already relative low impact on biodiversity during operation activities will be mitigated and monitored as described in the previous components, resulting in a negligible residual impact.			

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on legally protected areas and internationally protected areas during the operation and verify the effectiveness of the mitigation measures.

Monitoring measures will follow those listed in Chapters 7.2.2.2.2, 7.2.2.1.2, and 7.2.2.2.2.

7.2.2.5 Critical and Natural Habitats

The only component triggering a Critical Habitat (CH) under Criteria 1 identified in the baseline (Chapter 6.2.2.8) is the endangered flora species *Centaurea kilaea* present in the landfall area of the Project.

Considering that the species is included in the flora component (Chapter 7.2.2.1) and it is also part of the coastal dune habitat (Chapter 7.2.2.3) a **low residual impact** can be considered on this species for both construction and operation phases.

Based on IFC PS6 and GN6, No Net Loss and Net Gain shall be reached for Critical Habitats.

Even if a low residual impact is expected for the species triggering CH during both construction and operation, measures to prevent a Net Loss were put in place. In fact, an additional Biodiversity Action Plan (BAP) was developed for the site-preparation/construction phase in January 2022 and given the CH status of this species mitigation and monitoring measures for this component were aimed specifically to obtain the No Net Loss and Net Gain conditions (Appendix M).

The measures to be implemented according to the BAP included:

- Removal and transplantation of *C. kilaea* individuals from the landfall area to a suitable location external to the Project's AoI.
- Restoration of the dune habitat in the landfall to support the natural reinstatement of the species
- Monitoring program to assess the survival rate and general health of transplanted individuals

For this reason, **No Net Loss is assessed for the Critical Habitats triggered by *C. kilaea*.**

Considering the abovementioned reinstatement of the dune area, which is also defined as Natural Habitat, the vegetated area where the ETL will be constructed remains the only other terrestrial Natural Habitat incurring in a direct loss due to Project activities. During construction phase, in fact, the vegetation of about 1.3 ha will be removed to accommodate the pole stands and towers from the ETL. Within this area was subjected to a transplanting of a sensitive flora species (*C. coum var. coum*) was conducted as part of a series of preliminary mitigation measures (APPENDIX N) in order to satisfy the IFC requirements of “No net loss of biodiversity (in Natural Habitats), where feasible, through the design and implementation of various mitigation measures (GN 6.43: IFC, 2012b)”. All remaining impacts in this area will be mitigated and monitored as per Sections 7.2.2.1, 7.2.2.1, and 7.2.2.2, which have been also drawn from APPENDIX M.

These series of mitigations and monitoring measures are expected to achieve a No Net Loss of biodiversity for the area despite the permanent removal of vegetated cover.

Finally, the freshwater Natural Habitats present within the Project footprint are represented by Filyos River and the coastal pond area. Of these habitats only the pond riparian vegetation is expected to incur in area loss due to the Project actions (see section 7.2.2.1.1), and while both will be impacted by emissions (e.g., wastewater discharges, dust, light, and noise) the have also been the subjects of specific preliminary mitigation measures (APPENDIX O), which have been integrated into sections 7.2.2.2 and 7.2.2.2.

As per the ETL impacted areas, the series of mitigations and monitoring measures presented here are expected to achieve a No Net Loss of biodiversity for these freshwater natural habitats.

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