FICHTNER

October 2025

Biodiversity Surveys Summary - Interim Report

FIS0000584

Hyrasia One

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Document revision record

Rev.	Date	Details of revision	Fichtner Doc Ref.	Prepared by	Checked by	Approved by
0	10.12.2024	Draft	MF3SRKXVZ4VD-1389991721-3047	C Mansfeld	G. Scott	G. Scott
1	20.06.2025	Revision	MF3SRKXVZ4VD-1389991721-3047	ESA, KEP	G. Scott	G. Scott
2	23.09.2025	Revision	1389991721-9687	G. Scott	P. Ramos	M. Siems
3	14.10.2025	FINAL	1389991721-9687	G. Scott	P. Ramos	M. Siems
04	24.10.2025	FINAL FINAL	1389991721-9687	G. Scott	P. Ramos	M. Siems

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Abbreviations

ESIA	Environmental and Social Impact Assessment
GW	Gigawatt
IF	Industrial Facility
IUCN	International Union for Conservation of Nature
Km	Kilometer
Km^2	Square Kilometer
MPC	Maximum Permitted Concentration
NH4	Ammonium
NO2	Nitrite
NO3	Nitrate
OHTL	Overhead Transmission Line
P	Phosphorus
PAH	Polycyclic Aromatic Hydrocarbons
PV	Photovoltaic
RES	Renewable Energy Systems
RCM	Rotor Current Meter
ST	Station
TPC	Total Projective Coverage
VP	Vantage Point

1 Executive Summary

1.1 Scope and Purpose

This report presents a comprehensive summary of the biodiversity surveys conducted for the Hyrasia One green hydrogen project in Kazakhstan's Mangystau region. This report establishes a baseline of terrestrial and marine biodiversity in the Hyrasia One project area, based on three surveys—Vantage Point (birds and bats), Flora and Fauna (terrestrial habitats and species), and Marine Biodiversity (marine life and water quality) performed over a 12 month period. The report characterizes species, habitats, and ecological processes, identifies sensitive areas, and informs mitigation measures for the ESIA Scoping Phase. It supports initial impact assessment and provides a foundation for further environmental management and planning.

1.2 Project Overview

Svevind Energy GmbH and its Kazakh subsidiary, Hyrasia One LLP, are developing one of the world's largest green hydrogen projects in Kazakhstan's Mangystau region. The Project includes 40 GW of wind and solar generation, a 20 GW water electrolysis plant, and associated infrastructure, including transmission lines, storage, and an ammonia pipeline and production facility at the Caspian Sea coast.

1.3 Biodiversity Survey Objectives

In support of project planning and in compliance with international and national environmental standards, comprehensive baseline biodiversity surveys were conducted. The main objectives were to:

- Establish existing conditions for terrestrial and marine biodiversity;
- Assess the sensitivity of habitats, flora, and fauna to project impacts;
- Enable risk assessment and development of mitigation strategies.

1.4 Methodology

The surveys included vantage point (VP) monitoring for birds and bats, extensive flora and fauna sampling along project components (industrial site, renewable clusters, infrastructure corridors, ammonia pipeline, and logistical hub area near Kuryk port), and detailed marine surveys at 20 stations in the Caspian Sea near Kuryk.

Key survey activities included:

- Terrestrial biodiversity surveys:
  - Bird and Bat Surveys: 86 VPs established for bird observations from October 2023 to October 2024, supplemented with passive and walk-by bat detectors from March to October 2024.
  - Flora and Fauna Surveys: Transects and sample plots assessed plant communities and animal presence across varying landscape types, with special attention to protected species.
- Marine biodiversity survey: Seasonal monitoring assessed water quality, hydrobiology, and ichthyofauna in alignment with regulatory standards.

1.5 Key Findings

1.5.1 Terrestrial biodiversity

Over 31 dominant plant communities were identified, mainly comprised of desert-adapted species. No endemic or endangered plants were found, except for Khiva saltwort (*Xylosalsola chiwensis*) at two locations. Across the Project Area, the vegetation appeared mostly healthy, with signs of only low to moderate disturbance. Where dryness was observed, it was largely attributed to natural climatic variations.

The fauna observed during the VP Surveys painted a vivid picture of avian diversity, recording 107 bird species. Notably, bird abundance and species diversity were highest in the eastern regions of the Project – Rahym and Kanagat – while the western areas such as Talap, Enbek, and Teren Oi hosted fewer species. Among the bird species observed, skylarks served as an important ecological indicator, their numbers and diversity illustrating the broader landscape's sensitivity to human activity. The study also documented several protected raptor and bustard species traversing the area. However, there was no evidence of these birds nesting within the zones planned for development, suggesting limited impacts on breeding from project construction and operations.

Bat activity was found to be low overall, and three protected mammal species, the Honey Badger, Caracal, and Goitered Gazelle were recorded in the Project Areas. Honey Badger signs were found 39 times, especially in Teren Oi, Kanagat, and Rahym, with two individuals also captured on camera in Rahym. Caracal tracks were identified twice, at Kanagat and Teren Oi. The Goitered Gazelle was sighted 54 times, mostly in small herds, with sightings evenly split between Rahym and Kanagat, and additional evidence found in other areas, including Talap.

The Central Asian Tortoise was a common sight throughout the area, whereas amphibians were rarely encountered, with only minimal signs of presence detected over the course of the surveys.

Most habitats surveyed showed resilience and a low degree of sensitivity to typical project activities like earthworks, traffic, or dust generation. The risk of bird collisions with turbines was assessed as low overall, though several protected species – including MacQueen's Bustard, some raptors, and sandgrouse – were occasionally observed entering the risk zone. This highlights the importance of continued monitoring and the readiness to apply mitigation if required.

Additionally, the fauna surveys identified that bird abundance is much higher in the eastern districts (Beket-Ata, Rahym, Kanagat) than in the western districts (Talap, Enbek, Teren Oi), despite the latter's proximity to the sea. This difference is largely attributed to variations in nesting timing, with fledglings still present in the east during surveys, while those in the west had already migrated. Species diversity at specific habitat sites was greater in the west, though overall abundance was lower.

Sensitive locations along the overhead transmission line corridor showed the highest bird diversity and density near cliffs and mixed habitats. No raptor nesting was observed in any project area during the breeding season.

In summer, small rodents, tortoises, and hares formed the primary food base for birds and predators, but their scarcity limited raptor and snake numbers. Livestock presence in western areas further reduced wildlife densities. Insect abundance was low, with most butterflies belonging to the Pieridae family.

In autumn, rodent numbers increased, supporting more predators and migratory birds. Tortoises and lizards served as additional prey. The highest rodent and tortoise abundance was found in Rahym and Teren Oi, with significant variation across sites.

The Kuryk Area survey documented limited fauna due to the absence of freshwater and woody vegetation, but the coastal cliffs and sandbanks are ecologically valuable, supporting nesting and migratory birds.

1.5.2 Marine biodiversity

Throughout the monitoring of the Caspian Sea, the findings consistently pointed to good water quality. Across all measured parameters – nutrients, heavy metals, hydrocarbons, pesticides, and polycyclic aromatic hydrocarbons – no exceedances of regulatory limits were detected. The marine environment, shaped by the natural rhythms of the seasons, supports a typical array of plankton, zoobenthos, and fish communities.

Despite a comprehensive ichthyological survey, no significant populations of rare or commercially important sturgeon were found in the area. Nonetheless, these waters serve as a nursery and feeding ground for a variety of fish species, continuing their vital ecological role.

In the current state of the marine environment, impacts were found to be minimal; there was no evidence of pollution or disturbance in key faunal groups.

1.6 Conclusions

Three dedicated biodiversity surveys were undertaken in the project area: a Vantage Point Survey, a Flora and Fauna Survey, and a Marine Biodiversity Survey. The Vantage Point Survey recorded over 30,000 individuals from 107 bird species, with highest diversity found in undisturbed locations. Several protected species, such as Steppe Eagle and MacQueen's Bustard, were observed, but only a small proportion of birds were migratory. Bat activity was generally low, and no major roosts were found. The risk of bird collisions with wind turbines in the Hyrasia One Project Area is considered low.

The Flora and Fauna Survey documented three protected mammals - Honey Badger, Caracal, and Goitered Gazelle - as well as common wildlife across the site. Sensitive and protected fauna were present mainly at low densities or as transients. Plant communities were typical of regional desert ecosystems, with no widespread populations of endangered or endemic plants except for isolated findings of Khiva saltwort. While most areas experienced only minor human disturbance, some localized habitats were more affected.

The Marine Biodiversity Survey found a healthy marine ecosystem. Phytoplankton and zooplankton communities were seasonally dynamic and reflected natural productivity patterns, with no signs of ecological disruption. Water quality remained within regulatory standards and showed no evidence of anthropogenic contamination.

2 Introduction

2.1 Scope and Purpose

This Combined Biodiversity Summary Report presents a comprehensive synthesis of the biodiversity surveys conducted for the Hyrasia One green hydrogen project in Kazakhstan's Mangystau region. The primary purpose of this report is to establish a clear and integrated baseline of biodiversity conditions within the project area prior to the onset of any significant project activities.

Specifically, this report draws upon findings from three targeted surveys conducted over a 12-month period:

- **Vantage Point Survey:** Assessing avian and bat activity and migration patterns within and around the project area.
- **Flora and Fauna Survey:** Documenting terrestrial habitats, plant communities, and key terrestrial animal species to evaluate ecological sensitivity and biodiversity value.
- **Marine Biodiversity Study:** Investigating marine life, habitats, and water quality in the adjacent coastal and marine environments.

The objectives of these surveys were to characterize species composition, population dynamics, and other key ecological processes, as a way to identify areas and species of particular sensitivity, and to inform the development of appropriate mitigation measures during the ESIA Scoping Phase. The consolidated results provide a robust foundation for the initial assessment of potential project impacts on biodiversity and support the identification of preliminary mitigation strategies to be further developed in the full ESIA.

This summary report is designed to offer an accessible, concise, and integrated understanding of the project area's ecological characteristics, thereby supporting informed decision-making and effective environmental management planning.

2.2 Project Background

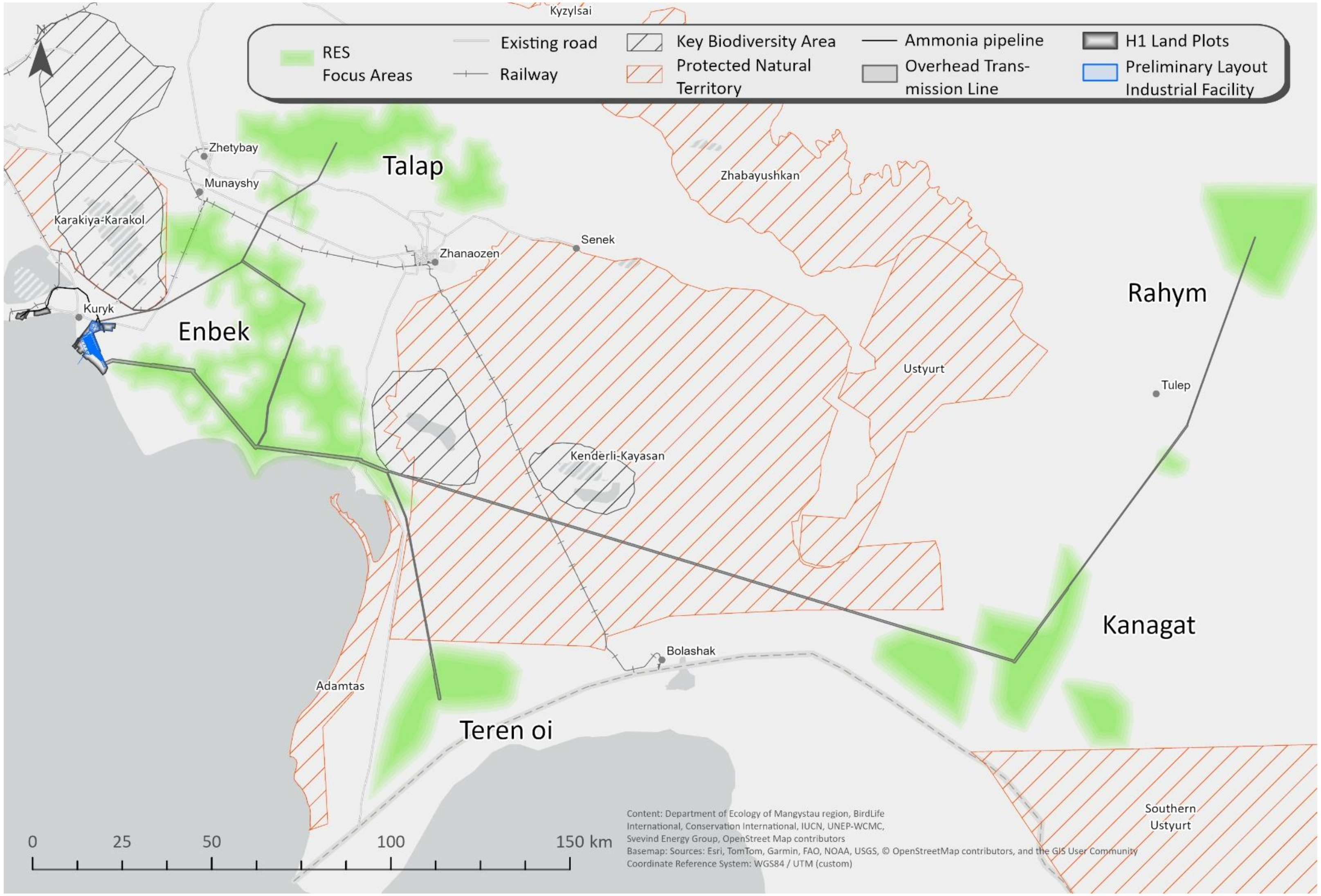
Svevind Energy GmbH (Germany) together with its Kazakh subsidiary Hyrasia One LLP (companies of Svevind Energy Group), to be referred to as SVEVIND, plans to develop one of the world's largest green hydrogen projects in the Mangystau region, in the southwest of Kazakhstan.

The Project will create an energy production hub, which includes the construction of wind and solar photovoltaic (PV) power stations with a total capacity of up to 40 gigawatt (GW), generating the power for a 20 GW water electrolysis plant at the industrial facility (IF) near Kuryk. The plant is expected to produce up to 2 million tonnes of green hydrogen, with the first volumes starting to be produced in 2031. The green hydrogen will then be converted into up to 11 million tonnes of green ammonia.

It is envisaged that the Project will be financed by international institutions.

The Project itself comprises two main components and several sub-components. To produce green electricity, Renewable Energy Systems (RES) with a total capacity of 40 Gigawatts (GW) are allocated in five macro-clusters over the Project Area as shown in Figure 1.

Such RES comprise Wind Turbine Generators (WTG) and Photovoltaic (PV) power plants. Each cluster of RES is identified by its name: Talap, Enbek, Teren oi, Kanagat and Rahym and will be implemented in phases over the construction period of the Project. The total amount of RES cluster area is estimated to amount to 5,500 km^2. Located in the centres of each cluster are substations that form the nodes of an island electrical grid. Such grid comprises earth-cables to collect the produced electricity at the RES, transform the electricity to higher voltage levels at the substations and transmit the power via Overhead Transmission Lines (OHTL) to the location of hydrogen production at the shoreline of the Caspian Sea.



Source: Client

Figure 1: Project Components (RES in green, IF in blue, overhead transmission line and ammonia pipeline corridor routings in grey) location map and the internationally and State protected nature areas avoided by the Project

2.3 Surveys Overview

Environmental baseline surveys are essential for establishing a comprehensive understanding of the current state of an environment before any development or major changes occur. It primarily serves to gather detailed information on various environmental components such as flora, fauna, air, water, soil quality, and land usage, creating a snapshot of existing conditions. This information is crucial for assessing potential impacts of proposed projects or activities, as an understanding of current conditions helps predict how they might change or be affected.

Additionally, environmental baseline surveys help ensure projects comply with environmental regulations and standards, often providing necessary documentation for environmental permitting processes. They establish benchmarks against which future changes can be measured, facilitating the evaluation of mitigation strategies and management plans post-implementation. Identifying potential environmental risks and sensitivities early in the planning process allows for the development of strategies to avoid or mitigate negative impacts.

The data gathered through these surveys also aids in informing and engaging stakeholders – such as the public, government agencies, and conservation groups – in environmental decision-making processes. Moreover, it is crucial for developing conservation and management plans to protect valuable ecological sites and species, especially in areas identified as environmentally sensitive or important. For Hyrasia One, three environmental baseline studies have been performed, the methodologies for which are defined in the following section:

- Vantage Point Survey
- Flora and Fauna Survey
- Marine Life Survey

2.4 Survey Methodology

Three distinct biodiversity surveys have been performed as part of the assessment for the Hyrasia One project: Vantage Point Surveys, a Flora and Fauna Survey, and a Marine Biodiversity Survey. Each survey serves a unique purpose and addresses specific components of the project area’s biodiversity.

Vantage Point Surveys are conducted to observe and quantify the movement, abundance, and behavior of birds and bats within and around the proposed project area. These surveys are particularly important for assessing the potential collision risks posed by wind turbine operations. By tracking flight activity and identifying the species present, Vantage Point Surveys help to determine which bird and bat populations may be most vulnerable to impacts, especially those that fly at the height of turbine blades or migrate through the area. The information gathered is essential for planning turbine placement, scheduling construction activities, and implementing targeted mitigation measures to reduce harm to birds and bats.

The **Flora and Fauna Survey** provides a comprehensive inventory of terrestrial plants and animals present in the project area. The main goal of this survey is to document the diversity, distribution, and ecological status of vegetation and key terrestrial wildlife species. Understanding the composition of plant communities and the presence of sensitive or protected species is crucial for assessing potential habitat loss or fragmentation due to project development. This survey also identifies critical habitats and ecological relationships, guiding the design of conservation and rehabilitation measures and ensuring compliance with biodiversity protection requirements.

The **Marine Biodiversity Survey** focuses on the coastal and marine environments adjacent to the project site. This survey is necessary for identifying and characterizing marine flora and fauna, monitoring water quality, and evaluating sensitive habitats such as spawning grounds, benthic communities, or migratory pathways for marine species. Assessing marine biodiversity is especially important in light of potential impacts from activities such as desalination, wastewater discharge, and marine infrastructure development. The survey results are vital for informing the placement and operation of water intakes and discharges to minimize risks to marine life and ecosystem health.

Further details on the Surveys performed are provided in Table 1.

Table 1: Detailed overview of survey activities

Survey object	Survey name	Survey time	Survey locations
Birds	Vantage Point Survey (VPS), Flora and Fauna Survey (FFS)	VPS: 36 hours in breeding season and 36 hours in non-breeding season (10/23 – 10/24), FFS: June 2024, Sep/Oct 2024; Kuryk Area: July 2023	VPS: 86 Vantage Points and routes between them, distributed within the renewable energy clusters. FFS: 80 Habitat Points and routes between them, distributed within the renewable energy clusters; ammonia pipeline; open storage areas near Kuryk port; Kuryk Industrial Site
Bats	VPS, FFS	VPS: spring, summer and autumn 2024, FFS: June 2024, Sep/Oct 2024; Kuryk Area: July 2023	VPS: stationary detectors at 43 Vantage Points, distributed within the renewable energy clusters; mobile detectors at locations of night camps, distributed within the renewable energy clusters FFS: mobile detectors at locations of night camps, distributed over all Project locations; Kuryk Industrial Site
Other Vertebrates	VPS, FFS	VPS: Oct 2023 until Oct 2024, FFS: June 2024, Sep/Oct 2024; Kuryk Area: July 2023	VPS: 86 Vantage Points and routes between them, distributed within the renewable energy clusters FFS: 80 Habitat Points and routes between them, distributed within the renewable energy clusters; ammonia pipeline; open storage areas near Kuryk port; Kuryk Industrial Site

Survey object	Survey name	Survey time	Survey locations
Invertebrates	FFS	June 2024, Sep/Oct 2024	80 Habitat Points and routes between them, distributed within the renewable energy clusters; ammonia pipeline; open storage areas near Kuryk port
Hydrobiology	Marine Biodiversity Survey (MBS)	Autumn 2023, Winter 2023/2024, Spring 2024, Summer 2024	20 Monitoring stations at the offshore impact area near Kuryk
Physical and chemical water parameters	MBS	Autumn 2023, Winter 2023/2024, Spring 2024, Summer 2024	20 Monitoring stations at the offshore impact area near Kuryk

2.4.1 Vantage point survey

2.4.1.1 Birds

Vantage Point Surveys (VPs) were performed from 18 October 2023 to 21 October 2024 across five Project Areas to assess bird sensitivity to proposed wind turbines and transmission lines and identify conditions that encourage bird concentrations. The survey utilized 86 VPs (see Figure 2) set orthogonally to expected migration routes across a 10,000 km^2 area, spaced 4 km apart to ensure a maximum recommended observation distance of 2 km. From the VPs and between them, species composition, abundance, behavior, flight direction, and height were recorded, with observations on the route between VPs assigned to the destination VP for analysis. Despite changes in the Project layout throughout the year, the positions of the VPs remained unchanged to meet the methodological requirement of 36 hours of observations during both the breeding and non-breeding seasons at each VP, except for VPs U1, U2, and U3, which were abandoned early due to layout changes.

Observations along routes between VPs adhered to recognized methodologies, moving at 15-20 km/h with a non-driving ornithologist noting species up to 500 m away for large birds (such as birds of prey), and up to 200 m for small birds (such as passerines), with stops for counts and identification. Other terrestrial vertebrate species observed were also recorded in the field log.

These observations were made using BPC 12x50 binoculars, and species identifications were verified with digital cameras equipped with full matrix tele lenses for photographic evidence.

2.4.1.2 Bats

Bats were surveyed using a hand-held Wildlife Acoustics Eco Meter Touch 2 Pro detector and 5 passive detectors Song Meter Mini Bat. The hand-held detector was used to capture bat calls around VP night camps when temperatures exceeded 5°C at night, focusing on habitats near camps as potential hunting or roosting sites. For arrangement of the passive detectors, the South African Guidelines[1] were used. Based on Appendix 1 of the Guidance the static surveys should have:

- Even spread of survey points with at least 1 point per 50-100 km^2 (100 km^2 constitutes to 6 km maximum coverage radius or 12 km between the observation points),

[1] McEwan *et al.* South African Best Practice Guidelines for Pre-construction Monitoring of Bats at Wind Energy Facilities. 2020

- Minimum of 75% coverage of the bat active period (in Mangystau Region from March to October),
- Placement of a low microphone at 7-10 m and a high microphone at 50-80 m at meteorological masts.

The stationary bat detectors are typically mounted on wind monitoring masts, which were due to the early Project stage unavailable in a sufficient density. Instead, a preliminary assessment was conducted using low-mounted microphones only, to detect bat foraging near the ground. This assessment took place from 18 March 2024 to 21 October 2024, aligning with the bat active seasons. Five Wildlife Acoustics Mini Bat detectors were installed at the top of 10-meter masts at every odd-numbered VP (totaling 43 points, Figure 2) and relocated every two weeks to the next set of points. With survey points spaced 8 km apart, each covered an area of 50.3 km² along the VPs line.

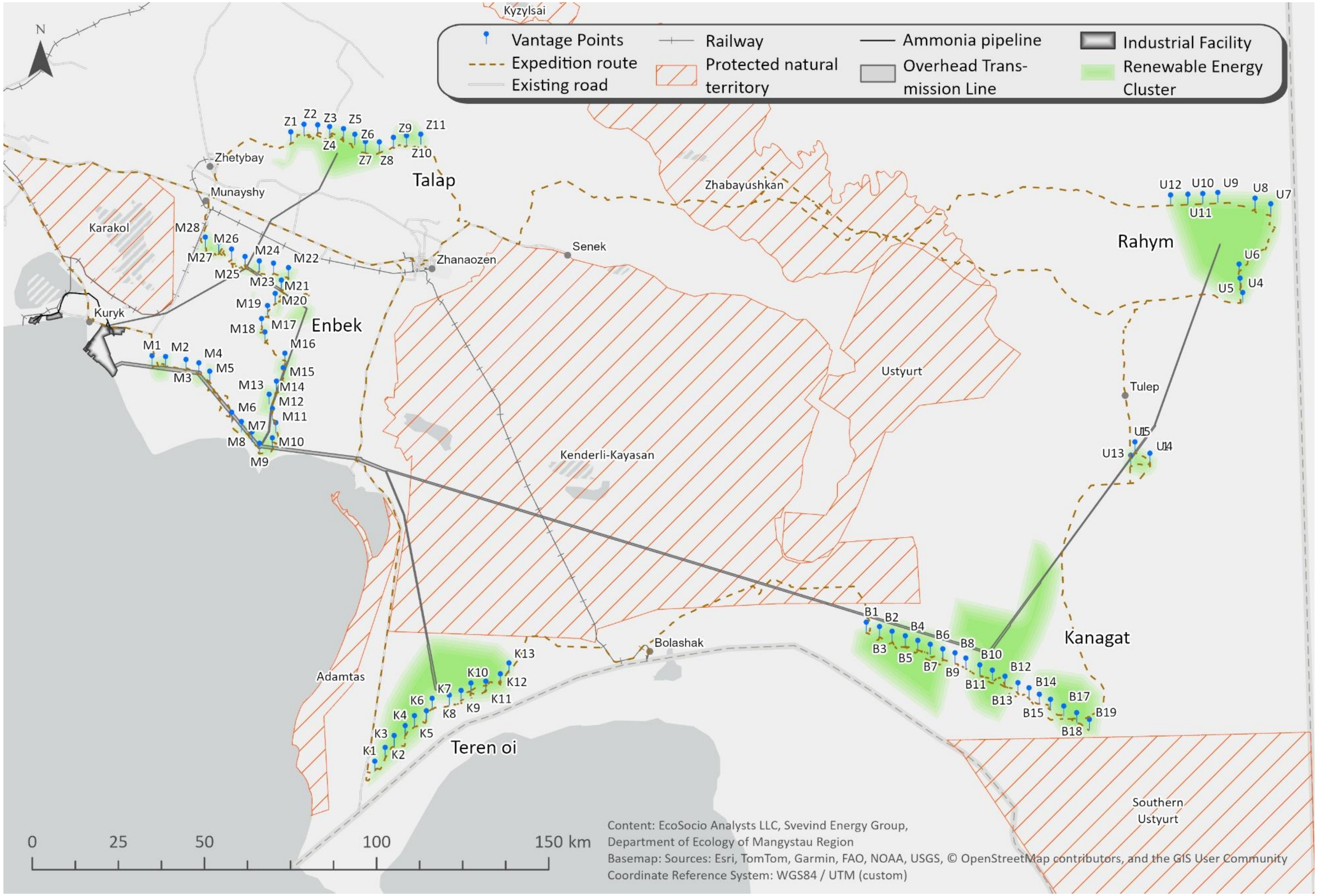


Figure 2: Overview map of the Project Areas, Project components and Vantage Points

2.4.2 Flora and fauna survey

The flora surveys were conducted from 12 to 21 May and 2 to 11 September 2024 in accordance with the methods accepted by the scientific community[2]. The main objective was to describe the vegetation and assess its sensitivity in the renewable energy clusters Talap, Enbek, Teren oi, Kanagat and Rahym, along the transmission line corridors, the ammonia pipeline corridor, and in two open storage areas at the sea shore near Kuryk port (see Figure 3 and Figure 5). The hydrogen plant area (Kuryk Industrial site) was already assessed on 18-22 July 2023, including the vegetation 2–5 km from the proposed industrial plant site (see Figure 6). Main plant habitats were mapped using satellite imagery, then verified in the field. On 10x10 m plots, researchers described floristic composition (including dominant, endemic, and protected species), projective cover, soils, and degree of degradation.

The primary aim of the fauna survey was to identify the species composition and quantitative diversity of terrestrial vertebrates and invertebrates, in order to assess the sensitivity of the above mentioned survey areas to potential impacts from the proposed Hyrasia One Project (see Figure 4 and Figure 5).

Fauna surveys were conducted from 11 to 22 June and 24 September to 1 November 2024, covering a total of 854 km along defined survey routes within Territories A and B. Observations were made using Berkut binoculars (7 x magnification), Levenhuk binoculars (25x magnification), and long-focus cameras.

Birds were observed from up to 2 km away while traveling at low speeds along roads, with stops every kilometer for systematic scanning. In total, 80 sample points were selected across five sites (17 in Enbek, 16 in Talap, 10 in Teren Oi, 19 in Rahym, and 18 in Kanagat). These points were chosen for their distinctive characteristics compared to the typical flat, mid-desert landscape dominated by perennial shrubs.

Detailed surveys were conducted at the 80 sample points and along the 33 km ammonia pipeline (see Figure 4 and Figure 5), with 0.5 x 0.5 km sample plots inspected by walking parallel transects spaced 10 meters apart to ensure full area coverage. At the pipeline's end, two open storage areas were surveyed by driving multiple transects, spaced 200 to 500 meters apart where terrain allowed.

In Territory C, along the overhead transmission line (OHTL) corridors, surveys were concentrated at eight focal points identified as likely to have higher sensitivity. Here, ground surveys covered a 1 km radius for terrestrial animals and a 2 km radius for birds and raptor nests.

Additional sample points were included in the second round of surveys to verify the spatial distribution of animal populations observed in the first round.

A bird distribution and abundance survey was conducted following the NatureScot guidance, based on which impacts such as habitat loss and displacement can be evaluated. To convert linear transect counts (with a 2 km observation width) to abundance estimates per square kilometer, the Yu. S. Ravkin method was used, which is endorsed by the International Society of Zoological Sciences. Although originally developed for Altay forest ecosystems, this method has been successfully applied to mid-desert environments characterized by perennial semishrubs and shrubs on grey-brown soils that freeze in winter.

[2] Braun-Blanquet, J. (1964): Pflanzensoziologie // 3. Auflage. Wien, 1964 and Kulikova G.G. Basic geobotanical methods for studying vegetation. Moscow State University, 2006, 152 pages.

To further contextualize findings, an additional route from Beket-Ata to Rahym outside the Project Area was surveyed to illustrate landscape transitions between the western and eastern Project zones.

Bat activity was assessed around night camps using a walk-by bat detector at dusk, prioritizing habitats suitable for foraging or roosting. These opportunistic walks were conducted until low light conditions precluded safe walking.

Spiders (Arachnida) and insects (Insecta) were sampled within a 50 m radius of each sample point using spiral transects spaced 5 meters apart. Large insects were captured with entomological nets, while smaller insects were collected with exhausters. Soil-dwelling insects were trapped using pitfall cups baited with beer-soaked rags and insect remains. Nocturnal and crepuscular insects were captured by turning stones. Large and medium-sized insects with dense cover were drenched with ethyl acetate vapors, which are less toxic than chloroform. This method preserves both chlorophyll and color, even with prolonged storage. Small insects or those with soft exoskeletons were preserved in formalin and transported using cushioned cardboard and fabric bags.

Due to anticipated differences in environmental impacts, the assessment methodology for the Kuryk area varied from that used in other Project Areas. Fauna surveys were conducted from 18–22 July 2023 using vehicle transects to cover broader areas and foot transects and point counts at habitats identified as particularly sensitive to impacts (see Figure 6). Observations were carried out twice daily from 5:00 to 11:00 and 18:00 to 22:00, with additional nocturnal counts from 22:00 to 01:00. Field equipment included MRC 12x50 binoculars, a Yukon 100 telescope, a Nikon D7200 camera with a Tamron 150–600 mm lens, and the "Birds of Kazakhstan" field guide.

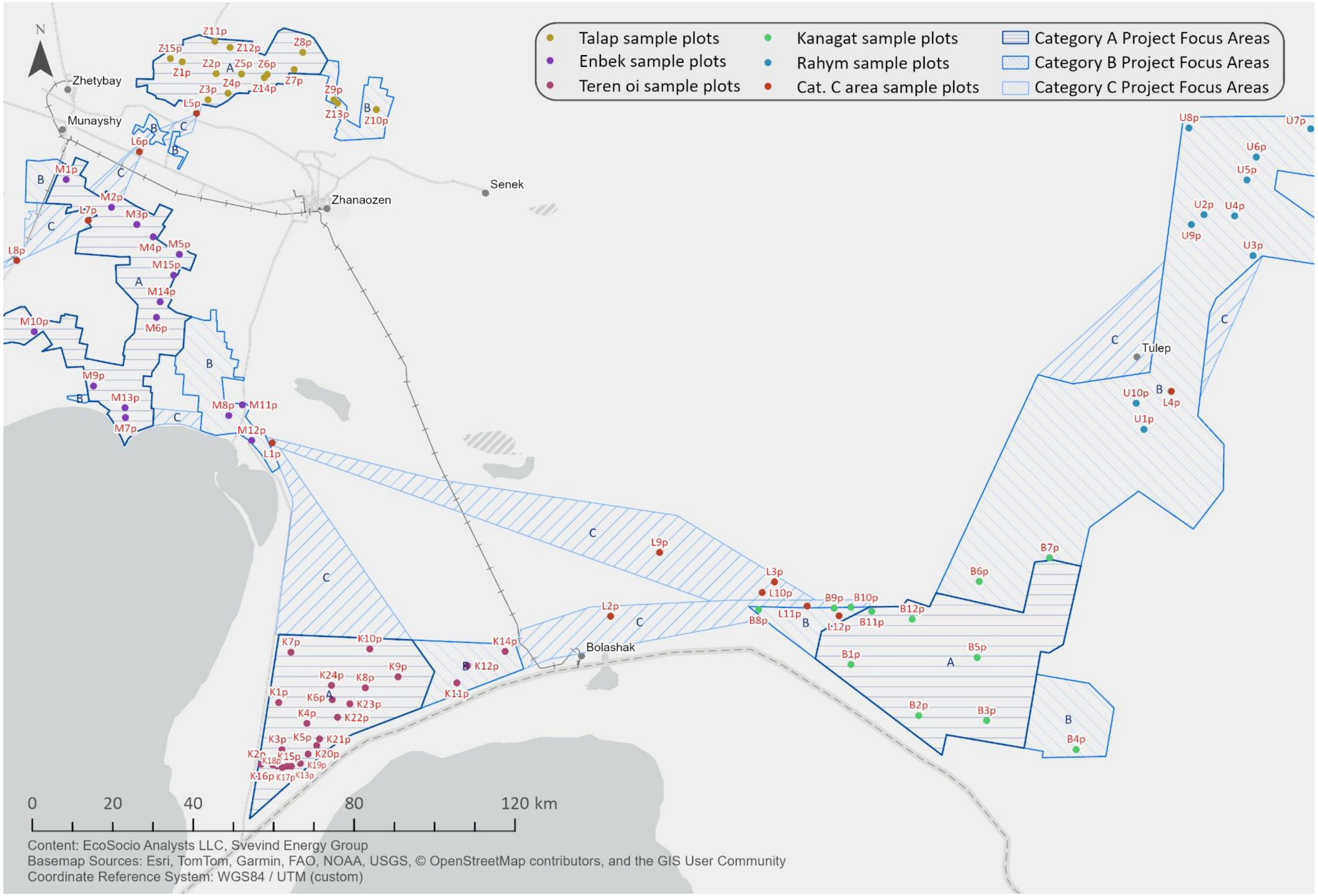


Figure 3: Overview of the flora survey area at renewable energy clusters (Category A and B areas) and overhead transmission line corridors (Category C areas)

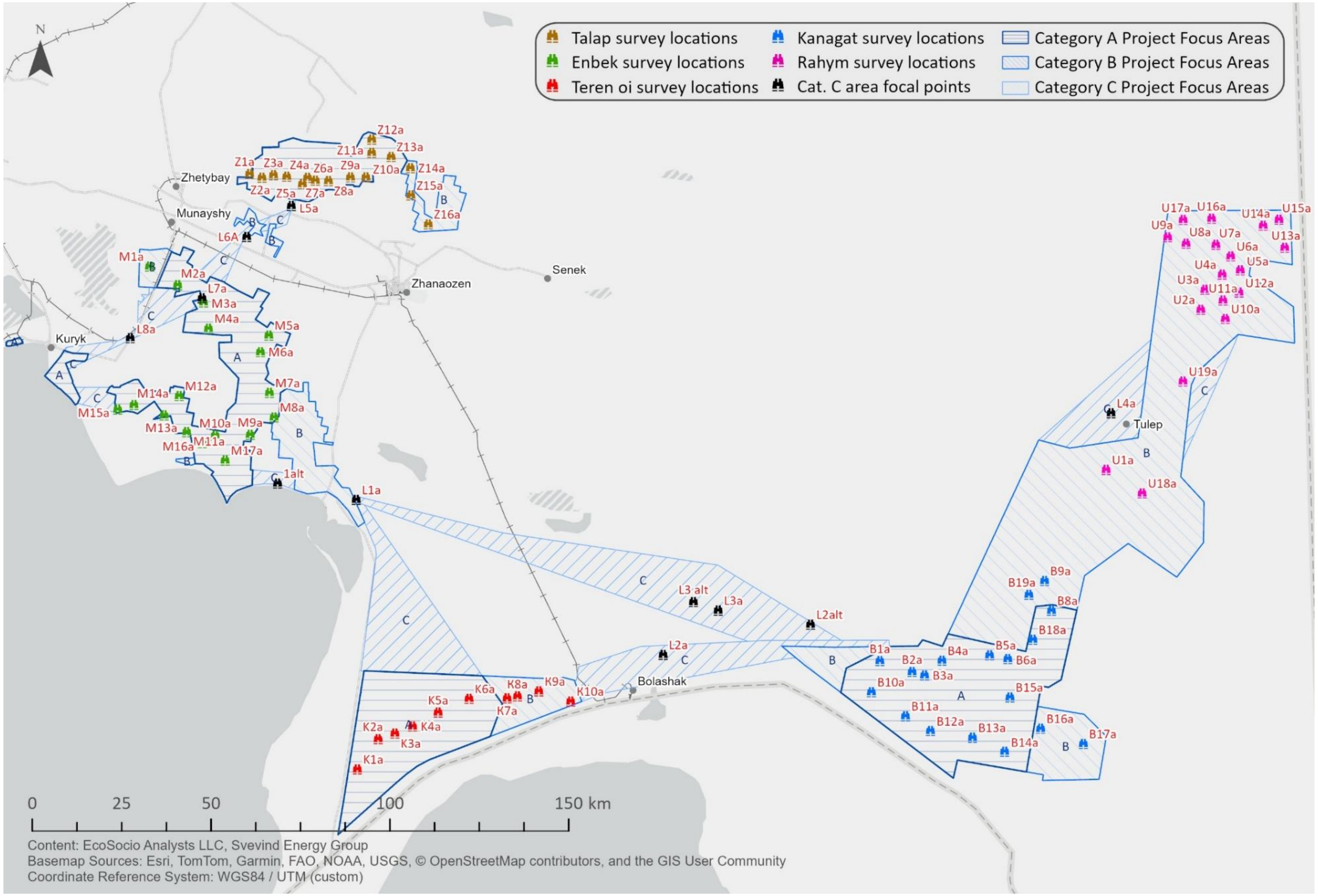


Figure 4: Overview of the fauna survey area at renewable energy clusters (Category A and B areas) and overhead transmission line corridors (Category C areas)

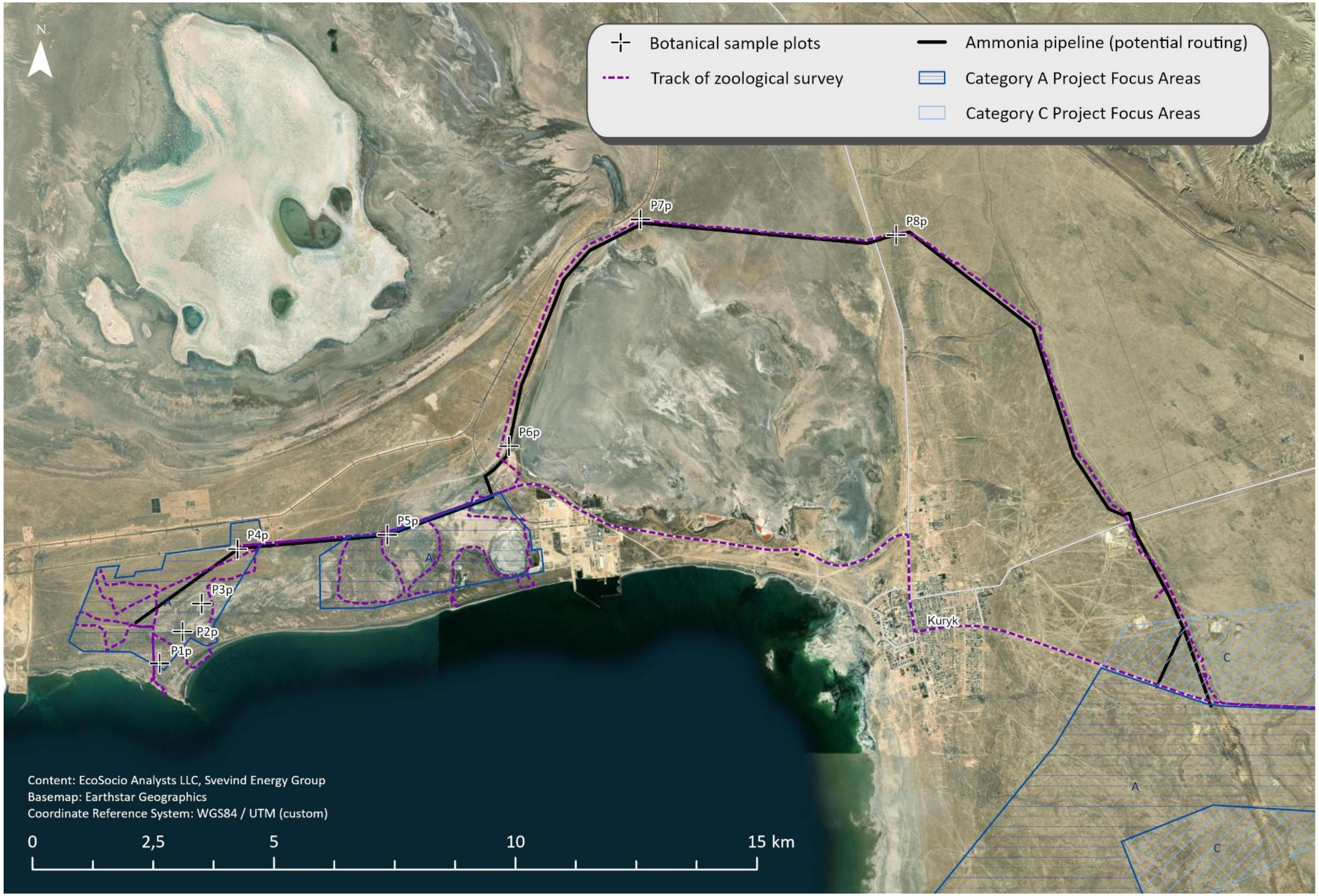


Figure 5: Flora and fauna survey areas at the ammonia pipeline corridor and two open storage areas near Kuryk port

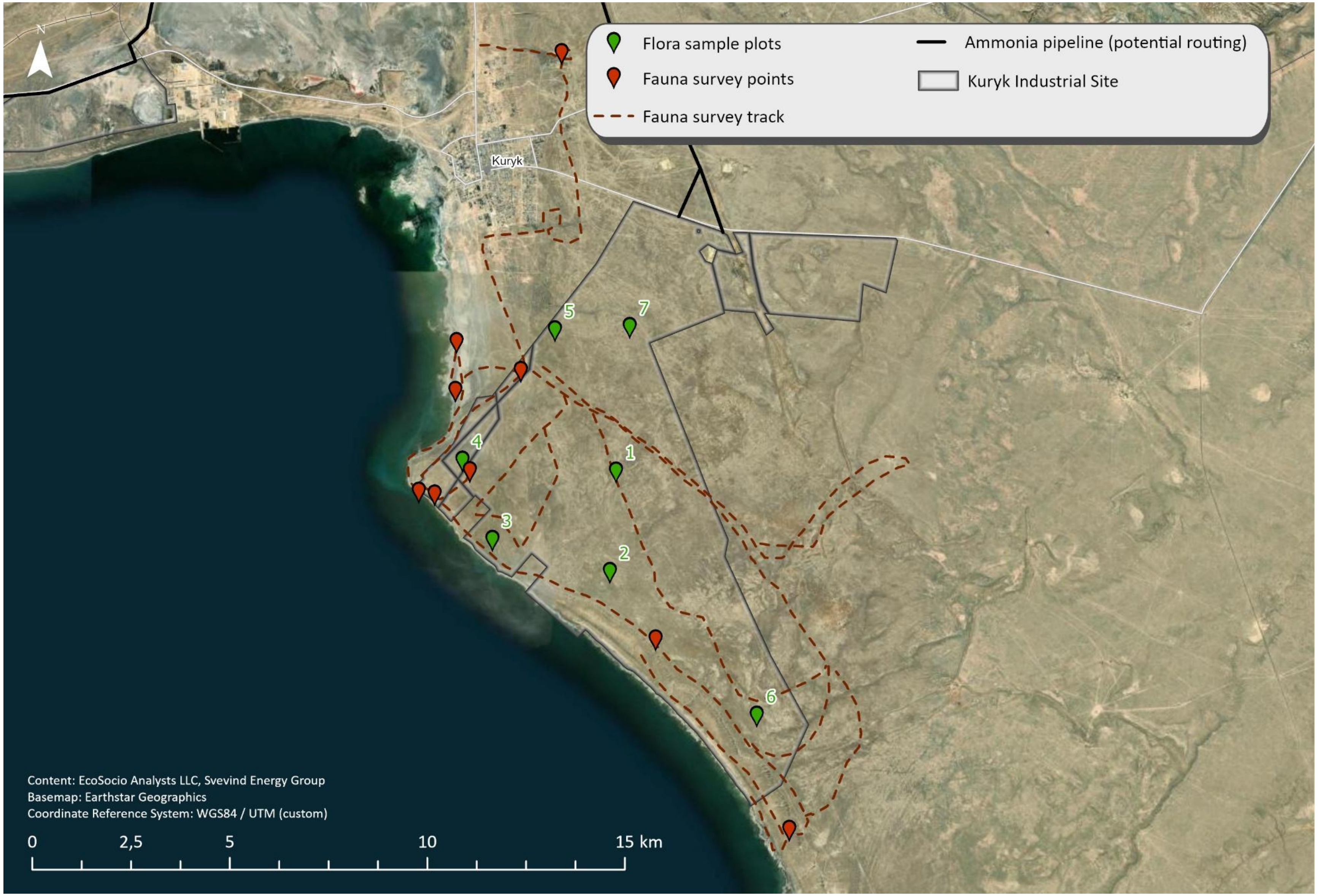


Figure 6: Flora and fauna survey areas at Kuryk Area

2.4.3 Marine biodiversity survey

A baseline survey of the marine environment of the Caspian Sea was conducted in the area, where the industrial facility of the Project will be located. The survey has been carried out during four climatic seasons (autumn and winter of 2023; spring and summer of 2024) and included hydro-physical, hydro-chemical, hydrobiological and ichthyological studies. The results of these studies assist in the understanding of the seawater quality and in the assessment of the baseline condition of marine flora and fauna before the construction and commissioning of the Project facilities.

The survey was conducted at 20 marine environmental monitoring stations. Of these, 13 stations were positioned along the planned alignment of the future water pipelines, while four stations were situated 500 meters from the planned discharge point of treated wastewater, in accordance with the Decree of the Minister of Ecology, Geology and Natural Resources of the Republic of Kazakhstan No. 250 dated July 14, 2021 ("Rules for Developing Industrial Environmental Control Programs for Facilities of the First and Second Category", item 13 of Article 2). The remaining three stations were located farther from the future discharge point and have been designated as control (baseline) stations in compliance with the aforementioned regulations. The monitoring station locations are shown in Figure 7.

The primary objective of the hydrophysical assessment was to measure in situ water parameters, including temperature, salinity, turbidity (using a Horiba U-53 probe); depth; sea current direction and velocity (with a RCM 9 W probe); and water transparency (measured with a Secchi disk).

Hydrochemical sampling involved the collection of seawater samples using a Niskin bathometer to analyze for biogenic substances (ammonium nitrogen, nitrate nitrogen, nitrite nitrogen, total phosphorus, and total nitrogen) as well as pollutants such as hydrocarbons, organochlorine pesticides, and selected heavy metals. All samples for hydrochemical analysis were submitted to the analytical laboratory of Kazecoanalysis LLP.

Hydrobiological investigations included sampling phytoplankton (with a Niskin bathometer), zooplankton (using a Juday net), and zoobenthos as well as occasional representatives of aquatic vegetation (using a Van Veen bottom grab). The presence and diversity of hydrobionts provided an indication of the state of the food base for ichthyofauna. Samples for hydrobiological analysis were sent to the SED LLP laboratory, where qualitative and quantitative parameters were determined.

Ichthyological surveys were conducted to obtain data on the species, sex, and age composition of the fish population, including their weight, size, and the presence of valuable commercial or rare species. Fish sampling was performed using trawl nets and gill nets during both day and night fishing sessions, under a scientific research fishing permit granted by the authorized body of the Republic of Kazakhstan.

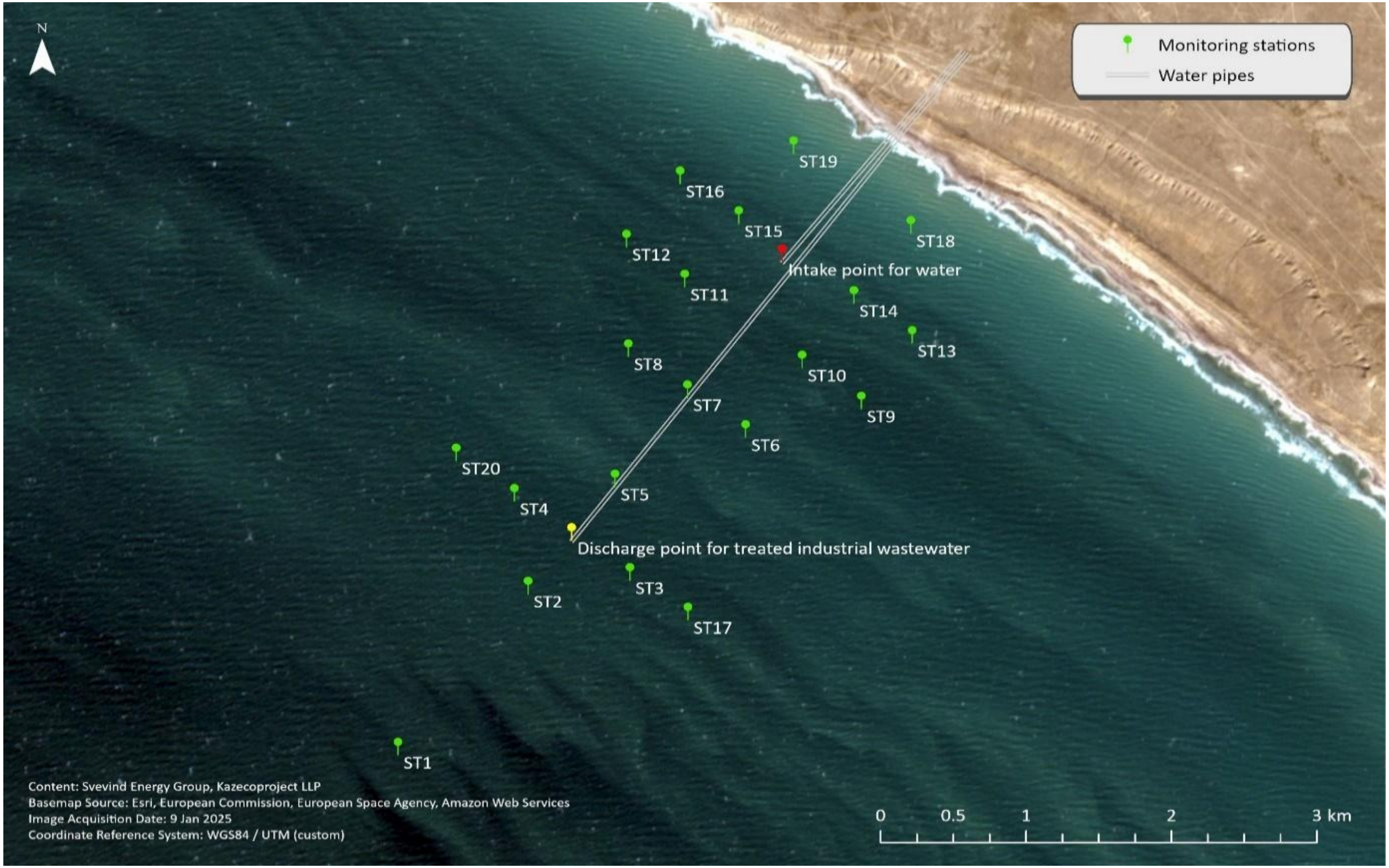


Figure 7: Layout of the marine monitoring stations

3 Vantage Point Survey

3.1 Overview

Detailed bird species observation data for each vantage point (VP) are provided in a separate Excel file to accommodate the large dataset and to facilitate analysis. A summary of the key findings is presented in Table 2.

Over the course of surveys at 86 VPs and along 418 km of routes, a total of 30,769 individual birds representing 107 species from 19 orders were recorded. Of these, more than a quarter (7,854) were resident species, while roughly half (15,662) were found nesting within the Project Areas. Fewer than 10% (2,871) had nests in adjacent areas. Notably, only 12% (4,361) of observed individuals were migratory species passing through the area.

3.2 Birds

3.2.1 The project areas birds sensitivity to human impact (based on larks, protected and prey birds)

To assess the sensitivity of the Project Areas to human impact, skylark density and diversity were used as indicators, since this bird family was present at all surveyed points year-round. Research indicates skylarks are highly responsive to environmental and climatic changes. In addition, raptors such as eagles, hawks, and vultures are particularly vulnerable to turbine collisions, as they often fly within the rotor-swept zone and may not notice obstacles while hunting or scanning for prey. Protected species, which exist in low numbers, are especially susceptible to population declines—even a few fatalities can have significant consequences.

Among all sites, Rahym — which showed the lowest levels of human disturbance — had the highest skylark density. In contrast, Enbek and Talap exhibited reduced skylark density and diversity, correlating with greater human activity and associated habitat modification. The following summary, organized by area, provide further detail on these observations.

Enbek

A total of 10,702 birds from 89 species across 17 orders were recorded at 28 vantage points (VPs) and along 153 km of routes. The surveyed area encompassed 153 km² for raptors and 61.2 km² for small passerines, reflecting observation corridor widths of 1 km and 0.4 km, respectively (see methodology). Passerines were the most abundant group (8,945 individuals), with skylarks comprising the majority (8,566), resulting in a skylark density of 140 birds/km². Notable protected[3] and prey species included:

- Greater Flamingo (6, Red Book Category II)
- Demoiselle Crane (207, V)
- Little Bustard (1, II)
- Macqueen's Bustard (52, II)

[3] For assessing the status of endangered species, the fourth edition of the Red Book Kazakhstan (redbook.kz) and the IUCN Red List (iucnredlist.org, Version 2025-1) was used.

- Black-bellied Sandgrouse (731, III)
- Pallas's Sandgrouse (94, IV)
- White-tailed Sea Eagle (2, I)
- Pallid Harrier (5)
- Hen Harrier (7)
- Long-legged Buzzard (7)
- Merlin (9)
- Lesser Kestrel (2)
- Common Kestrel (38)

Talap

Within this area, 3,118 birds from 49 species and 9 orders were observed at 11 VPs and along 47 km of routes. The surveyed area was 47 km² for raptors and 18.8 km² for small passerines. Passerines dominated (2,520), with skylarks accounting for 2,294 individuals, giving a skylark density of 122 birds/km². Key protected and prey birds included:

- Pallas's Sandgrouse (67, IV)
- Black-bellied Sandgrouse (381, III)
- Hen Harrier (1)
- Black Kite (4)
- Long-legged Buzzard (3)
- Saker Falcon (2, I)
- Pallid Harrier (1)
- Steppe Eagle (1 nest, V)
- Golden Eagle (5, III)
- Lesser Kestrel (2)
- Eurasian Kestrel (23)
- Short-eared Owl (2)
- Little Owl (3)

Teren Oi

In this area, 4,111 birds representing 77 species from 13 orders were recorded at 13 VPs and over 67 km of routes. Surveyed area was 67 km² for raptors and 26.8 km² for small passerines. Passerines were the most numerous (3,754), with skylarks numbering 3,496 (skylark density 130.4 birds/km²). Among raptors, falcons, and owls (119 individuals, density 0.9 birds/km²), the Common Kestrel (63) was dominant. Three raptor species recorded are Red Book-listed:

- Eastern Imperial Eagle (5)
- Golden Eagle (2)
- White-tailed Sea Eagle (1)

Kanagat

Recorded here were 6,023 birds from 88 species and 13 orders, at 19 VPs and 80 km of routes. The surveyed area was 80 km² for raptors and 32 km² for small passerines. Passerines again made up the majority (5,399), with 4,851 skylarks (density 151.6 birds/km²). Raptors and owls (133 individuals) resulted in a density of 0.8 birds/km². Significant species included:

- Macqueen's Bustard (73, II)
- Pallas's Sandgrouse (187, IV)
- Black-bellied Sandgrouse (observed twice, III)
- Steppe Eagle (14)
- White-tailed Sea Eagle (6)
- Saker Falcon (2)
- Golden Eagle (15)
- Eastern Imperial Eagle (15)
- Pallid Harrier (16, NT, IUCN Red List, observed 8 times)

Rahym

A total of 6,130 birds representing 61 species across 13 orders were recorded at 12 VPs and along 71 km of routes. Surveyed area covered 71 km² for raptors and 28.4 km² for small passerines. Passerines were most numerous (4,907), with skylarks comprising 4,750 (density 167.2 birds/km²). Raptors, falcons, and owls totalled 84 individuals (0.6 birds/km²). Thirty-one raptors recorded were Red Book-listed species:

- Steppe Eagle (10)
- Eastern Imperial Eagle (8)
- Short-toed Snake Eagle (1)
- Cinereous Vulture (3)
- Egyptian Vulture (5)
- White-tailed Sea Eagle (4)

*Table 2: Registered bird orders in Project Areas with number of species (and number of birds in brackets) recorded in each order. Birds of prey are shown in **bold**. Shading intensity indicates relevant diversity of each order.*

Presence of bird orders	Project Areas				
	Teren oi	Kanagat	Rahym	Talap	Enbek
Galliformes (hen like)		1(3)		1(138)	2(9)
Anseriformes (goose like)	2(7)	3(9)	1(8)		1(3)
Phoenicopteriformes (flamingo like)					1(6)
Gruiformes (crane like)			1(9)		2(208)
Charadriiformes (shore birds)	12(93)	6(49)	1(2)	4(15)	13(87)
Otidiformes (bustard like)	1(1)	3(77)	2(70)		2(53)
Cuculiformes (cuckoo like)		1(1)			
Columbiaformes (dove like)			1(1)	2(19)	2(50)
Pterocliformes (sandgrouse like)	2(54)	2(196)	2(999)	3(451)	2(825)
Caprimulgiformes (nighthawk like)			1(4)		1(1)
Apodiformes (swift like)	1(15)	1(1)		2(23)	1(51)
Gaviiformes (gavia like)	1(3)				
Suliformes (flap legged)	1(3)				1(32)
Pelicaniformes (pelican like)	1(7)	2(4)	1(2)		1(4)
Accipitriformes (hawk like)	1(4)	3(8)	4(4)	3(8)	2(12)
Strigiformes (owl like)	1(3)	1(4)	2(8)		4(22)
Bucerotiformes (horny nose like)	1(16)	1(36)	1(9)	1(11)	4(109)
Falconiformes (falcon like)	12(111)	18(165)	12(80)	8(38)	9(77)
Passeriformes (sparrow like)	41(3795)	46(6162)	32(5037)	26(2548)	41(9155)

3.2.2 Expected birds mortality

Bird mortality can be estimated using the Scottish Natural Heritage Guidance[4], a methodology recognized by international financial institutions and suitable for comparison with industry statistics. However, this approach requires comprehensive coverage of the wind farm area with observation points. Based on the current survey data and previous calculations, the number of birds observed within the risk window is very low.

Of the 586 birds that entered the risk window, 218 were passerines. Among 34 individuals from species listed in the Red Book of Kazakhstan, 27 were migratory. Additionally, it is likely that 10 MacQueen's Bustards have nested within the Project Area.

The total time (in seconds) that each species spent in the risk window — summarized in Table 3 — reflects the probability of collision with turbine blades. Meanwhile, the number of birds involved and their conservation status indicate the potential severity of impacts. Noteworthy observations include:

- MacQueen's Bustard: Entered the risk window on 11 occasions throughout the year at three areas (Kanagat, Rahym, Enbek). Only one Little Bustard was observed in the risk window (at U11 in April 2024).
- Steppe Eagle: Entered the risk window on 16 occasions during spring and autumn migrations, but only in the Kanagat, Rahym and Teren oi areas. Additional observations were made at one VP at Talap and Enbek, respectively, but these were above the risk window.

[4] Scottish Natural Heritage Guidance Wind farms and Birds: Calculating a Theoretical Collision Risk Assuming no Avoiding Action. 2000

- Black-bellied Sandgrouse (resident): Entered the risk window for brief periods (10–30 seconds) but on 90 occasions.
- Pallas's Sandgrouse: Entered the risk window 27 times for 9–17 seconds each, with a notable event where a flock of 180 birds entered the window in December 2023, substantially increasing risk for this species.
- Additionally, on 29 March 2024, a large flock of Demoiselle Cranes flew 100 meters above the M16 vantage point risk window for 15 seconds. While these birds could potentially descend into the risk window under poor weather conditions, the current mortality estimation methods do not account for such scenarios.

*Table 3: Birds in the risk window noticed during the field observations from 18.10.2023 to 21.10.2024. Protected species are shown in red and prey birds in **bold**. Birds that flew above the risk window but could descend in unfavourable weather conditions are shaded in grey*

Scientific name	Common name	# of birds	Seconds in risk window
Neophron percnopterus	**Egyptian Vulture**	3	60
Aquila chrysaetos	**Golden Eagle**	11	174
Aquila heliaca	**Eastern Imperial Eagle**	15	360
Aquila nipalensis	**Steppe Eagle**	36	565
Aquila sp.	**Eagle**	3	24
Haliaeetus albicilla	**White-tailed Sea-Eagle**	5	98
Hieraaetus pennatus	**Booted Eagle**	1	20
Falco columbarius	**Merlin**	5	109
Falco naumanni	**Lesser Kestrel**	67	2 010
Falco cherrug	**Saker Falcon**	2	20
Falco subbuteo	**Eurasian Hobby**	1	5
Falco tinnunculus	**Common Kestrel**	22	552
Accipiter nisus	**Sparrowhawk**	2	30
Milvus migrans	**Black Kite**	7	180
Circaetus gallicus	**Short-toed Snake-Eagle**	1	20
Buteo buteo	**Common Buzzard**	1	8
Buteo rufinus	**Long-legged Buzzard**	29	694
Buteo rufinus	**Long-legged Buzzard**	1	15
Circus cyaneus	**Hen Harrier**	9	278
Circus macrourus	**Pallid Harrier**	6	80
Circus pygargus	**Montagu's Harrier**	3	41
Circus sp.	**Harrier**	1	30
Apus apus	Common Swift	30	90
Apus melba	Alpine Swift	1	60
Ardea cinerea	Grey Heron	7	70
Ardea purpurea	Purple Heron	5	75
Chlamydotis macqueenii	MacQueen's Bustard	17	295
Anthropoides virgo	Demoiselle Crane	150	2250
Tetrax tetrax	Little Bustard	1	20
Fringilla coelebs	Eurasian Chaffinch	1	30

Scientific name	Common name	# of birds	Seconds in risk window
Fringilla montifringilla	Brambling	8	150
Phoenicopterus roseus	Greater Flamingo	3	60
Phoenicurus ochruros	Black Redstart	1	60
Egretta alba	Great Egret	2	30
Coturnix coturnix	Common Quail	1	20
Anas crecca	Eurasian Teal	7	70
Anas platyrhynchos	Mallard	2	22
Anas querquedula	Garganey	2	30
Anas strepera	Gadwall	5	75
Cygnus olor	Mute Swan	2	20
Granativora bruniceps	Red-headed Bunting	1	8
Himantopus himantopus	Black-winged Stilt	60	900
Larus ridibundus	Black-headed Gull	3	60
Phalacrocorax carbo	Great Cormorant	10	168
Phalaropus lobatus	Red-necked Phalarope	5	100
Pterocles alchata	Pin-tailed Sandgrouse	1	5
Pterocles orientalis	Black-Bellied Sandgrouse	1070	15 636
Sterna hirundo	Common Tern	10	175
Syrrhaptes paradoxus	Pallas's Sandgrouse	431	4629
Tringa glareola	Wood Sandpiper	13	5
Upupa epops	Eurasian Hoopoe	3	70
Columba livia	Rock Dove	12	212
Corvus corax	Common Raven	7	168
Corvus cornix	Hooded Crow	32	960
Corvus frugilegus	Rook	20	600
Alaudidae sp.	Lark	707	38171
Alauda arvensis	Eurasian Skylark	38	428
Calandrella brachydactyla	Greater Short-toed Lark	14	10 931
Calandrella rufescens	Lesser Short-toed Lark	777	1 318 002
Alaudala cheleensis	Asian Short-toed Lark	24	259 200
Eremophila alpestris	Horned Lark	23	253
Galerida cristata	Crested Lark	1	8
Melanocorypha bimaculata	Bimaculated Lark	46	281 020
Melanocorypha calandra	Calandra Lark	448	500 683
Melanocorypha leucoptera	White-winged Lark	17	149
Melanocorypha yeltoniensis	Black Lark	88	1210

3.3 Other Vertebrates

3.3.1 Bats

Bat surveys were conducted from 18 March to 21 October 2024. During this period, one detector mast was stolen and another was damaged by camels. Despite specialized training provided to the zoologists using the bat detectors, further issues with improper setup and maintenance resulted in data gaps during the initial survey. To address this, supplementary monitoring is planned from April to October 2025.

No bats were observed visually, nor were any reported by local residents. Only a single bat was acoustically detected during a walk-by Wildlife Acoustics bat detector survey at night in September 2024 at M28 (Enbek), approximately 12 km from the Karagie Depression.

Analysis of passive bat detector data using Kaleidoscope software revealed that bats were detected at 6 out of 11 surveyed locations in 2024 (see Table 4). The highest bat activity was recorded at VP M27, near the Karagie Depression cliff, with 59 bat passes documented over 20 summer nights and 120 additional passes during 9 autumn nights. At VP Z3, 61 passes were recorded over 10 autumn nights. Much lower activity was documented at VPs M17, M19, and M23, with only 2 bat passes detected over 22 nights at VP U5.

*Table 4: The passive bat detectors data collected from the vantage points. The highest results are shown in **bold**.*

Nights recorded/Number of bat calls				Number of records						Max. active recording hours		
VP	Spring (18.03-31.05)	Summer (01.06-31.08)	Autumn (01.09-12.09)	Spring		Summer		Autumn		Spring	Summer	Autumn
				FS	ZC	FS	ZC	FS	ZC			
B17	19/0			35						0,1		
U5	37/0	22/2		214		187				0,9	0,8	
U7/9		41/0					336				1,4	
U11			3/0					501				2,1
U13	37/0			6						0,02		
Z3			10/**61**					147	147			0,6
M17		43/6				501					2,1	
M19		33/9				8818					36,7	
M21		2/0					147				0,6	
M23		33/8				1	13652				56,9	
M27		20/**59**	9/**120**			216		97			0,9	0,4

FS/ZC Full spectrum or zero crossing recordings[5]. Maximum active recorded hours is derived by multiplying the max number of records by 15 sec maximum recording length =0,0042 hours

During the 2024 bat monitoring campaign, more than 20,000 recordings were collected. After manual review using BatExplorer (version 2.2, Elekon AG, Switzerland), only 265 recordings (Table 5) were confirmed to be bat activity.

Table 5: Recorded bat species groups 2024

Genus	Number of recordings
Nyctalus/Eptesicus/Vespertilio	*254*
Pipistrellus sp	*8*
Plecotus sp	*3*
TOTAL	*265*

[5] Zero crossing is a simple method for estimating frequency primarily used for basic tone detection, while full spectrum analysis provides a detailed and comprehensive frequency examination of a signal, suitable for more complex signal processing tasks. Both are suitable methods for the collection of bat call data.

The majority of species detected in the 265 recordings that were not considered to be noise can be attributed to the genera *Nyctalus*, *Eptesicus* or *Vespertilio*.

The following table (Table 6) shows the total number of monthly observations of each of the genera using detectors.

Table 6: Bat monitoring results 2024 by species group and month

Genus	Month								Total
	3	4	5	6	7	8	9	10	
Nyctalus/Eptesicus /Vespertilio	-	-	-	2	-	74	178	-	254
Pipistrellus sp	-	-	-	-	-	5	3	-	8
Plecotus sp	-	-	-	-	-	2	1	-	3
TOTAL	0	0	0	2	0	81	182	0	**265**

3.3.2 Mammals (excluding bats)

In total three protected mammal species (according to Kazakh regulation) have been recorded in the Project Areas: Honey Badger, Caracal and Goitered Gazelle. Signs of presence of the Honey Badger were found on 39 occasions in all areas albeit more in Teren oi, Kanagat and Rahym. Camera traps placed along the border east of Rahym area by a wildlife research project also fixated 2 badgers. Tracks attributed to two Caracals were found twice by two observers: once in February at Kanagat vantage point B3 and again in July in Teren oi at K6. The Goitered Gazelle was sighted on 54 occasions in the Project Area, mostly in small herds ranging from three to fourteen animals. Pairs were recorded four times, single gazelles three times, and one herd consisted of 30 gazelles. Sightings were equally divided between Rahym (27) and Kanagat (27) Project Areas, with tracks and droppings observed 18 times in all other Project Areas, including two instances at the Talap Project Area cliffs on 01.08.24.

Two burrows suspected to belong to the Old-World Porcupine were found, but their origin could not be confirmed.

*Table 7: Mammals noticed during the field observations from 18.10.2023 to 21.10.2024. The protected species (according to Kazakh regulation) are shown in red, species of concern in **bold** and species whose presence was not confirmed are shaded in grey.*

Common name	Scientific name	Quantity
African wildcat	*Felis lybica*	3
Bat	*Microchiroptera*	1
Caracal	*Caracal caracal*	2
Cheetah?	*Acinonyx jubatus*	1
Corsac	*Vulpes corsac*	>17
European badger	*Meles meles*	1
Field mouse	*Arvicolinae sp.*	Few
Gebril	*Gebrillinae*	Colonies
Goitered gazelle	*Gazella subgutturosa*	>443
Golden jackal	*Canis aureus*	>3, sporadic
Great gerbil	*Rhombomys opimus*	>11, colonies
Great jerboa	*Allactaga major*	11

Common name	Scientific name	Quantity
Grey hamster	*Cricetulus migratorius*	Many
Ground squirrels	*Spermophilus sp.*	>69
Hedgehog	*Erinaceidae sp.*	>23
Honey badger	*Mallivora capensis*	>9
Indian crested porcupine?	*Hystrix leucura*	1
Jerboa	*Pygeretmus sp. Allactaga sp. Stylodipus sp.*	>30
Large jerboa	*Allactaga sp.*	Sporadical
Meriones	*Meriones erythrourus*	1
Mustelidae	*Mustelidae sp.*	>1, sporadic
Northern mole vole	*Ellobius talpinus*	>15, colonies
Old World porcupine?	*Hystricidae*	2 (burrows)
Polecat	*Polecat sp.*	Sporadic
Red fox	*Vulpes vulpes*	>69
Russet ground squirrel	*Spermophilus major*	4
Saiga antelope	*Saiga tatarica*	Few
Small five-toed jerboa	*Allactaga elater*	6
Small mammals		Many burrows
Steppe polecat	*Mustela eversmanii*	2
Tolai hare	*Lepus tolai*	>169
Weasel	*Mustela sp.*	Droppings
Wolf	*Canis lupus*	Many
Yellow ground squirrel	*Spermophilus fulvus*	26

3.3.3 Reptiles and amphibians

Table 8 presents the results of the observations of reptiles and amphibians. No amphibians were observed during the monitoring period. The call of the European Green Toad was heard once in May 2024 in the Enbek area, but this was not visually confirmed and was not repeated in subsequent observations.

The internationally protected Central Asian Tortoise was abundant across all survey areas. While only about 50 individuals were seen, there were a total of 200 records including sightings, burrows, droppings, and tracks. The Steppe Agama was the second most frequently encountered reptile, with all records based on visual observations.

Table 8: Reptiles and Amphibians noticed during the field observations conducted from 18.10.2023 to 21.10.2024

Species	Scientific name	Quantity
Central Asian tortoise	*Agrionemys horsfieldii*	>354
Steppe agama	*Trapelus sanguinolentus*	160
Agama	-	79
Toadhead agama	*Phrynocephalus sp.*	131
Lizard	*Lacertilia sp.*	103
Sunwatcher toadhead agama	*Phrynocephalus helioscopus*	48
Central Asian racerunner	*Eremias velox*	39
Central Asian toadhead agama	*Phrynocephalus guttatus*	4
Snake	*Serpentes*	5
Eremias	*Eremias*	3
Gecko	*Gekkonidae*	2
Arrow snake	*Psammophis lineolatus*	2
Dwarf sand boa	*Eryx miliaris*	1
Sheltopusik	*Pseudopus apodus*	1
Dwarf sand boa	*Eryx miliaris*	1
European green toad	*Bufotes viridis*	1 (Voice)

3.4 Conclusions

During the VP Survey, over 30,000 individuals from 107 species were recorded during the monitoring period. Biodiversity and abundance were highest in undisturbed areas such as Rahym, while more disturbed sites supported fewer species and individuals, particularly among sensitive bird species. Several protected species were observed, including Steppe Eagle, Eastern Imperial Eagle and MacQueen's Bustard. Only 12 % of birds recorded were migratory. The risk of bird collisions with wind turbines is predicted to be low provided key migration and congregation areas are avoided during turbine sitting.

Bat activity was generally low across the project area, except at two sites (VP M27 near the Karagie Depression cliff and Z3 in Talap) where higher levels of activity were recorded. No major bat roosts or large populations were found.

Three protected mammal species, the Honey Badger, Caracal, and Goitered Gazelle—were documented, with Goitered Gazelle being the most frequently seen. Other mammals such as wolves, foxes, and rodents were common and widely distributed throughout the area. There was no indication of large populations of highly sensitive or critically endangered mammals within the project footprint.

The Central Asian Tortoise was common in all surveyed areas. No significant concentration of protected reptiles or amphibians was found, aside from a single auditory record of the European Green Toad.

4 Flora and Fauna Survey

4.1 Flora

4.1.1 Overview

During the assessment of 96 sample plots (distributed as follows: 24 in Teren Oi, 12 in Kanagat, 10 in Rahym, 15 in Talap, 15 in Enbek, 8 along the ammonia pipeline corridor and open storage areas, and 12 along the OHTL corridors) and 1,120 km of survey routes, over 31 dominant plant communities were identified.

According to recent botanical-geographical zoning, the Project Area lies within the Saharan-Gobi desert region, specifically the Irano-Turan sub-region. It spans the North-Turan (West North-Turan sub-province) and South-Turan (West South-Turan subprovince) provinces, within the middle and southern warm temperate desert subzones.

4.1.2 Talap

Most of the territory consists of *Anabasis salsa* communities on grey-brown saline soils of undulating plains and hillocks. Vegetation shows weak to moderate disturbance from grazing and vehicle traffic, though some areas (hillock tops, cattle camps) are highly degraded. On average, plant communities contain 10 species. The vegetation map is presented in Figure 8.

Total projective coverage (TPC) of vegetation is 20 - 25% in areas with minimal disturbance but decreases to 15% under greater anthropogenic pressure.

Biurgun communities *(Nanophyton erinaceum)* often form complexes with other species:

- On rubbly soils, with white-emergent sagebrush (*Artemisia terrae-albae*),
- On loamy soils, with keurek-biyurgun (*Caroxylon orientale, Anabasis salsa)* and keurek-wormwood (*Caroxylon orientale*, *Artemisia terrae-albae*).

In lowlands, *Anabasis aphylla* dominates with TPC of 5 -10 %, especially along takyrs.

Vegetation on hillock tops is nearly destroyed by vehicle traffic, remaining as isolated plants or small patches.

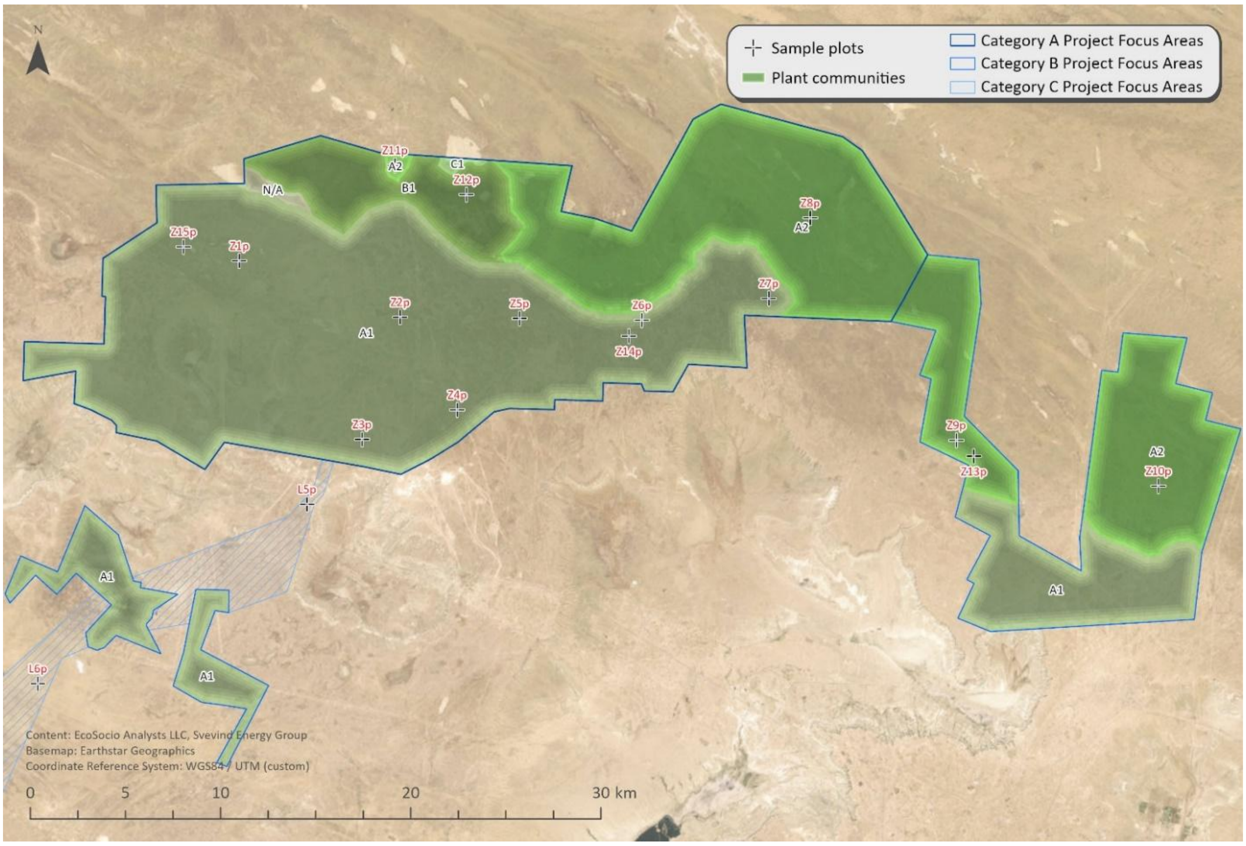


Figure 8: *Talap vegetation map with location of 15 plots where typical vegetation was described. The area is in the Middle Desert Subzone with 3 vegetation types andh 4 communities*

4.1.3 Teren Oi

The study area on the Kenderli-Kayasan plateau features highly heterogeneous vegetation, primarily on grey-brown loamy solonetz soils. Plant communities are typically oligo-dominant, often composed of three or more co-dominant species such as *Artemisia kemrudica, Caroxylon orientale*, and *Caroxylon gemmascens*, with *Anabasis salsa, Anabasis brachiata*, and *Nanophyton erinaceum* also important. Vegetation cover is complex, forming mosaics across convex and flat areas, with numerous depressions and takyrs that are nearly barren. The vegetation map is presented in Figure 9.

Most of the area consists of mixed desert communities, with total projective cover (TPC) generally between 25 – 35% in less disturbed conditions, falling to 15 – 25% where disturbance from grazing, roads, or excavation is greater. Communities usually include 4 – 10 species.

The southern and southwestern regions are dominated by perennial saltwort complexes, with TPC of 20 – 30% and species counts of 3–10 per community. These often combine with *Artemisia kemrudica* stands, which have higher TPC (30 – 35%) but lower diversity (2 – 4 species). Takyrs are nearly bare, with only scattered plants and a TPC below 3%.

Big Gerbil colonies create areas of significant disturbance with sparse vegetation (5 – 10% cover), mostly perennial saltworts. In the south of Teren Oi, hedgerow-lichen communities are notable. Hillock tops are also highly degraded by vehicle use, hosting only isolated plants.

The life state and phenological phase of many components of phytocenoses are normal. However, on a large area of the territory a dry state of Artemisia from 2-3 to 50-80%, Tetyrus from 5 to 60% and Keurek up to 80-90% were observed. The examination of dry plants, including their root systems, did not reveal any signs of insect pests or anthropogenic factors. Based on studies of similar conditions of desert vegetation in Turkmenistan (E.N. Zverev), it is assumed that this condition was caused by a particularly dry period. When normal conditions are restored, desert vegetation gradually recovers.

Figure 9: *Teren oi vegetation map with location of 24 plots where typical vegetation was described. The area is in the Southern Desert Subzone with 3 vegetation types and 4 communities*

4.1.4 Kanagat and Rahym

The study area is situated on the Ustyurt Plateau, within the middle desert subzone. Vegetation is characterized predominantly by *Anabasis salsa* communities. Overall, disturbance is low, limited mostly to localized motor vehicle tracks and occasional small colonies of Big Gerbils. The vegetation map is presented in Figure 10.

Anabasis salsa communities exhibit a total projective cover (TPC) of 20 – 25%. Mixed communities with *Caroxylon orientale* have slightly higher TPC (25 – 30%), while combinations with *Artemisia terrae-albae* or *Artemisia kemrudica* can reach 30 – 35%. Across all plots, 3 to 18 plant species were identified.

The surveyed area is dominated by sparse groupings of *Anabasis salsa, Caroxylon orientale, Evernia esorediosa f. terrestris,* and *Anabasis brachiata*.

Plant health and phenological stages were generally normal, though localised areas showed 40 – 90% dieback of *Artemisia kemrudica* and *Caroxylon orientale*, likely due to drought rather than pests or human activity.

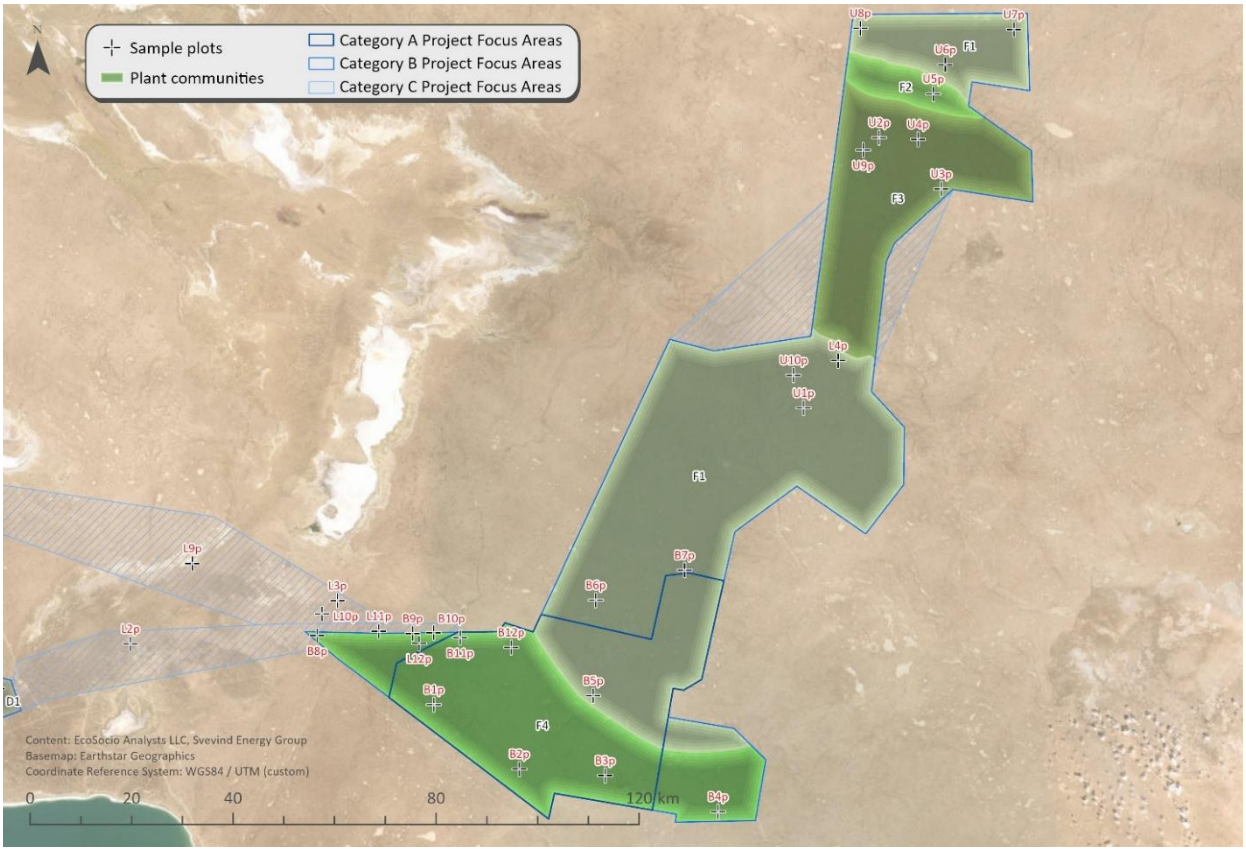


Figure 10: *Kanagat and Rahym vegetation map with location of 22 plots where typical vegetation was described. These areas are in the Middle Deserts Subzone with one type of vegetation and 4 communities.*

4.1.5 Enbek

The Enbek site, featuring flat terrain bordered by the Karagie depression, is characterized by complex vegetation on grey-brown saline soils. The northern part lies within the middle desert (North-Turanian) zone, dominated by *Artemisia terrae-albae* and *Anabasis salsa*, while the southern part falls within the southern desert (South-Turanian) zone, where *Anabasis salsa, Caroxylon orientale,* and *Nanophyton erinaceum* communities prevail.

Vegetation disturbance is generally low, primarily from vehicle tracks and unpaved roads, with limited grazing. Plant cover (TPC) ranges from 30 – 40% in weakly disturbed Artemisia communities to 20 – 30% in southern community types, with 6 – 15 species per community. Takyr depressions are largely barren or sparsely vegetated.

Most plant communities are healthy and in seasonally appropriate phenological phases, though some *Anabasis aphylla* galls were noted. Construction activities in the southern section have led to localized destruction or moderate disturbance of vegetation. The vegetation map is presented in Figure 11.

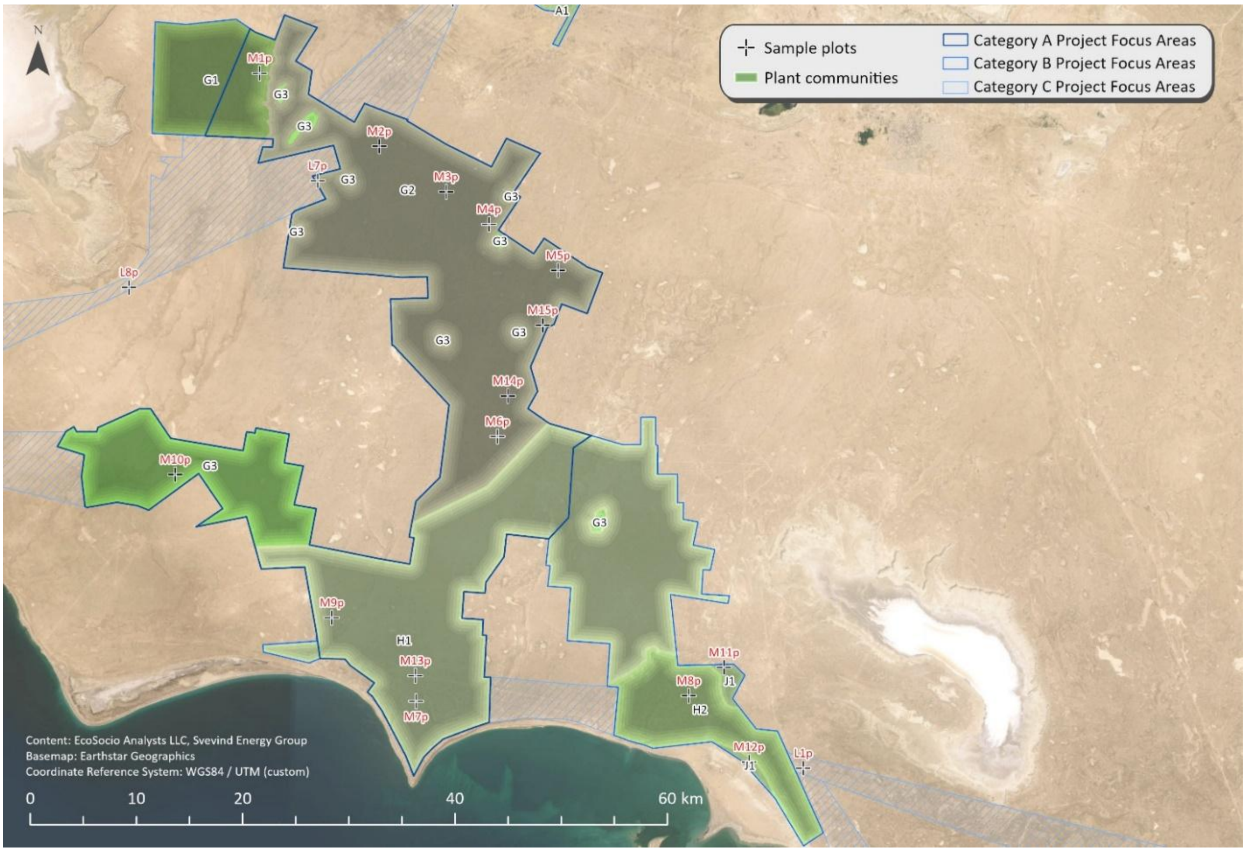


Figure 11: *Enbek vegetation map with location of 15 plots where typical vegetation was described. The area is in two subzones with 4 vegetation types and 7 communities.*

4.1.6 Ammonia pipeline and open storage areas

Vegetation along the ammonia pipeline corridor is characterized by low species diversity and sparse cover (< 45 %), reflecting extreme conditions such as high temperatures, wind, limited water, and strong soil salinity. Dominant plants include xerohalophytic shrubs, semi-shrubs, and perennials primarily from the *Chenopodiaceae, Asteraceae, Poaceae, Cruciferae,* and *Limoniaceae* families. Ephemerals are present briefly in spring.

Plant communities shift from *Salsola orientalis–Agropyron* fragile formations on loamy soils in the first half of the corridor to *Haloxylon aphyllum–Solanum* on saline soils in the second half and both storage areas. Vegetation is primarily impacted by grazing, occasional vehicle traffic, and earthworks; some strips are completely vegetation-free above newer pipelines.

Sand deposits from coquina limestone underlie much of the corridor and storage areas, supporting sparse vegetation. TPC ranges from 25 – 40%, with community diversity highest in less disturbed areas. The rare[6] Khiva saltwort (*Xylosalsola chiwensis*, Red Book category II, was recorded at two points. Vegetation is healthiest on consolidated sands and solonchak hillocks, with higher species counts (up to 15) in those areas. The easternmost survey point featured perennial saltwort and wormwood communities with TPC of 20 – 25% and some rock outcrops.

[6] To assess the Red Book status of plants, the following reference was used: Red Book of Kazakhstan, Part 1, Vol. 2. Plants. Astana: ArtPrint, 2014. 860 p.

Overall, plant cover is generally sparse and subject to moderate disturbance. The vegetation map is presented in Figure 12 below.

Figure 12: *Vegetation map of the ammonia pipeline corridor (black polyline) and 2 storage areas (blue polygons) with location of 8 plots where typical vegetation was described. The area is in the Middle Desert Subzone with 6 vegetation types and 7 communities.*

4.1.7 Overhead transmission line corridors

Geobotanical surveys were conducted at 12 plots along planned power transmission line corridors, with increased sampling south of the Ustyurt State Nature Reserve in areas considered sensitive to construction impacts. Vegetation communities across the plots were typically composed of species such as *Caroxylon gemmascens, Anabasis salsa, Artemisia terrae-albae, Artemisia kemrudica, Haloxylon ammodendron*, and *Caroxylon orientale*. Total projective cover (TPC) generally ranged from 10 – 40 %, while species richness per plot varied from 3 to 18.

Disturbance levels ranged from low to medium, mainly due to motor vehicle traffic, grazing, and, in some areas, road and pipeline construction or geological excavations. Several sites showed evidence of plant dieback, particularly *Artemisia kemrudica* and *Caroxylon gemmascens*, likely caused by recent droughts.

Overall, plant communities were in normal seasonal condition, with localized dryness reflecting natural climate variation. The sampling points are presented in Figure 13.

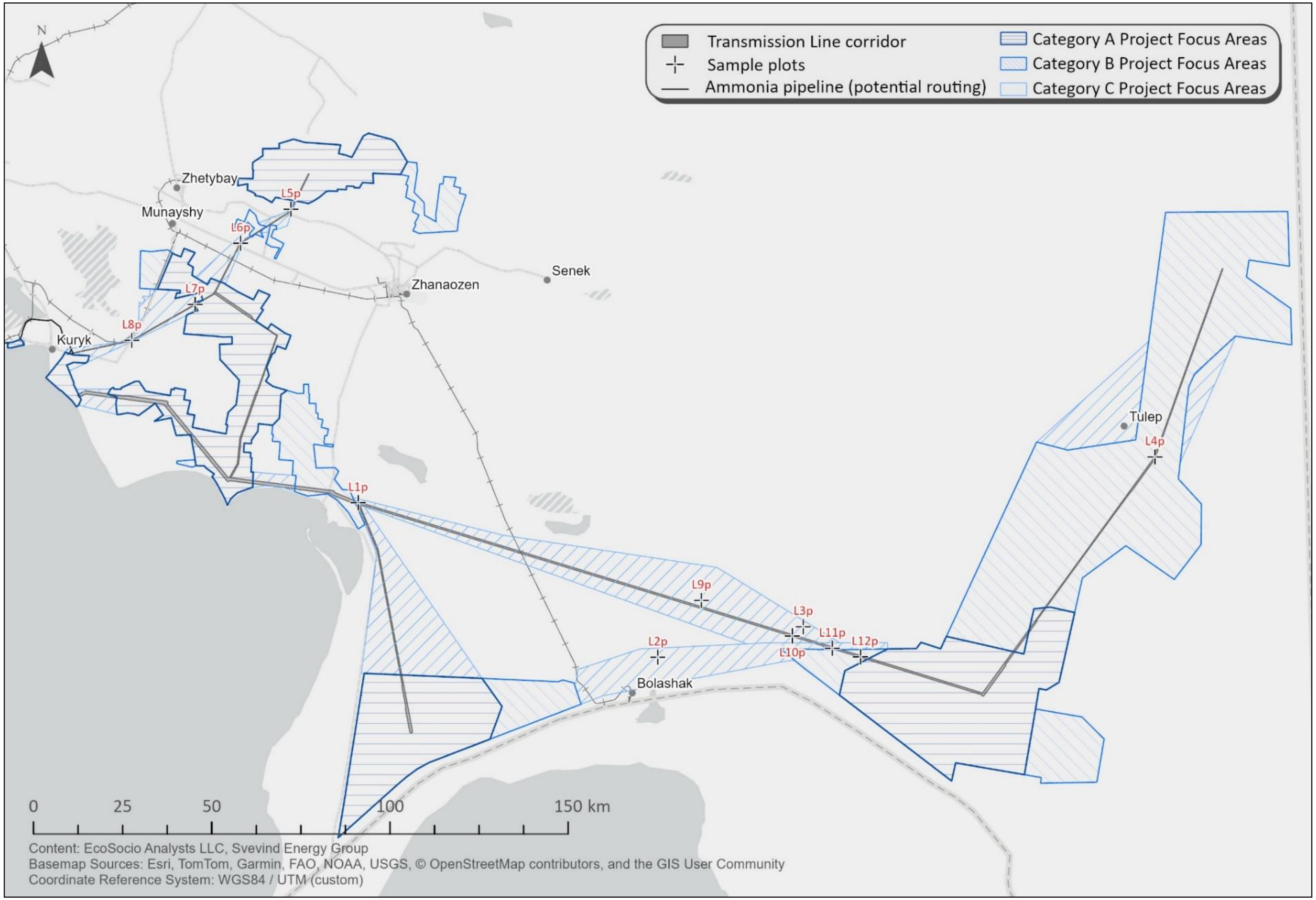


Figure 13: Location of 12 vegetation assessment plots in the transmission line corridors where vegetation was deemed to be more sensitive to the expected impact

4.1.8 Kuryk Area

In Kuryk Area, the ecological value and sensitivity of the site's vegetation to construction impacts such as earthworks, vehicle traffic, dust, and soil compaction are low. No endemic or protected plant species were found, except for *Rhamnus sintenisii*, which is only present on coastal escarpments outside the study area. The terrain is mostly flat, sloping gently toward the sea, with plant communities dominated by *Salsola orientalis*, *Agropyron fragile*, perennial *Solanum*, and various halophytic and Artemisia formations on different soil types. Vegetation is adapted to harsh conditions of water scarcity, high temperatures, and soil salinity, resulting in low biodiversity, sparse cover, and a patchy structure. Dominant life forms include xerohalophytic shrubs, semi-shrubs, and perennials, mainly from the *Chenopodiaceae, Asteraceae, Poaceae, Cruciferae,* and *Limoniaceae* families. The location of the 7 sample plots and the distribution of plant communities are shown in Figure 14.

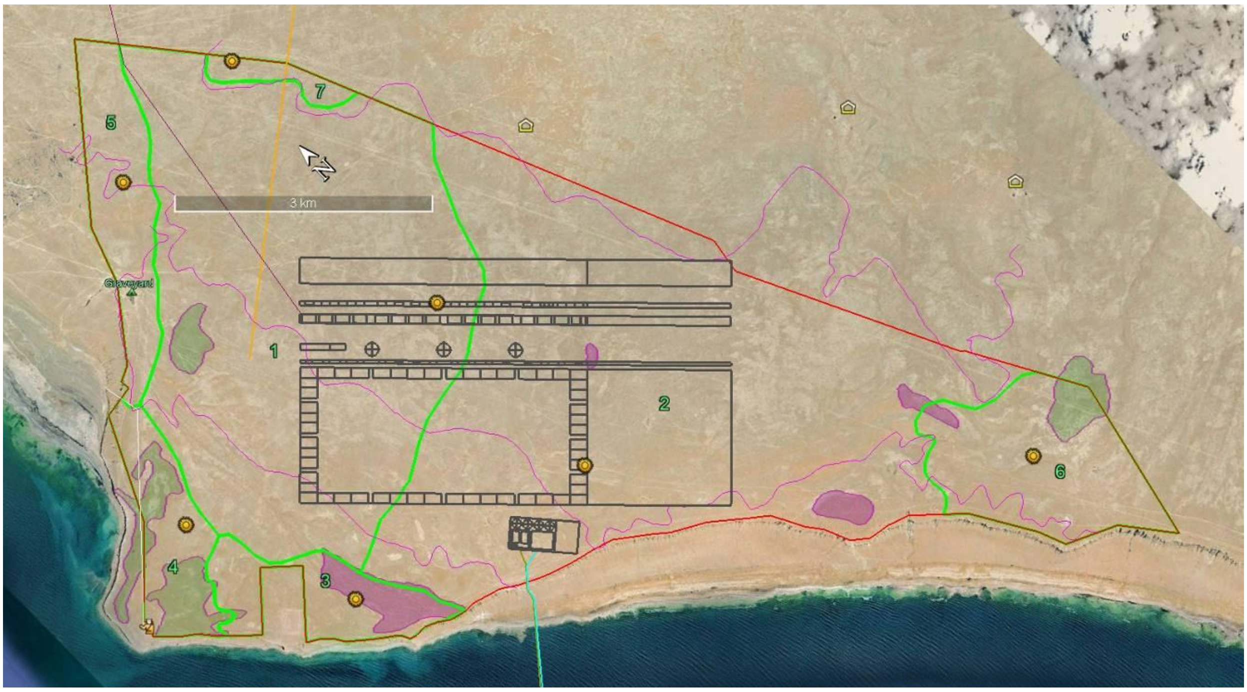


Figure 14: Kuryk area vegetation map with location of 7 plots (yellow) where typical vegetation was described, relief contours 10, 15, 20 and 30 m from the cliff to the east (depressions in green, elevations in purple), and distribution of plant communities (green outline)

4.1.9 Conclusions

No endemic or endangered plants were found in the surveyed sites, except for Khiva saltwort (*Xylosalsola chiwensis*, Red Book category II), identified only at two points along the ammonia pipeline corridor and storage areas. Across the project areas (Talap, Teren oi, Kanagat, Rahym, Enbek, the pipeline corridor, and powerline corridors), plant communities were dominated by typical desert species, with spatial heterogeneity and oligodominant complexes common. Disturbances were generally weak to moderate, mainly from grazing, motor transport, and occasional earthworks; some local areas (hillock tops, cattle camps, construction zones) were more severely impacted.

Widespread dryness in some key species (e.g. *Artemisia, Tetyrus, Keurek*) was observed, affecting up to 90% of individuals in places. This condition was not linked to pests or human impact and is likely weather-related, reflecting recent dry periods or alternating cool/wet springs. Most plant communities were otherwise healthy and in seasonally normal phenological phases, with no abnormal growth found. Geobotanical mapping and legends were produced for each site based on these field data.

4.2 Fauna

4.2.1 Birds - summer

Analysis of field survey results reveals an uneven distribution of bird species and abundance across the study areas. Bird abundance (see Table 9) is significantly higher in the eastern districts (Beket-Ata, Rahym, Kanagat) compared to the western districts (Talap, Enbek, Teren Oi). This is noteworthy, as the western areas are closer to the sea, where a greater diversity of bird species might typically be expected.

Table 9: Comparison of abundance (birds/km^2) on routes between habitat points. The order of species is given according to Koblik E.A., Redkin Y.A., Arkhipov V.Y. List of Birds of the Russian Federation. Moscow: Partnership of scientific publications KMK, 2006. 256 pages. Protected birds are highlighted in red.

Common Name	Scientific name	Talap	Enbek	Teren oi	Beket-Ata/ Ustyurt	Rahym	Kanagat	Average
Common kestrel	Falco tinnunculus	0.01		0.07				0.01
MacQueen's bustard	Chlamydotis macqueenii						0.05	**0.01**
Caspian plover	Charadrius asiaticus				0.2	0.96	1.33	**0.42**
Greater sand plover	Charadrius leschenaultii		0.02					**0.00**
Wood sandpiper	Tringa glareola	0.08						**0.01**
Green sandpiper	Tringa ochropus			0.16				**0.03**
Ruff	Philomachus pugnax			0.00			0.39	**0.07**
Black-tailed godwit	Limosa limosa			0.02				**0.00**
Rock dove	Columba livia		0.07					**0.01**
Black-bellied sandgrouse	Pterocles orientalis	0.38	0.23			0.03	0.02	**0.11**
Pallas's sandgrouse	Syrrhaptes paradoxus	0.35						**0.06**
Little owl	Athene noctua			0.02				**0.00**
Eurasian hoopoe	Upupa epops						0.22	**0.04**
Common swift	Apus apus			0.07			0.02	**0.01**
Barn swallow	Hirundo rustica	0.08	0.22					**0.05**
Greater short-toed lark	Calandrella brachydactyla							**0.00**
Mediterranean short-toed lark	Calandrella rufescens	4.46	19.62	2.54	23.9	32.19	24.36	**17.84**
Calandra lark	Melanocorypha calandra	1.07	1.68	3.46	0.6	4.47	6.02	**2.88**
Crested lark	Galerida cristata			0.38	9.8	2.11	3.59	**2.65**
Great Great grey shrike	Lanius excubitor			0.69			0.77	**0.24**
Rufous-tailed scrub robin	Cercotrichas galactotes					0.09		**0.02**

Common Name	Scientific name	Talap	Enbek	Teren oi	Beket-Ata/ Ustyurt	Rahym	Kanagat	Average
Western black-eared wheatear	Oenanthe hispanica					0.35		**0.06**
Isabelline wheatear	Oenanthe isabellina							**0.00**
Desert wheatear	Oenanthe deserti	0.08						**0.01**
Wheatear	Oenanthe sp.			0.46		0.26	0.22	**0.16**
Red-headed bunting	Emberiza bruniceps			0.31		0.18	0.22	**0.12**
Common raven	Corvus corax							**0.00**
Lark	Alauda sp.			0.23	0.4	1.58	0.92	**0.52**
Passerine	Passeriformes sp.	0.02	0.29	2.00	0.3	0.14		**0.46**
Total		**6.5**	**22.1**	**10.4**	**35.2**	**42.4**	**38.2**	**25.8**

Figure 15 illustrates that bird abundance in the main landscapes of Talap, Enbek, and Teren Oi is much lower than in the eastern areas of the study site. The average bird abundance in the western part was 13 birds/km², compared to 38.6 birds/km² in the east. Similarly, bird abundance at habitat points in Talap and Enbek was lower than in the east, while Teren Oi exhibited abundance levels nearly equal to Rahym.

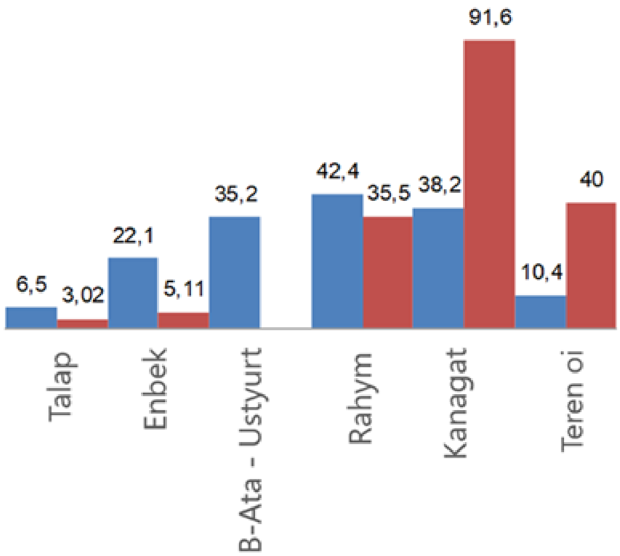


Figure 15: Abundance of birds per km² on the main landscape (blue) and in the habitats that differed from the main landscape (brown) between points

This variation may be explained by differences in nesting timing, which can significantly affect population counts. During the survey on 11–14 June 2024, passerines in Talap and Enbek had already completed the breeding season, and their fledglings had migrated to wintering grounds. In contrast, in Rahym and Kanagat, fledglings were still observed with their parents, and newly emerged chicks were present. The higher bird abundance recorded in Teren Oi is likely due to later nesting compared to Talap and Enbek, as indicated by the presence of family flocks with fledglings. For example, a Raven (Corvidae) family of five returned to its nest in the evening, and a Kestrel nest still contained chicks on 20 June 2024, which likely fledged on 21 – 22 June 2024.

Bird counts per kilometre of route in the main landscape confirm that individual abundance was higher in the eastern territories. However, unlike the general abundance pattern, species diversity at specific habitat sites was greater in the western territories.

Among sensitive locations along the OHTL (overhead transmission line) corridor, the highest species diversity was recorded at the L6a survey point, where a mix of shrubs, takyrs (bare salt flats), buildings, and an existing powerline provided varied habitats and perches for birds of prey (Table 10). The highest density was at L8a, attributed to the proximity to the cliffs.

No raptor nesting behavior was observed during the breeding season surveys in any Project Area, suggesting these areas are not used for raptor nesting; therefore, no nest searches within a 10 km radius were conducted, and no raptor nests were found during route transects.

Table 10: Species and quantitative composition of avifauna at sensitive locations in the OHTL corridors (L1a to L8a). Additional locations (L1alt, L2alt and L3alt) were added close to the main hotspot where higher sensitivity to the project impact was suspected.

Common name	Scientific name	L1a	L1 Alt	L2a	L2 alt	L3a	L3 Alt	L4a	L5a	L6a	L7a	L8a
Common buzzard	*Buteo buteo*					No birds				1	No birds	
European bee-eater	*Merops apiaster*									3		
Olive bee-eater	*Merops superciliosus*									1		
Barn swallow	*Hirundo rustica*									1		
Mediterranean short-toed lark	*Calandrella rufescens*	50		40	10					5		
Greater short-toed lark	*Calandrella brachydactyla*											
Calandra lark	*Melanocorypha calandra*	40						30		3		150
Crested lark	*Galerida cristata*						30					60
Wheatear	*Oenanthe sp.*	40										
Passerine	*Passeriformes sp.*											200
Brambling	*Fringilla montifringilla*											
Caspian gull	*Larus cachinnans*		1									
Sylviid warblers	*Sylviidae sp.*											
Rock dove	*Columba livia*											
Eastern black-eared wheatear	*Oenanthe melanoleuca*											

Bird abundance and diversity along the ammonia pipeline corridor were low, mainly due to a lack of water, sparse and degraded vegetation, and disturbances from human presence, noise, and artificial lights. Only a Common Kestrel, several seagulls, and Barn Swallows were observed near the Kuryk waste dump, 1.8 km west of the corridor (see Table 11).

Table 11: Birds diversity and abundance along the ammonia pipeline corridor and at the open storage areas and the shore near them. Residence form: R-resident, B-breeding, Bn-Breeding nearby, M-migrating.

Order	Scientific name	Species	Residence form	Birds/km pipeline route	Birds at the storage areas	Birds at the shore
Pelicaniformes	Phalacrocorax carbo	Great cormorant	Bn,M			40
Falconiformes	Falco tinnunculus	Common kestrel	Bn,M			1
Charadriiformes (shore birds)	Charadrius alexandrinus	Kentish plover	Bn,M			25
	Larus cachinnans	Caspian gull	Bn,M	0,1	6	12
	Sterna hirundo	Common tern	Bn.M	0,03	5	
	Gelochelidon nilotica	Gull-billed tern	Bn,M		2	
	Caprimulgus europaeus	European nightjar	Bn,M		1	
Caprimulgiformes	Columba livia	Rock pigeon	R	0,2	2	
Apodiformes	Upupa epops	Eurasian hoopoe	Bn,M	0,1		
Coraciiformes	Hirundo rustica	Barn swallow	Bn,M	1,2		
Passeriformes (sparrow like birds)	Galerida cristata	Crested lark	B,M	0,6		
	Sturnus roseus	Rosy starling	Bn,M	0,1		
	Oenanthe pleschanka	Pied wheatear	Bn,M	0,6		
	Oenanthe deserti	Desert wheatear	B,M	0,3		

4.2.2 Birds - autumn

The migration patterns of passerine birds were not clearly defined, with movements generally occurring in circular paths across territories. The majority of observed Passeriformes were larks, particularly the Grey Skylark, which typically flew below 5 m. The Steppe Skylark was mostly observed at 8–15 m, while the Tufted Lark flew at 5–10 m.

Raptors such as falcons, harriers, and hawks hunted at similar low altitudes, remaining below the wind turbine blade rotation zone (risk window). Eagles, Haliaeetus, and Snake Eagles foraged between 10–50 m, but during migration, these raptors could cross the area at heights of 200–400 m if well-fed, mostly passing through Rahym. Two abandoned eagle nests were found on old graves during autumn surveys.

Feeding habits varied by species: Buzzards (Buteo) preyed mainly on small mammals like rodents, Eagles (Aquila) targeted hares and corsaks but would hunt gerbils, tortoises, and hedgehogs if food was scarce, and other falcons and sparrowhawks focused on birds, usually at low altitudes. Cormorants fed mostly on orthopterans and dragonflies, while kestrels hunted small mammals, large insects, and occasionally small birds. The Little Owl, the primary nocturnal raptor observed, hunted rodents and small birds and rarely flew above 15 m.

Among flying insects, only large dragonflies (Aeshna and Anax species) were recorded above 10 m, and this occurred only once; Orthoptera species were not seen above 5 m.

4.2.3 Other vertebrate and invertebrate fauna - summer

Other animals serve as important prey for birds that may be exposed to wind turbine blades or power lines. Small rodents form the primary food base for many bird species; their scarcity and inactivity during summer contribute to low numbers of nesting raptors and snakes. Tortoises are the main food source for local ravens, while Tolai Hares are a significant prey item for eagles only in Rahym. Ravens and magpies also feed on lizards, while gophers, corsaks, and foxes are present but rare and do not significantly support large raptors.

Western territories showed more livestock presence near survey points, with shepherd settlements and livestock infrastructure. The presence of cattle, dogs, and humans deterred most wildlife, as indicated by the absence of gazelle tracks. Insect abundance and diversity were also low, with 90% of observed butterflies belonging to the Pieridae family, and limited numbers of dragonflies. This scarcity of insects likely further reduces the presence of insectivorous birds. An overview of the species present is presented in Table 12.

Table 12: Diversity and abundance of mammals and reptiles in the planned project territories. Protected species are high-lighted in red.

Species	Scientific name	Talap	Enbek	Kanagat	Rahym	Teren oi	Total
Small mammals burrows	*Gerbillinae*		58	144	198	200	**600**
Tortoise burrows	*Testudo horsfieldii*	8	67	117	160	200	**552**
Tortoise shell				46	41	114	**201**
Tortoise						2	**2**
Hedgehog	*Erinaceidae*			1		1	**2**
Tushkanchik	*Dipodidae*				1		**1**
Yellow ground squirrel	*Spermophilus fulvus*		1		2	1	**4**
Hare	*Lepus tolai*			2	21	1	**24**
Honey badger	*Mellivora capensis*				1	2	**3**
Fox	*Vulpes vulpes*		1		1	2	**4**
Corsac fox	*Vulpes corsac*	1	1				**2**
Caracal	*Caracal caracal*						**0**
Jeyran	*Gazella subgutturosa*			1	5		**6**
Lizards	Lacertilia	8	17	23	25	18	**91**
Snakes	Serpentes				1		**1**
Butterflies	Lepidoptera		12	6	24	8	**50**
Dragonflies	Odonata		1			3	**4**
	Total:	**17**	**158**	**340**	**480**	**552**	**1,547**

4.2.4 Other vertebrate and invertebrate fauna - autumn

The resumption of activity and increase in rodent numbers in autumn (sometimes 7-10 times higher than in summer) is partly responsible for the abundant autumn migration of predators, for which lizards and tortoises are only additional food after rodents. The highest number of small rodents and tortoise burrows was observed in Rahym and Teren oi territories, and the lowest in Talap territory.

Rodent and tortoise abundance varies greatly at the surveyed sites, from complete absence to hundreds of individuals per 1 ha. In the bare soils (called "takyrs") of Rahym, Kanagat and Teren oi territories, temporary impacts and displacement may be caused to colonies of Ellobius sp. On takyrs of Rahym and its vicinities it is necessary to carry out research on identification of the taxon of the mole vole (species, subspecies), because it is puzzling that colonies of 100-500 burrows are located exactly on takyrs devoid of vegetation, while the common mole vole *Ellobius Talpinus* (Pallas, 1770) feeds on plant roots.

Analyses of the terrestrial predators and birds of prey droppings (including those of ravens) suggested that tortoises were their common food source. Nocturnal butterflies, beetles (one species undertakes mass migrations southwards in spring and autumn) and orthopteras were found to be the main source of food for birds (except for birds of prey) during migration.

Spiders (Arachnida) and insects (Insecta) were represented by coleopterans (beetles), hymenopterans (ants, termites, wasps), hemipterans (bugs), neuropterans (clades), anisopterans (dragonflies) and lepidopterans (butterflies and moths). As expected in a desert area, nocturnal lepidopterans dominated over diurnal species.

4.2.5 Kuryk Area

The fauna survey in Kuryk Area documented 24 bird species, 3 reptile species, 3 mammal species, and one bat species (evidenced by guano in uninhabited cliff burrows). The area's limited fauna is linked to the absence of freshwater and woody or shrubby vegetation. Nonetheless, as this region lies on a major Siberia–Central Asia bird migration route, many more migratory species may be present seasonally, especially along the coast—literature suggests up to 174 bird species could occur.

The cliff and adjacent seashore hold high ecological value, with numerous ledges suitable for nesting birds and bats, and rock piles providing jackal habitat. The cliff continues the length of the site's western boundary before ending 1.3 km south. Offshore sandbanks serve as nesting, feeding, and resting sites for migratory birds, some of which are listed in Kazakhstan's Red Book, and the IUCN. During peak migration (20–23 April 2023), an additional coastal survey recorded 66 bird species in 28 families, including three Category II Kazakhstan-protected species: Greater Flamingo, Black-Bellied Sandgrouse, and Eurasian Eagle-Owl (the latter confirmed by pellets). A skin of Brandt's Hedgehog (*Paraechinus hypomelas*, also Category II) was also found.

Construction activities – such as increased noise, emissions, lighting, unfamiliar smells, and human presence – are likely to temporarily displace some sedentary and migratory species from the site and its surroundings. The results of the Kuryk Fauna Survey are presented in Table 13 below.

Table 13: Result of mammal, reptile and amphibian counts.

Species	Scientific name	Location	Quantity	Accounting type
Golden jackal	*Canis aureus*	Among the shoreline limestone bolders	7-10	Footprints, voice
Tolai hare	*Lepus tolai*	Graveyard 2 km NW of the plant	1	Visual
Bats	*Chiroptera Sp.*	Cliff 2.8 km north from the plant site	5-7	
Dice snake	*Natrix tessellata*	Zhilandy Cave 2.2 km west of the plant, Cliff slope and shoreline	3	
Steppe agama	*Trapelus sanguinolentus*	Kuryk waste dump	1	

Species	Scientific name	Location	Quantity	Accounting type
Great gerbil	*Rhombomys opimus*	Small colony on the proposed plant site	-	Footprints, burrows
Russian tortoise	Testudo horsfieldii	Cliff slope 6.25 km south from the plant	1	Footprints

Of the threatened animals, only the Russian Tortoise (IUCN Red List) was recorded at the cliff, and a migrating Glossy Ibis was observed at the sea shoal 3 km northwest of the plant site. The Glossy Ibis is listed as Category II in the Kazakhstan Red Book, indicating species with relatively large populations that are nevertheless declining rapidly and at risk of disappearing – and is classified as 'Least Concern' by the IUCN.

Table 14: Summary of birds observations with segregation into habitat types. Threatened species are shown in red.

***Types of presence in the study area**: M: Migrating; B: Breeding; Bn: Breeding nearby*

***Orders**: Pe - Pelicaniformes (pelican like); Ci - Ciconiformes (stork like); Fa - Falconiformes (falcon like); Ca – Caprimulgiformes; Col – Columbiaformes; Ap – Apodiformes; Co - Coraciiformes (roller like); Up - Upupiformes*

Order	Scientific name	Species	Residence form	Seashore	Cliff	Plateau
Pe	*Phalacrocorax carbo*	Great cormorant	Bn,M	200		
Ci	*Plegadis falcinellus*	Glossy ibis	M	1		
Fa	*Falco tinnunculus*	Common kestrel	Bn,M	1		
Charadriiformes (shore birds)	*Charadrius alexandrinus*	Kentish plover	Bn,M	70		
	Tringa totanus	Common redshank	M			25
	Tringa erythropus	Spotted redshank	M			20
	Xenus cinereus	Terek sandpiper	M			25
	Calidris ferruginea	Curlew sandpiper	M			10
	Gelochelidon nilotica	Gull-billed tern	M			20
	Limosa lapponica	Bar-tailed godwit	M			40
	Larus cachinnans	Caspian gull	Bn,M			60
	Sterna hirundo	Common tern	Bn.M			20
	Gelochelidon nilotica	Gull-billed tern	Bn,M			2
Ca	*Caprimulgus europaeus*	European nightjar	Bn,M			1
Col	*Columba livia*	Rock pigeon	R		17	7
Ap	*Apus apus*	Northern swift	Bn,M		30	
Up	*Upupa epops*	Eurasian hoopoe	Bn,M			*4*
Co	*Merops persicus*	Blue-cheeked bee-eater	Bn,M			2
Passeriformes	*Hirundo rustica*	Barn swallow	Bn,M			40
	Galerida cristata	Crested lark	B,M			20
	Sturnus roseus	Rosy starling	Bn,M			3
	Oenanthe pleschanka	Pied wheatear	Bn,M			20
	Oenanthe deserti	Desert wheatear	B,M			10

4.2.6 Conclusions

The project area supports a varied and seasonally dynamic fauna. Richer bird and small vertebrate populations are found in the less disturbed eastern territories and coastal zones, while the western regions are characterized by greater local (site-specific) species diversity. The Flora and Fauna Survey documented three protected mammals—Honey Badger, Caracal, and Goitered Gazelle—as well as common wildlife across the site. Protected and sensitive species do occur within the project area, but they are generally present at low densities and are mostly transient, appearing largely as migrants. Migration corridors, in particular in the coastal and cliff areas of Kuryk and Rahym, play a crucial role in conservation planning and the implementation of impact avoidance measures for fauna. During breeding season surveys, no raptor nesting was detected within the project boundaries. Small mammals and reptiles are commonly recorded and serve important roles in the local food web, although their abundance and distribution can vary substantially across both space and seasons. In the western part of the study area, the presence of livestock is associated with reduced densities of wildlife.

5 Marine Biodiversity Survey

5.1 Hydrobiological Survey

5.1.1 Phytoplankton

In autumn, the qualitative composition of phytoplankton in the surveyed area was represented by four divisions: *Cyanophyta*, *Bacillariophyta*, *Dinophyta*, *Euglenophyta*. In the winter period, it was represented by three divisions: *Bacillariophyta*, *Dinophyta*, *Chlorophyta*. In spring and summer periods, there were five divisions: *Cyanophyta, Bacillariophyta, Dinophyta, Euglenophyta* and *Chlorophyta*.

The taxonomic structure of phytoplankton in the surface and bottom horizons was dominated by diatoms, which also formed the basis of quantitative indicators. This is typical for algocenosis of the surveyed water area. The maximum values of phytoplankton biomass were recorded in the summer due to the full vegetation of diatoms, dinophytes, green and blue-green algae. The species diversity of phytoplankton has increased to 51 species because of the prevailing abiotic conditions, namely, due to the temperature regime. Small-celled blue-green algae, diatoms and partly dinophytic forms of algae developed quite intensively, which has a positive effect on the formation of the fodder base in this part of the sea.

The phytoplankton community in all seasons was represented by all ecological groups common for the Caspian Sea.

The distribution of biomass of algal flora was uneven in the surface and bottom horizons of the site. Uneven distribution is common, and this uneven distribution arises from a combination of physical, chemical, and biological factors such as light penetration, nutrient gradients, thermal stratification and oxygen levels.

5.1.2 Zooplankton

According to the survey results, zooplankton in the water area of the surveyed site was characterized by low diversity in all periods. *Acartia Tonsa* dominated in the zooplankton zoocenosis in the whole water area. The role of the other groups of zooplankton was insignificant. The Abundance and biomass of the zooplankton community depended mainly on the development of *Acartia Tonsa*. The temperature drops in winter have affected the quantitative indicators of zooplankton (the lowest values).

The distribution of quantitative indicators of plankton in the surveyed water area was uneven, which can be caused by a number of factors, such as temperature, availability of light and nutrients, and water circulation patterns.

During all survey sessions, the minimum concentrations of phytoplankton in the surface and bottom horizons and the maximum concentrations of zooplankton at the same stations were caused by a trophic pressure produced by plankters on the plant cells.

5.1.3 Zoobenthos

In all seasons of the survey, the abundance of benthic fauna was formed mainly by "soft" benthos, namely by crustaceans, which is common for the soils in the surveyed area (sandy soils with broken shells). The biomass values were composed of the representatives of "hard" benthos - bivalves.

The abundance of zoobenthos in both periods have varied depending on the development of crustaceans.

The distribution of the biomass of zoobenthos at the surveyed site was representative of the ecological groups within the Caspian Sea.

5.1.4 Aquatic flora

The survey of aquatic vegetation in autumn and winter periods has revealed the presence of two species of algae: *Laurencia caspica* and *Polysiphona caspica*. These species were not identified during the spring and summer surveys. Rocky ridges inhabited by macrophytes appear as separate inclusions on a surface of sandy-shell soils. The biomass of aquatic vegetation was low due to the low temperatures and wave activity. It is known that the optimal development of macrophytes requires a salinity of 8-10% and a certain depth (well-warmed shallow water with a depth from 0.5 to 4.0 m).

The concentrations of phytoplankton, zooplankton, zoobenthos and aquatic vegetation decreased from autumn to winter and then increased in spring and summer, which corresponds to the natural cycle of development of these organisms.

5.2 Ichthyological Survey

The catches of sturgeons in the offshore Project Area depend on the migration processes that affect the number of fish. Only young sturgeons were found in the trawl and gill net catches during the marine survey. The main biological parameters of the sturgeon fish were at the level of long-term dynamics and corresponded to these age groups. The absence of starry sturgeon and beluga in the catches indicates small populations of these species.

Marine ichthyofauna at the site was distinguished by the species diversity in all seasons. The catches included Caspian tulka, marine migratory herrings, gobies and mullets. By the end of the growing season, the number of goby species was significant. From autumn to winter, the migration processes were observed at the site, which were expressed in a multiple decline in the number of marine fish, as well as in the redistribution of their concentrations in the surveyed water area. At the same time, favourable feeding conditions were observed at the site during nursery period (spring, summer, autumn), which was confirmed by the high linear weight of fish, stability of the age and sex structure of the species populations.

Semi-anadromous fish in the surveyed water area were represented by Caspian Vimba and Estuarine Perch, whose populations were insignificant due to the small populations of these fish species.

Marine crayfish were actively feeding on almost the entire water area of the site in all seasons.

The only individual of the Caspian Seal was encountered during the route census at the site in autumn.

The survey results showed a decrease in the abundance and biomass of hydrobionts[7] inhabiting the planned construction site during the transition from autumn to winter season. The largest concentrations of aquatic biological resources at the site were recorded in the summer, which is explained by the optimal conditions used for feeding.

At the same time, low concentrations of hydrobionts and absence of the most species of ichthyofauna at the site in winter are the result of winter migration. The absence of ichthyofauna in the research catches is also explained by the reduced level of fish activity in the winter period.

Thus, the surveyed water area is used by aquatic species for feeding, spawning, wintering and pre-winter migrations throughout the whole year.

5.3 Hydrophysical Survey

During the survey, water depth at the project site ranged from 9.0 m to 22 m in autumn and winter. In the spring and summer periods, survey works were carried out at depths that ranged from 8.0 to 22.7 m.

The analysis of the results of hydrometric survey in autumn did not reveal any dependencies between the fluctuations in water transparency and water depth or distance from the coastal line. Thus, the maximum transparency (8.0 m) was recorded at the coastal stations (stations 18 and 19) characterized by the lowest water depth (9.3 m). The lowest transparency was recorded at the stations located as far from the coast as possible (stations 1-4), water depth of which ranged from 20.5 to 22.0 m. In spring, the maximum transparency (15.0 m) was observed at stations 12, 14 and 15 and depth of 16 m, 16.6 m and 17 m. The lowest transparency (8.0 m) was observed at station 8. During the summer survey session, the maximum transparency (14.0 m) was recorded at stations 14 and 16 at depth of 16.3 m and 16.8 m. The lowest value was recorded at station 8 at depth of 8.0 m.

In general, water temperature in the surveyed area met the long-term seasonal dynamics of water temperature regime in the eastern part of the Middle Caspian Sea. Absence of a sharp difference between the temperatures recorded in the surface and bottom layers in autumn and winter is explained by the phenomenon common for this period. According to this phenomenon, as air temperature declines in autumn, the surface layer of the sea cools down and the thermocline layer blurs. In spring, all water layers warmed up evenly, due to which uniform distribution of temperature values was observed. During the summer period, the near-bottom and deep-water layers warmed up evenly due to active circulation of water.

The decline in a salinity level from autumn to winter at the survey site is a reason for the decrease of horizontal circulation in summer, due to which saltier water from the southern part of the sea flows along the eastern coast to the Middle Caspian Sea. As temperature declines, saline water gradually outflows from the Middle Caspian Sea to the deep layers of the South Caspian Depression. Accordingly, salinity increases across all horizons in spring and summer periods because of an inflow of salty waters of the South Caspian Sea into the survey area.

[7] Hydrobionts is a term that broadly refers to all living organisms that inhabit aquatic environments.

The increase in turbidity during the autumn and winter survey sessions is apparently driven by the prevailing winds causing wind-induced mixing of the seawater. Thus, in autumn, winds of the southeasterly direction prevailed along the coast. In winter, winds were from the west prevailed being perpendicular to the coast. In this regard, the mineral suspension was agitated, and the turbidity level increased. In spring and summer survey periods, there was decline in turbidity level caused by the decrease in concentration of suspended substances affected by the decline in wave and wind activity.

Water temperature, salinity and turbidity were within the limits predetermined by the seasonal changes in climatic conditions of the surveyed area.

The analysis of the data of hydrometric studies showed that the sea currents with a velocity of 20-30 cm/s were predominant during the autumn and winter survey sessions. The main direction of the sea currents throughout all horizons (surface, middle, bottom) was southward in autumn, and southward and southwestward in winter. It should be noted that the sea currents with a velocity of 40-50 cm/s were observed in winter, which was probably driven by the strong winds during the survey, which caused intense wind-induced mixing of water masses. Lower values were recorded in spring and summer. In spring, the sea currents with a velocity of 10-20 cm/s prevailed. In summer, as in the most windless period, velocity of the sea currents varied mainly from 0 to 10 cm/s. The main direction of the sea currents was southeastward in the spring and summer periods.

5.4 Hydrochemical Survey

5.4.1 Biogenic elements

Biogenic substances were analyzed using DR 2800 instrument. Analyses were made by Kazecoanalysis LLP analytical laboratory.

In the Northern and in the Middle Caspian Sea, nitrogen is observed mostly in the form of ammonium nitrogen (NH_4). Ammonium nitrogen enters water bodies mainly from the untreated wastewater and from organic substances decomposing at the bottom. Nitrogen in nature is influenced by many factors, including anthropogenic ones. The biological system that fixes nitrogen in marine water is blue-green algae. MPC of ammonium nitrogen in the fishery water bodies is 2.9 mg/dm^3. According to the results of survey at Kuryk site in the Caspian Sea, the content of ammonium nitrogen in autumn 2023 did not exceed the fisheries regulations and ranged from 0.01 to 0.14 mg/dm^3 averaging to 0.07 mg/dm^3.

In winter as well, concentration of ammonium nitrogen in water did not exceed the MPC value and ranged from 0.02 to 0.12 mg/dm^3, averaging to 0.06 mg/dm^3. In spring, concentration of ammonium nitrogen in water varied from <0.03 to 0.90 mg/dm^3, averaging to 0.09 mg/dm^3. In summer, 2024, concentration of ammonium nitrogen in water varied from <0.03 to 0.08 mg/dm^3, averaging to 0.06 mg/dm^3.

According to the survey results for four seasons at Kuryk site in the Caspian Sea, concentration of ammonium nitrogen did not exceed the Maximum Permitted Concentrations (MPC) value and was insignificant. Therefore, it can be concluded that the seawater is not polluted and is not harmful environment.

Total nitrogen, phosphorus and nitrite nitrogen do not have MPC values, so the analysis was performed by comparing the analysis results received in autumn and winter of 2023 and spring and summer of 2024.

In autumn, the total nitrogen content ranged from 0.5 to 0.8 mg/dm^3, averaging to 0.648 mg/dm^3. In winter, the total nitrogen content varied within 0.5 - 0.7 mg/dm^3, averaging to 0.6 mg/dm^3. In spring and summer of 2024, concentration of nitrogen varied from 0.3 to 0.9 mg/dm^3 and from 0.4 to 0.8 mg/dm^3 respectively. This is explained by the fact that the seasonal fluctuations of ammonium nitrogen in the eastern part of the Middle Caspian Sea are more smoothed compared to the western part of the sea.

According to the survey results (autumn and winter of 2023 and spring and summer of 2024), concentration of nitrogen varied slightly staying within the same limits.

Phosphorus, along with carbon, oxygen, hydrogen and nitrogen, is of great importance for the existence of living organisms. It is the most important indicator of the trophic status of natural water bodies. It often determines the biomass and productivity of aquatic organisms, including the marine ones. Control and monitoring of phosphorus accumulation in the biological objects and environment is crucial, including for the marine biological system of the Caspian Sea.

During the survey in autumn, winter and spring, concentration of total phosphorus in the water area of Kuryk site was below the threshold sensitivity of the measuring instrument (0.005). In summer, concentration of total phosphorous varied from <0.005 to 0.08 mg/dm^3 averaging 0.008 mg/dm^3. Thus, the observed fluctuations were insignificant.

Nitrite nitrogen (NO_2). It indicates the pollution of a water body. Increased content of nitrite nitrogen indicates an increased decomposition of organic matter. In autumn 2023, concentrations of nitrite nitrogen in the seawater were insignificant at all stations, ranging from 0.014 to 0.036 mg/dm^3.

In winter, the nitrite nitrogen content varied slightly within 0.011 - 0.032 mg/dm^3. According to the survey results, average concentration of nitrite nitrogen was 0.024 mg/dm^3 in autumn and 0.018 mg/dm^3 in winter period. In spring and summer of 2024, concentration of nitrite nitrogen varied within the same limits (from 0.02 to 0.06 mg/dm^3) averaging 0.04 mg/dm^3.

According to the results of all survey sessions, concentration of nitrite nitrogen varied slightly staying within the same limits.

Nitrate nitrogen (NO_3). Nitrates are formed from nitrites in result of nitrification process or penetrate into the water bodies being washed off from the fertilizers from the fields, with atmospheric precipitation, and various runoffs. Nitrates are significantly less toxic than nitrites. MPC of nitrate nitrogen for the fishery water bodies is 9.0 mg/dm^3. In autumn 2023, concentration of nitrate nitrogen varied from 1.8 to 3.0 mg/dm^3. The average value over the sea was 2.4 mg/dm^3. In winter 2023, concentration of nitrite nitrogen varied from 1.6 to 2.5 mg/dm^3 averaging to 2.0 mg/dm^3. MPC value of nitrate nitrogen was not exceeded in autumn and winter periods of 2023.

In spring 2024, the concentration of nitrate nitrogen ranged between 1.4 and 2.5 mg/dm^3 averaging 1.9 mg/dm^3. In summer, concentration of nitrate nitrogen ranged between 0.7 and 2.2 mg/dm^3 averaging 1.74 mg/dm^3.

Thus, MPC values of biogenic elements were not exceeded in autumn and winter periods of 2023, nor in spring and summer of 2024. Concentrations of biogenic elements varied within the same limits or were below the threshold sensitivity of the instruments.

5.4.2 Heavy metals

Heavy metals are among the priority pollutants, monitoring of which is obligatory in the fishery water bodies. The following heavy metals were identified at the surveyed site: cadmium, copper, lead, mercury and zinc. Heavy metals were analyzed by Kazecoanalysis LLP analytical laboratory using ICPE 9000 instrument. According to the survey results in autumn, winter, spring and summer, concentrations of heavy metals were below the threshold sensitivity of the measuring instrument and below the MPC value

5.4.3 Petroleum products

Experts consider the petroleum products to be the most common and toxically hazardous substances that pollute the natural aquatic environment. Petroleum products are highly toxic substances that have a negative effect on hydrobionts and cause severe consequences. Thus, in fish, they cause motor reflexes disorder and loss of orientation, disturbance of physiological processes (loss of skin sensitivity, damage of reproductive function), accumulation of carcinogens (as a result, the development of deformity, loss of vitality of juveniles), etc. Therefore, studies of these pollutants are important for the life of aquatic organisms of the Caspian Sea.

Petroleum products were determined using GCMS-QP2010 instrument. MPC value of petroleum products in the fishery water bodies is 0.05 mg/dm^3. In autumn and winter of 2023, spring and summer of 2024, the maximum permissible concentration of petroleum products was not exceeded.

5.4.4 Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAH) are a part of petroleum products and can accumulate in various components of aquatic ecosystems. They migrate along food chains, while retaining the ability to cause mutagenic changes in organisms of hydrobionts. PAHs were determined using GCMS-QP2010 instrument. In the autumn and winter periods of 2023 and spring and summer periods of 2024, the recorded PAH values were below the sensitivity threshold of the instrument.

5.4.5 Organochloride pesticides

An important condition for effective protection of water bodies and their biological resources from pollution is complete and adequate information on the qualitative and quantitative composition of toxicants in the main elements of aquatic ecosystems. Among a wide range of pesticides, the most dangerous are compounds that can accumulate in vital organs of fish: persistent organochlorine pesticides, isomers of DDT (dichloro-diphenyl-trichloroethane) and HCCH (hexa-chloro-cyclo-hexane). Even the highest concentrations of persistent organochlorine pesticides in water cause pathological disorders in the organism of fish and other hydrobionts. High concentrations of persistent organochlorine pesticides are one of the most dangerous types of pollution of water bodies. MPC values of DDT and HCCH in the fishery water bodies are 0.01 mg/dm^3 and 0.05 mg/dm^3. Pesticides were determined using GCMS-QP2010 instrument. According to the results of survey in autumn and winter of 2023 and spring and summer of 2024, content of pesticides was below the threshold sensitivity of the measuring instrument. Concentrations of organochlorine pesticides in the surface and bottom horizons were below the MPC values.

5.5 Conclusions

The marine biodiversity survey at the project site in the eastern Middle Caspian Sea confirms the presence of a healthy, seasonally dynamic marine ecosystem. Throughout the year, phytoplankton communities exhibited moderate to high species diversity, typically representing three to five major taxonomic groups. Diatoms consistently dominated the phytoplankton assemblage in both abundance and species composition, reflecting ecological conditions characteristic of the Caspian Sea. Phytoplankton diversity and biomass were highest in summer, corresponding to warmer temperatures that favoured diatoms, small-celled blue-green algae, and dinoflagellates.

In contrast, the zooplankton community was characterized by low species diversity, with *Acartia tonsa* dominating both abundance and biomass across all seasons. Seasonal fluctuations in zooplankton numbers closely followed changes in water temperature and patterns of phytoplankton productivity. This seasonal succession and community structure in both phytoplankton and zooplankton indicate a stable and balanced lower trophic system, aligned with natural productivity cycles of the Middle Caspian Sea. No indications of ecological stress or disruption in these planktonic communities were observed during the survey period.

The hydrochemical conditions at the site further support this positive ecological status. Water depth, temperature, salinity, and turbidity exhibited normal seasonal variation, consistent with long-term regional trends. The quality of seawater was confirmed by hydrochemical measurements, with concentrations of nitrogenous compounds (ammonium, nitrite, nitrate, and total nitrogen), phosphorus, and other biogenic elements consistently below regulatory thresholds for fishery waters and displaying only minor seasonal variability.

Importantly, there was no evidence of anthropogenic pollution. All analyses for heavy metals (including cadmium, copper, lead, mercury, and zinc), petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides (such as DDT and HCCH) returned values below detection limits or well within acceptable limits for aquatic environments.

In summary, environmental conditions at the project site are conducive to supporting marine biota, with no signs of chemical or ecological disturbance, and continue to reflect the typical, seasonally driven productivity of the eastern Middle Caspian Sea.

6 Assessment of Potential Impacts and Initial Mitigation Measures

6.1 Assessment of Potential Impacts

During the construction phase of the Project, significant land clearance and site preparation will inevitably disturb local ecosystems, despite efforts to avoid areas of high environmental value, such as protected areas. Activities such as vegetation removal, ground leveling, and establishment of construction zones will lead to the loss of native plant communities and disrupt wildlife habitats critical for supporting species' shelter, feeding, and breeding. Disturbances to soil structure and composition can have knock-on effects on soil fertility and microorganisms essential for a healthy ecosystem. The sounds and vibrations from construction machinery can stress and displace local wildlife, particularly species reliant on specific habitats or sensitive to noise, potentially leading to a decline in population numbers or local disappearance. The Saiga Antelope and Goitered Gazelle are particularly sensitive to noise with loud noises potentially disturbing breeding and feeding activities. The construction of access roads and supporting infrastructure may fragment habitats used by migratory species such as the Goitered Gazelle and Saiga Antelope, impeding animal movement and genetic exchange, which compromises ecosystem resilience and adaptation. Wildlife corridors, crucial for the migration and movement of animals, may be blocked or narrowed, increasing risks such as collisions and predation. Construction activities also introduce additional risks such as pollution from dust, waste, and chemicals, which can affect air, water, and soil quality and impede plant physiological processes. Movement of vehicles and equipment raises the risk of introducing invasive species that can outcompete the native flora and fauna. In marine environments, the operation of a temporary desalination plant to meet construction water needs poses a threat to biodiversity through water intake and brine discharge. This can disrupt marine life by entraining small organisms, increasing salinity and chemical loads, and altering water chemistry and currents, all of which can reduce populations of fish and other marine organisms and undermine the overall ecological balance in the coastal zone. While many construction-phase impacts are temporary and may be reversed after completion, some—such as habitat fragmentation, soil degradation, and invasive species introduction—can persist unless carefully managed and mitigated.

During the operational phase, the most significant biological impacts are anticipated to result from the discharge of treated industrial wastewater into coastal waters and the collision risk posed to wildlife, especially birds and bats, by wind turbine blades. Discharge of treated wastewater can degrade marine habitats essential for sustaining biodiversity, altering species composition and leading to population declines among fish, crustaceans, and other marine life. These effects can be magnified by increased salinity or chemical residues that trigger harmful algal blooms and oxygen depletion, threatening both ecological health and human uses of the marine environment. The risk of collision is particularly acute for migratory birds, raptors, and night-flying species that may not visually detect turbine blades, with direct mortality disrupting population stability and ecological balances—such as through the loss of predator species. Wind turbines can also displace birds from feeding or nesting sites and force energy-intensive changes in migratory routes. Bats are similarly vulnerable to turbine collisions and barotrauma, a fatal injury caused by rapid changes in air pressure near moving blades. Such risks are influenced by turbine location, height, operational patterns, and proximity to sensitive habitats or migration paths. Regular maintenance and the physical footprint of operational infrastructure are expected to have only limited and mostly localized biological impacts by comparison.

6.2 Initial Mitigation Measures

Measures to minimize or mitigate impacts on the biological environment during the construction phase focus on careful planning, restricted activity zones, and active ecological management. All construction and related facility areas must be clearly marked, with activities strictly confined to these zones to avoid unnecessary disturbance to the surrounding environment. Vegetation clearance should be minimized wherever feasible, and any areas disturbed by demolition should be restored to resemble the natural local landscape. Topsoil should be preserved during excavation and clearing for use in site rehabilitation, while proper drainage systems must be designed to prevent seasonal flooding.

Construction activities should take place primarily during daytime hours to reduce disturbance to nocturnal wildlife. A comprehensive Biodiversity Management and Monitoring Plan may be established for the construction phase. This plan should include practical procedures for controlling alien invasive plant species, with clear schedules for implementation and monitoring, and an approved list of herbicides; monitoring protocols for terrestrial and aquatic flora and fauna, prioritizing any threatened or sensitive species; recommendations for landscaping and post-construction rehabilitation that prioritize native, non-invasive plant species and meaningful habitat creation; and strict controls to prevent unauthorized access, trespassing, and hunting by staff or contractors.

For marine environments, it is essential to design the water intake system with features that minimize harm to marine organisms, such as velocity caps or fine mesh filters. Desalination intake and treated wastewater discharge points should be sited following modelling that identifies areas of minimal ecological sensitivity, and all discharges must comply with regulatory standards for salinity, temperature, and chemical content. Continuous monitoring of marine water quality near desalination discharge points is necessary, and operational adjustments to brine discharge rates or locations should be made if negative impacts are detected.

To further minimize impacts, treated industrial wastewater can be mixed with other wastewater streams before discharge to dilute concentrations, while the use of diffusers helps reduce localized effects by dispersing the discharge over a wider area. Ongoing monitoring of salinity, temperature, and chemical levels in discharged water ensures early detection of potential problems and compliance with environmental requirements.

In the operational phase, post-construction monitoring is recommended to track bird and bat mortality rates around wind turbines. Based on monitoring results, adaptive operational practices such as curtailing turbines during periods of high migration activity can be implemented to further reduce wildlife impacts.

7 Annexes

Annex 1: Vantage Point Survey Report

Annex 2: Flora and Fauna Survey Report

Annex 3: Marine Biodiversity Survey Report