SECTION B: BASELINE ASSESSMENT

CHAPTER B7b: ECOSYSTEM SERVICES

Contents

Figures

Tables

7 ECOSYSTEM SERVICES

This chapter of the ESIA provides background information on ecosystem services (ES) and describes the baseline status of ES potentially applicable to the Project.

7.1 INTRODUCTION

As a relatively new way to assess environmental and social impacts, the Ecosystem Services framework has gained popularity since 2005, when the United Nations-sponsored Millennium Ecosystem Assessment (MA) was published. The MA put forward a framework to be used in assessing the linkages between people and the environment. This framework recognises that the relationship between humans and Ecosystem Services is dynamic, involving a complex set of interactions between the well-being of communities and the on-going functioning of ecosystem processes. The MA uses the following definition of Ecosystem Services:

> *Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other nonmaterial benefits (MA 2005).*

Ecosystem Services and the ESIA framework

Ecosystem Services are organised into four types:

(i) provisioning services, which are the products people obtain from ecosystems (e.g. agricultural products, water for drinking, construction materials, etc.);

(ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes (e.g. purification of water and air, control of pests and disease, natural hazard mitigation, etc.);

(iii) cultural services, which are the nonmaterial benefits people obtain from ecosystems (e.g. spiritual and sacred sites, recreational purposes, aesthetic enjoyment, etc.); and

(iv) supporting services, which are the natural processes that maintain the other services (e.g. nutrient capture and recycling, primary production, pathways for genetic exchange, etc.).

Where potentially significant project-related risks to Ecosystem Services are identified, “Priority Ecosystem Services” are identified. Priority Ecosystems Services are defined as (i) those services on which project operations are most likely to have an impact and, therefore, which result in consequent adverse impacts to Affected Communities and/or (ii) those services on which the Project is directly dependent for its operations (e.g., water)..

For the purpose of this analysis, Ecosystem Services are categorised as two types as follows.

Type I: Provisioning, regulating, cultural and supporting ecosystem services, over which the client has direct management control or significant influence, and where impacts on such services **may adversely affect communities**.

Type II: Provisioning, regulating, cultural and supporting ecosystem services, over which the client has direct management control or significant influence, and on which **the Project directly depends for its operations**.

An important input to the priority determination is the technical report of the “Oyu Tolgoi Project Critical Habitat Assessment prepared by The Biodiversity Consultancy and Fauna & Flora International (TBC/FFI, 2011), henceforth referred to as the CHA. The CHA was used to determine the extent of, and qualifying criteria for, Critical Habitat applicable to the Oyu Tolgoi Project.

The processes for determining Priority ES and Critical ES are similar, but use slightly different selection criteria for evaluating significance. In the CHA review, the criticality of an ecosystem service was defined along two independent axes. The first is the importance, value or significance of the service benefits to beneficiaries; the second is the availability of alternative areas of land ('spatial alternatives' per the IFC; TBC 2010) which have the potential to provide similar or equivalent ecosystem services. The outcomes of the CHA ecosystem services review were used to determine Critical Habitat trigger criteria. The significance of a service is made up of a combination of the intensity of use, scope of use (e.g. number of households) and degree of dependence (e.g. degree to which there exist market-based equivalents), and the 'irreplaceability' of the ecosystem service on a scale appropriate to the beneficiary. 'Irreplaceability' refers here to the existence of spatial alternatives (other sites where the same ecosystem service is also provided; e.g. medicinal plants may be harvested from a number of areas within and outside the unit of analysis). It does not refer to the replacement of a particular ecosystem service with a different but comparable service (e.g. the replacement of bushmeat with other protein sources such as livestock husbandry).

Regulating and supporting services were assessed based upon the potential to provide regional or landscape scale benefits, and provisioning and cultural services based upon whether the ecosystem processes or biodiversity products were fundamental to meeting the economic and cultural needs of a local community.

Baseline development process

Information gathered in June and July 2011 for the benefit of the CHA was also incorporated into the Ecosystem Services baseline assessment, as were the CHA findings and conclusions. In most cases, the ecosystem services covered in this analysis and analysed in the CHA are the same set of services. Occasionally, the organisational structure of the ecosystem services covered in this document departs from that employed in the CHA and in those cases the differences are noted.

An Ecosystem Services baseline assessment encompasses an extremely broad range of disciplines that contain a large volume of information. Therefore, a process was necessary to narrow the analysis and provide an efficient way to focus on the important Ecosystem Services components. The two step process is summarised below and illustrated in *Figure 7.1*.

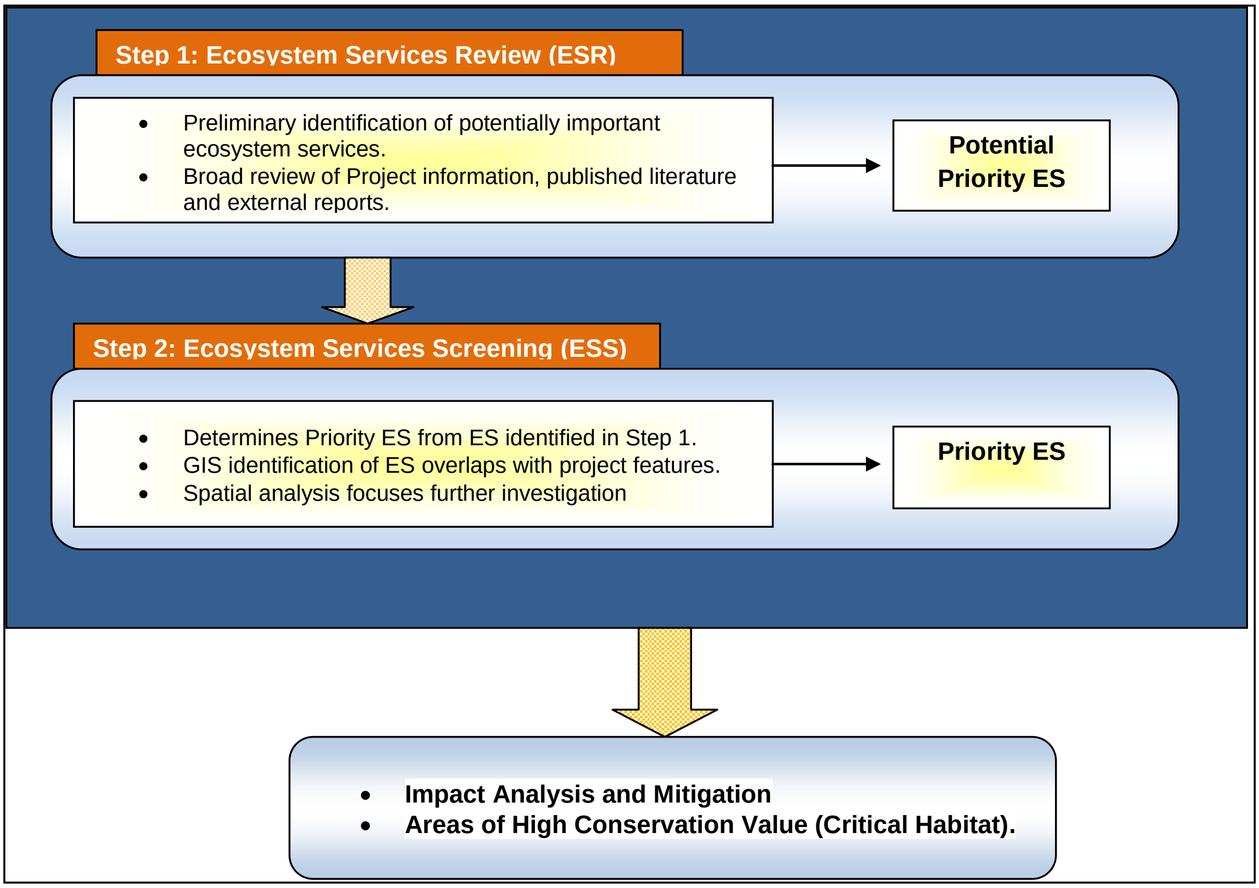
- **Step 1:** An ecosystem service review (ESR) serves as a preliminary identification of potentially important Ecosystem Services associated with the Project. The ESR identifies Ecosystem Services potentially affected by the Project by indicating where there could be a connection between an ecosystem service and the Project. The ESR is extremely conservative in identifying potential connections so they could be further evaluated as part of Step 2. A broad review of Project information, published literature and external reports are used in the ESR with the intent of reviewing all potential Ecosystem Services that could be Priority Ecosystem Services.
- **Step 2:** An Ecosystem Services screening (ESS) is then applied to determine Priority Ecosystem Services. The ESS uses the potential Priority Ecosystem Services identified during the ESR and applies a more in-depth and detailed examination. The ESS process involves using available geospatial data integrated into maps to examine the Project footprint and Area of influence (AoI) in relation to the important Ecosystem Services as indicated from the ESR. The result of the ESS is a spatial estimation of where Ecosystem Services occur in relation to project features.

A Type I and Type II Ecosystem Services determination is provided as the final result of the ESS. This uses the Priority Ecosystem Services and applies the criteria for Priority Ecosystem Services type a. Output is final determination of Type I and Type II Ecosystem Services that will then be used to evaluate impacts and mitigation development in the Ecosystem Services Impact Chapter.

7.2 BACKGROUND ON ECOSYSTEM SERVICES

An ecosystem is a complex relationship of the biophysical elements such as plants and animals interacting with each other and physical elements such as air and water (Krebs 1985). These complex functions produce many services, known as Ecosystem Services, which provide benefits to humans. Ecosystems produce goods that are directly consumed such as food and materials for shelter. Additionally, there are many Ecosystem Services that are indirectly consumed through the functions and processes that produce the materials essential to human life. Humans participate and receive goods and services that are produced by ecosystems. Furthermore, human activities influence the processes of ecosystems. The MA states that, *"…a dynamic interaction exists between people and other parts of ecosystems, with the changing human condition serving to both directly and indirectly drive change in ecosystems and with changes in ecosystems causing changes in human well-being*" (MA, p. 28).

Figure 7.1: Process for Ecosystem Services Baseline Analysis



Ecosystem Services can be quantified in a variety of formal ways, as has been accomplished in the context of Natural Resource Damage Assessments (NRDA) in the U.S. and in cost-benefit analyses for many years. More recent legislation in Europe, Latin America, and elsewhere follows similar approaches for quantifying Ecosystem Services such as recreation, habitat, carbon sequestration, and water quality. Techniques for quantification are necessarily interdisciplinary activities, involving ecologists, biologists, hydrologists, economists and other social specialists who help develop the interface between the ecological science and human concepts of value. In general, the ecological service may be thought of as a "flow" of service experienced directly or indirectly to humans through time. Metrics for the service flow will vary with the service. For example, carbon is often measured in terms of the tons of carbon sequestered per year; recreation is fundamentally expressed in recreational trips taken per year; species fecundity might be measured in population terms; and habitats are often evaluated in units of "Service Hectare Years" – a unit used to describe the full (100%) service level of a high quality habitat for one species for one year (NOAA 2011).

For the purpose of establishing the baseline Ecosystem Services levels in the AoI, and for conducting the ESR and the ESS, quantitative approaches are used to describe applicable Ecosystem Services where data are available. Where quantitative approaches are either not appropriate (e.g. cultural services) or not feasible due to lack of data, more qualitative methods have been used based on information collected in the local area. Information collected at the local level has been gathered through the on-going community engagement process of the Project, as part of the ESIA process, and through a series of assessments completed as part of the Rapid Biodiversity Assessment (RBA) process. Regardless of approach, all discussion of Ecosystem Services should recognise that Ecosystem Services flow from geospatially unique ecosystems, are evaluated throughout a temporal period, and have different kinds of value to humans.

7.3 SOURCES USED

The review was completed based on general examination of Project-specific information and pertinent supplemental literature. Geospatial data was provided by Oyu Tolgoi and obtained from public data sources including United States Geological Service (USGS) and National Aeronautics and Space Administration (NASA). Additional information was obtained from papers published in technical journals, Environmental Impact Statements (EIAs) prepared for other projects, World Bank reports, and studies by international conservation organisations. However unlike many of the other baseline chapters in this Environmental and Social Impacts Assessment (ESIA), this chapter actually depends more on the other chapters of the ESIA than on the outside information. Because the purpose of this chapter is to help identify the interactions between humans and ecosystems, this chapter will reinforce and at times reframe common themes among disparate pieces of information on Ecosystem Services topics documented more fully in the many individual ESIA chapters. As such, this process will serve to connect some of the primary issues that cut across several subject areas.

A list of fundamental Ecosystem Services provided by the Project area environment have been developed based on several guidance documents for Ecosystem Services, and on preliminary discussions with Oyu Tolgoi staff, local stakeholders, and community specialists. Services that have been identified as being applicable to the community and / or the Project are under consideration in this document. Services such as crops, capture fisheries, and aquaculture are not considered in this analysis due to little evidence of their relevance to the community and the Project. However, those services are briefly described in the CHA. The list is organised by the four MA service categories (provisioning, regulating, supporting, and cultural). Each Ecosystem Service was then reviewed in the context of the existing draft ESIA chapters, and the relevant subchapter headings were noted as the information was gathered. The results of this cross-referencing of information are provided in *Table 7.1* below. The information is further organised into the three topics later used in the Ecosystem Services screening and map review:

- **Physical,** including topography, water, and climate;
- **Biological,** including flora and fauna; and
- **Human use,** including cultural, recreational, economic and social values and uses.

At times throughout this chapter, both organisational systems (i.e. the MA framework of Provisioning, Regulating and Supporting Ecosystem Services and the Physical, Biological and Human Use framework described above) may be used depending on the nature of the discussion. The breakdown into physical, biological, and human use (sometimes also discussed as ‘abiotic, biotic, and social’) is a convenient way to organise Ecosystem Services data, because it simplifies the ecological relationships and overlaps so that these may be understood in the context of the human activities.

7.4 ECOSYSTEM SERVICES REVIEW (ESR) – IDENTIFICATION OF “POTENTIAL” PRIORITY ECOSYSEM SERVICES

As described in the introduction, the ESR is a preliminary and conservative selection of potential Priority Ecosystem Services. In the review, each of the Ecosystem Services considered in this baseline will be evaluated using available information to determine whether it should be considered for elevation to a priority Ecosystem Services. Given the lack of quantitative information on some of the more diffuse aspects of these Ecosystem Services, for instance, mechanisms that regulate climate change, extrapolation from similar situations elsewhere in the region or country may be necessary. In other instances where data are lacking, such as in the number or location of edible plant populations, it may be necessary to make broad assumptions about availability. In order to avoid eliminating an essential Ecosystem Services from consideration, this review will take a conservative estimate of effects.

Determinations of potential priority will use the following criteria:

- **Impact:** The Project will result in an adverse impact on the service and therefore will result in an impact on the dependant community.
- **Dependence:** The Project has a significant direct dependence on the service for its operations.
- **Relevance to Affected Community:** A community, or members of a community, will be affected by the loss or degradation of the service.
- **Management Control:** The client has direct management control or significant influence over the service in question.

Table 7.1: ESIA sources used in ecosystem service analysis (chapter and section of source)

Ecosystem Service	Human	Biological	Physical / Chemical
Livestock	▪ Ch A6: Community Consultation ▪ Ch B9: Employment and Livelihoods Baseline ▪ Ch B10: Land Use Baseline ▪ Ch C8: Population and Influx Impact Assessment ▪ Ch C10: Land Use & Displacement Impact Assessment	▪ Ch B7a: Biodiversity Baseline	▪ Ch B2: Climate Change Baseline ▪ Ch B5 Topography, Landscape, Geology & Topsoil Baseline ▪ Ch B6: Water Resources Baseline ▪ Ch B10: Land Use Baseline ▪ Ch C10: Land Use & Displacement Impact Assessment
Wild plants and animals	▪ Ch B10: Land Use Baseline ▪ Ch B13 Community Health, Safety & Security Baseline	▪ Ch B7a: Biodiversity Baseline	
Timber and other wood and plant fibres	▪ Ch B11: Transportation & Infrastructure Baseline		
Freshwater	▪ Ch A6: Community Consultation ▪ Ch B5: Topography, Landscape, Geology & Topsoil ▪ Ch B10: Land Use Baseline ▪ Ch B11: Transportation & Infrastructure Baseline		▪ Ch B6: Water Resources Baseline
Biomass fuel	▪ Ch B11 Transportation & Infrastructure Baseline ▪ Ch C8 Population and Influx Impact Assessment	▪ Ch B7a: Biodiversity Baseline	
Genetic resources		▪ Ch B7: Biodiversity Baseline	▪ Ch B6: Water Resources Baseline ▪ Ch B10: Land Use Baseline
Air quality regulation	▪ Ch A6: Community Consultation ▪ Ch B13: Community Health, Safety & Security Baseline ▪ Ch C8: Population and Influx Impact Assessment ▪ Ch C11: Cultural Heritage Impact Assessment		▪ Ch B10: Land Use Baseline ▪ Ch B5: Topography, Landscape, Geology & Topsoil Baseline ▪ Ch B11: Transportation & Infrastructure Baseline ▪ Ch C10: Land Use & Displacement Impact Assessment
Water regulation	▪ Ch A6: Community Consultation		▪ Ch B6: Water Resources Baseline
Waste treatment	▪ Ch B11: Transportation & Infrastructure Baseline ▪ Ch C8: Population & Influx Impact Assessment		

Ecosystem Service	Human	Biological	Physical / Chemical
Primary production		▪ Ch B7a: Biodiversity Baseline	▪ Ch B6: Water Resources Baseline
Pathways for genetic exchange		▪ Ch B7a: Biodiversity Baseline	▪ Ch B6: Water Resources Baseline
Nutrient capture and recycling		▪ Ch B7a: Biodiversity Baseline	▪ Ch B6: Water Resources Baseline
Cultural sites	▪ Ch A6: Community Consultation ▪ Ch B5: Topography, Landscape, Geology & Topsoil Baseline ▪ Ch B8: Population and Demographics Baseline ▪ Ch B12: Cultural Heritage Baseline	▪ Ch B7a: Biodiversity Baseline	
Campsites	▪ Ch A6: Community Consultation ▪ Ch B8: Population & Demographics Baseline ▪ Ch B10: Land Use Baseline		▪ Ch B6: Water Resources Baseline
Recreation		▪ Ch B7a: Biodiversity Baseline	

Relevance to the community has been identified through geospatial modeling, community consultation, and a review of other community and biological impacts associated with the Ecosystem Services. Relevance to the community was been categorised into high, moderate and low according to the following interpretation:

- **High:** Crucial to sustaining the economic, cultural or biological health of the affected area.
- **Moderate**: Significant to sustaining the economic, cultural or biological health of the affected area.
- **Low**: Little to no evidence of significance to the affected area.

An Ecosystem Service is considered to be applicable to the community if either a high or moderate evaluation was found.

The Project connection criteria described above are directly related to assessing vulnerability of Ecosystem Services consistent with project good practices. Vulnerability is the risk of the area being transformed by Project activities. This is determined by evaluating existing threats to the service and the extent to which these might be exacerbated by the Project.

In addition to these criteria, a criterion addressing the replaceability of the Ecosystem Service has been evaluated as well. Each Ecosystem Service was assessed to determine if the service has many, few, or no replacements in the area. This ranking is intended to assess the rarity, or uniqueness of the area where the Ecosystem Service occurs on a regional level. The question of replaceability is important to two fundamental features of value to humans: scarcity, and the availability of alternatives. If another source of an Ecosystem Service is readily available, then it must provide a similar service at a similar 'price' or community cost. If alternatives are available, then the service is replaceable. Areas with few replacements and high vulnerability will receive priority for conservation action. The review of all Ecosystem Services follows below.

7.4.1 Provisioning Services

Among the provisioning services provided by the ecosystem within the Project area, many have the potential to be negatively impacted. This does not necessarily imply an impact, but suggests that the Project could either directly or indirectly influence services within the affected communities, in this case, the four *soum*s or districts in the Omnogovi *aimag*. Crop agriculture and fishery resources are often included among provisioning services considered in an Ecosystem Services review, but neither of these Ecosystem Services are present in the AoI and therefore neither are considered in this review.

Livestock

For many people in this region of Mongolia, economic security is centered upon the benefits derived from livestock. Nearly 50% of the residents in Khanbogd *soum* are employed in livestock production (*Chapter B9* Section 9.6.1). In addition, herders rely on many of the resources livestock produces for household consumption. In order to obtain these benefits, herders rely predominantly on the ecosystem to produce their livestock. Through natural functions and processes, the local ecosystem provides pasture that herders use to graze their livestock. Pasture is the major resource used into the production of livestock. Pasture for livestock requires both suitable vegetation cover and access to water. In the Project area, pastureland is characterised by a desert steppe ecosystem of sparse and low-lying vegetation with minimal vegetation cover (<10%) (*Chapter B10*, Section 10.6.2). The distribution of water sources is a key limiting factor for use of pasture by livestock as it often dictates how far animals can move in a day. In Khanbogd *soum*, roughly 50 to 60 percent of the total pasture area has wells within a day's movement (*Chapter C10* Section 10.2.10). This percentage represents the estimated pasture for livestock available in Khanbogd *soum*. Owing to the arid climate and unpredictability of rainfall, there are relatively few spatial alternatives for livestock grazing in the Project area. The availability of pasture for livestock shifts year to year across the landscape depending on the level of rain (*Chapter B10* Section 10.6.2). Furthermore, different animal breeds are suited to different vegetation types (Fernandez-Gimenez 2000). The CHA examined livestock in terms of biodiversity and critical habitat in their analysis. Spatial alternatives have been observed in the production of livestock. Pasture for livestock has been observed to be replaceable in the Project area. Herders who have been physically displaced by the Project have accepted new pasture areas as long as a well was dug and access to water was provided (*Chapter C10* Section 10.2.5). The Project could affect this service both directly and indirectly. The magnitude of impacts can be controlled through proper management actions. Due to the economic and cultural relevance to the affected community, pasture for livestock is certainly a potential priority Ecosystem Services.

Wild plants and animals

The local population depends to a varying extent upon the provision of wild plant and animal resources for food and natural medicines. The arid vegetation of the area includes few edible plants of significance. The CHA considered wild plants and animals for food and natural medicines separately. This analysis examines them together. Urtnasan (2011) identified 11 plants that are eaten or used as herbs in cooking or for making teas. The more important ones include *Cynomorium songaricum* (stem), *Nitraria sibirican* (fruits), *Agriophyllum pungens* (seeds),*Rheum nanum* (root), *Allium polyrrhizum* (leaves and seeds), and *Ferula bungeana* (fruits). Urtnasan (2011) identified 57 indigenous medical and food plants used by the herder families that he interviewed across three *soum*s, including Khanbogd, while Khasbagan and Pei (2000) identified 77 plants used in the diet of Arhorchin herders of Inner Mongolia. Although strong quantitative data are lacking for documenting the use of wild plants as food, it has been acknowledged by some sources (e.g. Humphrey et al. 1993) that wild foods are entwined with herder culture, and influence their perceptions of the relative health of the surrounding environment. Interviews with herders and local communities have revealed a wealth of knowledge on the medicinal uses of plants both for human and livestock health.

The extent that animals are used for medicinal purposes is unclear. On-site interviews with some community leaders conducted in May 2011 confirmed that animals such as rabbits and wolves are used for medicinal purposes. Therefore, animals used for medicinal purposes are deemed to be applicable to the community.

Wild plants and animals for both food and medicine are widely, but patchily, distributed across this unit of analysis and so have many spatial alternatives. Nonetheless, these resources are likely to be affected by the Project and the Project has some control over the affect. Therefore, wild plants and animals used as food and medicine are a potential priority Ecosystem Service. The Project could affect this service and can be controlled through proper management actions.

Timber and other wood and plant fibers

For the purpose of this analysis natural material used by herder households and the community for making products are examined in this section. The CHA addresses this Ecosystem Service under the two categories of 'Timber and other wood fiber,' and 'Other fiber.' Timber and other wood and plant fibers are mostly used for construction of winter shelters. Traditional construction materials for winter shelters include dung, rock and wood. It has been noted that wooden shelters are preferred by herders (*Chapter C10* Section 10.2.5), but the type of wood was not mentioned and could be obtained from trade. Elms are not generally harvested for construction. Saxaul (*Haloxylon ammodendron*) and tamarisk (*Tamarix ramosissima*) characteristically do not usually reach tree-like size in this unit of analysis and so are not commonly used for making any products. Even though few alternative sources exist within the AoI, timber and other local wood fiber from the area are not extensively used. The Project is likely to affect wood and plants fibers and the magnitude of effects can be influenced through proper management controls. Since the services provided by local wood and plant fibers are not fully embraced by the local population, this is not deemed to be a potential priority Ecosystem Service.

Biomass fuel

In the Social, Economic, and Environmental Subset study by the Center for Policy Research in 2009, wood, charcoal, and dung were noted as being the main source of household heating in the AoI. Over 93% of households in the AoI rely upon these sources and in particular 83% of households use wood, 61% of households use coal, and 34% of households use animal dung. (*Chapter B11* Section 11.5.5). The type of fuel used varies between households and seasonally with many using a combination of fuels depending on availability. (*Chapter B11* Section 11.5.5). These sources along with diesel oil make up the only means of heating in the village areas (*Chapter B11* Section 11.3.5). Interviews with local representatives confirm that saxaul wood in particular is crucial as fuel for heating and cooking. It is estimated that one herder household uses approximately 1 ton of saxaul "wood" during winter and a public building may use about 10 truckloads (of about 5 ton each) during winter (Schmidt 2011). In addition, there has been a notable increase over the past decade in the total saxaul collected, especially with the development of the coal road (Schmidt 2011). Saxaul as a wood fuel is viewed as sacred and is applicable to the community in terms of a cultural resource and a source of heat. The CHA notes that due to the very cold winters in this region that biomass fuels, specifically wood plants, are believed to be of essential significance (FFI and TBC Ltd 2011). The Project is likely to affect this service, but the impact can be influenced through management controls. Wood for fuel therefore has the potential to be a priority Ecosystem Service and will be evaluated further in the screening process.

Freshwater

In the arid landscape, reliable access to drinking water is essential for the survival of the local population. The rural population depends almost entirely on the ecosystem to provide drinking water. In an area where surface water is scarce, the main source of water is provided through a network of shallow aquifers that are recharged from rainfall. Herders obtain fresh water from individual hand dug shallow wells. The water level is typically less than 3 meters below the surface and is extracted for potable and livestock water supply (*Chapter B11* Section 11.5.6). In the Project area, drinking water is provided through annual flooding of the Undai River which recharges shallow alluvial aquifers. The shallow alluvial aquifers in turn may recharge deeper aquifers and maintain surface water sources like Bor Ovoo Spring. During early consultations, herders identified drinking water provisioning to be one of their main concerns (*Chapter A6* Section 6.7.8). Given its scarcity, drinking water is considered of essential relevance to the affected community. The CHA examined this Ecosystem Service in terms of biodiversity and critical habitat. There are relatively few substitute sources of drinking water such as lakes or perennial systems that could replace the regenerative services of the Project area's groundwater resources. The Project is likely to directly and indirectly affect the provision of drinking water, but can influence the magnitude of effect through proper management controls. Since the Project is also reliant upon clean water to support worker communities, this service has the potential to be a priority Ecosystem Service and will be analysed closer in the screening process.

Genetic resources

This ecosystem service ensures the maintenance of biodiversity which provides ecosystem stability and essential resources for human populations. Since this service is widely available throughout the desert steppe, the project is unlikely to affect local or regional biodiversity. It is therefore not a priority Ecosystem Service and will not be elevated to the screening process.

7.4.2 Regulating Services

Air quality regulation

Air quality regulation services are the functions and processes that produce clean air and are vital for human health and well-being in the Project area. As defined by the MA, ecosystems both contribute chemicals to and extract chemicals from the atmosphere, influencing many aspects of air quality (MA 2005a), although other factors such as soil integrity and moisture can control the quantity of particulates in the air. In the arid climate of the Gobi Desert, the main threat to clean air is atmospheric dust from soil disruption and loss of vegetation. In early consultations, dust emissions were repeatedly mentioned as a concern by local herders (*Chapter A6: Community Consultation*) and are related rates of asthma and bronchitis in the Project area (*Chapter B13* Section 13.4.1). Air quality regulation in the Project area is achieved mostly through the ability of vegetation and cryptobiotic crusts to hold soils together, a function that will be discussed under *Erosion/Soils Regulation*. Large-scale vegetation such as forests that would be capable of absorbing and releasing gases are lacking, and there are no other natural sources or sinks that would be able to significantly attenuate human-induced changes in gas levels. Given the sparse vegetation, there are few alternatives to air quality regulation. Although impacts to air quality regulation would certainly affect human populations, the Project does not substantially affect any regulatory mechanisms beyond soil, and there is no Project dependence upon this service. Therefore, it is not considered to be a priority Ecosystem Service and will not be evaluated further in the screening process. The CHA addresses this Ecosystem Services in terms of biodiversity and critical habitat.

Regional/local/global climate regulation

Climate regulation is an important function that provides security to communities through the regulation of natural hazards and promotion of the basic materials for life. Ecosystems can influence climate at all levels which were analysed separately by The CHA. At the local and regional scales, changes in land cover can affect both temperature and precipitation. At the global scale, ecosystems regulate climate by either sequestering carbon or emitting greenhouse gases. Climate-regulated natural hazards identified by Mongolian pastoralist include drought, *dzud* (winter disasters), sand storms and patchy or localized rain events. Land disturbance associated with the Project will result in loss of vegetative cover, but it is unclear if dust releases over the life of the Project will have any long-term impact on the local or regional climate, and impacts to global climate are unlikely because the AoI lacks the biomass that is considered to be necessary for by significant carbon sequestration (desert steppe versus forests). There are many spatial alternatives for climate regulation on a global scale and the influence of the sparse vegetation provided by desert steppe ecosystems is likely to have a small influence on global climate. Though climate regulation is applicable to the community for the moderation of climate-related hazards, it is not likely to be affected by the Project. Climate regulation is therefore not considered an Ecosystem Service that the Project is likely to affect, and is therefore not considered a priority Ecosystem Service.

Water Regulation

Water regulation services produce clean water that is suitable for human and livestock consumption. The CHA only considers water quantity regulation and examines regulation services related to water in 'Water purification and waste treatment.' This analysis considers the water quality regulation effected by alluvial aquifers and vegetation as it has been identified as a relevant service by local herders. Herders have stated that they are concerned about both the reduction and pollution of water supplies (*Chapter B6* Section 6.7.8). Since this is an essential service for life in the desert, changes to water quality and quantity directly impact human health and population distribution, and is a dependency for both the local community and the Project. Soil and shallow geology can act as filters for ground water as it percolates to the surface. Evidence of this process has been observed in the form of temporal variations in water quality during Project well monitoring that correspond with seasonal "flushing" and remobilisation of salts accumulating in areas of shallow groundwater (*Chapter B6*, Section 6.5.1). Similarly, the water quality of Project area springs improves following a rainfall/flood event and then deteriorates as the water level declines and salt and mineral concentrations increase with increased evapotranspiration (*Chapter B6*, Section 6.5.5). There are no other special alternatives to water quality regulation in the region. Since most of the herding population relies upon shallow groundwater, Project activities that are likely to impact water and alter the amount or direction of groundwater flow, or that obliterates or alters stream channels can directly impact water quality for this community. These impacts can be modified through proper design, monitoring and other management controls. Water quality is therefore a priority Ecosystem Service and will be elevated to the screening process.

Surface water bodies are very limited and generally intermittent or ephemeral in nature. Water within the AoI is therefore provided by access to shallow aquifers (via hand-dug wells and a few Russian era machine-bored wells) throughout the year. Larger wells serve public water supplies in large towns such as Khanbogd, while herding families use smaller wells. In Khanbogd *soum*, there are 314 wells (79% shallow) for 494 herding families, with only four of these wells being disused (MSRM 2010). With the exception of a few isolated springs, there are no other shallow or surface water sources in the area and therefore, no other spatial alternatives to the water quantity regulation service. Water quantity has the potential to be affected by the Project through groundwater abstraction in the Gunii Hooloi Aquifer, temporary water withdrawals from shallow reservoirs during construction, the drawdown of the surrounding aquifers from a cone of depression centered on the mine, and the diversion of the Undai River. The Project itself is also dependent upon these services for its operation, and as a drinking water source for the worker camps. Water is a critical resource in the area and highly applicable to the affected community. In addition, the Project both relies upon and affects water quantity regulation. Project effects on water quantity can be modified through the use of management controls. Therefore this service will be elevated to the screening process as it has the potential to be a priority service.

Erosion Regulation

Erosion and soil stability have the potential to be impacted by the Project. The Project operation is not dependent upon these services, although certain aspects of later restoration may be dependent on these services. Herders, local communities and the water and biotic resources upon which they depend can be negatively affected by soil removal and compaction. Soil erosion is linked to water availability since vegetation growth may be affected by water use. Soil erosion is also inextricably related to air quality because it is the mechanism by which fine soil particles are released into the air. Mine construction and operation will remove vegetation and generate increased traffic that can contribute to already high background levels of dust. In early consultations, dust emissions resulting from soil erosion were repeatedly mentioned as a concern by local herders (*Chapter A6: Community Consultation*). Given that the sparse vegetation and cryptobiotic crusts occur throughout the unit of analysis, there are spatial alternatives to erosion regulation. The CHA examines this ecosystem service in terms of biodiversity and critical habitat. . However, due to its relevance to the community and the likely Project effects, this service will be elevated to the level of a priority Ecosystem Service and examined in more detail in the screening process.

Waste treatment

Waste treatment is a function of the ability of the environment to absorb and process extraneous materials imposed upon it. Some of what The CHA addressed under 'Water purification and waste treatment' is covered in this section. For the ESIA, natural water purification aspects are addressed in Water Regulation. In the context of the Project, this would include human waste from worker camps and local communities such as Khanbogd, and hazardous waste that might be released by construction activities. Desert soils are naturally thin and lack a strongly-defined layer of organic material conducive to the development of large populations of decomposers. The ability of this Ecosystem Service to process large quantities of human waste is therefore very limited. Furthermore, porous soils may also create conditions under which both biological and chemical waste can move into groundwater. Therefore, there are few spatial alternatives for waste treatment regulation. However, the Project will not rely upon natural systems for waste processing but will use a sewage treatment plant and recycle the processed effluent back into the mine or use it for dust suppression. Hazardous waste will be similarly stored and processed. Acid runoff from mine tailings poses a threat to water quality, but is unlikely due to local soil chemistry and construction measures designed to redirect runoff. As such, reliance upon the service of waste treatment will be minimised or bypassed by the creation of alternate systems. The local community that relies on this ecosystem service is likely to benefit from a more formal infrastructure for managing waste. Therefore, waste treatment is not considered a potential priority Ecosystem Service.

Disease and pest regulation

The CHA considered disease regulation and pest regulation separately. For the ESIA, these are combined for analysis. Pests and diseases such as insect or animal-borne diseases (e.g. malaria and rabies) are usually managed through natural predator-prey interactions that keep populations of lethal organisms relatively low. These cycles can be disrupted through the introduction of human waste and trash that can favour increases in scavenging animals such as black vultures and long-eared hedgehogs (*Chapter B7*, Section 7.4.7), or encourage concentrations of animals such as canids and vultures that would normally be more sparsely distributed. Human activities may also drive away beneficial animals that might otherwise control pests. In the desert steppe environment, these problems are not as prevalent as in less arid environments in part due to a lack of water-seeking insect pests like mosquitoes. Hot summers and cold winters ensure that diseases spread by arthropod or animal vectors are relatively uncommon. Furthermore, Project management controls are proposed that will incinerate and dispose of most trash. Therefore, pest and disease regulation are not considered to be potential priority Ecosystem Service.

Pollination

Ecosystems provide the service of transferring pollen from male to female flower parts. This service is applicable to the community in the continued pollination and production of wild plants and vegetation upon which humans rely. There are few crops grown in the AOI. Food production is not reliant upon specialised groups of insects, such as bees, for pollination. Wind and other insect orders such as flies and beetles are just as likely to be able to provide this service throughout the landscape to the degree necessary to sustain grasses and dicots. Despite the direct loss of vegetation within the Project footprint, there is enough vegetation left in the region to adequately support pollination services. Therefore, even though pollination is a service not easily replaced, the Project footprint is not so great as to reduce the population of pollinating insects, nor will it affect microclimatic wind dispersal, and so pollination is not considered a potential priority Ecosystem Service. The CHA examines this ecosystem services in terms of biodiversity and critical habitat.

Natural hazards regulation

Natural hazards common to the Project area include droughts, dzuds (extreme winters), and dust storms. Droughts and dzuds are most commonly linked to livestock mortality. Herders depend up on livestock for their economic security and therefore depend on summer and winter forage. In order for the livestock to survive the winter months, they must gain sufficient weight in summer to help sustain themselves through the leaner winter. Therefore, there must be adequate rainfall to support summer vegetation growth in order for livestock survive the winter. When a drought occurs before a dzud, the vegetation growth is reduced and livestock weight gain during summer is reduced. During a dzud, animals are unable to access winter pasture because ice and snow is too dense and harsh. A combination drought–dzud event happens periodically. The most recent and one of the worst recorded drought-dzud occurred in 1999–2001, when livestock mortality reached 8 to 10 million animals, approximately 30 percent of the national herd (Sternberg 2009). The Ecosystem Services that would mitigate these hazards are large-scale, dependent upon major climatic processes that impact local populations but cannot be controlled. Due to the large spatial and temporal scale this Ecosystem Service operates over, there are few alternatives to this Ecosystem Service. Though this Ecosystem Service is applicable to the community, it does not have the potential to be a priority Ecosystem Service given the lack of impact and control the Project will have over this service. The CHA examines this ecosystem services in terms of biodiversity and critical habitat.

7.4.3 Supporting Services

Primary productivity

Primary production is measured by the total photosynthetic output of vegetation and other autotrophic species. The desert steppe is one of the less productive ecosystems in the world because while light is plentiful, water and nutrients may severely limit ecosystem biomass. Although this service is essential to both wildlife and livestock production, many spatial alternatives exist throughout the Project area. In addition, the Project is not likely to impact the service. For these reasons, primary productivity is not considered to be a potential priority Ecosystem Service. The CHA addresses this Ecosystem Services in terms of biodiversity and critical habitat.

Nutrient capture and recycling

This supporting service refers to the capacity for ecosystems to capture nutrients from the atmosphere, soils and water, and to recycle these nutrients through biotic or abiotic pathways. The sparse vegetation that grows in the arid climate of the area provides a relatively limited contribution to nutrient capture and recycling on a global scale, although locally herder livelihoods are largely dependent on traditional pastoral grazing. Since there are other alternatives to nutrient cycling throughout the region and the Project is not likely to impact this service, this is not considered a priority ES. The CHA addresses this Ecosystem Services in terms of biodiversity and critical habitat.

Pathways for genetic exchange

This service is based upon the facilitation of gene flow within and among populations. In the desert environment where water is scarce, isolated springs and riverine habitats may support unique population assemblages of relatively species. However, in the Southern Gobi, there is a comparative lack of localized, or endemic, species that has been attributed either to frequent immigration among populations, or to the limited duration of time (on an evolutionary scale) that species have had to adapt to this area. While endemic species do occur within the Project AoI, their population boundaries are not confined to it. There are many pathways to genetic exchange in existence and no unique populations. Therefore, because the Project is unlikely to impact this service, this Ecosystem Service will not be analysed closer in the screening process. The CHA addresses this Ecosystem Services in terms of biodiversity and critical habitat.

7.4.4 Cultural Services

Cultural and recreational services are provided throughout the AoI. Details of the cultural areas of significance are briefly reviewed here.

Cultural and spiritual sites

Cultural and spiritual sites are covered in The CHA under 'Sacred or spiritual sites' and 'Areas used for religious purposes.' In addition, The CHA addresses aesthetic value separately. For the purpose of this analysis, these services are examined jointly due to multiple overlapping areas. Although traditional Mongolian beliefs were suppressed in socialist times (i.e., until 1990), there has been some recent revival of traditional rituals in recent years, dedicated to such natural features as mountain spirits, sacred trees, lakes, or springs. Some 160 sacred and traditional sites have been identified in total (*Chapter B12* Section 12.7.13). Most sacred natural sites, including the Undai River and sacred trees, are "key environmental points for herder survival" (Sampildondov & Purevjay 2011). Khanbogd Khairkhan Mountain was identified as a site of particular importance (about 56% of respondents worshipping this site). Non-natural sites of potential sacred or spiritual value have been identified in the AoI by Oyu Tolgoi surveys, including petroglyphs, tombs, a Turkic balbal, and old settlements (Oyu Tolgoi in prep.). Other examples of potential areas for cultural activities are apparent animal sacrifice sites associated with religious ceremonies which were identified by the Oyu Tolgoi surveys (Oyu Tolgoi in prep.).

The benefits of this ecosystem service predominantly accrue locally. While it is difficult to quantify the significance of these areas, it is believed that they have a high significance. The replaceability of religious sites is also difficult to know, but new sites are developed with some regularity and there may be some degree of geographic replaceability. For the purposes of this analysis, it is judged that few spatial alternatives may exist within this unit of analysis. Due to the relevance and likely impact and management from Project related activities, this Ecosystem Service has the potential to be a priority Ecosystem Service and will be evaluated further in the screening process.

Campsites

Careful attention is given to the selection of summer and winter campsites sue to the nomadic herders' reliance upon environmental factors for economic survival. Locations are chosen based upon the intersection of multiple ecosystem services, many of which, such as water, are comparatively scarce. This restricts the number of ideal sites much more than the seemingly vast and empty landscape might imply. Campsites have been observed to be replaceable Herder relocations have already taken place. Herders that have chosen not to move may find the availability of campsites is reduced in the future due to the escalating magnitude of effects from mine expansion and increased road use. The Project is likely to indirectly impact other campsites. These effects can be modified through proper management controls. Campsites therefore have the potential to be a priority Ecosystem Service and will be evaluated further in the screening process.

Recreation

During interviews with local representatives conducted in May 2011, all interviewees acknowledged that upon occasion they enjoy traveling to scenic locations for picnicking and recreational purposes. Swimming and wading in local springs, sitting under shady trees, hiking, and enjoying scenery were all identified. Hunting was not mentioned, although hunting for illicit trade and 'sport' in some areas of Mongolia apparently continues at unsustainable levels. Places such as Demchigy Temple, Zuun Mondy Am, Bayajihyn and Gurvan Zeerdiin caves, and Chingisiin Uurgany Nuh are popular among foreign and domestic visitors. The CHA discusses recreational use as well as an ecosystem service. None of these areas will be directly impacted by the Project. No data have been found that addresses the effect of mining upon visitors. Recreation is there not considered to be a priority Ecosystem Service.

Ecotourism

There are a few ecotourism facilities that are beginning to become popular within the AoI. Such facilities provide access to ecological resources, lodging, transportation, and guide services for tourists to the region. Ecotourism benefits the well-being of the local community by encouraging the preservation of local ecological features, and by providing local communities with employment and business opportunities. As with recreation, the extent to which the Project will affect this industry is unknown, but the size of the region provides many other opportunities for visitors. This is therefore unlikely to be a priority Ecosystem Service. The CHA examines this ecosystem services in terms of biodiversity and critical habitat.

7.4.5 Summary of ESR

Table 7.2 serves as a tool to prioritize Ecosystem Services that will be examined closer in the Ecosystem Services screening process. An 'X' in the table indicates a potential substantial connection between an Ecosystem Service and the Project. A blank in the table indicates that a connection between the Ecosystem Service and the Project is unlikely. For this review activity, all phases of the Project (construction, operation, and closure) are considered.

Table 7.2: Preliminary ecosystem service review indicating where there could be a potential connection between an Ecosystem Service and the Project

Ecosystem Service	Impact	Dependence	Relevance to Affected Community	Management Control	Replaceability	Potential Priority ES
Provisioning						
Livestock	X		X	X	Few Alternatives	✓
Wild plants and animals	X		X	X	Many alternatives	✓
Timber and other wood and plant fibres	X			X	Many alternatives	
Freshwater	X	X	X	X	Few alternatives	✓
Biomass fuel	X		X	X	Few alternatives	✓
Genetic resources			X		Many alternatives	
Regulating						
Air quality regulation			X		Many alternatives	
Regional/local/global climate regulation			X		Many alternatives	
Water regulation	X	X	X	X	Few alternatives	✓
Erosion regulation	X		X	X	Many alternatives	✓
Waste treatment			X		Many alternatives	
Disease/pest regulation			X		Many alternatives	
Pollination			X		Few alternatives	
Natural hazard regulation			X		Many alternatives	
Supporting						
Primary production			X		Many alternatives	
Nutrient capture and recycling			X		Many alternatives	
Pathways for genetic exchange			X		Many alternatives	
Cultural						
Cultural or spiritual sites	X		X	X	Few alternatives	✓
Campsites	X		X	X	Many alternatives	✓
Recreational value	X				Many alternatives	
Ecotourism areas	X				Many alternatives	

7.5 ECOSYSTEM SERVICES SCREENING – IDENTIFICATION OF PRIORITY ECOSYSTEM SERVICES

This step in the baseline development process is provided to determine Priority Ecosystem Services (Step 2 as described in the introduction). The screening will apply a more detailed examination of the Ecosystem Service determined to have the potential to be priority, and include the use of geospatial data to evaluate the extent to which services are located where elements of the Project could affect them.

Based on the ESR (above), the following potential Priority Ecosystem Services have been identified for further investigation in the screening phase of the baseline:

- Livestock;
- Wild plants and animals;
- Freshwater;
- Biomass fuel;
- Water regulation;
- Erosion regulation;
- Cultural or spiritual sites; and
- Campsites.

Data for this process are dependent in large part upon existing studies and recent surveys completed by the Project proponents. In many instances, data were not collected pursuant to an analysis of Ecosystem Services and are therefore not available for the determination of priority Ecosystem Services. Therefore, this analysis must use surrogates to ascertain the effects the Project may have on the delivery of these services to the local populations. For instance, the presence of shallow water is presumed to be indicated by ephemeral channels with a buffer to indicate recharge areas. Wood for fuel is mapped as saxaul forests. Pasture has been assumed to comprise most of the *soum*, so activities that remove vegetation are also presumed to remove grazing land from use. The relative importance of an Ecosystem Service to the local community is estimated both from the results of interviews and from the overlap of mapped Ecosystem Services with evidence of human populations, including wells and herder camps. In areas where Ecosystem Services overlap with the Project footprint, it is assumed that the Project will have an impact of some magnitude upon that service. Using this approach, this screening seeks to determine how important Ecosystem Services are to the local community, the extent to which they are affected by the Project, and the degree to which the Project can control that effect.

7.5.1 Geospatial Orientation

The Area of Influence (AOI) is defined as follows, consistent with the CHA report:

Area of Influence (AOI): The area within which both direct and indirect impacts are expected to occur; this extends beyond the borders of the mine lease and associated Project areas to include the entirety of Khanbogd *soum* as well as Bayan-Ovoo, Manlai and Tsogt-Tsetsii *soum*s within the Amnogovi bag in southeast Mongolia along the border with China. This area includes the land that will be directly disturbed by mining activities, as well as human settlements, immigration, infrastructure, water resources and physical and biological environments.

Project Footprint: The Project footprint includes those areas that are directly occupied by the Oyu Tolgoi mine, infrastructure, and facilities, including temporary laydown and work areas associated with the Project components. The Project components include the Mine Licence Area (MLA) where mining activities will be focused, permanent and temporary airport facilities, the Gunii Hooloi borefield, the pipeline extending from the borefield to the Mine Licence Area, the Oyu Tolgoi to Gashuun Sukhait road, and a transmission line that roughly parallels the road.

Potential Effect Analysis Areas: Direct project impacts may extend beyond the direct Project footprint. For instance, water diversion can affect downstream resources and air impacts can have regional implications. For the purposes of completing the impact analysis, an area around each Project component was identified that was intended to incorporate the area of direct impact associated with each component. Indirect effects (e.g. air emissions) may extend beyond the analysis areas. These analysis areas were defined as follows:

- **Mine Licence Area:** The analysis area extended 10km beyond the boundary of the Mine Licence Area to cover potential impacts to the many winter camps of local migratory herding families surrounding the mine, and the possible effects of mine dewatering on herder wells and springs that line the Undai River.
- **Permanent and temporary airport facilities:** The analysis area extended 5 km beyond the boundaries of the airport, including the runway. This distance was selected to reflect the area potentially affected by noise impacts (Map 9).
- **Gunii Hooloi Borefield:** The analysis area around borefield extended 1 km beyond the Project footprint to cover possible impacts of land disturbance, increased activity on herder camps and cultural sites (Map 8) and possible impacts on groundwater abstraction on shallow herder wells in the vicinity (Map 2).
- **Pipeline between Borefield and Mine Licence Area:** The analysis area around the pipeline extended 1 km beyond the Project footprint to cover possible impacts of land disturbance and increased activity on herder camps and cultural sites (Map 8).
- **Oyu Tolgoi to Gashuun Sukhait Road:** The analysis area extended 1 km on either side or the road to capture the potential impacts of dust and traffic on concentrations of herder camps and pastures along the corridor (Map 10).
- **Transmission line:** A 100m analysis area was defined on either side of the transmission line to encompass impacts from construction and maintenance on air quality and pastureland (Maps 10).

In addition to defining analysis areas around the various Project components, an analysis area was also defined around the Undai River, extending 100 m on either side of the river. This area incorporates the potential impacts of diversion on downstream springs and associated vegetation, as well as herder wells concentrated in areas of shallow groundwater (Maps 3 and 6). The buffer on the Undai River extends from the licence area downstream to a point where geomorphology may change with the new diversion. An analysis areas was also defined around the smaller tributary that will receive water from the diversion is because hydrology and geomorphology of that tributary may also be impacted. The analysis areas reflect the significance of the hydrological features in maintaining surface water features in the drainages downstream of the mine.

The Project AoI is divided into three geographic areas shown in Map 1. The Gunii Hooloi pipeline and borefield reference area focuses on Ecosystem Services that may be affected through exploitation of the Gunii Hooloi aquifer and installation of the water pipeline to the Mine Licence Area. The Mine Licence Area (MLA) is comprised of the mine and surrounding exclusion area, the Budaa River watershed up and downstream of the mine, and the permanent airport. The infrastructure corridor encapsulates the area that may be subject to impacts from the construction of a high voltage power transmission line and upgrade of the existing Oyu Tolgoi to Gashuun Sukhait road.

The Project footprint and the potential effect analysis areas are depicted in maps 2 through 10. Due to the number of Environmental Services, depiction of all of the services on one map was not feasible. Therefore, the various Ecosystem Services have been grouped by their physical, cultural, and biological attribute as follows:

- Maps 2, 3, and 4 depict the physical features of the borefield, Licence Area, and infrastructure reference areas for the Project;
- Maps 5, 6, and 7 depict the available data regarding biological features such as the saxaul forests and sacred trees for each of the three reference areas; and
- Maps 8, 9, and 10 do the same for all of the human uses including culturally important areas, herding campsites, and wells and springs used by people.

7.5.2 Physical and Chemical Ecosystem Services

Freshwater and Water Regulation

The provisioning services supported by surface and shallow groundwater enable nomadic herders to survive in the southern Gobi. The complexities of the interrelationships between surface water, shallow, and deep-water aquifers and the connections among them are explained in great detail in *Chapter B6*

Water Resources, and will form the basis for the following discussion of the provisioning services that water quality and quantity afford both humans and animals.

The Mongolian pastoral system relies on the use of camels, horses, cattle, sheep and goats, and it is the availability of water that determines where and how frequently herders move and what animals they keep. During early consultations, herders indicated they were concerned about water supply (*Chapter B6* Section 6.7.1). Herders frequently identified increasing access to water as a mitigation measure for potential impacts to pasture (*Chapter B6* Section 6.6.3, 6.7.2). Additionally, a recent study found that when asked which issues most affect their lives, water was the most frequently cited issue. Water issues specifically conveyed by herders included access and supply, precipitation, and drought (Sternberg 2008). In areas such as the desert steppe, which lack standing water bodies, herders must water their animals every day during summer (Simukov, 1934; Mearns, 1993 as cited in Marin (2009)). One herder indicated that it took 6 hours to water 276 animals by hand (Sternberg 2008). Within the AoI, is the importance of water is evidenced in part by the relatively low number of herders in areas lacking springs or ephemeral channels such as the Gunii Hooloi borefield (*Chapter B6* Section 6.4.2) where mostly camels are grazed (Map 8).

The Mine Licence Area is a particularly favorable environment for grazing because it is located at a point where several major watercourses and smaller channels converge, feeding a network of springs and alluvial aquifers which provide a reliable source of water that can support relatively high densities of animals and herder camps (Map 9). Herders in arid areas must move further and more frequently in search of pastures with water, and tend to keep higher numbers of drought-tolerant camels than in the wetter areas to the north.

Surface waters such as springs and ponds that form after rainfall events are highly valued by humans and animals alike. Bor Ovoo springs, within the Mine Licence Area (Map 3), is a sufficiently reliable source of water that reportedly supports up to 20 families. The Khanbogd massif, upon which the *soum* centre of Khanbogd is located (Map 1), is another feature that provides surface run-off and fracture flow through the bedrock that feeds shallow aquifers and springs used by herders (Map 2).

Bor Ovoo spring (Map 3), provides the most consistent supply of fresh water, an essential ecosystem function in the dry environment of the Southern Gobi. A series of other, smaller springs follow the course of the Undai down through the southern end of the AoI and ephemeral channels south of Khanbogd (Map 2). All are in relatively close proximity to herder wells.

Where surface water is ephemeral and no springs are available, herders rely upon shallow hand-dug wells that exploit subsurface water within the alluvium of major ephemeral watercourses, such as the Undai River. Surveys have identified 46 herder wells within the 10 km buffer and the Mine Licence Area (Map 3). Alluvial floodplains are comparatively common in this area. Wells are also frequently found in the ephemeral channels along the road to the border (Map 4).

Water of suitable quality for drinking is a service provided in part by rainfall recharge of the springs and shallow aquifers upon which the herders themselves rely. Rainfall recharges the shallow aquifers through the infiltration of surface waters. Measurements of lower TDS adjacent to the Undai River are the likely result of rainfall recharge through soils. This process flushes and remobilises salts that would otherwise naturally accumulate. Spring water quality will improve following a rainfall or flood event and then deteriorate as the water level declines and salt and mineral concentrations increase with increased evapotranspiration. Herders have noted that during summer months with infrequent rain, available water will become too salty and will not be suitable for livestock. If the water is too salty livestock become ill from dysentery and lose weight. Warm water also causes an increase in worms which also results in weight loss (Fernandez-Gimenez 2000). Threat of weight loss means livestock may not survive the winter.

Besides providing a source of drinking and stock water, springs attract many desert animals which congregate for water, forage, and shelter. These include the the migratory Asiatic wild ass (*Equus hemionus*) and Black-tailed gazelle (*Gazella subgutturosa*) (*Chapter C6 Biodiversity*). Qualitative evidence of the value of surface water to animals may be seen in the clustering of wildlife observations along the Undai River (Map 6). Water sustains life, and for centuries, nomadic peoples have honored this association by assigning spiritual values to such areas (*Chapter B12* Section 12.7.13), as evidenced by concentrations of culturally significant sites (Map 9).

Shallow water aquifers also support vegetation communities, providing herders with a range of services not found in other less hospitable habitats. Elms rely upon the alluvial aquifers along the Undai River, establishing extensive lateral root systems within shallow river sediments. For this reason, elms tend to be concentrated in areas of riverine alluvium and are used as an indicator of the presence of a shallow water table (Map 6). Other trees such as *Tamarix* and tooroi (*Populus diversifolia*) are also strongly dependent on shallow groundwater, and provide shade, wood, and wildlife habitat.

The CHA identified fresh water and water regulation as a critical habitat. This analysis comes to a similar conclusion in terms of relevance to the herders and the community.

Project likelihood to affect service: High. Project activities overlap with areas where water is comparatively abundant (e.g. ephemeral channels).

Dependence: The Project depends on water for its workers and its processes (Type II).

Relevance to Affected Community: High. Herders and the population of Khanbogd rely on shallow water resources and there is a potential for the Project to generate impacts that may adversely affect these communities (Type I)

Management Control: The Project cannot avoid impacts but can minimise or replace.

Priority: Type II

Erosion Regulation

The desert steppe, by virtue of its dry environment and low biomass, lacks the layers of decaying vegetation that provide substantive resistance to surface erosion by water and animals. Nevertheless, plant and microbial communities have a substantial role in holding the soil surface layers intact by the action of both roots and chemical reactions that bind soil. An example on the macro level are the hillocks of soil held in place by the shrub *Nitraria siberica* south of the Mine Licence Area and around Tsagam Khad towards the Chinese border (Map 7). Their wide-root systems trap windblown sand, moisture and nutrients, stabilizing the desert surface and creating habitat for small wildlife. Similarly, the stems of tamarisk catch windblown sand which creates a sandy hummock that retains moisture at night. Surface water and alluvial aquifers perform a similar function by maintaining seasonal vegetation communities (SEC 2010) that can secure the soil.

On a smaller scale are the thin, hard crusts comprised of algae and fungi that form on the surface of undisturbed desert soils and are known as cryptobiotic crusts (Walton 2010). Considerable study of these crusts suggest that they perform a wide range of valuable functions including fixing carbon and nitrogen, capturing nutrient-rich dust, and stimulating plant growth. Studies have shown that there are strong relationships between biological soil crust cover and aggregation, and therefore wind erosion (Eldridge et al. 2003, pg. 464). Furthermore, biological crusts help trap moisture and promote water retention in desert soils. These crusts are vital for vegetation in dry landscapes and are a major contributor to enabling native grasses and vegetation to thrive in arid and semi-arid environments. The crusts are extremely vulnerable to disturbances such as off-road vehicles and grazing livestock and may take many decades to recover (Belnap 2003).

Changes to soil content, structure, or cover can all degrade its ability to function and can reduce the quality and amount of the services that it provides. The Gobian soils characteristic of the Oyu Tolgoi area have a high silt content and low content of organic matter. They are therefore easily eroded and dispersed by water and wind as well as being vulnerable to disruption (e.g. vehicle tracks) which breaks up the surface crust. These are the main contributory factors to soil degradation in the area which is an issue recognised locally (*Chapter B5* Section 5.8). These soils are also prone to deep penetration by rainfall utilising cracks and more permeable routes to reach the low permeability carbonate horizons typically present at depths of >25 cm. The moisture remaining at depth after these rainfall events is less susceptible to evaporation and is an important resource for local plant species. Compaction by tires or removal by excavation can destroy this function. Even after restoration on the macro level, at the micro level, soils will take a long time to recover chemically and biologically and redevelop the type of internal structure that is essential for them to function both physically and biologically.

Loss of vegetation through water diversions and groundwater withdrawals can also contribute to erosion and airborne dust in habitats such as playas, or takyre, which occur along the road corridor south of the Undai River (Map 7). Soil desiccation in and of itself can create conditions of airborne dust, an extreme example of which is the Aral Sea (Giles 2003).

Herders expressed concerns about soil disruption during early consultations. Herders do not fully recognise grazing to be a contributor to soil erosion and instead attribute more anthropogenic influences such as heavy trucks and vehicles. Specifically, they identify herding to be in harmony with soil stability because most livestock do not disrupt the root system. However, some herders identified horses and sheep to cause soil disruption because they paw at the ground and break the soil crust (Fernandez-Gimenez 1993).

Dust caused from soil disruption can have wide-reaching effects not only on primary productivity, as discussed, but also upon water quality and wildlife habitat. During early consultations, herders identified dust was one of the main concerns regarding environmental issues. It was mentioned as an environmental concern that was affecting their lives and was mentioned as one of the most important rangeland issues (Sternberg 2008). The landscape provides more than economic security through forage for livestock. A study found that the largest proportion of Mongolian herders gave the aesthetic values of the pasture ecosystem the highest priority, as they found beauty in various aspects of the ecosystems, including the clean air (Zhen et al. 2010). Therefore, dust affects not only the physical health of herders and their livestock, it also detracts from their quality of life.

The CHA identified erosion regulation as high importance, but the service does not trigger critical habitat due to the spatial alternatives. This analysis comes to a similar conclusion that erosion control is of high importance in terms of relevance to the herders and the community.

Project likelihood to affect service: High. The Project removes soil and recontours the landscape to produce steep surfaces. Road access will be a critical component of the Project in areas where none now exist.

Dependence: None for Project (excludes Type II)

Relevance to Affected Community: High. Multiple aspects of the herder lifestyle will be affected by dust and vegetation loss.

Management Control: The Project can control the extent and duration of soil disturbance.

Priority: Type I

7.5.3 Biological Services

Livestock

The local herders in Khanbogd *soum* employ the practices developed over millennia of grazing a diversity of livestock and relying on accumulated knowledge of animal physiology, plant ecology and a flexible nomadic herding strategy. Through these methods, pastoralists have been able to graze herds across the landscape and produce a continual output of animal-based products with few inputs other than those provided by the ecosystem service of pasture for livestock (Fernandez-Gimenez 1999). Standing vegetation provides an estimated 97 percent of livestock forage intake throughout the yearly cycle (Bergzsuren 2004).

The desert steppe is dominated by grasses, herbs, and shrubs with a wide range of annual standing crop yields. Desert steppe and desert communities, by virtue of climate and topography, generally have a patchy distribution of high and low forage areas and vegetation types based in part upon rainfall patterns and subsurface water. Khanbogd *soum* has pasture resources amounting to 1,278,000 ha. Use of *soum* pasture is dependent upon the distribution and abundance of vegetation species and water. Herders have organised their livestock based on the suitability of the breed with the available desert steppe vegetation as well as market demands for animal based products.

In 2010, there were 2,067 rural herders within Khanbogd *soum*. Herders accounted for just under two thirds of the overall *soum* population (*Chapter B8* Section 8.5.1). Most herders in Khanbogd *soum* own between 100 and 500 animals with the average number of livestock per family being 224 head of livestock. Herders have indicated that a herd of about 400 animals is considered generally sufficient to support a family of 4-5 people, although they also indicated that herd quality is more important than total head count. The composition of livestock in Khanbogd *soum* includes goats, sheep, camels, horses and cows. The local herders are interested in all livestock breeds but are particularly interested in goats due to cashmere sales (*Chapter B10* Section 10.6.5). Herders have identified camels and goats being as the most suitable animals to graze on the available vegetation provided by the desert steppe ecosystem (Fernandez-Gimenez 2000). Around 54 percent of the livestock in the *soum* are goats, 26 percent are sheep, 14 percent are camels and the remainder is horses (4 percent) and cows (2 percent). The most dramatic shift in herd growth has occurred in goat and camel numbers. The percentage of goats increased from 30 percent to 57 percent between 1970 and 2009 and the percentage of camels decreased from 18 percent to 2.6 percent (*Chapter B10* Section 10.6.5).

Larger animals, such as camels, graze mostly in southern part of the *soum* or where shrub and semi-shrub plants are dominant while smaller animals such as sheep and goats are concentrated in northern part of the *soum* with more grass and grass-like plants (about 17.8 percent of the total). Camels are also able survive on less water than other livestock, so camel pastures have been mapped in areas with fewer water sources than the pastures identified as suitable for sheep and goats (Map 10). During extreme climatic events such as *dzuds* and droughts, the majority of the herders move towards the state border or Gobi Strictly Protected Areas for survival. The forage yield in these areas is higher in most years and richer in nutrition.

There is no system to harvest rain or flood water; pasture conditions are dependent on variable rainfall. Forage abundance is closely linked to surface water. Herders observe that the droughts over the last few years caused a reduction of the growth of indigenous pasture grasses and some grasses ceased to grow at all. Seasonal vegetation in spring habitats may include *Carex duriscula, Puccinellia teniufolia, Glaux maritima* (near the Bor Ovoo Spring), *Iris lactaea, Phragmites communis, Achnatherum splendens* (near the Central Oyu), *Kaldiium gracile, Nitraria sibirica*, and *Carex duriuscula*. In the playas (takyres) along the road corridor (Map 7), surface run-off for short periods following heavy rainfall supports the growth of distinctive meadow communities with hydrophyllic species such as *Iris bungei, I. octopetala, I. lactea, C. duriuscula, Tamarix ramosissima, R. soongarica,* and *S. passerina*. (SEC 2010).

Walton (2010) describes how Mongolian government studies and *aimag* and *soum* officials have expressed concern that a large percentage of Mongolia's territory is affected, to some degree, by land degradation. From a local perspective, land degradation (often described loosely as desertification) is stated as a real concern. Walton (2010) lists several causes of land degradation in southern Gobi region including:

- Reduced precipitation;
- Increases in herd size;
- Herd concentration in smaller areas due to decreases in functioning water points;
- Changes in herd composition—more goats, and fewer camels, horses, and cattle;
- Damage by vehicle traffic; and
- Dust that accumulates on leaves and blankets roots, impeding plant growth.

Vegetation at Oyu Tolgoi and throughout the region is subject to a variety of pressures, including grazing, scarcity of water, and the influence of extreme weather conditions. The process of pasture degradation is evident through wind erosion, soil loss and the lack of regeneration of perennial plants. Overgrazing of pasture in this area depends on the livestock density and population of wild animals (for example, Asiatic wild ass). Herders have expressed increasing concerns about pastureland degradation and damage, particularly from dust, heavy vehicle use, mining and a lack of water and other climatic conditions (*Chapter B10* Section 10.6.8). Long term changes in vegetation quality were explained by herders to be mostly related to rainfall and soil fertility (Fernandez-Gimenez 2000). Herders reported that pasture access is becoming an increasing problem in Khanbogd, with 5 to 6 herding camps (generally composed of 12 households) reported in a single 2.5 km^2 pasture area (*Chapter B10* Section 10.6.8). This is partially related to the livestock density which is three times the carrying capacity of the land (Section *C10, Table 7.3* Pastureland Carrying Capacity, 2007).

Grazing pressure surrounding stock wells is most severe due to use by both livestock and wildlife. The result has been a reduction in vegetation cover and diversity at these locations. Impacts associate with livestock densities have been exacerbated by recent environmental conditions.

Recovery from overgrazing can be a slow process and may result in changes in vegetation composition which are undesirable for livestock grazing. A study of Mongolian rangeland pasture management found that recovery from animals bedding around wells took about 10 years and was characterized by a successional process beginning with disturbance-related unpalatable forbs and, after many years, by thinner more tender grasses (Fernandez-Gimenez 2000).

The CHA identifies Livestock to be an ecosystem service that qualifies as Critical Habitat. Our analysis draws a similar conclusion in terms of relevance to the community.

Project likelihood to affect service: Moderate. Less than 1 percent of the total pastureland in *Khanbogd soum* lies within the Project footprint. There is the potential for additional acreage to be indirectly affected by shifts in use patterns, water availability, and dust. Herders will be disrupted by relocation.

Dependence: None for Project (excludes Type II).

Relevance to Affected Community: High. All herders rely on good pasture close to water.

Management Control: The Project cannot avoid impacts but can minimise or replace through appropriate management controls.

Priority: Type I

Wild plants and animals

The use of native plants is an important part of the culture of the nomadic people of the Gobi. Many of the species listed as “very rare” by Mongolian law appear to have medicinal or other uses. The CHA (FFI and TBC Ltd 2011 General studies indicate 845 species of medicinal plants are used in Mongolia but less than 100 are found in the South Gobi region (Ministry for Nature, Environment, and Tourism 1996). The Government of Mongolia’s National Biodiversity Strategy specifically mentions medicinal plants as a biological resource requiring management for their conservation and sustainable use (Ministry of Nature, Environment, and Tourism 2009).

An assessment of the extent and use of medicinal plants in the AoI was conducted by Professor Ligaa Urtnasan, from the University of Mongolia (Urtnasan 2011). The research team interviewed more than 60 herding families, representing 163 people during the first 2 weeks in June, 2011. The purpose of the assessment was to understand how people currently use the medicinal resources of local plants, and not merely to compile lists of traditional medicinal uses. The study identified 57 local names of indigenous medicinal and food plants used in the area. Of these, 54 species are found corresponding to official Mongolian and scientific (Latin) names. The most commonly used plants are *Salsola laricifolia* (used by 80.3 percent of respondents), *Cynomorium songaricum* (72.1 percent), *Erodium stephanianum* (67.2 percent), and *Agriophyllum pungens* (60.6 percent).Respondents most often use medicinal plants chiefly in the treatment of gastro-intestinal disorders, common weakness, fatigue, infant dyspepsia, cold, and influenza. However, none are used on a daily basis. It is unclear whether the use of medicinal plants and herbs are on the increase or decrease. Some respondents have stated that medicinal plants are being over-harvested due to strong demand for these. Others argue that younger people prefer man-made pharmaceuticals. Urnnasan (2011) finds that another contributing factor to decreased availability of medicinal plants is natural disasters such as drought, flooding, and strong storms. Herders have expressed interest in projects that would help increase the number of plants by re-establishing and protecting them from various effects.

Herders in Khanbogd *soum* are well aware of the properties of the forage plant species that animals eat; which plants result in increased nutrition, body mass, milk output and wool growth, and whether those plants are poisonous or affect animal health. For instance, they know that *Convolvulus fruticosus* increases the milk output of camels, that consumption of large quantities of *Reaumuria soongorica* results in miscarriage in camels, that liver disorders may be caused by *Zygophyllum xanthoxylon*, and stomach gas may be caused by *Anabasis brevifolia*. The CHA identified wild foods to be of moderate significance but low importance when determining Critical Habitat.

Commercial pharmaceuticals may yet be found in these areas; it is therefore important to document the traditional uses of plants for future research before losing entire populations.

The CHA found wild foods to be of moderate significance but low importance in terms of Critical Habitat and identified natural medicines to be of moderate importance in their assessment of ecosystem services in Khanbogd *soum* due to their continued use to treat less severe illnesses. Our analysis draws a similar conclusion and finds wild plants and animals to be of moderate relevance to the community.

Project likelihood to affect service: Moderate. There will be losses of land with useful plants and animals, though of a magnitude similar to that for pastures.

Dependence: None for Project (excludes Type II).

Relevance to Affected Community: Moderate. Herders don’t rely entirely on plants and can find substitutes.

Management Control: The Project cannot avoid impacts but can minimise or replace through appropriate management controls.

Priority: Type I

Biomass Fuel

Saxaul trees (*Haloxylon ammodendron*) are considered sacred (Sampildondov and Purevjav 2011) and are important for several services including wood for fuel (Eco-Trade LLC 2004b as cited in World Bank 2003). Tolerant of arid, saline habitats, the highest densities of saxaul tend to occur in the drier areas to the south of Oyu Tolgoi (Maps 6 and 7). The saxaul tree is the major source of fuel wood in the desert regions of Central Asia. In Mongolia about 2 million ha of land are covered with saxaul. Focus Groups in early consultations discussed changes and trends in natural resources and their conditions, and ranked natural resources with regard to their significance for local livelihoods. Water was always ranked first, followed by the key forage plants including saxaul (Schmidt et al. 2011). *Soum* households in other parts of the Gobi may consume anywhere from between 1,200 and 1,600 kg of saxaul wood per year (Schmidt et al. 2011). Supplies of coal and dung, as well as ease of transport, may influence the use of saxaul (Neusel 2005). Locally, there may be some recent overharvest of saxaul for firewood, largely related to the availability of trucks to transport the wood (Schmidt et al. 2011). Shrubs such as *Caragana leucophloea* and *Eurotia ceratoides* are also occasionally collected for fuel. CHA identified biomass fuels to be a critical habitat in terms of biodiversity. Our analysis draws a similar conclusion in terms of relevance to the community given the extreme winters and reliance on the service.

Project likelihood to affect service: Moderate. Project footprint and buffers do not overlap with larger areas of saxaul forest.

Dependence: None for Project (excludes Type II).

Relevance to Affected Community: High. **Management Control:** Indirect through monitoring groundwater withdrawals.

Priority: Type I.

7.5.4 Human Use and Non-Use

Sacred, Spiritual and Cultural Sites

Human evolution resulted in more than a biophysical reliance on Ecosystem Services; it also deeply connected humans spiritually and culturally to the natural phenomena that humans depend on for health and well-being. Cultural identity is therefore partially shaped by the processes and functions of the surrounding ecosystem. This spiritual and cultural dependence is expressed by herders in Mongolia through the designation of landscapes, vegetation and animals as being sacred such as saxaul wood. Cultural services provided by the ecosystems can be tangible such as sacred species and intangible such as sense of place and traditional knowledge. Herders perceive themselves as being under the control of nature which is expressed through their spiritual traditions. Land is viewed as being controlled by governing spirits who have the power to bestow good weather or drought. Mountains are viewed as powerful forms of nature, but even these are inferior to the supreme power of the sacred sky. The spiritual dimension of nature is reconfirmed in worshipping rituals, offerings, and dedications to nature such as ovoos (Marin, 2010). Priority cultural services are in the process of being addressed in the current ESIA and other Project-related documents. These include the several cultural resource documentation efforts (e.g. Sampildondov, and Purevjav, 2011; Citrus, 2011 ESIA Chapter B15; Centre for Policy Research, Population Training and Research Centre, Chapter 12.2, 2009) and outreach surveys that capture local views on cultural and religious sites. There are also overlaps with water, such as the sacred nature of the Undai River. In general, there is overlap between key environmental points and sacred places. Authors Sampildondov and Purevjay write in the first of three recommendations based on their ethnographic overview:

> "*Most of the sacred mountain and rivers are mainly key environmental points of survival in the landscape for herders around that area. For example Uulzvar, Tsahildagtai, Darvagai and Undai rivers are the crucial water supply sources for the area herders and their cattle herds. Therefore, it [an analysis of cultural sites of importance] should consider that mountain, river and open water (zadgai us) sacred places are mainly pointing the crucial important areas for local livelihood and culture survival*".

Human use maps (Maps 8-10) have been developed that include some of the data from Sampildondov and Purevjay (2011). Due to the vulnerability of cultural sites to exploitation, the exact locations of sites are not provided. Instead, sites are contained within a 3 km radius representation of the general area of the site. Locations have been intentionally obscured by randomly placing the location area indicator over the location, but in no uniform fashion (in other words, the center of the location indicator does not represent the site location. The result is a screening-level effort; much of the data still outstanding. The maps show that dozens of wells, springs, cultural sites, and campsites within the AoI, most of which are concentrated in areas where water and vegetation are more common. Although most of these have already been surveyed as part of the Project through the Ecosystem Services approach, it is important to locate all of the human activities and areas of importance (use and nonuse) to determine where potential priority Ecosystem Services are located in relation to Project activities.

To understand the role of priority Ecosystem Services for human uses, the focus should be at the household uses of Ecosystem Services. For example, in the social, economic, and environmental subset study by the Center for Policy Research (2009), "wood, charcoal, and dung" are the most common household heating sources for homes in the affected area with over 93 percent of homes using these sources. Though it is not clear which fuels are used and in what proportions, it is clear that some come directly from plants and shrubs, and that at least in some areas of the Gobi, saxaul is a commonly used fuelwood (Neusel et al. 2005). Also, the same report cites that just under 59 percent of all households in the area sometimes use natural plants in the household and another 6 percent report that they often use natural plants.

Cultural and spiritual sites are covered in The CHA under 'Sacred or spiritual sites' and 'Areas used for religious purposes.' Their analysis identified these sites to be of low importance in terms of biodiversity and critical habitat. Our analysis identifies these sites to be high relevance to the community given that these locations represent cultural heritage and spiritual connection to their ecosystem. These locations will be treated as a priority in order to properly and adaptively manage impacts to them.

Project likelihood to affect service: Moderate. Cultural sites overlap with the Project footprint and AoI in multiple areas.

Dependence: None for Project (excludes Type II)

Relevance to Affected Community: High. There are no substitutes for the loss of some sites.

Management Control: The Project cannot avoid impacts but can minimise or mitigate through appropriate management controls.

Priority: Type I.

Campsites

Campsites provide essential services for herders in the harsh environment of the Gobi, and the criteria which determine a suitable campsite overlap with many of the Ecosystem Services previously discussed. Sites must be close to an adequate source of water for livestock and domestic use, have adequate forage nearby, be on high enough ground to avoid floods, and be in proximity to other services such as fuel. These choices are reflected in the distribution of winter shelter (Maps 8-10), which are typically kept very close to springs and ephemeral water courses. High concentrations of campsites within the 10 km buffer of the Mine Licence Area (Map 9) reflect in part the relatively abundant water resources of the area provided by the Undai River and its ephemeral tributaries. Not surprisingly, areas of cultural significance may also be found in these same areas, representing many generations of use.

Competition for winter camps may be particularly keen, as it is necessary to use sites that have adequate water and winter forage. Other features such as protective rock faces may also be important considerations when determining winter camp locations (Fernandez-Gimenez 1993).

Project likelihood to affect service: Moderate. There will be losses of land suitable for campsites, and indirect effects on other sites.

Dependence: None for Project (excludes Type II)

Relevance to Affected Community: Moderate. Herders have many options for campsites.

Management Control: The Project cannot avoid impacts but can mitigate or replace through appropriate management controls.

Priority: Type I

7.5.5 Determination of Priority Ecosystem Service types

Based on the ESS (Step 2) in the previous section, the third step involves a determination of the most important Ecosystem Services that are considered as Priority Ecosystem Services. This step in the baseline development process uses the Priority Ecosystem Services identified in the ESS and applies the criteria for Priority Ecosystem Services type to designate Type I and Type II Priority Ecosystem Services. Those services that meet the criteria for a Type I priority Ecosystem Services are those over which Oyu Tolgoi has direct control or significant influence, and where impacts on such services may adversely affect the community. Those services that meet Type II criteria are considered Ecosystem Services that the Project itself is dependent and which have the potential to impact the local communities.

Type I and Type II Ecosystem Services determination is provided as the last step in establishing the baseline Ecosystem Services. Output from this final determination of Type I and Type II Ecosystem Services will then be used in the Ecosystem Services Impact Chapter of the ESIA (see

Table **7.3**). The Ecosystem Services Impact Chapter describes the potential impacts on Ecosystem Services associated with the construction, operation and closure phases of the Oyu Tolgoi project. This chapter describes the direct measures that have been implemented to “design-out” or avoid adverse impacts together with the specific measures to minimise, mitigate, offset or compensate for those impacts that have been identified as unavoidable. Long-term management and monitoring measures are integrated into the relevant discipline chapters and related Impact Management Plans.

Type I priority Ecosystem Services are:

- Livestock;
- Wild plants and animals;
- Biomass fuel;
- Erosion regulation;
- Cultural and spiritual sites; and
- Campsites.

Priority Ecosystem Services that are determined to be Type II are those related to water:

- Fresh water; and
- Water regulation.

In its analysis of the same ecosystems services relative to Critical Habitat criteria (Key ecosystem services and Biodiversity of social, economic or cultural significance for local communities), the CHA determined that four were determined to be critical habitat: livestock, biomass for fuel, water regulation, and freshwater.

Table **7.3** below depicts the screening processes which affect each Type I and Type II determination. For a Type **I** service to qualify as a 'priority service', the following boxes would be ticked: Impact, Relevance to Affected Community, Management Control. For a Type **II** service to qualify as a 'priority service', the following boxes would be ticked: Dependence, Management Control.

Table 7.3: Priority Ecosystem Services based on ESR and ESS processes in the preceding sections

Ecosystem Service	Impact	Dependence	Relevance to Affected Community	Management Control	Priority Type	Critical Habitat
Provisioning						
Livestock	X		high	X	I	X
Wild plants and animals	X		moderate	X	I	
Fresh water	X	X	high	X	II	X
Biomass fuel	X		high	X	I	X
Regulating						
Water Regulation	X	X	high	X	II	X
Erosion regulation	X		high	X	I	
Cultural						
Sacred or spiritual sites	X		high	X	I	
Campsites	X		moderate	X	I	

7.6 SUMMARY OF ECOSYSTEM SERVICES BASELINE CHAPTER

This chapter reviewed and screened 21 provisioning, regulating, and supporting Ecosystem Services for priority status and determined 8 to be priority Ecosystem Services. Of those, two (fresh water and water regulation) have Project dependencies that elevated them to Type II status, while the remaining 6 are Type I.

Criteria used to determine priority were:

i) the likelihood that Project activities would directly or indirectly affect the provision of the service;
ii) the Project's dependence on the service;
iii) the relevance of the service to the lives of herders and local communities such as Khanbogd; and
iv) the ability of the Project to manage the effects that it might have upon the Project.

This approach differed slightly from that used in the CHA to determine which Ecosystems Services trigger Critical Habitat. The CHA evaluated each Ecosystem Service using significance x irreplaceability matrix. Four ES were identified as Critical Habitat: livestock, biomass fuel, freshwater, and water regulation. These ES are included within the list of priority ES determined by this analysis (*Table 7.3*). Instead the priority Ecosystem Services are those that are sufficiently important and significant to warrant a more complete impact analysis in the ESIA process.

To facilitate the analysis, GIS was used to map the general location of each service, or a suitable surrogate, relative to the Project footprint. Areas in which each Ecosystem Service and the Project footprint overlapped were presumed to indicate a higher likelihood that that Ecosystem Service would be affected. A review of the available data from Project proponents or local and regional literature was used to determine if Ecosystem Services were also affected indirectly, and the extent to which the Ecosystem Service was applicable to the local community.

Data for many Ecosystem Services were lacking due to the remoteness of the location, and the absence of a directed effort to collect data on Ecosystem Service function. In some cases, it was necessary to use the available literature to draw inferences about how Ecosystem Services might be concentrated, or how they were useful to the local population. Subsequently, the results of this analysis may be viewed as very conservative. It is understood, however, that mitigation measures will be implemented to address the effects of most Project activities and that, in many instances, anticipated effects will either be avoided or adequately mitigated such that the residual effects will be few.

The Ecosystem Services Impact Chapter will estimate the extent and magnitude of impacts to the priority Ecosystem Services identified in this chapter based upon an examination of spatial overlap among Project impact areas and associated Ecosystem Services. This will in turn inform the development of management and mitigation plans to reduce impacts on Ecosystem Services. Data gaps that remain from this effort will be carried over to the monitoring programs that the Project is developing to adaptively manage its influence on the local environment and economy.

7.7 LITERATURE CITED

Abrahams, P.W. 2002. Soils: their implications to human health. Science of the Total Environment, 291(1-3):1-32.Be

Bell, M.L., J.K. Levy, and Z. Lin. 2008. The effect of sandstorms and air pollution on cause-specific hospital admissions in Taipei, Taiwan. Occup Environ Med 2008, 65:104-111.

Centre for Policy Research, Population Training and Research Centre, 2009. Oyu Tolgoi Project Social, Economic and Environmental Subset, Final Report, September.

Eldridge, D.J., J. F. Leys. 2003. Exploring some relationships between biological soil crusts, soil aggregation and wind erosion. Journal of Arid Environments, 53: 457 – 466.

Fernandez-Gimenez, M.E. 1993. The role of ecological perception in indigenous resource management: a case study from the Mongolian forest-steppe. Commission on Nomadic Peoples, 33:31-46.

Fernandez-Gimenez, M.E. 1999. Sustaining the Steppes: A Geographical History of Pastoral Land Use in Mongolia. Geographical Review, 89(3):315 – 342.

Fernandez-Gimenez, M.E. 2000. The role of Mongolian nomadic pastoralists' ecological knowledge in rangeland management. Ecological Applications, 10(5):1318-1326.

Gao Y., M. Giese, S. Lin, B. Sattelmacher, Y. Zhao, and H. Brueck. 2008. Below ground net primary productivity and biomass allocation of a grassland in Inner Mongolia is affected by grazing intensity. Plant and Soil: 41-50.

Giles, F.S, S.L. O'Hara, J. Weger, J. Van Der Meer, I. Small, and R. Hubbard. 2003. The dynamics and characteristics of aeolian dust in dryland Central Asia: possible impacts on human exposure and respiratory health in the Aral Sea basin. 2003. The Geographical Journal 169(2): 142–157.

Kellogg, C.A., D.W. Griffin, V.H. Garrison, K.K. Peak, N. Royall, R.R. Smith, and E.A. Shinn. 2004. Characterization of Aerosolized Bacteria and Fungi From Desert Dust Events in Mali, West Africa Aerobiological, 20(2): 99-110.

Khasbagan H.H. and S. Pei. 2000. Wild plants in the diet of Arhorchin Mongol herdsmen in Inner Mongolia. Economic Botany, 54(4):528-536.

Krebs, C. J. 1985. Ecology: The Experimental Analysis of Distribution and Abundance, Third Addition. Institute of Animal Resource Ecology, University of British Colombia. Harper & Row. New York.

Urtnasan L. 2011. Ethnobotanical and ethnomedical investigations on medicinal and food plants growing in the territory of Khanbogd *Soum* and neighboring areas of Manlai and Bayan ovoo *soum*s in Omnogovi *Aimag* Revised Report.

Marin, A. 2009. Riders under storms: Contributions of nomadic herders' observations to analysing climate change in Mongolia. Global Environmental Change 20(1):162-176.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Full Document. World Resources Institute, Island Press, Washington, DC. Available online at: http://www.maweb.org/en/Global.aspx.

Mongolian Society for Range Management. 2010. Initiation of Rangeland Health Monitoring Program in Khanbogd *Soum*, Omnogovi *Aimag*. Funded by Oyu Tolgoi, LLC. Ulaanbaatar, Mongolia.

Natsagdorj, L., D. Jugder, and Y.S. Chung. 2003. Analysis of dust storms observed in Mongolia during 1937 – 1999. Atmospheric Environment, 37:1401 – 1411.

Neusel, B, D. Dashzeveg, and M. Mühlenberg. 2005. Report on saxaul utilisation in Southern Mongolia. Part II. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Eschborn, Germany. 17 pp.

Ni, Jian. 2004. Estimating net primary productivity of grasslands from field biomass measurements in temperate northern China. Plant Ecology, 174(2): 217-234.

NOAA. 2011. National Oceanic and Atmospheric Administration. Website available at: http://www.csc.noaa.gov/coastal/economics/habitatequ.htm.

Pei, S., H. Fu, and C. Wan. 2008. Changes in soil properties and vegetation following exclosure and grazing in degraded Alxa desert steppe of Inner Mongolia, China. Agriculture, Ecosystems & Environment, 124(1-2): 33-39.

Sampildondov, C., and L. Purevjav, 2011. The Report on Ethnographic Assessment for Sacred and Inherited Places Around Oyu Tolgoi Project Construction Objects (Oyu Tolgoi to Gashuun Sukhait Road, Power Towers, Water Pipeline and New Airport), Ulaanbaatar.

Schmidt, S., E. Baasandamba, A. Khaulenbek, and D. Bug. 2011. Saxual and Elm Assessment Khanbogd *Soum* for Oyu Tolgoi Critical Habitat Analysis IFC (International Finance Corporation) – Performance Standard 6. New Zealand Nature Institute – Initiative for People Centred Conservation.

SEC. 2010. Amendment to Mine and Processing Detailed Environmental Impact Statement. Revised November 2010.

Sternberg, T., N. Middleton, and D. Thomas. 2009. Pressurised pastoralism in South Gobi, Mongolia: what is the role of drought? Transactions of the Institute of British Geographers, 34: 364 – 377.

Walton. T. 2010. Southern Gobi Regional Environmental Assessment. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department, World Bank. Washington, D.C.

World Bank. 2003. Mongolia Environment Monitor: Land Resources and Their Management. World Bank, Washington, D.C.

Zhen, L, B. Ochirbat, Y. Lv, Y. J. Wei, X. L. Liu, J. Q. Chen, Z. J. Yao, F. Li. 2010. Comparing patterns of ecosystem service consumption and perceptions of range management between ethnic herders in Inner Mongolia and Mongolia. Environmental Research Letters. 5:1.