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ESIA Appendix 3

Biodiversity Impacts and Mitigation Actions for the Oyu Tolgoi Project

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1 Summary

This document briefly discusses the major potential impacts on biodiversity from the Oyu Tolgoi project, and details the major mitigation actions that will be undertaken. It is based upon a series of eight Biodiversity Management Plan Options Papers and a summary Biodiversity Management Plan Options Paper produced by the Rapid Biodiversity Assessment team to help the Oyu Tolgoi project meet the requirements of the International Finance Corporation's Performance Standard 6 (IFC PS6), the European Bank for Reconstruction and Development's Performance Requirement 6 (EBRD PR6), and Rio Tinto's Biodiversity Strategy (Rio Tinto 2010). It is complemented by the accompanying five appendices, the Biodiversity Strategy, Critical Habitat Assessment, Offsets Strategy, Net Positive Impact forecast and Monitoring & Evaluation.

This document discusses major potential impacts on priority biodiversity features. These are features for which the area of influence (Khanbogd soum) was found to qualify as:

- Tier 1 Critical Habitat: Asiatic Wild Ass
- Tier 2 Critical Habitat: Mongolian Chesney, Argali, Goitered Gazelle, Short-toed Snake-eagle, granite outcrop floral communities, and four ecosystem services (water regulation, livestock [pasture], biomass fuel and freshwater)
- Additional significant features under Rio Tinto Biodiversity Action Plan guidelines: Mongolian Gazelle, nine bird species and two habitats

Before the application of the mitigation actions, the Oyu Tolgoi project will have six main impacts on these priority biodiversity features:

- Direct habitat loss
- Indirect habitat loss (due to avoidance of infrastructure by animals)
- Fragmentation (reduced connectivity) of animal populations
- Direct mortality (from collision with vehicles and power lines, and electrocution by power lines)
- Indirect mortality from hunting and collecting (from increased numbers of people and increased access)
- Indirect mortality from increased populations of natural predators (from increased food and nesting opportunities)

In addition, some hydrological uncertainties could have significant consequences, and could require mitigation actions. The Oyu Tolgoi project has committed to undertake further research and monitoring to better assess these uncertainties.

The likelihood, consequence and risk of each impact were assessed for each priority biodiversity feature for each infrastructure unit. For all impacts assessed as Critical Risk or High Risk, mitigation options were identified. Actions required to mitigate low and moderate risk

impacts to priority biodiversity features or impacts to biodiversity features not of high conservation concern, are not presented in this document. These mitigation actions will be articulated in biodiversity-specific construction and operational management plans currently in development by the Oyu Tolgoi project.

The Oyu Tolgoi project has committed to adopt the mitigation options proposed for the Critical Risk and High Risk impacts, as summarised in Table 1. The Oyu Tolgoi project did not adopt a number of other options, almost all avoidance options, for various reasons, notably the advanced state of construction.

Implementation of these mitigation actions and offsets will reduce the residual impacts on priority biodiversity features, as quantified in the accompanying document 'Net Positive Impact forecast for the Oyu Tolgoi project'. Moreover, demonstration of best-practice road mitigation is a step towards achieving future regional connectivity of ungulate populations by facilitating similar mitigation of non-project regional infrastructure.

Table 1: Mitigation actions for all Critical and High Risk impacts agreed and committed to by Oyu Tolgoi

Infrastructure	Step in the mitigation hierarchy	Action
Roads	Minimise	Deter vehicles leaving, but facilitate wildlife crossing, the OT-GS, OT-Khanbogd and OT-airport roads (probably by using immovable boulders or posts, and optionally also ditches, but this needs further research, to prevent vehicles leaving either side of the road except for agreed herder crossings)
	Minimise	Provide driver awareness and training for all OT staff and contractors with specific information on priority biodiversity features (e.g. ungulates and birds)
	Minimise	Enforce no unauthorised waste disposal/littering from OT vehicles or around work place
	Minimise	Enforce low speed limits of OT vehicles on sealed and unsealed roads on and off-lease (speed limits for OT vehicles will be reviewed in consultation with a wildlife expert).
	Minimise	Engage with key stakeholders to support the adoption and enforcement of suitable speed limits (in line with OT vehicle speed limits) on all public users of the OT-GS Road
	Minimise	Restrict OT vehicles from parking beside roads except in an emergency or to manage fatigue
	Minimise	Engage with key stakeholders to encourage all road users to minimise parking beside roads except in an emergency or to manage fatigue
	Minimise	Erect signage on roads to warn drivers of risk of collision with wild animals
	Rehabilitate	Inspect and remove litter and other anthropogenic waste from along the OT - GS Road, OT - Khanbogd Road and OT Borefield Access Road 3 times weekly during peak construction period (frequency of inspections to be reviewed on an ongoing basis, and is expected to be reduced as project moves to operational phase and traffic on roads reduces)
Hunting and collecting	Minimise	Control illegal hunting by OT personnel (awareness, publicity and enforcement of strict no-hunting policy, including inspection as required and suitable penalties)

	Minimise	Engage with local and regional stakeholders to control hunting in the OT Aol and more broadly within Khanbogd soum (research the best actions to address illegal hunting and collecting, and undertake actions adequate to reduce the level and impact of illegal hunting and collecting to baseline levels)
	Minimise	Provide all project operations staff and contractors fuel for fires to prevent collection of local timber (i.e. saxaul)
	Minimise	Inspect an adequate proportion of all aircraft under OT control for illegal wild animal products
	Minimise	Inspect all vehicles entering the OT site for illegal wild animal products
Regional	Minimise	Provide adequate funding, capacity-building and other support to enable biodiversity mitigation actions to be integrated into regional planning, including infrastructure development, within Khanbogd soum (It is noted that more detailed commitments may be developed in association with the Oyu Tolgoi project social team)
Power Lines	Minimise	Add bird flight diverters to all power lines (install alternating flapper-type flight diverters and large spirals, alternating contrasting colours, at a frequency of at least one of each every 10 - 20 m i.e. one device every 5 -10 m)
	Minimise	Insulate medium-voltage powerline poles, dead-ends and sub-stations, and on pylons where necessary
	Rehabilitate	Document and remove collision carcasses and nests from medium voltage and high-voltage powerlines during regular inspections. Review periodicity of inspections after 6 months then at annual intervals
	Rehabilitate	Remove nests of birds which predate bustards, except where known to be Saker Falcon nests, where made on project-related infrastructure
Rehabilitation	Rehabilitate	Rehabilitate and restore at least equal areas or numbers of features impacted (in line with Oyu Tolgoi Rehabilitation Management Plan and standard Rio Tinto rehabilitation and restoration practice)
	Rehabilitate	Ensure replacement spring mimics the ecological functions of Bor Ovoo spring
Offsets	Offset	Undertake adequate offset actions to achieve a Net Positive Impact at low risk as discussed in the separate offsets discussion paper

2 Purpose of this paper

This document briefly discusses priority biodiversity features of the Oyu Tolgoi project area in southern Mongolia and major potential biodiversity impacts from the Oyu Tolgoi project, before detailing mitigation actions that Oyu Tolgoi LLC will undertake. It is the result of discussion between Oyu Tolgoi LLC and the Rapid Biodiversity Assessment team regarding appropriate mitigation actions for biodiversity impacts. These discussions were based upon a series of eight Biodiversity Management Plan Options Papers and a summary Biodiversity Management Plan Options Paper produced by the rapid biodiversity assessment team to help the Oyu Tolgoi project meet the requirements of the International Finance Corporation's Performance Standard 6 (IFC PS6), the European Bank for Reconstruction and Development's Performance Requirement 6 (EBRD PR6), and Rio Tinto's Biodiversity Strategy (Rio Tinto 2010).

This document is complemented by the accompanying appendices, which together provide a summary explanation of how the Oyu Tolgoi project will comply with Paragraph 10 of IFC PS6/Paragraph 14 of EBRD PR6:

- Appendix 1 Oyu Tolgoi LLC Biodiversity Strategy
- Appendix 2 Critical Habitat Assessment
- Appendix 4 Offsets Strategy
- Appendix 5 Net Positive Impact forecast
- Appendix 6 Monitoring & Evaluation

This document does not discuss the following points which were discussed in each of the eight Biodiversity Management Plan Options Papers:

- Description of each infrastructure component
- Sphere of influence of each infrastructure component

3 Priority biodiversity features within area of influence

Priority biodiversity features for the Oyu Tolgoi project comprise all biodiversity features for which the Oyu Tolgoi project area of influence qualifies as Critical Habitat under Paragraph 9 of IFC PS6 / Paragraph 13 of EBRD PR6 as well as all biodiversity features which are considered significant under Rio Tinto Biodiversity Action Plan guidelines. The Oyu Tolgoi project area of influence is considered here to be the sum of the areas of influence for each of the infrastructure components, which is the whole of Khanbogd soum as impacted by the secondary impact of illegal hunting, as used by the ESIA (Oyu Tolgoi LLC in prep.). However the Critical Habitat Assessment and the Oyu Tolgoi Project Guidance Note on Critical Habitat note that some impacts may extend beyond this area, notably the secondary impact of illegal hunting, but also the possible impacts on habitat and water availability over the deep Gunii Hooloi, Galbyn Gobi and Durulj Mount Southern aquifers. For the purpose of planning mitigation actions, a practical area of influence is needed, and is defined as Khanbogd soum. It is recognised that the secondary impact of illegal hunting may extend further, and it is recommended that offset and additional conservation actions are adequate to address this possible additional area of impact. The impacts on the aquifers are inadequately known and it is recommended that these are subject to further monitoring and research.

Although there has been limited baseline surveying, and some priority species may remain undetected, the Critical Habitat analysis was based on the best available maps of predicted distribution which have been developed or are under development for most taxa. National and international expert opinion was also solicited to ascertain inclusion of all plausible priority species. The monitoring and evaluation protocols to be developed in 2012 will also address the need for improved baseline data.

3.1 Biodiversity features which qualify for Critical Habitat

The rapid biodiversity assessment team's Critical Habitat Assessment (Appendix 2) found that the area of influence (Khanbogd soum) is:

- Tier 1 Critical Habitat for Asiatic Wild Ass;
- Tier 2 Critical Habitat for Mongolian Chesney, Argali, Goitered Gazelle, Short-toed Snake-eagle, granite outcrop floral communities, and four ecosystem services (water regulation, livestock [pasture], biomass fuel and freshwater).

A summary of the biodiversity values identified as qualifying for Critical Habitat is given in Table 2

Table 2: Critical Habitat qualifying biodiversity features

Criterion	Qualifying value	Biodiversity type	Critical Habitat category
1. Critically Endangered or Endangered species	Asiatic Wild Ass	mammal	Tier 1 (globally important concentrations of a globally Endangered species: >10% of the global population in the unit of analysis)
	Mongolian Chesney	plant	Tier 2 (nationally important concentrations of a potentially nationally Endangered species: >10% of the national population in the unit of analysis)
	Argali	mammal	Tier 2 (nationally important concentrations of a nationally Endangered species: >10% of the national population in the unit of analysis)
	Short-toed Snake-eagle	bird	Tier 2 (nationally important concentrations of a nationally Endangered species: >10% of the national population in the unit of analysis)
2. Endemic or restricted-range species	Not triggered		
3. Migratory or congregatory species	Goitered Gazelle	mammal	Tier 2 (nationally important concentrations of a migratory species: >1% of the global population in the unit of analysis)
4. Unique assemblages of species	Granite outcrop floral communities	species assemblage	N/a
5. Key evolutionary processes	Not triggered		
6. Key ecosystem services	Water regulation	ecosystem service	N/a
7. Biodiversity of social, economic or cultural importance to local communities	Livestock (pasture)	ecosystem service	N/a
	Biomass fuel	ecosystem service	N/a
	Freshwater	ecosystem service	N/a

Ecosystem services (Criteria 6 and 7 in Table 2) are considered to be a component of biodiversity but impacts and mitigation actions on ecosystem services are not discussed here because these need socio-economic, rather than biodiversity, assessment.

3.2 Additional biodiversity features considered significant under Rio Tinto Biodiversity Action Plan guidelines

All biodiversity features which qualify for Critical Habitat are considered to be significant under Rio Tinto Biodiversity Action Plan guidelines. In addition, Rio Tinto considers other key stakeholder biodiversity features (which may be primarily of local rather than global concern) within Biodiversity Action Plans (i.e. impacted features for which action may be needed). Within the Oyu Tolgoi project area of influence, these are considered to comprise:

- all globally and nationally threatened species
- all globally restricted-range species (i.e. terrestrial and freshwater fauna with ranges of <

- 50,000 km²; expert advice is needed to identify restricted-range flora)
- all habitats of conservation value; following the Critical Habitat report (Appendix 2), these are identified at an ecosystem level
- key habitats (finer-scale than ecosystems) advocated by stakeholders as documented in the Critical Habitat Assessment (Appendix 2)

3.3 Full set of priority biodiversity features

A full list of priority biodiversity features, combining those identified in Sections 3.1 and 3.2, is presented in Table 3. Additional plants, including those listed as Very Rare in the national *Law on Natural Plants*, may occur in the Oyu Tolgoi project sphere of influence (18 such species were identified as known or likely from the area in Appendix 2). There is very limited data on their distribution, status and ecological requirements, and they are considered to be sufficiently represented here by Mongolian Chesney which is the only species triggering Critical Habitat (Appendix 2). This will be updated as further data becomes available, such as in the forthcoming Mongolian Red List for Plants, and additional species may need to be treated separately.

Not all priority biodiversity features listed in Table 3 were included in all previous iterations of Biodiversity Management Plan Options Papers. Knowledge of features' distribution and status has increased over time, causing some features to be excluded and others to be included. Table 3 reflects best current knowledge.

All priority biodiversity features are priorities but the ungulates, notably Asiatic Wild Ass, could be considered as a 'flagship' species for mitigation and conservation actions. Southern Mongolia remains one of three areas in Eurasia that still hold viable communities of nomadic or migratory ungulates (the others being the Tibetan plateau and the Kazakhstan steppes; Harris *et al.* 2009; Mallon and Jiang 2009). Not only are these communities of ungulates now very restricted, but the global and Mongolian distributions of Asiatic Wild Ass and Goitered Gazelle are now extremely reduced. Indeed, since the 19th century the Asiatic Wild Ass has probably lost as much as 70% of its original Mongolian range because of human encroachment (Kaczensky *et al.* 2011). The unit of analysis represents a vital part of these ungulates' remaining global range – perhaps the most important remaining part for Asiatic Wild Ass as it is situated in the middle of their only sizeable remaining population (IUCN 2010; Kaczensky *et al.* 2011). Maps illustrating the species' global and national distribution are given in the Offsets strategy.

The ungulate communities are nomadic in response to pasture and water resources that are naturally patchy in space and time – an area that is important now may not be important next month, but may be important again in five years' time. Such nomadism in an area of sparse resources necessarily occurs over very large areas. Asiatic Wild Ass, for example, move an average of c. 12 km per day (Kaczensky *et al.* 2006). The 'A' and 'B' sections of the Small Gobi Strictly Protected Area are important refuges for these ungulates, but only form a minor part of the range of any individual ass or gazelle.

Table 3: Priority biodiversity features within area of influence

Taxonomic group	Biodiversity feature	Scientific name	Critical Habitat	IUCN Red List status	National Red List status	Status in unit of analysis
Plant (herb)	18 'very rare' plants such as Mongolian Chesney	<i>Chesneya/Chesniella mongolica</i>	Tier 2	-	EN?	Patchily distributed throughout – assumed here to represent all 18 'very rare' plants known or predicted from the project area
Mammal (carnivore)	Snow Leopard	<i>Panthera uncia</i>	-	EN	EN	Very rare 'resident'
Mammal (ungulate)	Asiatic Wild Ass	<i>Equus hemionus</i>	Tier 1	EN	EN	Nomadic 'resident'
Mammal (ungulate)	Argali	<i>Ovis ammon</i>	Tier 2	NT	EN	Localised resident
Mammal (ungulate)	Goitered Gazelle	<i>Gazella subgutturosa</i>	Tier 2	VU	VU	Migratory 'resident'
Mammal (ungulate)	Mongolian Gazelle	<i>Procapra gutturosa</i>	-	LC	EN	Rare visitor from the east
Mammal (rodent)	Long-eared Jerboa	<i>Euchoreutes naso</i>	-	LC	VU	Likely very rare in far south Undai
Bird	Swan Goose	<i>Anser cygnoides</i>	-	VU	NT	Likely a regular migrant over the area
Bird	Ferruginous Duck	<i>Aythya nyroca</i>	-	NT	VU	Likely a regular migrant over the area
Bird	Short-toed Snake-eagle	<i>Circaetus gallicus</i>	Tier 2	LC	EN	Breeds
Bird	Saker Falcon	<i>Falco cherrug</i>	-	VU	VU	Breeds
Bird	Egyptian Vulture	<i>Neophron percnopterus</i>	-	EN	LC	Probably breeds
Bird	Great Bustard	<i>Otis tarda</i>	-	VU	VU	Regular migrant (stops over in the area)
Bird	Houbara Bustard	<i>Chlamydotis undulata</i>	-	VU	VU	Breeds
Bird	Relict Gull	<i>Larus relictus</i>	-	VU	EN	Likely a rare migrant over the area
Bird	Pallas' Sandgrouse	<i>Syrrhaptes paradoxus</i>	-	LC	LC	Breeds
Bird	Mongolian Accentor	<i>Prunella koslowi</i>	-	LC	LC	Very localised breeder
Bird	Mongolian Ground-jay	<i>Podoces hendersoni</i>	-	LC	VU	Breeds
Bird	Yellow-breasted Bunting	<i>Emberiza aureola</i>	-	VU	NT	Likely a regular migrant
Species Assemblage	Granite Outcrop Floral Communities	n/a	Tier 2	n/a	n/a	Khanbogd and other massifs
Habitat	Riverine Elm Trees	n/a	-	n/a	n/a	Mostly in Undai riverbed
Habitat	Ephemeral Lakes and Pools	n/a	-	n/a	n/a	Scattered near to hills in south
Habitat	Tall Saxaul Forest	n/a	-	n/a	n/a	Mostly in borefield and depressions
Habitat	Eastern Gobi desert-steppe	n/a	-	n/a	n/a	Major habitat type in the region - widespread

Habitat	Alashan Plateau semi-desert	n/a	-	n/a	n/a	Major habitat type in the region - widespread
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CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern

As Table 4 illustrates, it is essential to understand what maintains biodiversity features in order to understand how they might be threatened and to set management objectives. Knowing why a biodiversity feature is of value helps prioritise which features need to be managed in order to have the biggest conservation impacts, to minimise negative reputational impacts and to identify opportunities. Values may range from global to local, and from scientific to practical. Table 4 and the rest of this report excludes five biodiversity priority features which are believed to occur in Khanbogd soum but not to be impacted by the Oyu Tolgoi project: Snow Leopard, Long-eared Jerboa, Mongolian Accentor, Granite Outcrops Floral Communities and Ephemeral Lakes and Pools.

Table 4: Summary of priority biodiversity features impacted in the area of influence, and their values and risks (illustrative, so not all priority biodiversity features included)

Priority biodiversity feature	What maintains the biodiversity feature	Value to Oyu Tolgoi or others	Risks to Oyu Tolgoi if not managed
Mongolian Chesney ¹	Poorly-known	Very rare medicinal plant	Lenders' and national regulations, Rio Tinto policies
Asiatic Wild Ass	Pasture, drinking water, extensive contiguous habitat, limited hunting pressure	Iconic species of extensive steppe and desert	Lenders' regulations, reputation, Rio Tinto policies
Argali	Pasture, drinking water, limited hunting pressure	Iconic species of rocky hills and mountains	Lenders' regulations, reputation, Rio Tinto policies
Goitered Gazelle	Pasture, drinking water, extensive contiguous habitat, limited hunting pressure	Iconic species of extensive steppe and desert	Lenders' regulations, reputation, Rio Tinto policies
Mongolian Gazelle	Pasture, drinking water, extensive contiguous habitat, limited hunting pressure	Iconic species of extensive steppe and desert	Lenders' regulations, reputation, Rio Tinto policies
Swan Goose	Safe migration route, open water habitat	Iconic international migrant	Lenders' regulations, reputation, Rio Tinto policies
Ferruginous Duck	Safe migration route, open water habitat	International migrant	Reputation, Rio Tinto policies
Short-toed Snake-eagle	Elm trees for nesting	International migrant	Lenders' regulations, Rio Tinto policies
Saker Falcon	Prey availability, nesting trees	Iconic predator of extensive steppe	Lenders' regulations, reputation, Rio Tinto policies
Egyptian Vulture	Carrion, nesting cliffs	Large bird, scavenging	Lenders' regulations, Rio Tinto

¹ assumed here to represent all 18 'very rare' plants known or predicted from the project area.

		services	policies
Great Bustard	Safe migration route, open grassy/scrubby habitat	Iconic international migrant	Lenders' regulations, reputation, Rio Tinto policies
Houbara Bustard	Safe migration route, open stony habitat, limited hunting pressure	Iconic international migrant and inhabitant of extensive steppe and desert	Lenders' and national regulations, reputation, Rio Tinto policies
Relict Gull	Safe migration route, open water habitat	International migrant	Lenders' and national regulations, Rio Tinto policies
Pallas' Sandgrouse	Semi-desert habitat, drinking water	Conspicuous resident susceptible to collisions with overhead wires	Reputation, Rio Tinto policies
Mongolian Ground-Jay	Scrubby habitat	Declining resident	Reputation, Rio Tinto policies
Yellow-breasted Bunting	Vegetation along migration route, especially near water	International migrant	Lenders' regulations, Rio Tinto policies
Riverine Elm Trees	Surficial (primary alluvial) aquifers, limited grazing pressure to allow regeneration	Shelter for animals from heat, sun, wind and predation; nesting for birds	Reputation, Rio Tinto policies
Tall Saxaul Forest	Surficial aquifers / soil moistures, limited grazing pressure to allow regeneration	Shelter for animals from heat, sun, wind and predation; nesting for birds	Reputation, Rio Tinto policies

4 Major potential impacts on biodiversity

Before the application of the mitigation hierarchy, the Oyu Tolgoi project will have six main impacts on priority biodiversity features, for which more details are given in Appendix II:

- Direct habitat loss
- Indirect habitat loss (due to avoidance of infrastructure by animals)
- Fragmentation (reduced connectivity) of animal populations
- Direct mortality (from collisions with and electrocution by vehicles and power lines)
- Indirect mortality from increased hunting and collecting
- Indirect mortality from increased populations of natural predators

In addition, the hydrological uncertainties in Box 1 could have significant implications for risk assessments and mitigation actions (further details in Appendix I). The Oyu Tolgoi project has committed to undertake further research and monitoring to better assess these uncertainties:

Box 1: Hydrological uncertainties, requiring further research and monitoring

Dewatering of the mine area

The Oyu Tolgoi project will:

In consultation with experts, establish a groundwater monitoring programme sufficient to detect project-related impacts of mine dewatering on surficial and alluvial aquifers (temporal and spatial analyses required to assess rate and extent)

Maintained groundwater flow in the Undai river

The Oyu Tolgoi project will:

In consultation with experts, establish a groundwater monitoring programme sufficient to enable the detection of project-related impacts on groundwater levels and surface hydrology in the Undai downstream of the mine.

Connectivity between the Gunii Hooloi deep and shallow aquifers

The Oyu Tolgoi project will:

In consultation with experts, establish a groundwater monitoring programme sufficient to detect impacts on surficial and alluvial groundwater levels related to abstraction from the Gunii Hooloi deep cretaceous aquifer.

Connectivity between the Gunii Hooloi and Galbyn Gobi aquifers

The Oyu Tolgoi project will:

In consultation with experts, establish a groundwater monitoring programme sufficient to detect any change in groundwater level of the deep Galbyn Gobi aquifer arising from abstraction from the Gunii Hooloi deep cretaceous aquifer.

Water abstraction from Durulj Mount Southern aquifer

The Oyu Tolgoi project will:

In consultation with experts, establish a groundwater monitoring programme sufficient to detect impacts on surficial and alluvial groundwater levels related to abstraction from the deep Durulj Mount Southern aquifer.

5 Priority biodiversity features to manage

The likelihood, consequence and risk of each impact were assessed for each priority biodiversity feature for each infrastructure unit, following Rio Tinto guidance note (Rio Tinto 2011). Methods and example risk assessment tables are in Appendix III. Risk assessment matrices for each priority biodiversity feature and each significant impact are presented in the constituent Biodiversity Management Options Papers (which have been made available to the lenders). Mitigation options were identified for all Critical and High Risks, as listed in Table 5:

Table 5: Priority biodiversity features at Critical and High Risk (in approximate order of significance)

Feature	Impact	Likelihood	Consequence	Risk
Asiatic Wild Ass, Goitered Gazelle	Indirect habitat loss due to avoidance of infrastructure	Likely	Serious	Critical
Asiatic Wild Ass	Indirect mortality from hunting facilitated by increased access	Possible	Major	Critical
Argali, Goitered Gazelle, Saker Falcon, Houbara Bustard, Tall Saxaul Forest	Indirect mortality from hunting and collecting facilitated by increased access	Possible	Serious	High
Argali, Houbara Bustard	Indirect habitat loss due to avoidance of infrastructure	Likely	Medium	High
Great Bustard, Houbara Bustard, Saker Falcon	Direct mortality from collision with and electrocution by power transmission lines	Almost Certain / Likely	Medium	High
Mongolian Chesney, Asiatic Wild Ass, Goitered Gazelle, Houbara Bustard, Mongolian Ground-Jay	Direct habitat loss under infrastructure	Almost Certain	Medium	High
Houbara Bustard, Mongolian Ground-Jay	Indirect mortality from increased predation rates	Likely	Medium	High

Mitigation options were not identified in this analysis for Medium and Low Risks. Most mitigation options for these risks will be covered by the options proposed for Critical and High Risks.

6 Mitigation options

Mitigation options were developed for all Critical Risk and High Risk potential impacts in the Options Papers. Throughout this section, the mitigation options committed to by OT are given in bold.

The uncertainties highlighted in Box 1 require ongoing monitoring and evaluation which may indicate the need for additional mitigation actions to ameliorate or restore impacts in priority biodiversity features.

Actions required to mitigate low and moderate risk impacts to priority biodiversity features or impacts to biodiversity features not of high conservation concern, are not presented in this paper. These mitigation actions will be articulated in biodiversity-specific construction and operational management plans currently in development by the Oyu Tolgoi project.

The biodiversity-specific construction and operational management plans will be complemented by a suite of other environmental management plans (e.g. air quality, waste, topsoil, water, transport) each of which will contain mitigation actions that contribute directly and indirectly to Oyu Tolgoi project's management of biodiversity.

From the perspective of biodiversity, the most effective mitigation is almost always avoidance. The Oyu Tolgoi project has stated that a number of optimal avoidance options cannot be adopted for various reasons, notably the advanced state of construction. These include the options in Box 2. There may however be opportunities to incorporate some of these options in future works, e.g. Oyu Tolgoi project is commissioning best-practice rare plant and Houbara Bustard surveys before deciding the route of a spur road between the mine and the Tavan Tolgoi 'coal road'. The Oyu Tolgoi project is committed to implementing all other proposed mitigation options except for those in Box 2:

Box 2: Mitigation options not taken

- Export ore via railway
- Bury lengths of road in tunnels
- Combine roads from Tavan Tolgoi and Oyu Tolgoi to Gashuun Sukhait
- Survey infrastructure routes and sites for immoveable priority biodiversity values
- Bury high-voltage power transmission lines
- Bury medium-voltage power distribution lines
- Use pylons with horizontal rather than vertical line alignment
- Use pylons with lighting arrestors at transmission towers rather than
- Use bird-friendly (low electrocution risk) poles for the medium-voltage power line
- Design the current temporary airport so that it could be developed and extended into a permanent airport
- Daily closures of the road upgrade to Gashuun Sukhait, to facilitate direct crossings and use of wildlife crossings by wild animals

The Oyu Tolgoi project has committed to implementing a number of best practice actions to mitigate the potential impacts of fragmentation by improving the connectivity of ungulate populations. Increased traffic volumes, notably along the road upgrade to Gashuun Sukhait, risk creating functional barriers to some animals, notably ungulates which are hunted (and hence wary of vehicles), as discussed in Appendix II.3. The actual residual impact of the road upgrade to Gashuun Sukhait will be limited given that it runs approximately in parallel to the Tavan Tolgoi to Gashuun Sukhait 'coal road' which lacks any mitigations against fragmenting ungulate populations. However, the Oyu Tolgoi project is committed to demonstrating best practice to mitigate the impacts of fragmentation and indirect habitat loss, and improve connectivity, between these roads, and to play a leading role in facilitating higher regional standards of infrastructure mitigation.

Table 6: Mitigation actions for all Critical and High Risk impacts

Infrastructure	Step in the mitigation hierarchy	Action
Roads	Minimise	Deter vehicles leaving, but facilitate wildlife crossing, the OT-GS, OT-Khanbogd and OT-airport roads (probably by using immovable boulders or posts, and optionally also ditches, but this needs further research, to prevent vehicles leaving either side of the road except for agreed herder crossings)
	Minimise	Provide driver awareness and training for all OT staff and contractors with specific information on priority biodiversity features (e.g. ungulates and birds)
	Minimise	Enforce no unauthorised waste disposal/littering from OT vehicles or around work place
	Minimise	Enforce low speed limits of OT vehicles on sealed and unsealed roads on and off-lease (speed limits for OT vehicles will be reviewed in consultation with a wildlife expert).
	Minimise	Engage with key stakeholders to support the adoption and enforcement of suitable speed limits (in line with OT vehicle speed limits) on all public users of the OT-GS Road
	Minimise	Restrict OT vehicles from parking beside roads except in an emergency or to manage fatigue
	Minimise	Engage with key stakeholders to encourage all road users to minimise parking beside roads except in an emergency or to manage fatigue
	Minimise	Erect signage on roads to warn drivers of risk of collision with wild animals
	Rehabilitate	Inspect and remove litter and other anthropogenic waste from along the OT - GS Road, OT - Khanbogd Road and OT Borefield Access Road 3 times weekly during peak construction period (frequency of inspections to be reviewed on an ongoing basis, and is expected to be reduced as project moves to operational phase and traffic on roads reduces)
Hunting and collecting	Minimise	Control illegal hunting by OT personnel (awareness, publicity and enforcement of strict no-hunting policy, including inspection as required and suitable penalties)
	Minimise	Engage with local and regional stakeholders to control hunting in the OT AoI and more broadly within Khanbogd soum (research the best actions to address illegal hunting and collecting, and undertake actions adequate to reduce the level and impact of illegal hunting and collecting to baseline levels)
	Minimise	Provide all project operations staff and contractors fuel for fires to prevent collection of local timber (i.e. saxaul)
	Minimise	Inspect an adequate proportion of all aircraft under OT control for illegal wild animal products
	Minimise	Inspect all vehicles entering the OT site for illegal wild animal products
Regional	Minimise	Provide adequate funding, capacity-building and other support to enable biodiversity mitigation actions to be integrated into regional planning, including infrastructure development, within Khanbogd soum (It is noted that more detailed commitments may be developed in association with the Oyu Tolgoi project social team)
Power Lines	Minimise	Add bird flight diverters to all power lines (install alternating flapper-type flight diverters and large spirals, alternating contrasting colours, at a frequency of at least one of each every 10 - 20 m i.e. one device every 5 -10 m)
	Minimise	Insulate medium-voltage powerline poles, dead-ends and sub-stations, and on pylons where necessary

	Rehabilitate	Document and remove collision carcasses and nests from medium voltage and high-voltage powerlines during regular inspections. Review periodicity of inspections after 6 months then at annual intervals
	Rehabilitate	Remove nests of birds which predate bustards, except where known to be Saker Falcon nests, where made on project-related infrastructure
Rehabilitation	Rehabilitate	Rehabilitate and restore at least equal areas or numbers of features impacted (in line with Oyu Tolgoi Rehabilitation Management Plan and standard Rio Tinto rehabilitation and restoration practice)
	Rehabilitate	Ensure replacement spring mimics the ecological functions of Bor Ovoo spring
Offsets	Offset	Undertake adequate offset actions to achieve a Net Positive Impact at low risk as discussed in the separate offsets discussion paper

6.1 Construct appropriate and sufficient underpasses

Indirect habitat loss, fragmentation and reduced connectivity of wildlife populations by roads can be mitigated by construction of appropriate and sufficient 'wildlife crossings' including overpasses (e.g. tunnels and wildlife overpasses) and underpasses (e.g. viaducts and culverts). Based on available evidence from priority species and similar species, and acting on a precautionary basis, such underpasses should be as long (where length is the axis of the road not the axis of animal movement) as possible (minimum 12 m long) and at least 4.5 m high along the entire length. It is estimated that one such underpass would be needed approximately every 6 km along roads to ensure appropriate ecological permeability for Asiatic Wild Ass and gazelles.

Such underpasses may potentially not delay current road construction if temporary diversions could be incorporated into the road until these structures were in place. The maximum grade of the road will be determined during design. A grade of e.g. 2% would mean that wildlife underpasses of 4.5 m height would require lead-in distances of 225 m each side. Thus, diversions of c. 500m would be required parallel to the road. These diversions could be used until suitable underpasses were constructed. It is possible that this strategy would need permission from the government, who may not favour underpasses as government will ultimately become responsible for their maintenance.

Any elevated infrastructure may provide nesting platforms for predators of Houbara Bustard. Any such structures should thus be designed with nest deterrents and/or be regularly monitored and nests removed.

Underpasses designed for wildlife along the road upgrade to Gashuun Sukhait will be most effective and cost-effective when situated over river beds. In such locations, it is likely that culverts will be required at minimum (to avoid flood damage to roads). River beds in the area are likely to also be a focus for wildlife activity, given the higher availability of water (e.g. springs) in such areas. In India, Asiatic Wild Ass more frequently travel along river beds (World Bank 2002).

Wildlife crossings can also be used by domestic livestock as long as monitoring is established to

ensure that livestock use does not prevent use by wildlife. If possible, vehicles should be prohibited from using wildlife crossings. If herder vehicles need to use wildlife crossings, they should be limited to only part of the width of such crossings or their damage to substrate may reduce or prevent use by wildlife. Vehicle routes can be indicated by placement of medium-sized rocks (large rocks and other blockages must be avoided as these will reduce or prevent use by wildlife). The substrate of the underpass must be natural, not waterlogged and have no obstructions or non-natural features such as litter, other anthropogenic waste, or excessive vehicle tracks.

Building solid sides at least as high as the highest Oyu Tolgoi project vehicles will render vehicles on the bridge invisible to wild animals considering crossing, and improve the likelihood of crossings. Building an earth berm along a length of road either side of any underpasses will help to hide traffic (enabling animals to approach roads), funnel animals towards the crossings and reduce incidence of collisions.

This demonstration of best-practice is a step towards achieving future regional connectivity of ungulate populations by facilitating similar mitigation of non-project regional infrastructure. Further background information to this recommendation is given in Appendix IV.

The Oyu Tolgoi project will:

Construct appropriate and sufficient underpasses (at ecologically suitable locations such as river beds, approximately every 6 km along the OT-GS road, as long as practically possible but minimum 12 m long, at least 4.5 m high along the whole length, with solid sides at least as high as highest OT vehicles, a natural, non-waterlogged substrate with no obstacles, affording a view of the horizon from either side, and with earth berm along edge of road either side of underpass to funnel wildlife towards underpasses; to be constructed before hand-over to GoM, probably in 2013)

6.2 Daily closures of the road upgrade to Gashuun Sukhait

Asiatic Wild Ass in the south-west Gobi region of Mongolia are most mobile at 16:00-20:00 (P. Kaczensky *in litt.* 2011), but these times will vary seasonally (earlier in winter, later in summer) so further study is desirable to identify the peak mobility period during each season. Kiang, Tibetan Antelope and Tibetan Gazelle most frequently used wildlife crossings under the Qinghai-Lhasa railway in the morning when traffic was lightest (Baofa *et al.* 2006; Xia *et al.* 2007), although it is not clear whether the key factor was traffic volumes or peaks of activity in mammals in mornings. In India, Asiatic Wild Ass most often crossed roads in mornings and evenings (World Bank 2002). Daily closures of the upgraded road to Gashuun Sukhait to Oyu Tolgoi project traffic is likely to facilitate direct crossing of the road and use of wildlife crossings by wild animals notably Asiatic Wild Ass, which may otherwise stay too far away from the road. However, it would be counter-productive if closures encouraged any non-Oyu Tolgoi project vehicles to drive off-road to avoid closures.

The Oyu Tolgoi project is investigating opportunities to address this option (December 2011).

6.3 Driver awareness and training

Vehicle drivers who are aware of and trained in safe driving techniques will have fewer collisions with wild animals, other vehicles and livestock, which have additional social and health/safety benefits.

The Oyu Tolgoi project will:

Provide driver awareness and training for all OT staff and contractors with specific information on priority biodiversity features (e.g. ungulates and birds)

6.4 Enforce no waste disposal from vehicles or around work place

Organic waste, especially foodstuffs, attracts and supports predatory and scavenging birds and mammals, which may predate priority biodiversity features.

The Oyu Tolgoi project will:

Enforce no unauthorised waste disposal/littering from OT vehicles or around work place

6.5 Enforce low speed limits

Enforcing low speed limits will reduce collisions with wild animals, other vehicles and livestock, which has additional social and health/safety benefits.

The Oyu Tolgoi project will:

Enforce low speed limits of OT vehicles on sealed and unsealed roads on and off-lease (speed limits for OT vehicles will be reviewed in consultation with a wildlife expert).

Engage with key stakeholders to support the adoption and enforcement of suitable speed limits (in line with OT vehicle speed limits) on all public users of the OT-GS Road

6.6 Prevent vehicles leaving, but facilitate wildlife crossing roads, by use of boulders and/or posts and/or ditches

Vehicles currently readily leave roads in the area when their quality degenerates, resulting in increased habitat loss, wildlife avoidance distances and impacts such as hunting or wildlife collisions. The road upgrade to Gashuun Sukhait should largely alleviate these problems. In order to ensure this, obstacles are necessary to prevent vehicles leaving the road at will (though vehicles will ultimately be able to leave the road at designated herder crossings). These obstacles may comprise immovable boulders (immovable boulders could be partially buried to leave the minimum exposure to prevent vehicle passage), or short (above vehicle axle height) but solid posts (e.g. concrete with steel cable core), either obstacle being accompanied by shallow ditches (c.1 m deep and 2 m wide). None of these features are likely to present a significant barrier to wildlife after they have habituated to their presence, though boulders (as

a natural feature) and shallow ditches are likely to present the least barrier to wildlife. Boulders could be sourced from the mine provided that there is a low risk of acid leaching. Ditches may promote vegetation growth (being nearer the water table), thus attracting wildlife and livestock and increasing collision risks, but would increase difficulty of vehicles squeezing between boulders or posts. As long as ditches are designed so that wildlife cannot be trapped in them, their biodiversity benefits are likely to outweigh their costs.

The Oyu Tolgoi project will:

Deter vehicles leaving, but facilitate wildlife crossing, the OT-GS, OT-Khanbogd and OT-airport roads (probably by using immovable boulders or posts, and optionally also ditches, but this needs further research, to prevent vehicles leaving either side of the road except for agreed herder crossings)

6.7 Prevent vehicles parking beside roads

Parking vehicles beside roads increases the barrier effect of roads to wild animals which are hunted by people in vehicles.

The Oyu Tolgoi project will:

Restrict OT vehicles from parking beside roads except in an emergency or to manage fatigue

Engage with key stakeholders to encourage all road users to minimise parking beside roads except in an emergency or to manage fatigue

6.8 Erect warning signs

Erection of suitable signs to warn vehicle drivers of the risks of collisions with wild animals and other obstacles will reduce collisions with wild animals (Huijser *et al.* 2009), other vehicles and livestock, which has additional social and health/safety benefits.

The Oyu Tolgoi project will:

Erect signage on roads to warn drivers of risk of collision with wild animals

6.9 Regularly remove litter and collision carcasses

Litter, especially foodstuffs, and collision carcasses, attract and support predatory and scavenging birds and mammals, which may predate priority biodiversity features. Removing all litter and carcasses will rehabilitate the habitat (with respect to populations of predators and scavengers) as well as monitoring the impact of collisions. Other anthropogenic waste can add to the barrier effect of infrastructure towards wild animals, and reduce habitat quality. The periodicity of removal will be refined based on the design and results of the monitoring and evaluation plan; at present (December 2011), the monitoring needs but not methods have been determined (Appendix VI Monitoring and Evaluation).

The Oyu Tolgoi project will:

Inspect and remove litter and other anthropogenic waste from along the OT - GS Road, OT - Khanbogd Road and OT Borefield Access Road 3 times weekly during peak construction period (frequency of inspections to be reviewed on an ongoing basis, and is expected to be reduced as project moves to operational phase and traffic on roads reduces)

6.10 Control illegal hunting in the wider landscape

The primary impact from in-migration of people and money associated with, but not under direct control of, the Oyu Tolgoi project is indirect mortality from illegal hunting and collecting. As well as the increase in direct mortality, hunted species show greater avoidance of infrastructure, which increases the area of indirect habitat loss and the chance of fragmentation of hunted species' populations. A model for control of illegal hunting exists in western Mongolia where WWF has been successfully developing national-level anti-poaching government enforcement teams and informant networks. Actions to control illegal hunting and collecting are complex and are discussed more fully in the offsets discussion paper. It is important to differentiate between mitigation actions, which would maintain the levels of hunting at that of the base-line before any impacts from the Oyu Tolgoi project, and offset actions, which would improve the levels to better than the base-line. To clarify the difference between mitigation and offset, and enable undisputed quantification of offset gains, it could be easier to classify these actions based on location, for example, all actions in Khanbogd soum are mitigation actions, and all actions in neighbouring soums are offset actions.

The Oyu Tolgoi project will:

Control illegal hunting by OT personnel (awareness, publicity and enforcement of strict no-hunting policy, including inspection as required and suitable penalties)

Engage with local and regional stakeholders to control hunting in the OT Aoi and more broadly within Khanbogd soum (research the best actions to address illegal hunting and collecting, and undertake actions adequate to reduce the level and impact of illegal hunting and collecting to baseline levels)

6.11 Provide all project operations, staff and contractors with fuel other than firewood

Fuel needs of local people are primarily fed by dried livestock dung and, in winter when heating needs are high, woody plants, notably saxaul (Damdin 2011; Center for Policy Research 2009 in Environ 2011). Tall Saxaul Forest is a priority biodiversity feature and supports other features such as Saker Falcon. Tall Saxaul Forest is currently over-collected in Khanbogd soum, and this is predicted to increase with increasing in-migration of people (Schmidt *et al.* 2011).

The Oyu Tolgoi project will:

Provide all project operations staff and contractors fuel for fires to prevent collection of local

timber (i.e. saxaul)

6.12 Inspect goods being transported by plane (for hunted animals)

Inspection of all aircraft under the control of the Oyu Tolgoi project for illegal wild animal products will help reduce the impact of constructing an airport on the rate of illegal hunting. Inspection could be undertaken on all aircraft or an effective random proportion of aircraft. There must be adequate publicity and enforcement of punishments to act as an effective deterrent.

The Oyu Tolgoi project will:

Inspect an adequate proportion of all aircraft under OT control for illegal wild animal products

Publicise and apply suitable penalties to offenders under OT control found trafficking illegal wild animal products

6.13 Inspect vehicles (for hunted animals) at start and end of roads

Inspection of all vehicles under the control of the Oyu Tolgoi project for illegal wild animal products will help reduce the impact of upgrading roads on the rate of illegal hunting. Inspection could be undertaken on all vehicles or an effective random proportion of vehicles, at the start and end of all roads which may act as conduits for hunters or movement of hunted animal products. The road to Gashuun Sukhait is the highest priority given its length and connection to China which is a major market for wild animal products. There must be adequate publicity and enforcement of punishments to act as an effective deterrent.

The Oyu Tolgoi project will:

Inspect all vehicles entering the OT site for illegal wild animal products.

Publicise and apply suitable penalties to offenders under OT control found trafficking illegal wild animal products.

6.14 Enable balanced and sustainable regional planning

Secondary impacts of the increased number of non-Oyu Tolgoi project employees in Khanbogd soum can be mitigated by enabling balanced and sustainable regional planning, including infrastructure development, within Khanbogd soum. Currently Khanbogd does not have the infrastructure or administrative capacity to manage such large transformations without significant support from both the Government of Mongolia and the major project developers in the region. The Oyu Tolgoi project is establishing a Local Regional Planning and

Infrastructure (LRPI) unit to coordinate with the Southern Gobi Regional Development Council (SGRDC) that is being established by the Government of Mongolia. Moreover, a regional, landscape level approach is required to address the cumulative fragmentation effects of infrastructure development in the southern Gobi region. This is best achieved through close cooperation between key regional stakeholders on regional planning issues. The recently agreed MoU on biodiversity management and monitoring between OT and Energy Resources LLC provides an excellent example of opportunities for collaboration between key stakeholders in the southern Gobi region.

The Oyo Tolgoi project will:

Seek opportunities to engage with key stakeholders and provide adequate funding, capacity-building and other support to enable biodiversity mitigation actions, including those that minimise cumulative fragmentation effects of linear infrastructure, to be integrated into regional planning, including infrastructure development, within Khanbogd soum. (It is noted that more detailed commitments may be developed in association with the Oyo Tolgoi project social team).

6.15 Add bird flight diverters to all power lines

Most collisions are with the highest and thinnest wires, usually the earth wire. Various 'bird flight diverters' can increase visibility and avoidance of these wires. Bird flight diverters can be both visual and auditory markers of power lines. The most common visual markers are large PVC spirals (e.g. "Swan Deflectors" of 1 m length and 30 cm diameter; Figure 1). The most common auditory markers are 'flappers' – these are usually smaller (less visible) but make a noise when they blow in the breeze. PVC spirals alone have been shown to reduce bird collision mortality by up to 81% (Janss & Ferrer 1998), flappers on their own have been shown to reduce bird collision mortality by 60-63% (Brown & Drewien 1995; Yee 2008), and flappers added to spirals have been shown to reduce bird collision mortality by an additional 52% (Anderson 2002). Noise-generating flappers may be particularly important for bustards, which show poor visual detection of power transmission lines (Martin & Shaw 2010). Because bustards migrate during the day and at night, a particularly effective flapper may be the "Bird Mark AG" (Figure 2), which glows in the dark for up to ten hours after dark.

Frequencies of bird flight diverters of every 5-10 m along the earth wire have been shown to reduce collision rates (Jenkins *et al.* 2010; Barrientos *et al.* 2011; J. Shaw pers. comm. 2011). It is assumed that increasing these frequencies further will further reduce the collision rate, e.g. a frequency of every 1.5 m is recommended for high-risk lines for Little Bustard in Portugal (J.-P. Silva pers. comm. 2011). It has been suggested that bird flight diverters be yellow or yellow-green, or alternating contrasting colours (dark and light), to maximise effects within the avian visual spectrum (Crowder & Rhodes 2001) but this has not yet been adequately tested in the field (Jenkins *et al.* 2010). Nonetheless, alternating contrasting colours inherently have more likelihood of including colours that are visible to birds.

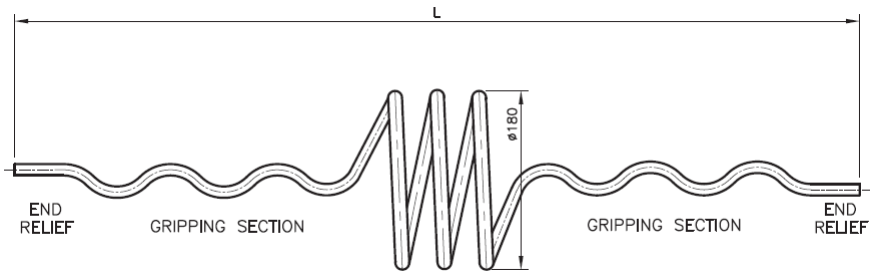


Figure 1: Spiral bird flight diverter



Figure 2: "Bird Mark AG" flapper bird flight diverter in daylight and at night

The Oyu Tolgoi project will:

Add bird flight diverters to all power lines (install alternating flapper-type flight diverters and large spirals, alternating contrasting colours, at a frequency of at least one of each every 10 - 20 m i.e. one device every 5 -10 m)

6.16 Insulate medium-voltage powerline poles, dead-ends and sub-stations, and on pylons where necessary

Retrofitting customised insulation to problem areas of medium-voltage (<40 kV) distribution powerline infrastructure can reduce the risk of perching birds being electrocuted. Insulation will require regular inspection and will probably need replacing every few years given the harsh weather conditions (A. Dixon pers. comm. 2011). Similarly, any jump wires and sub-station wires identified as presenting a high risk to birds should be insulated or routed under conductor arms. The Oyu Tolgoi project is currently (December 2011) in discussion with bird electrocution experts to determine the exact insulation needs.

The Oyu Tolgoi project will:

Insulate medium-voltage powerline poles, dead-ends and sub-stations, and on pylons where necessary

6.17 Remove nests of birds which predate bustards, where made on infrastructure

Any elevated infrastructure could provide nesting and perching areas for predatory birds. This would increase the local population densities of these predators, and increase the level of predation on Houbara Bustard and other priority biodiversity species. It is considered more cost-effective to remove nests of species that are potential predators of Houbara Bustard nests and young (e.g. buzzards *Buteo* spp., Black Kite *Milvus migrans* and Common Raven *Corvus corax*) as they are built rather than to mitigate this risk through perch-deterrents (such as the spikes commonly seen to deter perching pigeons in American and European cities). It is standard practice for Mongolian companies maintaining electricity infrastructure to remove birds' nests annually, after they have laid eggs in spring (G. Sundev pers. comm. 2011). Although Saker Falcon is commonly used by falconers to hunt Houbara Bustard, wild Saker Falcon appear to very rarely hunt Houbara Bustard in this region (Sundev *et al.* 2001; G. Sundev pers. comm. 2011). Therefore, nests known to be of Saker Falcon, which is a priority biodiversity feature), should not be removed.

The Oyu Tolgoi project will:

Remove nests of birds which predate bustards, except where known to be Saker Falcon nests, where made on project-related infrastructure

6.18 Regularly remove collision carcasses

Collision carcasses under power lines, attract and support predatory and scavenging birds and mammals, which may predate priority biodiversity features. Removing every carcass will rehabilitate the habitat (with respect to populations of predators and scavengers) as well as monitoring the impact of collisions. Standard methods exist for adjusting bird carcass surveys to account for scavenging rates. OT is currently (December 2011) investigating the potential to install Bird Strike Indicators which are electronic devices mounted on power lines to detect actual collisions. These could be used to directly quantify bird collisions in sensitive areas and control areas. They could also be used to compare pre- and post-mitigation collisions in offset areas. The periodicity of carcass removal will be refined based on the design and results of the monitoring and evaluation plan; at present (December 2011), the monitoring needs but not methods have been determined (Appendix VI Monitoring and Evaluation).

The Oyu Tolgoi project will:

Document and remove collision carcasses and nests from medium voltage and high-voltage powerlines during regular inspections. Review periodicity of inspections after 6 months then at annual intervals

6.19 Rehabilitate and restore vegetation, specifically including Mongolian Chesney, Riverine Elm Trees and Tall Saxaul Forest

Rehabilitation and restoration are largely considered to be a standard best practice and, as such, not detailed here. However the mitigation options for impacts on the vegetative priority biodiversity features (Mongolian Chesney, Riverine Elm Trees and Tall Saxaul Forest) include explicit rehabilitation and restoration of these species and habitats. There are opportunities for enabling regeneration of Tall Saxaul Forests as young regenerating saxaul is currently widespread in Khanbogd soum including in Gunii Hooloi around the borefield (Schmidt *et al.* 2011). It is noted that propagation could be undertaken at the recently established Khanbogd nursery, and also that three elm trees have already been transplanted, the long-term outcome of which is being monitored.

The Oyu Tolgoi project will:

Rehabilitate and restore at least equal areas or numbers of features impacted (in line with OT Rehabilitation Management Plan and standard Rio Tinto rehabilitation and restoration practice)

6.20 Ensure replacement spring recreates ecological functions of Bor Owoo spring

The Oyu Tolgoi project proposes to establish an artificial spring at the point where the proposed Undai groundwater diversion pipe terminates, to replace the Bor Owoo spring which will be covered by the waste dump rock. The spring should mimic the characteristics of the Bor Owoo spring as closely as practicable - taking into consideration the extent of inundation and catchment size, establishing vegetation and rocky outcrop habitats. It should be noted however, that the location of the spring will limit its use as it will be located within the zone of avoidance for ungulates.

The Oyu Tolgoi project will:

Ensure replacement spring mimics the ecological functions of Bor Owoo spring

6.21 Establish conservation actions specific to impacted biodiversity features

Most residual impacts are technically feasible to offset. Offset options include addressing illegal hunting, improving pasture and habitat quality, mitigating other infrastructure in the region and propagation and planting of Riverine Elm trees and Tall Saxaul Forest. Offsets are feasible but expensive and are not an alternative to following the mitigation hierarchy. More details are available in the rapid biodiversity assessment team's draft offsets paper and no further consideration is presented here.

The Oyu Tolgoi project will:

Undertake adequate offset actions to achieve a Net Positive Impact at low risk as discussed in

the separate offsets discussion paper

There are also a range of best-practice mitigation measures such as minimising noise and dust pollution, and preventing establishment of invasive alien species. These standard procedures are dealt with in Environmental Management Plans and are not discussed further here. A number of these mitigation actions will also address health and safety objectives (e.g. reduction of collisions with vehicles) and social objectives (e.g. pasture management).

7 Monitoring

Monitoring and evaluation is addressed in Appendix 6 Monitoring & Evaluation. It is noted that many of these mitigation actions will be inadequate if not supported by suitable monitoring and evaluation. These monitoring actions will be captured in the ongoing process of developing a Biodiversity Action plan workbook for the Oyu Tolgoi project.

It is noted that some monitoring actions are needed to assess the likelihood of low-probability high-consequence impacts which are currently assessed as 'uncertainties' and discussed in Appendix I. These monitoring actions are essential to indicate whether any of these 'uncertainties' are likely realities. The Oyu Tolgoi project has committed to undertake the monitoring actions for these 'uncertainties' as detailed in Box 1.

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Appendix I: Hydrological uncertainties

A number of hydrological uncertainties have been identified which could have significant influence on the risk assessments of priority biodiversity features or on the mitigation of other impacts. The Oyu Tolgoi project has committed to undertake further research and monitoring to better assess these uncertainties, as detailed in Box 1. For each hydrological uncertainty, a summary description is given here, followed by fuller background details.

I.1 Dewatering of the mine area

The impact of dewatering of the mine area on the neighbouring shallow and alluvial aquifers is inadequately known as the connections between these aquifers are uncertain. If there are significant functional hydrological connections, dewatering may cause loss of habitat, springs and waterholes across a large cone of depression.

I.2 Maintained groundwater flow in the Undai river

The ability of the river diversions to maintain the original hydrological connections and flows, particularly given mine dewatering, is uncertain. If the flows are impacted, the sustainability of groundwater flow and springs downstream of the mine may be compromised, and a large area of the lower Undai basin may be impacted.

I.3 Connectivity between the deep Gunii Hooloi aquifer and overlying surficial and alluvial aquifers

The impact of abstracting water from the deep Gunii Hooloi aquifer is inadequately known as the connectivity between this deep aquifer and the overlying alluvial and surficial aquifers is uncertain. If there are significant functional hydrological connections, abstraction may cause loss of habitat, springs and waterholes across the whole Gunii Hooloi borefield.

I.4 Connectivity between the Gunii Hooloi and Galbyn Gobi aquifers

The impact of abstracting water from the deep Gunii Hooloi aquifer is inadequately known as the connectivity between this aquifer and the neighbouring Galbyn Gobi aquifer is uncertain. If there are significant functional hydrological connections, abstraction may cause drawdown in the Galbyn Gobi aquifer. As noted above, if there are significant functional hydrological connections with surficial aquifers, abstraction may cause loss of habitat, springs and waterholes across the whole Galbyn Gobi area.

I.5 Connectivity between the deep Durulj Mount Southern aquifer and overlying surficial aquifers

The impact of abstracting water for Khanbogd camp from the deep Durulj Mount Southern aquifer is inadequately known as the connectivity between this aquifer and overlying shallow surficial aquifers is uncertain. If there are significant functional hydrological connections, abstraction may cause drawdown in the adjacent shallow surficial aquifers which may cause loss of habitat, springs and waterholes in the area of influence of these aquifers.

Dewatering of the mine area

Riverine Elm Trees, Tall Saxaul Forest, Asiatic Wild Ass, Argali and Goitered Gazelle are all dependent on groundwater resources – elms and saxaul tap groundwater through their deep (up to approximately 40 m) root systems and ungulates rely on groundwater fed springs. Saker Falcon is dependent on elm and saxaul trees for nesting but may be able to nest on electricity transmission pylons being erected by the project. At present it is not entirely clear what impact the effects of dewatering will have on groundwater resources outside of the Mine License Area. The impact assessment in this options paper is based on assumptions presented in the ESIA (2011) and the Amendment to the Mine & Processing DEIA (2010), which state that the shallow groundwater system present within the surface materials and weathered bedrock across the Mine License Area has limited hydrological connectivity with the alluvial aquifer beneath the Undai. Until actual flow rates are established and investigation of intersected aquifers takes place (during construction of the underground mine and open pit), the actual impact on groundwater dependent priority biodiversity features remains unclear.

Priority biodiversity features would suffer significant consequences if mine dewatering causes significant draw down of groundwater in the Undai channel. The likelihood of Riverine Elm Trees in the dewatering zone being impacted by mine dewatering is considered possible but the consequence only medium - given the very small number of trees – resulting in a moderate risk. However, the consequence of Riverine Elm Trees downstream of the dewatering zone being impacted by mine dewatering is Serious given that this section of river supports a globally significant population (H. von Wehrden *in litt.* 2011) of Riverine Elm Trees. The likelihood of this second impact is uncertain as discussed in Box 3; if possible or likely, this would imply a high risk. Impacts on Saker Falcon and ungulates are assessed as unlikely or possible, resulting in minor or moderate risk.

If the effects of dewatering are shown to have a significant impact on groundwater resources in the Undai then the likelihood and threat rating for all groundwater dependent biodiversity features will be elevated – the degree of elevation will depend on how far the impacts are felt from the Mine License Area. Box 3 summarises the potential risk from hydraulic connectivity, and primary mitigation and monitoring actions.

Box 3: Potential risk from mine dewatering

Construction of the open pit will dewater sediments around the pit, some of which form surficial aquifers (Amendment to the Mine & Processing DEIA 2010). There is a risk that these surficial aquifers have functional hydrological connectivity with the alluvial aquifer beneath the Undai. Dewatering could then affect the downstream hydrology of the Undai. The relative contribution of the Undai to downstream alluvial aquifers is poorly-known, but mine dewatering could potentially affect a very large area of alluvial aquifers which support a large proportion of the Riverine Elm Trees and the best-quality Tall Saxaul Forest in the unit of analysis. This would have a serious or major impact, and is potentially a critical risk.

Currently and provisionally, the risk of hydrological connectivity is considered low based on the limited evidence from current monitoring. Water abstraction for construction activities has resulted in groundwater levels dropping by up to 8 m (although a limited (<1 m) drop in water level has occurred in some boreholes) since baseline conditions were established in 2003 but water levels away from these active bores has remained relatively constant suggesting low hydrological conductivity. A full risk assessment cannot be completed without better hydrological modelling of the connectivity between these aquifers. If significant induced connectivity is detected, the primary mitigation action would be to amend the design of the river diversion so that water is transferred to a point on the downstream reach of the Undai down-gradient, which will protect downstream springs and users.

As well as modelling and monitoring hydrological flows, the health of Riverine Elm Trees needs to be monitored within the zone of predicted drawdown from dewatering, and in control areas outside this zone.

I.6 Maintained groundwater flow in the Undai river

Under the current mine plan, the Southern Oyu open pit will extend into the Undai flood plain and the Waste Rock Dumps will lie directly across the Undai river channel. Given the size of the Undai and the operational (flooding) risks involved, Oyu Tolgoi has determined that the best solution will be to divert the watercourse, thus allowing both the flood water and subsurface flows to pass safely around the open pit and waste dumps and to re-join the course of the Undai about two kilometres south of the Mine Licence Area.

In the absence of comprehensive investigations into physical attributes of the subsurface, including the existence of paleochannels, the actual impact on groundwater-dependent priority biodiversity features remains unclear (Box 4).

Groundwater flow from the Undai is believed to be responsible for sustaining springs downstream of the Mine Licence Area including Khukh Khad, 5 km downstream of Bor Ovoo Spring, Buural and Maanit, a further 8 km further downstream, and Tavan Ovoo, a further 7 km. Although the Brown Hill river is believed to have a larger catchment area than the Undai, it joins the Undai to the south of these springs. If reinstatement of the groundwater flow is unsuccessful, or the compaction of the soil substrate underneath the TSF depletes or alters groundwater flow, there could be major potential impacts on the availability of water in springs downstream of the Mine License Area with consequent impacts on priority biodiversity features.

Box 4: Uncertain downstream impacts

If the river diversions fail to maintain the original hydrological connectivities and flows, sustainability of groundwater flow and springs downstream of the Mine License Area may be compromised. Further research and monitoring is needed to quantify the potential hydrological changes. The consequence of a significant reduction in flow on Riverine Elm Trees (of which the Undai supports a globally significant population (H. von Wehrden *in litt.* 2011) and Tall Saxaul Forest would be serious. If the likelihood of significant reduction in flows was possible or likely, this would imply a high risk; if almost certain, this would imply a critical risk

I.7 Connectivity between the deep Gunii Hooloi aquifer and overlying surficial and alluvial aquifers and deep Galbyn Gobi aquifers

According to the Oyu Tolgoi ESIA (Water Resources Management Plan, Citrus, 26112010), the baseline data for the main aquifer units in the Project area can be separated into three main hydrogeological units which have varying degrees of hydrological connectivity in the different parts of the Project area: Alluvial, Bedrock and Late Cretaceous aquifers. Full characterisation of the aquifers has not been completed; however, additional monitoring and investigation are underway.

The most significant aquifers (volume) in the Project Area of Influence are the Late Cretaceous aquifers which comprise a thick sequence of clastic sediments deposited into rift basins with a predominant WSW-ENE trend. In the vicinity of the Project area, Oyu Tolgoi identified and subsequently investigated three basins based on the gravity surveys of the area. These basins were Gunii Hooloi to the northeast, Galbyn Gobi to the southeast and Nariin Zag located to the southwest (Figure 3).

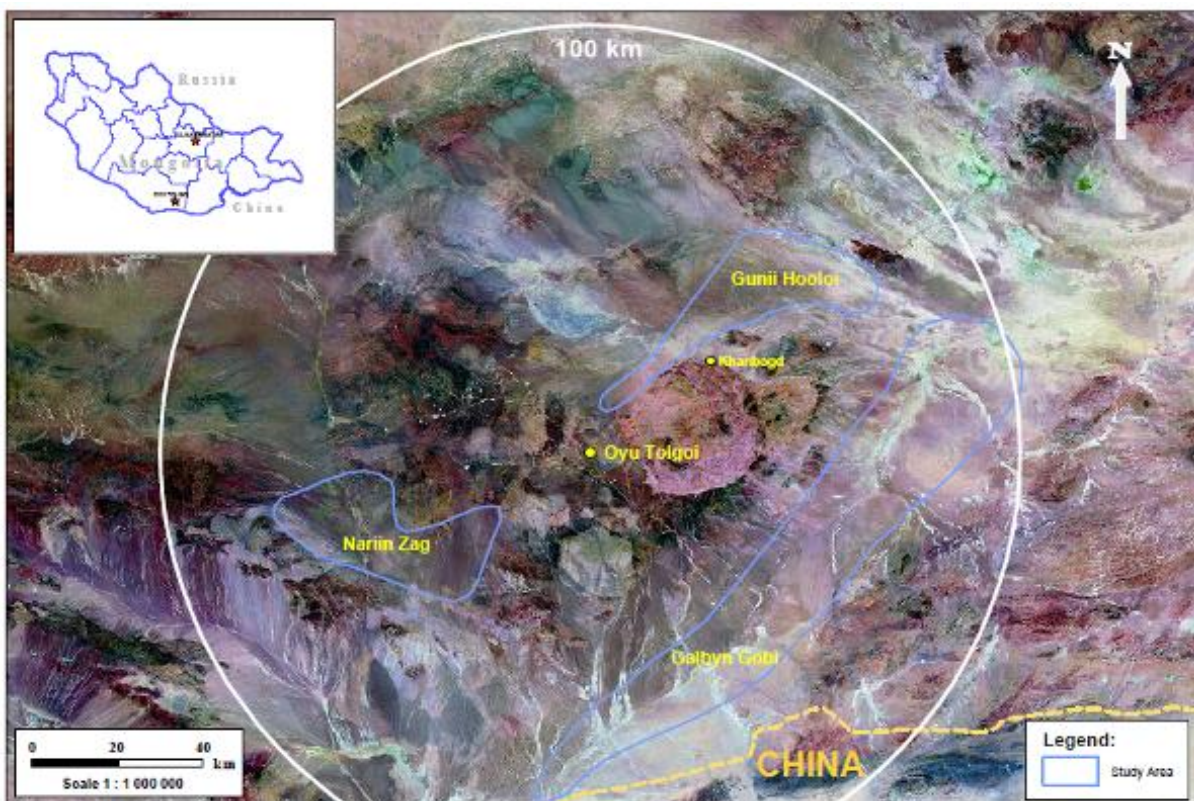


Figure 3: Significant aquifers around the Oyu Tolgoi project

The primary aquifer for the Oyu Tolgoi development is the Gunii Hooloi Aquifer (Late Cretaceous), from which the primary Gunii Hooloi Borefield is being developed to supply water

to the mine operations. There are no short to medium term plans to pump water from the Galbyn Gobi Aquifer (Late Cretaceous) because a) significant resources are defined within the Gunii Hooloi aquifer and b) concerns relating to environmental impacts to groundwater-dependent vegetation in the Galbyn Gobi area. Although the Gunii Hooloi and Galbyn Gobi basins essentially merge at their eastern ends in the Duut Toirem area, partly separated by a low fault defined ridge of basement (Figure 4), for the purposes of this assessment they are treated as individual units because the proposed exploitation area is in the central and western parts of Gunii Hooloi, a significant distance (over 50 km) from where the basins merge. The Galbyn Gobi is not considered further in this Options Paper however, the Oyu Tolgoi project does intend to establish future reserves which it can draw on as/ when required in the future and the option of utilising the Galbyn Gobi is likely to be further explored. Further monitoring of this aquifer as part of the Oyu Tolgoi project long term ground water monitoring programme should be undertaken to provide baseline data on the relationship between the Gunii Hooloi and Galbyn Gobi aquifers (which are thought to have a degree of connectivity) and to determine potential impacts of drawdown of the Gunii Hooloi on the Galbyn Gobi system.

Aquifers abstracted from during the construction are dispersed across the zone of influence of the mine license area and are not considered further here.

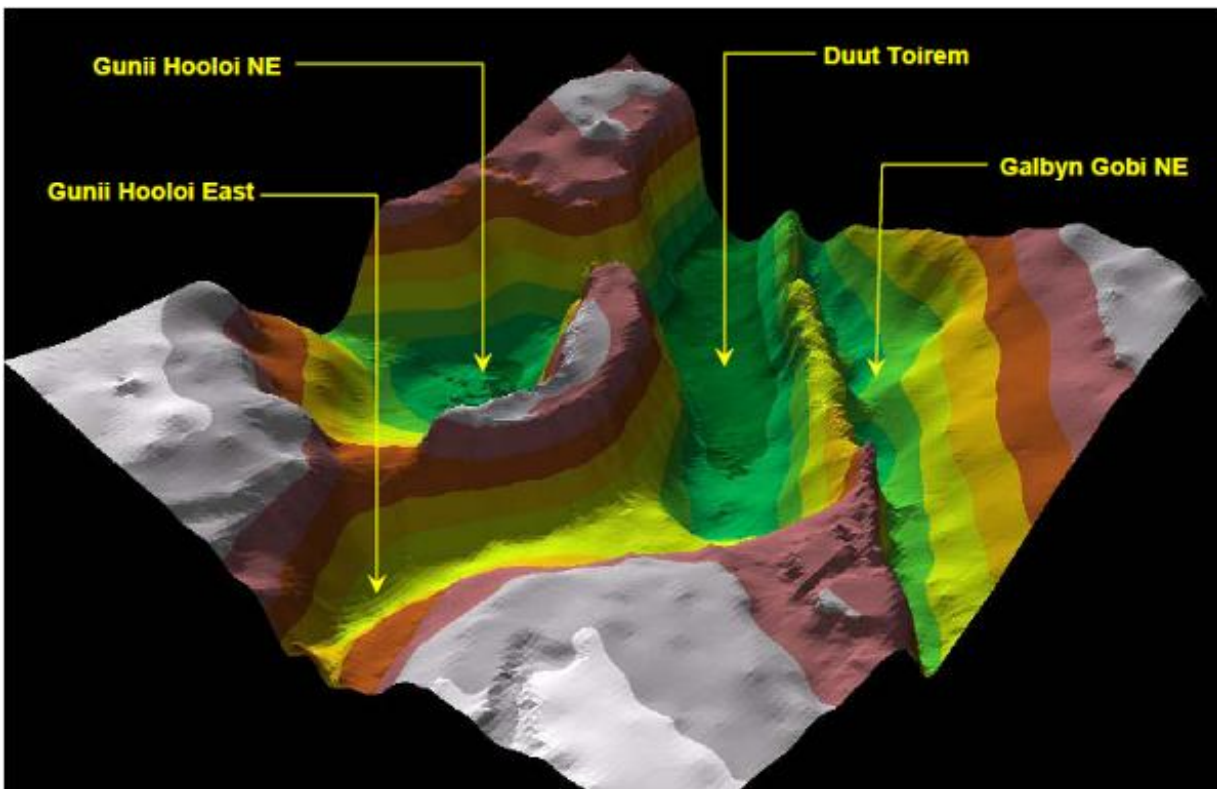


Figure 4: Major Cretaceous Aquifers within the scope of exploitation for Oyu Tolgoi (Aquaterra 2004)

The Gunii Hooloi borefield extends to the northeast of the Oyu Tolgoi mine. The Late Cretaceous aquifer is inferred to extend over 40 km, thickening to the northeast where it is approximately 10 km wide. It is generally separated from the shallow surficial aquifers by the low and impermeable sediments. The surficial aquifer is variably developed within the alluvium that exists over the surface of most of the Gunii Hooloi catchment area, however, it is only strongly developed along the ephemeral watercourses. Recharge to this surficial aquifer occurs directly by rainfall infiltration through the soils and more significantly by infiltration along the drainage courses during flow events. These surficial aquifers, mostly in the stream channel environments, are accessed by hand dug wells and are used by local herders for domestic and stock water supplies.

There are no apparent discharge areas for the groundwater in the basin, with no areas of springs or permanent deep rooted vegetation along the eastern edges of the basin. Flows from the basin may pass to a basin located further to the east (Gunii Hooloi NE Basin) or south-eastwards to merge with the Galbyn Gobi basin. The hydrogeological reports could not confirm that the targeted deep aquifer is not connected to other aquifers and surface water anywhere in the area of influence however, it is considered to pose the lowest risks (c.f. other Cretaceous aquifers) to groundwater dependent vegetation.

Groundwater plays an important role in water supply and the ecology of arid and semi-arid areas where the landscape is fragile due to frequent droughts over the past few decades (Cui *et al.* 2005). Water table depth is a key factor controlling the water balance, groundwater flow, and salt transportation in the saturated envelope. Drawdown of the water table is a primary cause of desert expansion (e.g. inland basins of north-west China). Ground water extraction is known to change the natural water cycle and balance and damage the delicate ecological environment, causing a series of ecological failures such as disappearance of springs, drying of inland lakes, land desertification of downriver areas and salinisation. The key to preventing ecological disaster is to keep the water table at a suitable depth above the 'withering depth' and below the root zone to prevent damage to roots. This will be different for different species - pasture plants have roots which extend up to 2–3 m and are sensitive to soil moisture content and shallow ground water (Cui *et al.* 2005); Saxaul has roots extending to depths of 30–40 m, and is reliant on deeper alluvial groundwater in and adjacent to ephemeral rivers.

Tall Saxaul Forest, Asiatic Wild Ass, Argali and Goitered Gazelle are all dependent on groundwater resources. Saker Falcon is dependent on elm and saxaul trees for nesting but may be able to nest on electricity transmission pylons being erected by the project. At present, it is not entirely clear what impact drawdown of water from the deep, late cretaceous aquifer will have on the shallow groundwater aquifers, upon which these features depend, because the detailed relationship between the recharge events from seasonal rainfall and potential losses from the surface aquifer to deeper formations through vertical permeability have not been adequately characterised (Box 5).

Box 5: Uncertain connectivity between aquifers

The extent of connection between the late cretaceous deep aquifer and the shallow groundwater aquifers is crucial for the impact of pumping from the deep aquifer on water levels in the streambed aquifers. Most of the potential impacts and their implications (on priority biodiversity features and existing wells) depend on the lowering of the water table in the shallow aquifer caused by pumping from the deep aquifer.

According to the ESIA (Environ, 2011) as a deep clastic aquifer, the Gunii Hooloi is reported to receive little or no recharge from annual rainfall. However, this is contradicted by statements in the Water DEIA (Citrus, 2010) which suggest that, in the west of the groundwater study area, there is likely to be recharge (which implies connectivity) to the system where the confining sediments are thinner and/ or more permeable allowing surface water infiltration.

This is supported by data from the Oyu Tolgoi project's monitoring borehole system which shows that in the west of the groundwater study area the piezometric head of the deep aquifer may coincide with the shallow aquifer associated with the water course in this area, indicating that some recharge may occur.

If the aquifers are found to be hydrologically connected then the threat rating, and associated mitigation actions, to the priority biodiversity features considered would necessarily be reviewed.

The impact assessment in this paper is necessarily based upon assumptions outlined in the ESIA (chapter C6 Water Rev D, 2010) which states that, with the exception of the deeper herder well, the Oyu Tolgoi project considers any impact on the shallow groundwater aquifers (and herder wells) unlikely however, it recognises that there is the potential for an impact to exist.

Priority biodiversity features would suffer significant consequences if drawdown of groundwater resources in the deep aquifer causes drawdown in the shallow surficial aquifer. The consequence of this is assessed as serious for Tall Saxaul Forest, and moderate for Saker Falcon and ungulates. Given that the Oyu Tolgoi project recognises that there may be limited hydrological connectivity, and therefore a risk of drawdown in the shallow aquifer, these impacts are assessed as possible, resulting in High Risk.

Further long-term monitoring of flow events and stream sediment storage characteristics tied to monitoring water levels in all aquifers, including in the near-surface aquifers used by the herders hand dug wells, must be undertaken by Oyu Tolgoi. The results of this monitoring will better inform the relationship between shallow surficial aquifers and rainfall and whether there are any drawdown impacts measurable in this shallow aquifer. If the aquifers are found to be hydrologically connected then the threat rating, and associated mitigation actions, to the priority biodiversity features considered would necessarily be reviewed.

The primary risk is posed by loss of habitat from drawdown of groundwater resources at the Gunii Hooloi borefield. In order for these risks to be mitigated, first a comprehensive

understanding of the hydrological linkages between the deep and alluvial aquifers needs to be established. The key issue here is to what extent the deep and shallow alluvial aquifer at Gunii Hooloi are connected - this is not known yet, but it is crucial to the impact of pumping from the deep aquifer on groundwater levels in the shallow surficial aquifers. Most of the potential impacts and their implications (on priority biodiversity features and existing wells) depend on the lowering of the water table in the shallow aquifer caused by pumping from the deep aquifer.

Although monitoring is not considered to be a mitigation action *per se*, here it is considered pre-requisite to establishing effective mitigation actions. The deep aquifer is fairly well studied and, with the monitoring during operation of the borefield, the knowledge of the groundwater flow system will further improve. A similar approach is needed for the shallow, surficial aquifer, defining the baseline and dedicated monitoring (rainfall, infiltration, groundwater levels, flowpaths) will build the understanding of this aquifer and show:

- How the current system works (water balance): recharge, lateral flow, vertical flow evaporation, baseflow to streams, abstraction, water level fluctuations
- If any future changes in groundwater levels (or stream flows) and/ or groundwater quality are due to pumping from the deeper aquifer or caused by changes in the shallow system itself (rainfall variability, changes in land use, increased abstraction etc)
- How local interventions (linkage between landscape management and water buffering, management of the aquifer recharge, micro climate interventions) can prevent or mitigate the impacts on priority biodiversity features, ecosystems services and local water supply (whether caused by pumping or by changes with the minor aquifer itself).

The latter will be important for the Oyo Tolgoi project because any future changes in the (ground) water system (wells falling dry, vegetation changes etc) are likely to be attributed to the deep groundwater abstraction (A. Tuinhof *in litt.* July 2011).

Tall Saxaul Forest and priority ungulate species will all be adversely impacted if groundwater availability in the shallow surficial alluvium is reduced. In this event, if abstraction from highly water stressed areas is halted and the surficial aquifer recharges, then it may be possible to rehabilitate Tall Saxaul Forest, and priority ungulates will return to the area. However, in the event that it is not possible to re-establish groundwater in the surficial aquifer, no rehabilitation of Tall Saxaul Forest would be possible and a suitable offset would need to be identified.

I.8 Connectivity between the deep Durulj Mount Southern aquifer and overlying surficial aquifers

Khanbogd centre is located at the foothill of the Khanbogd massif on the southern side of the Gunii Hooloi basin. Water is supplied from a mixture of private and public wells which abstract groundwater from the surficial quaternary sediments. These sediments are believed to be recharged by groundwater flowing through the fractures and fissures of the weathered zones of the granite body immediately to the south and the associated sedimentary formations (ESIA 2010). They are also believed to be separate from the Gunii Hooloi aquifer system, being present around the periphery of the Khanbogd massif in a sub-basin to the south of the main basin however, full characterisation of the Gunii Hooloi borefield has not been undertaken. There is little detail on the well construction and generally no information on the aquifer parameters has been gathered.

In order to satisfy the demands of the predicted in-migration, the Oyu Tolgoi project has contracted a geophysical investigation covering a 20 by 10 km area around Khanbogd Centre to study the potential groundwater resources. The geophysical survey has identified a prospective groundwater aquifer called the Durulj Mount Southern Basin (Geomaster Engineering 2010) which is located 2-6 km from Khanbogd Centre. The Oyu Tolgoi project has commissioned the drilling of seven exploration boreholes in this aquifer (water level is anticipated to be at an average depth of 150-200 m) and the results will be used to prepare a submission of a water reserve estimate to enable the design of the water abstraction system.

As described in previous sections, groundwater plays an important role in water supply and the ecology of arid and semi-arid areas where the landscape is fragile due to frequent droughts over the past few decades (Cui *et al.* 2005). Water table depth is a key factor controlling the water balance, groundwater flow, and salt transportation in the saturated envelope. Drawdown of the water table is a primary cause of desert expansion (e.g. inland basins of north-west China). Ground water extraction is known to change the natural water cycle and balance and damage the delicate ecological environment, causing a series of ecological failures such as disappearance of springs, drying of inland lakes, land desertification of downriver areas and salinisation. The key to preventing ecological disaster is to keep the water table at a suitable depth above the 'withering depth' and below the root zone to prevent damage to roots. This will be different for different species - pasture plants have roots which extend up to 2–3 m and are sensitive to soil moisture content and shallow ground water (Cui *et al.* 2005); Saxaul has roots extending to depths of 30–40 m, and is reliant on deeper alluvial groundwater in and adjacent to ephemeral rivers.

Riverine Elm Trees, Tall Saxaul Forest, Asiatic Wild Ass and Goitered Gazelle are all dependent on groundwater. Saker Falcon is dependent on tall elm and saxaul trees for nesting but may be able to nest on electricity transmission pylons being erected by the project. Until the results of the groundwater investigations at the Durulj Mount Southern aquifer are available, it is not possible to infer whether or not groundwater abstraction from this aquifer will cause a drawdown in groundwater in any of the shallow surficial aquifers upon which these features depend (Box 6) or, indeed, whether abstraction will go ahead at all.

Box 6: Uncertain impacts of water abstraction from Durulj Mount Southern Aquifer

Priority biodiversity features would suffer significant consequences if drawdown of groundwater resources in the deep Durulj Mount Southern aquifer impacts any of the shallow surficial aquifers. Until studies are completed to characterise this aquifer and its hydrological connectivity with adjacent shallow surficial aquifers, it is not possible to make any estimates of surficial groundwater drawdown and therefore impact on priority biodiversity features. If significant connectivity is detected between the deep and shallow aquifers, the likelihood of impacts would be Likely or Almost Certain, and if this impacts an extensive area, this implies Critical or High Risks/ threats to Riverine Elm Trees and Tall Saxaul Forest and High Risks/ threats to ungulates. In this case, an alternative source of water supply for Khanbogd should be investigated.

Appendix II: Project impacts

These descriptions are updated consolidations of the impact information given in each of the eight individual Biodiversity Management Plan Options Papers. Impacts are primarily documented where they lead to a high or critical risk to a priority biodiversity feature, based on the risk assessment process (Appendix III). In addition, owing to concerns about connectivity issues prior to mitigation actions, this issue is also discussed – even though it only ranked as a 'medium risk'.

II.1 Direct habitat loss

Habitat supporting many priority biodiversity features will be lost under the Oyu Tolgoi project's direct infrastructure footprint. This includes 64 km² in the mine licence area, 1.5 km² for the airport and 1.3 km² for the borefield/pipeline corridor. The additional direct footprint of the road upgrade to Gashuun Sukhait is small, primarily comprising 19.4 km of linear infrastructure of c.15 m width, as the remainder of the road will be constructed over an existing track, which has deteriorated in places to a series of tracks where vehicles have followed parallel routes. There will be very little direct habitat loss under the medium-voltage and high-voltage power distribution lines as there will be no vegetation clearance except for very small direct losses under the pylon supports. It is assumed that no significant habitat loss will occur under the Undai and Budaa diversions, the borefield *per se* or the Khanbogd Area.

The vast majority of this area is open dry rangeland habitat. However, the Mine License Area footprint will also destroy c.52 ha of the ephemeral Undai river, including the Bor-Ovoo Spring, and c.7 ha of numerous small ephemeral water courses which flow into Budaa water course (ESIA 2011; Purevsuren Nyambuu pers. comm. 2011).

Most significant impacts will be on plants, which cannot move. *Potaninia mongolica* is known from the pipeline route, according to the DEIA. The other rare plants are not known to occur under planned infrastructure, but there is a possibility that they occur as they are widespread in the general area. Impacts are also expected on the largely resident species and, to a lesser extent, migrant birds. Impacts on other priority species are not expected to be significant because they are not likely to use the area substantially or are largely passage migrants that only fly through the area. Three individual Riverine Elm Trees are known to have been impacted – these were transplanted away from the mine site but their long-term survival prospect is unknown. Tall Saxaul Forest may be impacted by the Gunii Hooloi borefield but most saxaul forest is low and heavily degraded.

These risk assessments and mitigation plans assume that the Oyu Tolgoi project will follow standard best practice for minimisation and restoration of construction (including construction camps, access roads, borrow pits and temporary parking areas) and operation footprints.

II.2 Indirect habitat loss due to avoidance

Many priority biodiversity features are predicted to avoid areas close to project infrastructure and activities. Such avoidance is not complete and total: for example, avoidance may be 100%

within several metres of a road, 50% within 500 m, 25% within 1 km, etc. Avoidance distances depend on factors such as noise, dust, local topography and vegetation, and hunting pressure. Within the Oyu Tolgoi Area of Influence, background hunting pressure is the strongest driver of avoidance, especially for Asiatic Wild Ass and other ungulates avoiding vehicles and people. Avoidance distances are likely to be higher during construction, when noise and dust pollution will be greatest, and animals have not yet habituated to the infrastructure. Most of the soil, at least in the Mine License Area, comprises a 10-15 cm thick layer of fine to very fine particles (0.1 mm-0.001 mm in diameter) beneath a gravelly protective surface layer (Amendment to Mine and Processing DEIA 2010). Once the protective surface layer is eroded, e.g. by vehicles, the fine particular material, which is usually very dry, will be carried by winds and contribute to the avoidance impact. Some data on avoidance distances may be possible to obtain empirically (e.g. by aerial surveys) and monitoring. For example, Asiatic Wild Ass in the southern Gobi region are estimated to avoid areas within 5 km of vehicles (P. Kaczensky *in litt.* 2011). However, given likely habituation to static infrastructure, it has been necessary to infer and extrapolate avoidance distances. For example, impacts have been demonstrated up to 1,600 m for Great Bustard (Lane *et al.* 2001; López-Jamar 2010; Raab 2011) and Reindeer have shown reduced population effects up to 17 km from similar infrastructure where historically hunted (Benítez-López *et al.* 2009). Complete avoidance creates a barrier effect and fragmentation but powerlines and fully mitigated roads are not expected to act as full functional barriers to any species (see Section II.3 below).

Avoidance of powerlines by (hunted) ungulates is predicted to be significantly less than from other infrastructure associated with human or vehicular activity. There is however predicted to be a significant avoidance of powerlines by Houbara and Great Bustards based on avoidance measured up to 800 m and possibly up to 1600 m for Great Bustard (Lane *et al.* 2001; Raab 2011) and strong avoidance by Little Bustard within 400 m of power lines (J.-P. Silva *in litt.* 2011; Silva *et al.* 2010). Based on these limited data, a precautionary estimate of 1 km avoidance distance was made for bustards and powerlines. Similar data for roads and agricultural buildings lead to similar estimates of 1 km avoidance distances for bustards. Avoidance distances from Khanbogd town for all species was estimated to be much greater given the likelihood of regular human and vehicular traffic radiating out from the town.

Provisional estimates of avoidance distances are given in Table 7:

Table 7: Provisional estimates of avoidance distances for priority biodiversity features from project infrastructure

Priority biodiversity feature	Hunted?	Mine site/airport	Busy road	Powerlines	Khanbogd town
Mongolian Chesney	n/a	n/a	n/a	n/a	n/a
Snow Leopard	yes	n/a	n/a	n/a	n/a
Asiatic Wild Ass	yes	5 km	5 km	500 m	10 km
Argali	yes	500 m	1 km	0	5 km
Goitered Gazelle	yes	1 km	5 km	500 m	10 km

Mongolian Gazelle	yes	1 km	5 km	500 m	10 km
Long-eared Jerboa	no	n/a	n/a	n/a	n/a
Swan Goose	yes?	likely some avoidance but very limited habitat for this rare migrant			
Ferruginous Duck	yes?	likely some avoidance but very limited habitat for this rare migrant			
Short-toed Snake-eagle	no	0	0	0	0
Saker Falcon	(no)	0	0	0	0
Egyptian Vulture	no	0	0	0	0
Great Bustard	yes	1 km	1 km	1 km	5 km
Houbara Bustard	yes	1 km	1 km	1 km	5 km
Relict Gull	no?	likely some avoidance but very limited habitat for this rare migrant			
Pallas' Sandgrouse	no	0	0	0	0
Mongolian Accentor	no	n/a	n/a	n/a	n/a
Mongolian Ground-Jay	no	0	0	0	0
Yellow-breasted Bunting	no	0	0	0	0
Granit Outcrop Floral Communities	no	n/a	n/a	n/a	n/a
Riverine Elm Trees	no*	n/a	n/a	n/a	n/a
Ephemeral Lakes and Pools	no*	n/a	n/a	n/a	n/a
Tall Saxaul Forest	no*	n/a	n/a	n/a	n/a
Eastern Gobi desert-steppe	no	n/a	n/a	n/a	n/a
Alashan Plateau semi-desert	no	n/a	n/a	n/a	n/a

*Although not hunted and not showing avoidance distances, plants and habitats may be collected or otherwise impacted. The rapid biodiversity assessment team has not estimated the impact distances of collection as this is a social research question.

The Oyu Tolgoi road upgrade to Gashuun Sukhait is likely to act as a deterrent to some animal populations, causing avoidance of habitat near the road and thus indirect habitat loss. The impacts of this indirect habitat loss are factored into the discussion of road mitigations and Net Positive Impact calculations.

II.3 Fragmentation (reduced connectivity) of populations

The Oyu Tolgoi project has made a world-leading commitment to put in place appropriate and sufficient underpasses along the road upgrade to Gashuun Sukhait. This demonstration is a step towards achieving future regional connectivity of ungulate populations by facilitating similar mitigation of non-project regional infrastructure. These are planned to be appropriate for the wide-ranging species of conservation concern in the region, given best international knowledge to date, and are planned to be sufficient to allow ecological permeability, given known animal daily ranging distances. Given this, the fragmentation impacts of this road upgrade are expected to be negligible in the medium- to long-term (after animals have habituated to the road, and a concurrent anti-poaching programme has sufficiently reduced hunting such that animals have reduced fear of vehicles). In particular, it is considered that

cumulative impacts will be negligible given the existing presence of the unmitigated Tavan Tolgoi 'coal road' and its heavy traffic volumes. The 'coal road' runs approximately parallel to the Gashuun Sukhait road upgrade, and is likely to have already fragmented ungulate populations (as discussed below). The residual, cumulative risk of the Oyu Tolgoi road upgrade to Gashuun Sukhait causing fragmentation of ungulate populations was assessed as:

- likely (loss of some of the feature would occur in majority of cases) likelihood
- minor (would cause an insignificant noticeable portion to be lost) consequence
- therefore 'medium' risk

Although few data yet exist to assess impacts, the pre-existing 'coal road' from Tavan Tolgoi to Gashuun Sukhait, and its heavy traffic volumes, is likely to be having a significant fragmentation effect on wide-ranging species in South Gobi. Cumulatively (i.e. over and above this existing road), a well-mitigated Oyu Tolgoi road upgrade to Gashuun Sukhait would be likely to have negligible fragmentation impacts.

The Trans-Mongolia railway acts as a barrier that Asiatic Wild Ass are unable to cross, such that 17,000 km² of suitable habitat on the eastern side of the railway has now been lost (Kaczensky *et al.* 2006; Kaczensky *et al.* 2011). Likewise, Mongolian Gazelle find the railway an almost impermeable barrier, despite the presence of concrete box culverts designed for livestock passage (Ito *et al.* 2005, 2008). Because the Chinese border fence to the south presents another major barrier to movement, east-west connectivity across Umnogobi and Dornogobi is vital. Although little quantitative research has been carried out on roads in the region, traffic volumes of >2,000 vehicles/day have been shown to have a barrier effect (Sawyer & Rudd 2005; Clevenger & Huijser 2011) and volumes of >4,000 vehicles/day are considered "strong to complete barriers to wildlife movements" in North America (Mueller & Berthoud 1997). In the open environments of southern Mongolia, where wild animals have a much clearer view of long stretches of road and are very wary of vehicles due to hunting pressure and harassment, it is likely that – without the world-leading mitigation planned by the Oyu Tolgoi project – the predicted traffic volume on the road upgrade to Gashuun Sukhait (>1,600 vehicles/day by 2030) would create a complete functional barrier to ungulates (i.e. some individuals will be able to cross, but functional ecological and genetic connectivity would be lost). P. Kaczensky (*in litt.* 2011) has estimated a serious barrier effect for Asiatic Wild Ass at 400 vehicles/day and a complete ecological barrier at 1,000 vehicles/day². Current traffic volumes are below 400 vehicles/day and are expected to decline immediately after construction (increasing again owing to non-mine traffic in the longer term). Current traffic volumes would thus be expected to have a partial, but not total, barrier effect if appropriate and sufficient underpasses had not been planned. Current traffic volumes on the 'coal road' from Tavan Tolgoi to Gashuun Sukhait

2 The figure of 400 is based on fleeing distances of c. 1 km, maximum speeds of 4 km/h, and thus a need for a break in traffic of 15 minutes for an animal to feel comfortable crossing. This equates to an average of 96 vehicles/day if evenly spaced. Assuming vehicles are not evenly spaced (i.e. bunched), perhaps four times as many cars could still leave similar gaps in traffic – i.e. 400. These are of course very rough approximations, and based on continued hunting (and thus car avoidance). They do, nonetheless, provide some level of assessment tailored to the situation in the area.

are expected to have a complete functional barrier effect.

Fragmentation can occur for all terrestrial species to some extent, but is most significant in this region for ungulates (Asiatic Wild Ass, Argali, Goitered Gazelle and, to a lesser extent because it is on the limit of its distribution in this area, Mongolian Gazelle). Fragmentation splits populations into smaller, more vulnerable and genetically weak units. For nomadic or migratory species, fragmentation can cut off access to critical resources, directly kill animals (e.g. Ito *et al.* 2008) and thus lead to overall population decline or regional extinction (e.g. Ben-Shahar 1993). A study of effects on wildebeest (a similarly wide-ranging large ungulate) of a proposed road in the African Serengeti concluded that, even without factoring in habitat loss, the barrier effect of the road could cause the Wildebeest population to decline by a third because it would no longer be able to effectively track temporal shifts in pasture resources across the landscape (Holdo *et al.* 2011). As a result of this study, and public concern, the road has recently been cancelled (http://news.mongabay.com/2011/0623-hance_serengeti_road.html). The similarities between the temporal shifts in pasture resources required for wildebeest regional survival and the ecological situation faced here by the large ungulates are significant.

Powerlines are not expected to act as functional barriers creating significant population fragmentation or reduced connectivity (but are expected to be avoided by some species, creating indirect habitat loss).

II.4 Direct mortality from collision with vehicles and powerlines, and electrocution by power distribution lines

Some priority biodiversity features are at risk of death and injury from collision with vehicles and power lines, and from electrocution by power lines.

Several priority species are susceptible to injury or death from collision with vehicles. This risk increases with the speed and size of vehicles. Large vehicles are less able to brake or take evasive action. In a study of animal collisions in Israel, 31% of 226 collisions were with (domestic) horses and donkeys and 3 of 18 collisions with wild animals were with gazelle (Inbar *et al.* 2006). Asiatic Wild Ass, a close relative of the horse and donkey, may potentially be at elevated risk owing to their propensity to run when alarmed. However, another study found medium-sized animals most at risk of collisions (Barthelmess and Brooks 2010), perhaps owing to greater avoidance of more obvious large animals. Overall, mortality from collision with vehicles is likely to be limited, with impacts manifested more as avoidance of roads with heavy traffic unless hunting is controlled and animals habituate to traffic.

Although a range of bird species suffer mortality from collisions with wires, bustards and birds of prey are particularly susceptible to collisions with power lines (Martin & Shaw 2010). Mortality from such power lines can be severe; appearing to have exceeded 10% of total population in the short-term in some studies of Houbara Bustard (Martin *et al.* 2006) and accounting for high percentages of overall mortality in many studies (e.g. >80% of mortality in adult Great Bustard in one study was caused by collision with power lines and fences; García-

Montijano *et al.* 2002). Estimates of total bird collision rates vary from about 0.1 to 80 casualties per km per year (Jenkins *et al.* 2010). Ludwig's Bustard *Neotis ludwigii*, which is particularly susceptible (as it undertakes daily flights to and from roost sites as well as longer distance movements; Allan 2005) has an average of several casualties per km per year (> 0.63 corpses found per km plus those removed by scavengers; Jenkins *et al.* 2011).

The high-voltage power transmission lines are planned to be suspended at 25.8 - 49.5 m above ground level (three vertically parallel sets of lines plus two optical ground wires [OPGWs]). These heights are above normal flight heights by Houbara Bustards during the breeding season (which is extremely limited; N. Batbayar pers. comm. 2011; O. Combreau pers. comm. 2011) but within the range of migration flight heights (mostly below 100 m altitude; O. Combreau *in litt.* 2011). Houbara Bustard migrates east-west in this region (Tourenq *et al.* 2004; Judas *et al.* 2006; Gao *et al.* 2009), perpendicular to the power line orientation and thus exposed to maximum threat. Houbara Bustard is also known to migrate both by day and at night (O. Combreau pers. comm. 2011). At night, Houbara Bustard may suffer a higher rate of collisions because wires are less visible, as is the case for Little Bustard (J.-P. Silva pers. comm. 2011). Thinner wires (such as the earth wires) pose more of a risk of collision owing to their lower visibility (e.g. Faanes 1987). The risk to other priority bird species is less well known but resident Egyptian Vulture and migrating Swan Goose, Great Bustard and Relict Gull are assessed as being at moderate risk.

There is also a risk of electrocution to any medium or large bird that can span the distance between the conductors or grounded and energised hardware (e.g. Tintó *et al.* 2010). A range of bird of prey species, including Saker Falcon, often perch and nest on power line poles and pylons (Potapov *et al.* 2001), which makes them particularly susceptible to electrocution. The conductors on the pylons used at the Oyu Tolgoi project are at least 2.5 m from any grounded hardware and so do not represent a significant electrocution risk for birds. However, the designs chosen for the Oyu Tolgoi medium-voltage power distribution lines do cause significant risk owing to short distances between conductors and grounded/energised hardware. Electrocutions, mostly from medium voltage power lines, were responsible for 54% of 64 Saker Falcon found dead in Mongolia 1998-2004 (Sundev *et al.* 2001) and Harness *et al.* (2008) found 0.7 dead birds/km under concrete poles along medium-voltage power lines in Mongolia, of which 19% were Saker Falcons (many fewer were found under older wooden poles).

II.5 Indirect mortality from illegal hunting and collecting facilitated by increased access and in-migration

The primary threat to the survival of Asiatic Wild Ass, Argali, Goitered Gazelle and Houbara Bustard is illegal hunting. Hunting for sale of meat caused catastrophic declines of Asiatic Wild Ass in Central Asia in the 1990s, including extirpation from Kazakhstan, Uzbekistan and Ukraine (IUCN 2010). Likewise, high levels of hunting in the 1980s severely decreased the species' populations in northern China (IUCN 2010). Wingard & Zahler (2006) reported that approximately 3,000 Asiatic Wild Ass were illegally hunted and traded in Mongolia in 2004, out of an estimated total of 17,513-19,309 in Mongolia (Lhagvasuren 2007). This rate is

unsustainable and would lead to the species' extirpation (Moehlman *et al.* 2008). Total numbers of Argali in Mongolia appear to have declined from about 60,000 in 1985 to 13,000-15,000 in 2001 (Amgalanbaatar *et al.* 2002). Hunting levels are less well known for Goitered Gazelle. Houbara Bustard are currently primarily hunted in their non-breeding range outside of Mongolia, where declines in some areas have reached 30% per annum (Tourenq *et al.* 2005). Saker Falcon is also at risk of being collected for the falconry trade although there is currently a moratorium on the export of Saker Falcons. Tall Saxaul Forest is at risk from collection for firewood, which is largely illegal. Saxaul collection is increasing as more people move to Khanbogd soum, remote areas become more accessible by road and there is increased demand by roadside restaurants for fuelwood (Schmidt *et al.* 2011).

The Mongolian 'Law on Fauna' prohibits hunting of 'very rare' and 'rare' species including Asiatic Wild Ass, Argali, Goitered Gazelle and Houbara Bustard except under licence. Mongolia has also ratified the 'Convention on International Trade of Endangered Species' (CITES) which strictly regulates trade in Appendix I species including Asiatic Wild Ass, and regulates trade in Appendix I species including Argali and Saker Falcon.

The Oyu Tolgoi project prohibits hunting by employees but hunting and collecting is likely to be increased by the regional influx of people not employed by the project, and by increased use of the roads by public traffic. In-migration associated with economic activities at the Oyu Tolgoi project may see an influx of up to 32,000 people into the soum (ESIA, Draft Influx Management Plan 2010). Hunting is a traditional activity for many Mongolian and Chinese people, and subsistence hunting alone is unlikely to pose a significant threat. However, pursuit with fast-moving vehicles and hunting with fire-arms are a much higher threat. Hunters can and will drive off-road, but will tend to follow better (faster) roads where available. Furthermore, the upgraded road to the border at Gashuun Sukhait increases accessibility to China, the world's biggest market for wild animal products. The rate of such hunting will be determined by factors such as local access to fire-arms and ammunition and enforcement of laws against hunting these species by non-mine traffic along the road, but is poorly-known and needs monitoring.

Fuel needs of local people in this sphere of influence are primarily met by dried livestock dung and, in winter, when heating needs are high, woody plants – primarily saxaul (Damdin 2011). Elm, Poplar and Tamarisk species are not commonly used for fuel in the area (Damdin 2011). The majority (93%) of local households used wood, charcoal and dung in unknown proportions (Center for Policy Research 2009 in Environ 2011). Availability of trucks has enabled recent over-harvesting of woody plants, notably saxaul (Damdin 2011; Environ 2011; K. Olson pers. comm. 2011; S. Schmidt *in litt.* 2011).

II.6 Indirect mortality from increased populations of natural predators

Among priority biodiversity features, this impact is mainly relevant to Houbara Bustard nesting in the area. The primary predators of breeding and migrant Houbara Bustard in the region are mammals, notably foxes *Vulpes spp.* (Combreau *et al.* 2002; Yang *et al.* 2002). A range of other predators, including smaller mammals and birds such as Long-legged Buzzard *Buteo rufinus* and Common Raven *Corvus corax*, are likely to predate eggs and chicks (Heredia 1995;

Combreau & Smith 1998; Combreau *et al.* 2002). Although Saker Falcon is commonly used by falconers to hunt Houbara Bustard, wild Saker Falcon appear to very rarely hunt Houbara Bustard in this region (Sundev *et al.* 2001; G. Sundev pers. comm. 2011).

Terrestrial predation levels are often elevated along roads and other linear infrastructure. Vehicles and powerlines will inevitably kill and injure at least small mammals and birds, resulting in some dead and injured animals along the route. These, along with litter that has been thrown from vehicles along the road, are likely to increase populations of scavengers such as Raven, Black Kite, foxes and Long-eared Hedgehog *Hemiechinus auritus* (all potential predators of nests, including those of Houbara Bustard) along the route. Increased use of linear routes and predation rates has been demonstrated for Wolves *Canis lupus* (James and Stuart-Smith 2000; Whittington *et al.* 2011). Avian predators, including buzzards, Black Kite, Saker Falcon and Common Raven, perch and nest on all types of power line towers and raised artificial structures where there is a lack of elevated perching and nesting sites (e.g. Potapov *et al.* 2001). Thus, susceptible species including Houbara Bustard are likely to suffer increased terrestrial and avian predation rates along road and power line routes. The sum of elevated mortality from these varied types of elevated predation pressure is difficult to calculate without monitoring actual impacts. This was assessed for the ground-nesting Houbara Bustard and Mongolian Ground-Jay as having a 'medium' consequence (i.e. a noticeable portion degraded/lost, but viability/function not reduced) and hence a 'high' risk following Rio Tinto's risk assessment matrix (Appendix III).

Appendix III: Risk assessment

In order to assess the risk represented to priority biodiversity features, each impact and feature was individually assessed according to standard Rio Tinto Biodiversity Action Planning methods (Rio Tinto 2010). Rio Tinto risk assessment is in line with its Health, Safety and Environment Quality Management Systems (HSEQMS) and attempts to classify risks based on the consequence and the likelihood of an event. A set of subjective but practical 'Biodiversity Likelihood and Consequence Descriptors' have been developed (Table 8a, 8b) for use in the risk assessment matrix (Table 9). At the outset, to identify a baseline, these assume that no mitigation is put in place.

Table 8a: Biodiversity-specific descriptors for (a) likelihood

A- Almost Certain	B- Likely	C- Possible	D- Unlikely	E- Rare
<p>Degradation/loss of some/all of biodiversity feature is <u>inevitable</u> because of the company's existing/proposed activities.</p> <p>E.g. tailings site will be located where individuals of an endangered plant species are present.</p>	<p>Degradation/loss of some/all of biodiversity feature <u>would occur in the majority of cases</u> because of the company's existing/proposed activities.</p> <p>E.g. berry crops harvested by native communities are in the company's airshed and may receive some particulate matter under prevailing wind conditions.</p>	<p>Degradation/loss of some/all of biodiversity feature will not occur in the majority of cases, <u>but is not unexpected</u>, because of the company's existing/proposed activities.</p> <p>E.g. high precipitation event (once in 10 years) increases sedimentation to river from company lands.</p>	<p>Degradation/loss of some/all of biodiversity feature is <u>not impossible but should not occur under normal circumstances</u> because of the company's existing/proposed activities.</p> <p>E.g. unpredicted subsidence from block caving causes loss of natural features important to local indigenous community.</p>	<p>Degradation/loss of some/all of biodiversity feature <u>will only occur under force majeure</u> under the company's existing/proposed activities.</p> <p>E.g. an act of sabotage results in dam malfunction causing excessive flooding and scouring of fish habitat.</p>

Table 8b: Biodiversity-specific descriptors for (b) consequence

1- Minor	2- Medium	3- Serious	4- Major	5- Catastrophic
<p>The company's existing/proposed activities cause an <u>insignificant portion</u> of the biodiversity feature to be degraded/lost.</p> <p>E.g. reduction in forest cover in mine concession causes slight reduction of water availability in dry season, with no discernible effect for downstream users.</p>	<p>The company's existing/proposed activities cause a <u>noticeable portion</u> of the biodiversity feature to be degraded/lost, but the <u>viability/function of feature is not reduced</u>.</p> <p>E.g. company activities cause the loss of several individuals of a threatened plant species, but this does not reduce the viability of the local population.</p>	<p>The company's existing/proposed activities cause a <u>significant portion</u> of the biodiversity feature to be degraded/lost, and the <u>viability/function of some portion of the feature is reduced</u>.</p> <p>E.g. company activities reduce the viability of the local population of a threatened plant species, but national and global conservation status of the species is unchanged.</p>	<p>The company's existing/proposed activities cause a <u>significant portion</u> of the biodiversity feature to be degraded/lost, and the <u>viability/function of the entire feature is reduced</u>.</p> <p>E.g. reduction in forest cover in mine concession causes significant reduction of water availability in dry season, resulting in regular dry season water shortages for downstream users.</p>	<p>The company's existing/proposed activities cause the <u>entire biodiversity feature to be degraded/lost</u>.</p> <p>E.g. company activities cause the extinction of a threatened plant species known only at that site.</p> <p>E.g. reduction in forest cover in mine concession permanently eliminates dry season water flow for downstream users.</p>

Table 9: Risk assessment matrix

Likelihood	Consequence				
	1 - Minor	2 - Medium	3 - Serious	4 - Major	5 - Catastrophic
A - Almost Certain	Moderate	High	Critical	Critical	Critical
B - Likely	Moderate	High	High	Critical	Critical
C - Possible	Low	Moderate	High	Critical	Critical
D - Unlikely	Low	Low	Moderate	High*	Critical
E - Rare	Low	Low	Moderate	High*	High*

Risk assessment tables were populated in each of the eight BMP options papers for each key biodiversity feature x impact. In the interests of space, these are not copied here but are available in the eight BMP options papers, but these are potentially outdated as the list of

priority biodiversity features has been updated and some new baseline data may have become available. Examples are given below in Tables 10 and 11. Mitigation actions were developed only those impacts assessed as High or Critical risk to specific priority biodiversity features (Table 2).

Table 10: Threat rating from indirect mortality from hunting and collection at the Khanbogd Area

Feature	Likelihood	Consequence	Threat rating
Mongolian Chesney	Possible	Serious	High
Asiatic Wild Ass	Possible	Major	Critical
Argali	Possible	Serious	High
Goitered Gazelle	Possible	Serious	High
Mongolian Gazelle	Possible	Medium	Moderate
Swan Goose	Unlikely	Minor	Low
Ferruginous Duck	Unlikely	Minor	Low
Short-toed Snake-Eagle	Unlikely	Minor	Low
Saker Falcon	Possible	Serious	High
Egyptian Vulture	Unlikely	Minor	Low
Great Bustard	Possible	Medium	Moderate
Houbara Bustard	Possible	Serious	High
Relict Gull	Unlikely	Minor	Low
Mongolian Ground-jay	Unlikely	Minor	Low
Yellow-breasted Bunting	Unlikely	Minor	Low
Gobi Naked-toed Gecko	Unlikely	Minor	Low
Riverine Elm Trees	Possible	Medium	Moderate
Tall Saxaul Forest	Likely	Serious	High

Table 11: Threat rating from direct loss of habitat at the Khanbogd area

Feature	Likelihood	Consequence	Threat rating
Mongolian Chesney	Possible	Minor	Low
Asiatic Wild Ass	Almost certain	Minor	Moderate
Argali	Possible	Minor	Low
Goitered Gazelle	Almost certain	Minor	Moderate
Mongolian Gazelle	Unlikely	Minor	Low
Swan Goose	Unlikely	Minor	Low
Ferruginous Duck	Unlikely	Minor	Low
Short-toed Snake-Eagle	Possible	Minor	Low
Saker Falcon	Almost certain	Minor	Moderate
Egyptian Vulture	Possible	Minor	Low
Great Bustard	Possible	Minor	Low
Houbara Bustard	Almost certain	Minor	Moderate
Relict Gull	Unlikely	Minor	Low
Mongolian Ground-jay	Almost certain	Minor	Moderate
Yellow-breasted Bunting	Possible	Minor	Low
Gobi Naked-toed Gecko	Possible	Minor	Low
Riverine Elm Trees	n/a	n/a	n/a
Tall Saxaul Forest	n/a	n/a	n/a

Appendix IV: Background to construction of wildlife passes

From a realistic, current perspective, options to minimise fragmentation effects of roads as a barrier to animal movement or to improve connectivity across roads primarily comprise (in order of effectiveness) underpasses (raised sections of road); wildlife overpasses (wildlife-specific bridges); wildlife culverts (small crossings under roads designed for wildlife); and road closures at key times. Construction of tunnels, underpasses, wildlife overpasses and wildlife culverts is considered best practice in Europe and North America (Bruinderink & Hazebroek 1996; Clevenger & Huisjer 2011; www.wildlifeandroads.org). These are expensive but proven effective solutions to the barrier effects of roads on wildlife. The type, size, design, frequency and location of such 'wildlife crossings' are tailored to specific sites and species. Burying the road in tunnels would be preferable but is apparently too expensive and would cause too long a construction delay. In southern Mongolia, available evidence indicates that underpasses would be the next most effective wildlife crossings, although they are expensive in areas of flat topography.

Wildlife overpasses are essentially vegetated bridges for wildlife that are built over a road and are wide enough to screen the road from view. In closed environments such as forests, widths are usually a minimum of 50 m as trees and tall shrubs screen the road from view by wildlife. However, this design has no functioning precedent in open environments (where animals can see a long way), though experimental designs are in development for Pronghorn Antelope *Antilocapra americana* in North America. Expert opinion is mixed over whether overpasses would be suitable (e.g. P. Kaczensky pers. comm. 2011) or not (e.g. K. Olson pers. comm. 2011) for the open habitats and sensitive ecosystems of southern Mongolia. If such a design were to be trialled experimentally in this area, such a trial should be outside of the Small Gobi Strictly Protected Area (to avoid further construction of unproven value), closely monitored to assess connectivity value, and such overpasses should be as wide as possible (minimum 500 m; P. Kaczensky pers. comm. 2011) to avoid animals' perception of being on a bridge. Given the uncertainty over success of overpasses in the open habitats of the Gobi, underpasses or culverts are the most appropriate wildlife crossings. As no overpasses have been built for hunted open-country species anywhere, their efficacy is unknown in this environment, and any overpasses would be considered an experiment rather than a mitigation action. Crossings designed for larger species will generally be effective for smaller species. Given the importance of the unit of analysis for Asiatic Wild Ass, the largest priority species, it is crucial to understand what kind of crossings are suitable for this species.

The only infrastructure barrier minimisation attempted to date specifically for Asiatic Wild Ass has been in eastern Mongolia (on the Ulaanbaatar-Beijing railway) and in India. Asiatic Wild Ass and Mongolian Gazelle do not use concrete box culverts (c. 2.5 m high and 4 m wide) under the Ulaan Baatar-Beijing railway that are used by vehicles and livestock (Ito *et al.* 2005, 2008; Kaczensky *et al.* 2006, 2011). In India, where Asiatic Wild Ass are not hunted and are well-habituated to humans and human infrastructure, animals occasionally used culverts of 2.5 m height and 7 m width (on a natural substrate) but more frequently used culverts of 3 x 7 m and 5 x 24 m (World Bank 2002). Given the limited information available on suitability of wildlife

crossings for Asiatic Wild Ass, it is useful to draw on closely-related species in similar environments elsewhere. Kiang *Equus kiang* (formerly considered to be the same species as Asiatic Wild Ass), Tibetan Antelope *Pantholops hodgsonii* and Tibetan Gazelle *Procapra picticaudata* use underpasses and culverts of 3.9-8 m high and 15-3,500 m width under the Qinghai-Lhasa railroad, but not underpasses 2.5 m high even when >11 km in length (Baofa *et al.* 2006; Xia *et al.* 2007). Further, although Tibetan Gazelle and Tibetan Antelope were recorded using culverts 7-8m high and 3 m wide, Kiang have not been recorded using these narrow culverts (a view of the horizon is believed to be important in encouraging wild ass to use crossings). Natural, non-waterlogged substrate with no obstacles was optimal for maximising wildlife use of these crossings (Baofa *et al.* 2006; Xia *et al.* 2007). More detailed studies of large ungulate species in North America have shown that culverts for Bighorn Sheep *Ovis canadensis* and Mountain Goat *Oreamnos americanus* need to be a minimum of 4.5 m high and 12 m wide, and 4 m x 7 m for other large ungulates (Clevenger & Huisjer 2011).

Where large mammal crossings are used in North America, they are located every 1.5-6 km (average 1.9 km) (Clevenger & Huisjer 2011). An ecological spacing metric based on animal home range sizes recommends that passes are provided at intervals of territory size (or 'linear measure of home range area') to achieve ecological 'permeability' across the road (Bissonette & Adair 2007). Asiatic Wild Ass do not have standard territories but given that the species walks an average of 12 km/day (Kaczensky *et al.* 2006), this correlates to one crossing every 12 km. An equivalent distance for Mongolian Gazelle is c. 3 km (Olson *et al.* 2010; Mueller *et al.* 2011; K. Olson *in litt.* 2011). Equivalent distances are not known for Goitered Gazelle and Argali, but are likely to be longer than the ecologically closest American species, Pronghorn Antelope *Antilocapra americana* and Bighorn Sheep. Dodd *et al.* (2011) who concluded that one crossing every 5 km (half the average daily travel distance) is necessary for Pronghorn Antelope which are ecologically similar to, but better-studied than, gazelles, and Bissonette & Adair (2007) recommended one crossing is at least every 3.3 km for Bighorn Sheep which have small territory sizes. Fewer crossings are likely to be required along the road upgrade to Gashuun Sukhait as the key species are more mobile and nomadic than species with fixed home ranges. On a precautionary basis, one appropriate crossing every 6 km (c. 2 days' walk for a gazelle or 0.5 day's walk for an ass between crossings) is likely to facilitate effective ecological permeability. Less frequent crossings will enable a level of connectivity, but not effective permeability: such reduction, but not removal, of fragmentation effects will still result in negative residual impacts on connectivity. In extreme situations such as droughts or *dzuds*, animals will walk long distances in an attempt to cross linear barriers (e.g. 90 km by Asiatic Wild Ass; Kaczensky *et al.* 2006), but this may induce considerable stress and mortality.

A full cost analysis of underpasses and overpasses has not been conducted here as it is best performed by engineers familiar with materials and labour costs in Mongolia. However, some figures from elsewhere are detailed here for guidance. Estimates of – presumably higher – bridge construction costs in the US are \$100-150/square foot; Sawyer & Rudd 2005). Underpasses have, for example, cost US\$9 million for a 200 m wide (along highway) underpass in Canada in 2007 (Huijser *et al.* 2007) or US\$680,000–1,000,000 for a 60 m wide (along highway) underpass in the US in 2005 (Sawyer and Rudd 2005). Example costs of specific

wildlife underpasses are US\$40,000/m width for underpass 13 m wide x 5 m high in Canada in 2007 and c. \$220,000 for underpasses 7 m wide x 4.8 m high x 22 m long (Huijser *et al.* 2007), and US\$33,000-55,000/m width for underpasses 7- 10 m wide x 5 m high in Netherlands in 2005 (Kruidering *et al.* 2005). Underpasses specifically designed for Asiatic Wild Ass in India were estimated at c. \$230,000 for those 5 m high x 10.4 m wide and c. \$189,000 for those 4 m high x 10 m wide (World Bank 2002). Costs for overpasses are potentially higher – e.g. \$1.75-2.5 million for a small overpass of 30 m width and 45 m length (Sawyer & Rudd 2005), with – for example – materials costs of c. \$540,000 for a 30 m-wide overpass across a dual-carriageway in the US in 2010 (Dodd *et al.* 2010). Other examples are c. US\$1.2 million for an overpass 52m wide x 70 m long in Canada in 2007 and \$1.5-2.4 million for an overpass across a two-lane highway in the US in 2007 (Huijser *et al.* 2007) or c.US\$1.7-7.0 million for each of seven different overpasses in Netherlands (Kruidering *et al.* 2005).