Climate Risk Vulnerability Assessment

Mongolia - Regional Improvement of Border Services Project

Project Number: 47174-001
Loan Number: 3387-MON

August 2017
### ABBREVIATIONS AND DEFINITION OF TERMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AB-BCP</td>
<td>Altanbulag Border Crossing Point</td>
</tr>
<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>Aimag</td>
<td>Province; first level administrative division of Mongolia</td>
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<tr>
<td>BCP</td>
<td>Border Crossing Point</td>
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<tr>
<td>CAREC</td>
<td>Central Asia Regional Economic Cooperation</td>
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<tr>
<td>DDIS</td>
<td>Detailed Design and Implementation Supervision, or Engineer</td>
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<tr>
<td>EA</td>
<td>Executing Agency</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<tr>
<td>EMP</td>
<td>Environmental Management Plan [for entire Project]</td>
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<tr>
<td>GABP</td>
<td>General Authority for Border Protection</td>
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<td>GACT</td>
<td>General Authority for Customs and Taxation</td>
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<tr>
<td>GASI</td>
<td>General Agency for Specialized Inspection</td>
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<td>GOM</td>
<td>Government of Mongolia</td>
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<tr>
<td>IEE</td>
<td>Initial Environmental Examination</td>
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<tr>
<td>IFC</td>
<td>International Finance Corporation</td>
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<tr>
<td>MNET</td>
<td>Ministry of Environment and Tourism</td>
</tr>
<tr>
<td>MUST</td>
<td>Mongolia Regional Upgrades of Sanitary and Phytosanitary Measures for Trade</td>
</tr>
<tr>
<td>PIU</td>
<td>Project Implementation Unit (of the GOM)</td>
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<tr>
<td>RIBS</td>
<td>Regional Improvement of Border Services</td>
</tr>
<tr>
<td>SB-BCP</td>
<td>Sukhbaatar Border Crossing Point for Rail</td>
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<tr>
<td>SEMP</td>
<td>Site Environmental Management Plan</td>
</tr>
<tr>
<td>Soum</td>
<td>County or district; second level administrative subdivision of Mongolia</td>
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<tr>
<td>SSSC</td>
<td>Single Stop Service Center</td>
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<tr>
<td>TTFS</td>
<td>Transport and Trade Facilitation Strategy</td>
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EXECUTIVE SUMMARY

This is the draft Climate Risk Vulnerability Assessment (CRVA) report for the Asian Development Bank (ADB) Regional Improvements for Border Services (RIBS) Project in Mongolia. The Project includes the three border crossing points shown in Figure 1.

Figure 1. Map showing project site locations

In particular, this CRVA covers the two sites shown in Corridor 4b: the Altanbulag Border Crossing Point (BCP) improvements, including a new access road; and, a building to house a new Single Stop Service Center at the Sukhbaatar BCP for rail, consolidating a number of Government border and customs agencies and activities.

A complete description of the project is contained in the Appendix to this CRVA report. Although the BCPs at Zamyn Uud and at Bichigt are included in the RIBS Project, the improvements there are non–structural, involving capacity enhancement and training measures, and new equipment. They are therefore not susceptible to climate change impacts, and are excluded from this CRVA study.

The CVRA considers the existing Project environment subject to climate change, to potential or likely impacts of that change, and makes recommendations for mitigating effects to the extent that they are predictable in a region well known for extreme swings in weather. An approximate estimate of increase in project bill of quantities for materials of 2% above normal non-climate related costs is recommended to be
included as a climate risk contingency. Based on a current constructed infrastructure cost of $15 million, the indicative increase due to climate-related costs is $300,000.

1 Review of relevant literature

The following documents and sources were reviewed. See Table 1. Document Nos. 1-3 were supplied by ADB. Items 4-7 were cited by the first three documents. The remainder were obtained by independent research. The results of current research on the potential effects of global climate change specifically on northern Mongolia are not yet abundant in the literature.

Table 1. Literature reviewed

<table>
<thead>
<tr>
<th>No.</th>
<th>Document</th>
<th>General contents</th>
<th>Implications for RIBS Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ADB “Climate Aware for Projects: Climate Risk Screening Exercise for Altanbulag Border Crossing Point”</td>
<td>Indicates increased precipitation and flooding</td>
<td>Increased temperature, permafrost issues, floods and snow loading</td>
</tr>
<tr>
<td>2</td>
<td>ADB “Climate Aware for Projects: Climate Risk Screening Exercise for Zamyn Uud Border Crossing Point”</td>
<td>Negligible risk for impacts on equipment additions, training and capacity enhancement</td>
<td>None. Snow loading identified.</td>
</tr>
<tr>
<td>3</td>
<td>ADB “Climate Aware for Projects: Climate Risk Screening Exercise for Bichigt Border Crossing Point”</td>
<td>Negligible risk for impacts on equipment additions, training and capacity enhancement</td>
<td>None. Snow loading identified.</td>
</tr>
<tr>
<td>4</td>
<td>World Meteorological Organization, “The Global Climate 2001-2010: A Decade of Climate Extremes. Summary Report,” WMO-1119 (2013)</td>
<td>General review of decadal global climate trends with little specific regional information. “Much of Asia saw anomalies exceeding +1°C over the course of the decade, including China, the Islamic Republic of Iran, Mongolia and the Russian Federation. For the whole continent the median temperature anomaly of the decade was +0.84°C.” No anomalous increases in precipitation for northern Mongolia were noted, and no extreme flooding events.</td>
<td>Some question as to whether annual precipitation will increase so as to increase flooding. But see reference number 12.</td>
</tr>
<tr>
<td>No.</td>
<td>Document</td>
<td>General contents</td>
<td>Implications for RIBS Project</td>
</tr>
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<td>-----</td>
<td>--------------------------------------------------------------------------</td>
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<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td>9</td>
<td>Climate change and water resources in northern Mongolia; Menzel, Lucas; Törnros, Tobias; Marberg, Ines; EGU General</td>
<td>Direct observations over recent decades indicate strong warming, decreased</td>
<td>May need to direct attention to potential permafrost</td>
</tr>
<tr>
<td>No.</td>
<td>Document</td>
<td>General contents</td>
<td>Implications for RIBS Project</td>
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<tr>
<td>Assembly 2014, held 27 April - 2 May, 2014 in Vienna, Austria</td>
<td>precipitation and flooding events.</td>
<td>melting and local flooding</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>“Spatial and seasonal variation of climate on steppe slopes of the northern Mongolian mountain taiga,” Choimaa Dulamsuren and Markus Hauck. Grassland Science, 17 December 2008.</td>
<td>Soils on the open slope are warmer than at the tree-line between taiga forests and grasslands and adjacent plains, thus, less suited for tree growth.</td>
<td>Background mainly, although it confirms a marked decadal temperature increase for the region.</td>
</tr>
<tr>
<td>12</td>
<td>“Interviews of Mongolian herders and high resolution precipitation data reveal an increase in short heavy rains and thunderstorm activity in semi-arid Mongolia.” Clyde E. Goulden (author), Jerry Mead, Richard Horwitz, Munhtuya Goulden, Banzragch Nadintsetseg, Sabrina McCormick, Bazartseren Boldgiv, Peter S. Petraitis, Climatic Change, May 2016, Volume 136, Issue 2, pp 281–295.</td>
<td>Important if controversial research indicating that short, high-intensity Summer storms with damaging effects are supplanting longer-term more mild precipitation events characteristic of the northern Mongolia steppe. 24-hour daily precipitation records mask the data for short heavy “aadar” storms. Precipitation events such as those experienced—up to ≥0.8 mm/5 minutes, and 8.8 mm during a 35-min period—can cause rapid flooding.</td>
<td>Similar to findings of the Climate Aware Screening reports for RIBS Project area.</td>
</tr>
<tr>
<td>13</td>
<td>Encyclopedia Brittanica, Mongolia Climate and Soils, <a href="https://www.britannica.com/place/Mongolia/Climate-and-soils">https://www.britannica.com/place/Mongolia/Climate-and-soils</a></td>
<td>General background</td>
<td>N/A</td>
</tr>
<tr>
<td>14.</td>
<td>Primer on Developing and Managing Infrastructure in Permafrost Regions, Transportation Association of Canada, 2010, pp. 3-5.</td>
<td>A good standard guidebook</td>
<td>Used for developing some of the recommendations in</td>
</tr>
<tr>
<td>No.</td>
<td>Document</td>
<td>General contents</td>
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5 **Summary of historical climate (including trends)**

Situated at high latitudes (between 41° and 52° N) and high elevations (averaging about 5,180 feet [1,580 metres]), Mongolia is far from the moderating influences of the ocean—at its nearest point some 435 miles (700 km) west of the Bo Hai (Gulf of Chihli). Consequently, it experiences a pronounced continental climate with very cold winters (dominated by anticyclones centered over Siberia), cool to hot summers, large annual and diurnal ranges in temperature, and generally scanty precipitation. The difference between the mean temperatures of January and July can reach 80 °F (44 °C), and temperature variations of as much as 55 °F (30°C) can occur in a single day. Mean temperatures in the north generally are cooler than those in the south: the mean January and July temperatures for the Ulaanbaatar area are −7

![Physiographic map of the region encompassing Sukhbaatar soum, location of the Sujhbaatar BCP for rail is on the west (left). Altanbulag soum, location of the Altanbulag BCP is on the northeast (upper right)](image-url)
°F (-22 °C) and 63 °F (17 °C), respectively, while the corresponding temperatures for the Gobi area are 5 °F (-15 °C) and 70 °F (21 °C).  

Precipitation increases with elevation and latitude, with annual amounts ranging from less than 4 inches (100 mm) in some of the low-lying desert areas of the south and west to about 14 inches (350 mm) in the northern mountains; Ulaanbaatar receives about 10 inches (250 mm) annually. The precipitation, which typically occurs as thunderstorms during the summer months, is highly variable in amount and timing and fluctuates considerably from year to year.

A remarkable feature of Mongolia’s climate is the number of clear, sunny days, averaging between 220 and 260 each year. Yet the weather may also be severe and unpredictable. Sandstorms or hailstorms can develop quite suddenly. Heavy snow occurs mainly in the mountains, but fierce blizzards sweep across the steppes. Even a thin coating of ice or icy snow can prevent animals from getting to their pasture.

Mongolia is facing a large number of water-related problems, such as adverse natural conditions, increasing water withdrawals, scarce environmental information and a lack of structures which control the appropriate distribution and protection of water. Since 2010, the University of Heidelberg has conducted a monitoring program in northern Mongolia which aims at better understanding the climatic characteristics, the freshwater generating processes as well as the impact of environmental change on the water resources in a semi-arid environment. Focus is on the meso-scaled Kharaa catchment (14,500 km²) north of Ulaanbaatar which includes the transition belt between the extended steppe ecotone, the Siberian taiga as well as the alpine tundra of the Khentii Mountains which act as the major freshwater generating area of the region. Based on the information gained during their field studies, researchers successfully applied the hydrological HBV-D model to simulate the discharge at the outlet of the basin and for a number of sub-basins. They were able to show that runoff within the study region is strongly influenced by the high climate variability. For example, the observed runoff in the basin shows a sudden decrease in the middle 1990s. At the same time, precipitation is decreasing and temperature is strongly increasing. The study is based on data from only six meteorological stations. Therefore, output from Global Climate Models has been considered as another potential data source. Accordingly, the HBV-D model was driven with WATCH forcing data for the years 1901-2000. This made it possible to simulate the runoff for years where no runoff observations exist. The results show that mean annual air temperature has been rising in recent years.

For example, between 1940 and 2001 MAT increased by 1.7°C) while precipitation shows strong, long-term oscillations. Accordingly, simulated mean annual discharge shows a high temporal variability with high fluctuations during the first half of the 20th century when air temperature was relatively low. Furthermore, in order to address the hydrological impacts of future climate change, the HBV-D model was applied on

1 Encyclopedia Brittanica, Mongolia Climate and Soils, https://www.britannica.com/place/Mongolia/Climate-and-soils
2 Ibid
3 Ibid
WATCH scenario data for the years 2001-2100, including the output from three GCMs driven by two IPCC emission scenarios. Results indicate that the clear increase of MAT is projected to continue over the coming 100 years while mean annual precipitation appears to slightly increase. However, simulated discharge shows a decrease, evidently as an effect of increasing evapotranspiration and possibly changing precipitation characteristics.\textsuperscript{4}

The climate-dependent forest–steppe border runs through northern Mongolia. The area encountered late 20th century warming far above the global average. The overall climate of the area is characterized by highly variable, low annual precipitation (<300 mm), an annual average of air temperature around the freezing point and a high seasonal amplitude of temperature of 80°C. South-facing slopes are warmer and drier than the floodplain. High soil temperatures with maxima of nearly 60°C at 1 cm depth and low soil moisture are capable of inhibiting tree growth on the south-facing slopes. Soils on the open slope are warmer than at the treeline between taiga forests and grasslands and, thus, less suited for tree growth. On the open slopes, soil temperatures primarily depend on the inclination, aspect (whether slopes are north-south, east-west facing, etc.), and vegetative cover, suggesting an interrelationship between topography, the present vegetation, microclimate and the potential for the establishment of trees.\textsuperscript{5}

6 Description of climate projection methodology

6.1 General

No original data were collected and therefore no climate projection beyond what was available in the Climate Aware Screening reports and the extensive climate change literature were consulted. A review was made of climate projection methodology as part of the literature review, and a number or more-or-less practical methods have been developed and published, although there are no convenient and reliable

\textsuperscript{4} Climate change and water resources in northern Mongolia; Menzel, Lucas; Törnros, Tobias; Marberg, Ines; EGU General Assembly 2014, held 27 April - 2 May, 2014 in Vienna, Austria

\textsuperscript{5} Spatial and seasonal variation of climate on steppe slopes of the northern Mongolian mountain taiga, Choimaa Dulamsuren and Markus Hauck. Abstract.
handbooks or guidelines that would allow for the quick appraisal called for by construction Projects such as RIBS. There are many down-scaled projections available and in the public domain. The comprehensive models of future temperature and precipitation change in the East Asia-Tibetan Plateau region, produced by the Intergovernmental Panel for Climate Change (see reference #7 in Table 1) are useful indicative guides, provided an understanding of the intra- and inter-model variance is kept in mind. The Climate Aware Screening for Projects methodology is described below, while the references cited for complementary and contrasting viewpoints and findings state their own methodology.

6.2 Climate Aware Methodology

Screening data resolution. The proprietary Aware data set operates at a resolution of 0.5 x 0.5 decimal degrees (approximately 50 km x 50 km at the equator). These proprietary data represent millions of global data points, compiled from environmental data and the latest scientific information on current climate / weather related hazards together with potential changes in the future. Future risk outcomes are based on projections data from the near- to mid-term time horizons (2020s or 2050s, depending on the hazard and its data availability).

Global climate model output, from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3) multi-model dataset,6 were downscaled to a 0.5 degree grid.

Aware data application. In some instances Risk Topic ratings are only based on Aware data, including:

- Flood
- Permafrost
- Landslides

Country level risk ratings. These are generated from the data points within a country’s borders. For single locations, sites specific data are used, and for multiple locations or countries, composite data across the portfolio of locations are used.

The thresholds shown in Table 2 are used as a means of providing a project-wide risk score where a project may be spread across multiple locations. This requires more than one individual location to be at risk to begin signifying whether there is a risk at the overall project level.

<table>
<thead>
<tr>
<th>Table 2. Glossary of terms used in the Climate Aware Screening reports</th>
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<tbody>
<tr>
<td>• &quot;Climate model projections agree&quot;: defined as more than 14 out of 16 GCMs agreeing on the magnitude (e.g. temperature warming of 2 °C) and / or direction of change (e.g. seasonal precipitation).</td>
</tr>
<tr>
<td>• &quot;Climate model projections do not agree&quot;: defined as 14 or fewer out of 16 GCMs agreeing on the magnitude (e.g. temperature warming of 2 °C) and / or direction of change (e.g. seasonal precipitation).</td>
</tr>
<tr>
<td>• “Significant proportion”: defined as at least 25% of locations when multiple locations are selected.</td>
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<tr>
<td>• “Large proportion”: defined as at least 75% of locations when multiple locations are selected.</td>
</tr>
</tbody>
</table>

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However, it is always recommended that individual locations are analysed separately for more accurate, site-specific risk screening. The overall risk score for the project (high, medium or low) is based on a count of high risk topic scores. A project scores overall high risk if greater than or equal to 3 individual risk topics score high. A project scores overall medium risk if between 1 and 2 individual risk topics score high. A project scores overall low risk if none of the individual risk topics score high.

7 Summary of projected changes in climate at project location

7.1 Zamyn-Uud and Bichigt Border Crossing Points (BCPs)

The Climate Aware screening analysis for Zamyn-Uud and Bichigt Border Crossing Points (BCPs) show increased risk for snow loading on structures, and no other risks. Since no structural improvements under the RIBS Project are programmed for either Zamyn-Uud and Bichigt BCPs, those BCPs are removed from the analysis CRVA and no further discussion is devoted to them here.

7.2 Altanbulag and Sukhbaatar BCPs

The Climate Aware screening analysis for the Altanbulag and Sukhbaatar area highlighted the following concerns:

- The impact of increasing average temperatures will be more noticeable in the higher latitudes and therefore assets and infrastructure built during stable ground conditions could be at risk.
- Existing engineering designs may not take into consideration the impact of climate change on permafrost.
- If ground stability in permafrost regions can be identified as a potential problem for the project, it is recommended that a more localised and in-depth assessment is carried out. This information can then be used to inform the project design process if necessary.7

Discussion. Altanbulag, the northernmost BCP with a construction component is located in areas well known for permafrost conditions. According to local officials familiar with the access road alignment indicated that freezing and thawing are both experienced at the site. It is assumed that the engineers have incorporated this phenomenon in their designs, but if not, special care should be taken to do so.

The construction site at Sukhbaatar BCP for rail Is located in an urban industrial zone of the soum, and it is not known at this time what the permafrost situation is at that site. It is advisable that similar precautions as for Altanbulag BCP be taken in the engineering design.

The temperature projections for the 21st century, based on the Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change: Annex 1 - Atlas of Global and Regional Climate Projections, suggest an acceleration of warming and, with less confidence and more variability, higher precipitation, over that observed in the 20th century in the East Asia-Tibetan Plateau

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7 Climate Aware 1 (Altanbulag BCP), Section 4.
region. Warming is least rapid, similar to the global mean warming, in South-East Asia, stronger over South Asia and East Asia and greatest in the continental interior of Asia (Central, West and North Asia). In general, projected warming over all sub-regions of Asia is higher during northern hemispheric winter than during summer for all time periods.\(^8\)

Because climate in Mongolia is predicted to become warmer and wetter, but possibly drier in places with adverse topographic and vegetative factors, hot and dry soil conditions inhibiting the establishment of trees may be expected to be more common in future. An expansion of such unfavorable conditions could cause the spread of grasslands to slopes in western and eastern aspects, which are presently occupied by forest.\(^9\)

There is evidence that: (1) almost the entire Mongolian steppe region experienced significant vegetation biomass declines between 1988 and 2008; (2) about 60% of the decline can be attributed to climate trends: in particular, decreasing precipitation and increasing temperature; and (3) the dramatic increase in goat numbers and grassland burning is likely to account for most of the remaining decline. Average air temperature is projected to increase and precipitation to decrease in Mongolia over the next three decades [23]. The implications of this changing climate will further stress an already fragile environment and likely accelerate grassland degradation.\(^10\)

### 8 Summary of likely physical impacts on project; project assets (mapping of climate impacts to assets)

Based on the Climate Aware Screening reports, and on literature indicating increased temperatures and more intense storm events, the following are the two most likely form of impacts anticipated for the RIBS Project facilities in Altanbulag and Sukhbaatar:

- Possible settling or buckling of road or foundation subsoils due to increased or more frequent permafrost melting events, unaccustomed higher soil temperatures, and more frequent high-intensity storm events, even though total annual precipitation is decreasing
- Increased intensity of storm-events, overtaxing drainage facilities for the road and nearby drainage systems

#### 8.1 Road and building foundation subsoil considerations

Two approaches are possible in the design of roadways on permafrost:

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• Make the fill section thick enough to prevent thaw penetration and frost penetration into the permafrost; or
• To allow thaw penetration and frost penetration into the subgrade.

Whether one of these or an intermediate approach is taken, the roadway must be adequately stabilized against cracking, differential settlement and frost heaving. Frost susceptibility of construction materials and subgrade soils should be evaluated in conjunction with the thaw weakening characteristics. Factors affecting mechanical and thermal stability going beyond climatic factors, to soil type and composition, precipitation, energy exchange components and others must be considered. Pending the results of such studies, for the access road at Altanbulag BCP quantitative data are lacking. For safety, an increase in the current standard approach for embankment volume, variation in fill materials to suit increased freeze-thaw episodes, and improved subgrade and surface layers may be anticipated. In embankment areas where thaw-unstable conditions are anticipated, the side slopes should be flattened, bermed or insulated to ensure that the integrity of the main embankment is maintained. In general, increased attention and resources must be dedicated to the roadway construction if resilience to increased freeze-and-thaw conditions is desired.

Construction challenges presented by permafrost and permafrost melting are well understood by engineering personnel in northern Mongolia. However, careful attention must also be devoted to the design of drainage facilities, which are in independent need of upgrading.

For the building foundation at Sukhbaatar BCP for rail, construction standards may need to be adapted to reflect changing conditions and to reduce the vulnerability of infrastructure to melting permafrost, e.g., deeper pilings, air allowed to circulate beneath buildings, thicker insulation to be employed, and facilities are located on gravel pads or other insulated materials. Buildings and infrastructure should generally be designed for lighter weight and subject to regular repair and maintenance programs.

8.2 Drainage facilities

Given the evidence for climate change induced increases observed in high intensity storm events, with their possibility of overtaxing existing storm drains and culverts, designers should consider an increase in diameter for all culverts and other drains, or to at least the next larger pipe diameter above the existing standard that is available in Mongolia seems prudent at this time.

9 Summary of likely financial (economic) impacts on project

Development of cost estimates for climate change mitigation estimates requires detailed examination of potential design changes by the Project DDIS/Engineer, based in part on the recommendations in section 8 of this CRVA report. In lieu of these estimates, some degree of reasonableness and assessment of the risks of both overestimating as well as underestimating the likelihood of the predicted climate changes should be applied.

Needed increases in sub-grade thickness, improvements in fill materials, and the like will likely cause proportional increase in material quantities. Increased drain size will
require larger diameter of purchased polyethylene or concrete pipe. Other changes, such as employing the principles of good roadway design and best practices for drainage are essentially costless, and lead to lower life-of-project expenditures.

In the current context, an estimate of increased total project construction costs of 2% seems reasonable. Based on a current constructed infrastructure cost of $15 million, the indicative increase due to climate-related costs is $300,000. This figure is not derived empirically; rather, it is an added safety factor that will have to be tested with time. Also, the cross section of highway, illustrated in the Appendix, Figure 9, gives no indication of surface or subgrade measures against permafrost freeze-thaw conditions. The recommended increase would apply to the bill of quantities for materials, as well as design and construction labor costs, which can also be expected to increase.

10 Adaptation and/or mitigation measures required to improve the project feasibility over its design life and the anticipated climate change

10.1 Road Engineering Considerations

The road should be aligned as far as feasible from drains and natural watercourses, such as the one on the east side of the proposed alignment.

When it comes to embankment design in permafrost conditions, the basic principle is to protect the integrity of the embankment’s structural core; this can be achieved through both surface preservation and avoidance of cuts in thaw-sensitive soils. Cuts in the permafrost soil, as well as stripping or grubbing to remove the vegetative layer, may promote unwanted thawing and lead to settlement of the embankment.

Wide shoulders and gentle side-slopes will give an overall wider configuration to the embankment, which will in turn move settlements away from the structural core, mitigate the impact of thaw and help reduce snow accumulation. In permafrost conditions, it is advisable to undertake activities that are likely to improve slope stability or, at a minimum, avoid design and construction activities that promote instability.11

When designing a structure requiring high reliability in very sensitive permafrost conditions, thermal stabilization using special protection techniques might be required. Consider techniques to reduce heat intake in the embankment during summer and allow heat extraction during winter and/or embankment reinforcement techniques.12

The loss of the permafrost is now inevitable; the only issue is when. In many settings pre-melting of the permafrost to allow de-watering and compaction prior to construction may be preferable to preserving permafrost in situ. Consider Figure 3 in

11 Design Considerations for Roadways on Permafrost, Dr. Arvind Phukan, School of Engineering, University of Alaska, 1980
Dashjamts et al. (2013). Altanbulag and Sukhbaatar both appear to be in a region of discontinuous permafrost, and near the boundary between Zones 1 and 2 as defined by the authors. They instruct:

“According to Dashjamts (1999), the territory of Mongolia can be divided into two main zones based on consideration of its geocryological and climatic conditions ...

Figure 3. Regional classification of permafrost in Mongolia

In the Region I areas, where the climate is colder with an average annual temperature falling below −2 °C, soil freezes permanently and continuous, discontinuous, and scattered types of permafrost have been developed. In such conditions, Principle I of foundation design on permafrost (keeping the permafrost in a frozen condition) is preferred. In the Region II areas, with an average annual temperature ranging from 0 °C to −2 °C, the permafrost is relatively thin and sporadic. In such areas, Principle II of foundation design on permafrost should be followed, which offers solutions to deal with the possibility of permafrost thawing.

“The Principle II method of construction on permafrost should be used in areas with sporadic permafrost distribution, and it offers two options. The first option takes into account the possibility of thawing during building operation, and the foundation is designed to be able to endure slight settlement (the constructive method). The second option is to thaw and compact the frozen soil prior to constructing buildings. The first option should be used when soil settlement resulting from permafrost melting is expected to be within the permissible limit, whereas the second method can be used when rock and gravel deposits are located under the thin permafrost layer. If the

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14 Ibid., pp. 672 ff.
thermal regime of the permafrost is unstable, pre-thawing and compacting of the frozen soil is suggested as a permanent solution (Figure 8).”

Project design and other personnel should consider at a minimum (i) any changes in the status of permafrost since ca. 1999 when Dashjams’ (1999) study was conducted; (ii) the project life span and (iii) reasonable assumptions about the status of permafrost toward the end of that period. Dashjams’ guidance concerning mean annual temperatures can then be applied to determine if Method I (preserving permafrost) or Method II (pre-melting and compacting) is preferable. To reiterate, we know with certainty that the permafrost in this area will eventually be lost.

Relative to precipitation increases, especially for extreme events, the design team should prepare detailed site drainage and flood control plans to ensure that site drainage as well as upstream drainage areas can be conveyed through the site safely. Include an evaluation of the access road elevation and any building elevations, and consider raising the level if necessary. Relative to the potential for hotter, dryer summers, consider low water use for landscaping roads, parking lots, and buildings.

10.2 Energy efficiency measures and climate change adaptation

Energy efficiency measures such as purchasing energy efficient equipment, and imposing restrictions on truck idling may result in less energy consumption and therefore lower contributions to greenhouse gas (GHG) emissions. The reduced time of travel for cargo trucks and reduced time in transit across the BCP, which are basic Project objectives, may also result in lower GHG emissions.

Building design onsite should consider risk factors for increased snow loading, permafrost and flood occurrence. Building design features to adapt to climate change impacts should include energy efficiency measures such as high-grade insulation for heat retention and possible installation of roof solar panels.

Although somewhat beyond project scope, national and regional or local policy changes are worth mentioning. Opportunities for significant emission reductions include implementing a carbon constraint, raising efficiency standards for vehicles, blending low-carbon fuels with gasoline, and changing land-use patterns through urban design and planning. Each of these measures could contribute to reducing GHG emissions, but none is sufficient alone. Some studies estimate that a combination of reasonable measures would reduce carbon emissions by about 20 percent in the short term, to almost 50 percent in the long run, compared to “business as usual.”

Finally, as more detailed design data become available, the entity responsible for final design should review ADB’S recently published “Guidelines for Estimating Greenhouse Gas Emissions of Asian Development Bank Project: Additional Guidance for Transport Projects” (2016). Although directed mainly at large transport projects, the guidance may prove relevant for some RIBS Project components.

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10.3 **Drainage, Flood and Erosion Control**

Drainage and erosion control are critically important design considerations for roads, especially in northern permafrost environments. Poor drainage conditions along a road over permafrost terrain may cause surface water ponding, thermal erosion, thermokarst and or formation of icings. The effects of these processes may have a serious impact on the environment and traffic, and can lead to higher maintenance costs. Many potential drainage problems associated with new roads constructed in permafrost terrain can be avoided or minimized by careful selection of the road alignment and minimizing stream crossings.

In ice-rich soils, stream and surface water runoff hydrology during all seasons must be fully understood so that bridge span and foundation structures are appropriately designed. Ideally, bridges should be placed at narrow and straight channel locations, on bedrock or coarse, ice-poor, non-settling foundation soils.

Culverts in permafrost regions require constant maintenance and should be used only when necessary. Where large diameter culverts cannot be avoided, it is recommended to use riveted or bolted culverts and consider installation of polystyrene insulation beneath the culvert bedding material on the bottom and sloped sides of the excavation.

Erosion control design should be based on soil erosion codes and aimed at minimizing changes to existing drainage patterns. In addition to selecting correct erosion control structures for a specific road construction project, proper and environmentally friendly construction practices should be used during road construction to minimize the potential for erosion.\(^\text{17}\)

11 **Recommendations for project climate risk management**

In addition to the recommendations included above, ongoing monitoring of climatic conditions (in this case, capturing temperature records) should be considered an important and ongoing component of project climate risk management.

12 **Cost estimates of proposed climate proof materials and technologies to be incorporated into the design, if any**

Monetary cost increase is to be determined by Engineer, based on the parameters specified herein and the recommended 2% contingency allowance as insurance against unforeseen future climate change conditions.

13 **Implementation arrangements**

EA should consider the recommended changes in consultation with ADB, and if in agreement, forward them to the PIU and/or chief engineer of the design team.

14 **Monitoring and Evaluation plan**

14.1 **Road and foundation subsoil considerations**

Altanbulag BCP. Records should be kept by maintenance personnel of the number of incidents of permafrost buckling, as compared with previously constructed roads. A

\(^{17}\text{Ibid, pp. 5-6.}\)
data capture procedure should be set up by appropriate road management authority and/or the Border Control Point physical plant superintendent.

**Sukhbaatar BCP.** Similar records should be kept for the SSSC building at Sukhbaatar, post-construction. The local buildings department for the soum of Sukhbaatar should set up a data capture system for this purpose.

14.2 **Drainage and flooding**

It is recommended that a municipal engineer, if available, or the BCP officer in charge of maintenance and engineering, if any, be tasked to maintain records of extreme precipitation events, flooding, etc. This information will be valuable to ADB and others for lessons learned and future advisories regarding preservation of Project facilities.
APPENDIX 1 - DESCRIPTION OF THE PROJECT

Existing Environment of Project Sites

Altanbulag BCP is located in Selenge aimag at the northern border of Mongolia with the Russian Federation. The city of Altanbulag has a population of approximately 5,000 residents and is connected to the city of Ulaanbaatar by a 400 kilometer, two-lane highway, AH3. Terrain is hilly (Figure 5), with steep slopes in some areas. Altanbulag’s top soil appears to be sandy. The annual average temperature is 5.5°C. The northern part of the province averages a cold 0.3°C, but other parts are warmer and the mean temperature is 3.5°-3.7°C. The territory is covered by forest and the remaining parts are covered by pastureland. Pine trees make the most of the forest, but many other species of trees can be found, such as cedar, lurch, birch, aspen, fir, silver fir and poplar. The region is rich in fruit and berry bushes such as strawberry, red currant, black currant, blackberry, blueberry, black cherry, hawthorn and raspberry. The region also has wild animals such as bear, lynx, fox, wolf, Pallas, wildcat, ermine, weasel, badger, deer, moose, antelope and boar. Known endangered fur species exist in the Selenge River basin, well beyond the Project area of influence, such as sable and onadatra (muskrat). Swan, goose, crane, bustard, partridge, hazel grouse, wood grouse, quail, eagle, hawk, vulture and buzzard inhabit in the region. No protected flora or fauna or cultural, paleontological or archeological sites are known to exist in the Project area itself.

The proposed Single Stop Service Center (SSSC) at the Sukhbaatar BCP for Rail is located in in Sukhbaatar soum of Selenge aimag. Physical and ecological conditions in the region are similar to Altanbulag about 20 km from Sukhbaatar. No protected flora or fauna or cultural, national parks, protected areas, paleontological or archeological sites are known to exist in the Project Area.

Project Background

Under the Central Asia Regional Economic Cooperation (CAREC) program’s Transport and Trade Facilitation Strategy (TTFS) 2020, CAREC member countries, including Mongolia, are pursuing coordinated initiatives for the development of six CAREC corridors through infrastructure investments and trade facilitation initiatives to improve the movement of goods and people through and across these corridors. The Government of Mongolia (GOM) requested the Asian Development Bank (ADB) to support the Mongolia: Regional Improvement of Border Services project (RIBS or the Project).

The proposed project will promote the efficiency and transparency of trade processes and procedures and facilitate cross border trade along CAREC Corridors 4B and 4C by (i) improving and upgrading Altanbulag/Sukhbaatar, Zamyn-Uud and Bichigt Border Crossing Points (BCP) facilities and equipment for customs operations; (ii) improving the customs automated information system (CAIS); and (iii) undertaking preparatory work for the establishment of a single window.

As per discussions with GACT, investments will focus on BCPs located along CAREC corridors that are critical for the movement of goods. A list of modernization investments and equipment has been prepared. Consultants specialized on border
infrastructure and customs processes calculated cost estimates and prioritized investments.

The proposed RIBS infrastructure improvements involve renovation of existing facilities within the footprint and land ownership of the existing BCPs and new equipment procurement. The facilities and activities of several GOM agencies are involved, including GACT, the General Authority for Border Protection (GABP), and the General Agency for Specialized Inspection (GASI), which has responsibility for, inter alia, animal and animal products inspection at the border.

BCP are not discussed in this IEE. This section of the IEE describes the existing infrastructure at the project sites along with drawings showing the sites and the interaction of the MUST and RIBS improvements at the two project sites of Altanbulag and Sukhbaatar. The quarantine and storage areas are called out in section 3.3, below.

Altanbulag BCP Proposed Project Improvements

The existing conditions at the Altanbulag BCP (AB-BCP) are illustrated in Figure 6. Access to the BCP for all vehicles—trucks and passenger vehicles—is via the main road, a continuation of Mongolia highway AH3 that runs through the Altanbulag soum from south to north, and enters the crossing point from the east.

The following is a description of current operations at the Altanbulag BCP, followed by a drawing showing the existing infrastructure and the improvements proposed by the MUST (SPS) and RIBS projects:

- Potable water is supplied from an onsite well and the complex uses approximately 3000 liters per day.
- Heat is supplied from an onsite coal-fired boiler.
- The onsite GASI laboratory has an existing laboratory waste pit that will be upgraded with the MUST (SPS) project.
- Some solid waste is burned onsite but this practice will now be eliminated. Other solid waste is hauled 8km to the Altanbulag soum disposal site. Total solid waste produced by the BCP is estimated to be 18-30 tons per year.
- Wastewater of an estimated 2,000 liters per day is conveyed offsite to the Altanbulag soum septic tanks. A GOM project had begun to convey all the Altanbulag soum and BCP wastewater about 25km to Sukhbaatar soum WWTP, but this project has now been stopped. As such, a new wastewater management system is definitely needed for the BCP and soum.
- There is significant vehicular congestion in the soum adjacent to the BCP southern entrance.

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18 Information in whole or part taken from Lawrence Quinn, Ph.D., P.E., ADB - MON: Regional Improvements of Border Services (RIBS) Strategic Recommendations for Environmental and Social Improvements Mongolia Border Crossing Points (BCPs) Draft Final 10 March 2016.
Figure 6. Current conditions at Altanbulag BCP

Changes programmed for the AB-BCP are illustrated and listed in Figures 7 and 8.
Figure 7. Proposed changes at Altanbulag BCP – 1 of 2. Proposed new access road enters from the left (south).
Figure 8. Proposed changes at Altanbulag BCP – 2 of 2. New access road, general alignment, is shown in red color. Freight road for future expansion (blue color) is for illustrative purposes. [Alignment now being refined in order to avoid the wet pasture land between the new road and the soum.] North direction is toward the left of the figure; east and Altanbulag soum are toward the top of the figure.
The proposed road is designed as a four lane divided highway for both trucks and passenger vehicles. Total width as indicated by the cross section shown in Figure 9, is 26.5 meters, including asphalt driving lanes, gravel shoulders and center divider.

Figure 9. Cross section of 4-lane carriageway alternative for proposed new access road to Altanbulag BCP.

Considerable “greening” of this access road is proposed, although not yet approved. An artist’s conception of a section of the finished highway is shown in Figure 10.

Figure 10. Artist's concept for greening of proposed Altanbulag BCP access road.
Two additional areas that are part of the overall Project are of environmental interest: (1) a livestock quarantine area of 1.5 ha with a capacity of about 100 animals; (2) an equipment and chemicals storage facility, of undetermined dimensions. The approximate locations of these two areas are shown in Figure 11.

Figure 11. Approximate locations of the planned open animal quarantine area and equipment and chemicals storage facility.

Figure 12. Above, view of the AB-BCP proposed equipment and chemical storage area from west. BCP is visible in background. Left, view of the area proposed for livestock quarantine, view from west toward Altanbulag soum, toward which prevailing winds flow.
Sukhbaatar BCP for Rail Proposed Single Stop Service Center (SSSC)

A map of the railroad station complex in Sukhbaatar, showing the location of the proposed jointly administered SSSC building for all agencies concerned with the Sukhbaatar BCP (SB-BCP) for rail is shown in Figure 13.

A somewhat better idea of the surrounding area can be seen in Figure 14.

The SSSC itself will occupy virtually the entire vacant lot, an area of about 1/10 hectare. An artist’s conception of the appearance of the 6-levels, 3,460 m² building is shown in Figure 15. The building lot is given as 39 m wide on the railroad frontage x 25 m deep (= 975 m²). The closest school is 1.5 km distant. Residences and a commercial laundry are in the near rear of the site, across a dirt access road.

Figure 13. Proposed Single Stop Service Center (SSSC) for rail at the Sukhbaatar railroad station complex. To be constructed on a vacant lot indicated as number 9 on the figure.
Figure 14. Environment of the proposed SB-BCP for Rail SSSC building. The few structures and access road to the northeast of the SSSC will be temporarily affected. Access to the public park, to the southeast, and the park itself will not be affected.

Figure 15. Single Stop Service Center (SSSC) for all border agencies at Sukhbaatar BCP. A municipal park (ellipse structure) is visible to the right rear of the construction zone.
APPENDIX 2 – CLIMATE AWARE SCREENING REPORT FOR ALTANBULAG BORDER CROSSING POINT

[Submitted as a separate pdf file with the Draft CRVA as a Word document. Will be bound with Final CRVA when both are submitted as PDF files.]