Environmental Impact Assessment (Final)

November 2014

PRC: Yunnan Pu'er Regional Integrated Road Network Development Project

Prepared by Pu’er Municipal Government for the Asian Development Bank for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 30 November 2013)

Currency unit	–	Yuan (CNY)
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$1.00	=	CNY6.078

ABBREVIATIONS

AC	–	asphalt concrete
ADB	–	Asian Development Bank
ADB SPS	–	Asian Development Bank Safeguard Policy Statement 2009
AQG	–	Air Quality Guideline
BOD	–	biological oxygen demand
C&D	–	construction and demolition
CBD	–	central business district
CEWP	–	Construction Environmental Work Plan
CNY	–	Chinese Yuan
CO	–	carbon monoxide
COD	–	chemical oxygen demand
CPS	–	Country Partnership Strategy
CTB	–	Country Transport Bureau
DBA	–	decibel audible (to the ear)
EA	–	Executing Agency
EARF	–	Environmental Assessment and Review Framework
EHS	–	Environmental Health and Safety
EIA	–	Environmental Impact Assessment
EIR	–	Environmental Impact Report
EIT	–	Environmental Impact Table
EMC	–	Environmental Management Consultant
EMP	–	Environmental Management Plan
EMS	–	Environmental Monitoring Station
EPB	–	Environmental Protection Bureau
EPD	–	Environmental Protection Department
ESE	–	Environmental Supervision Engineer
FYP	–	Five-Year Plan
GDP	–	gross domestic product
GHG	–	greenhouse gas
GRM	–	grievance redress mechanism
HC	–	hydrocarbon
IA	–	Implementing Agency
IPCC	–	Intergovernmental Panel on Climate Change
LIEC	–	Loan Implementation Environmental Consultant
MASL	–	meters above sea level
MEP	–	Ministry of Environmental Protection
NH_3-N	–	ammonical nitrogen
NO_2	–	nitrogen dioxide
O&G	–	oil and grease
O&M	–	operation and maintenance

PAM	–	Project Administration Manual
PEMS	–	Pu'er Environmental Monitoring Station
PEPB	–	Pu'er Environmental Protection Bureau
PM	–	particulate matter
$PM_{2.5}$	–	particulate matter with diameter of particles ≤2.5 μ
PM_{10}	–	particulate matter with diameter of particles ≤10 μ
PMG	–	Pu'er Municipal Government
PMO	–	Project Management Office
PMTB	–	Pu'er Municipal Transport Bureau
PPMO	–	Pu'er Project Management Office
PPTA	–	Project Preparatory Technical Assistance
PRC	–	People's Republic of China
RoW	–	right-of-way
RP	–	Resettlement Plan
RSP	–	respirable suspended particulates
SO_2	–	sulfur dioxide
SS	–	suspended solids
STI	–	Sustainable Transport Initiative
TPH	–	total petroleum hydrocarbon
TSP	–	total suspended particulates
TTM	–	Temporary Traffic Management
USD	–	United States Dollar
VOC	–	volatile organic compound
VPD	–	vehicles per day
WHO	–	World Health Organization
YEPD	–	Yunnan Environmental Protection Department

WEIGHTS AND MEASURES

a	–	annum
^oC	–	degrees celsius
μ	–	micron
cm	–	centimeter
h	–	hour
ha	–	hectare
kg/d	–	kilogram per day
km	–	kilometer
km/h	–	kilometer per hour
km^2	–	square kilometer
m	–	meter
m^2	–	square meter
m^3	–	cubic meter
m/s	–	meter per second
m^3/d	–	cubic meter per day
m^3/s	–	cubic meter per second
mg/l	–	milligram per liter
mg/m^3	–	milligram per cubic meter
mm	–	millimeter
mu	–	unit of measure of approximately 666 m^2
s	–	second

t	–	metric ton
t/a	–	metric ton per annum
$t/km^2.a$	–	metric ton per square kilometer per annum
y	–	year

NOTE

In this report, "$" refers to US dollars.

In preparing any country program or strategy, financing any project, or by making any designation of or reference to a particular territory or geographic area in this document, the Asian Development Bank does not intend to make any judgments as to the legal or other status of any territory or area.

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EXECUTIVE SUMMARY

A. Background

1. The Yunnan Pu'er Regional Integrated Road Network Development Project is located in Pu'er Prefecture in the province of Yunnan, PRC. It involves three components:

(i) Component 1: Regional Roads Development
- Ning'er-Longfu Road (256 km) upgrade
- Menglian-Meng'a Road to Class II (44.85 km) upgrade
- Border Facilities

(ii) Component 2: Rural Access Improvement
- Rural Road Improvement (paving of 600 km of rural roads)
- Rural Road Maintenance
- Village Access Road Spot Improvements–spot improvements of village access roads that connect with project rural roads
- Rural Transport Services

(iii) Component 3: Institutional Development
- Road Safety
- Overseas Training
- Project Management Consultant (PMC)

2. The Pu'er Municipal Government (PMG) is the Executing Agency (EA) and is responsible for preparing the draft feasibility studies, providing counterpart funding and overall project oversight. The Implementing Agency (IA) is the Pu'er Municipal Transport Bureau (PMTB). A steering committee (SC) exists within PMTB and is responsible for providing overall direction and approval during project preparation. Procurement of civil works and consultants under the project will be handled by a Project Management Unit under the IA and will adhere to ADB Procurement Guidelines and Guidelines on the Use of Consultants.

3. This Environmental Impact Assessment (EIA) report and Environmental Management Plan (EMP) is for the Yunnan Pu'er Regional Integrated Road Network Development Project which has been classified as environment category A. This report was prepared during the Project Preparatory Technical Assistance (PPTA) study drawing on information in the three domestic Environmental Impact Reports (EIR)—Lancang-Menglian-Meng'a EIR and Supplementary EIR, Ning'er-Longfu Road EIR. These EIRs were approved by the Yunnan Environmental Protection Department (YEPD) in 2013. A domestic Environmental Impact Table (EIT) was prepared covering the 31 proposed rural roads, which was approved by the Pu'er Environmental Protection Bureau (PEPB) in March 2014. In March 2014, rural roads 1, 3 and 6 were substituted with rural roads 32, 33, 34, 35 and 36. A supplementary EIT was prepared for the five substitute rural roads in May 2014. It has been submitted to PEPB and approval is expected in June 2014. Information on the newly proposed rural roads has been assessed and included in this EIA. However, there are likely to be other changes to the final inventory of rural roads, substitute roads will be assessed in accordance with domestic and ADB requirements as described in the Environmental Assessment and Review Framework (EARF) in Appendix 2. The domestic EIRs and EIT were prepared based on information in the domestic Feasibility Study Reports (FSR) and the soil conservation reports for the project. The soil and water conservation reports for the Lancang-Menglian-Meng'a Road and the Ning'er-Longfu Road have also obtained domestic approval by the Yunnan Provincial

Water Resources Department. The rural roads do not require a soil and water conservation report.

4. Yunnan is a land-locked province, situated in the less-developed southwestern area of the People's Republic of China (PRC). The province's per capita gross domestic product was CNY15,749 in 2010, only 53% of the national average and the lowest in the PRC except for Guizhou and Gansu. Pu'er is a prefecture level city of 2.59 million people in southern Yunnan Province. Rural residents in Pu'er have low incomes that averaged CNY4,338 per capita in 2011. There are over 1.5 million people in Pu'er below the poverty line (CNY2,300 per year in 2011) and all 9 counties in Pu'er are national poverty counties. Pu'er is strategically located along the PRC border with three neighboring countries: Vietnam, Lao PDR, and Myanmar. Pu'er is a key stakeholder in the government's "Gateway" Strategy that provides a link between the PRC and Southeast Asia. During the 12th Five-Year Plan (FYP) period (2011–2015), the national government seeks to establish an international channel and import-export processing base in Yunnan to support further development and regional cooperation for the PRC and ASEAN Free Trade Area now under negotiation. The project roads are located in the region of the Greater Mekong Sub-region (GMS) North South Economic Corridor's (NSEC) Western Sub-corridor. The Western Sub-corridor begins in Kunming, Yunnan Province, and traverses Pu'er before crossing into Louang Namtha and Bokeo provinces on the Lao PDR side and Shan State on the Myanmar side. The sub-corridor then passes through Thailand's Chiang Rai Province, where the route finally reaches Bangkok. The PRC's section of the NSEC opened to traffic in 2011.

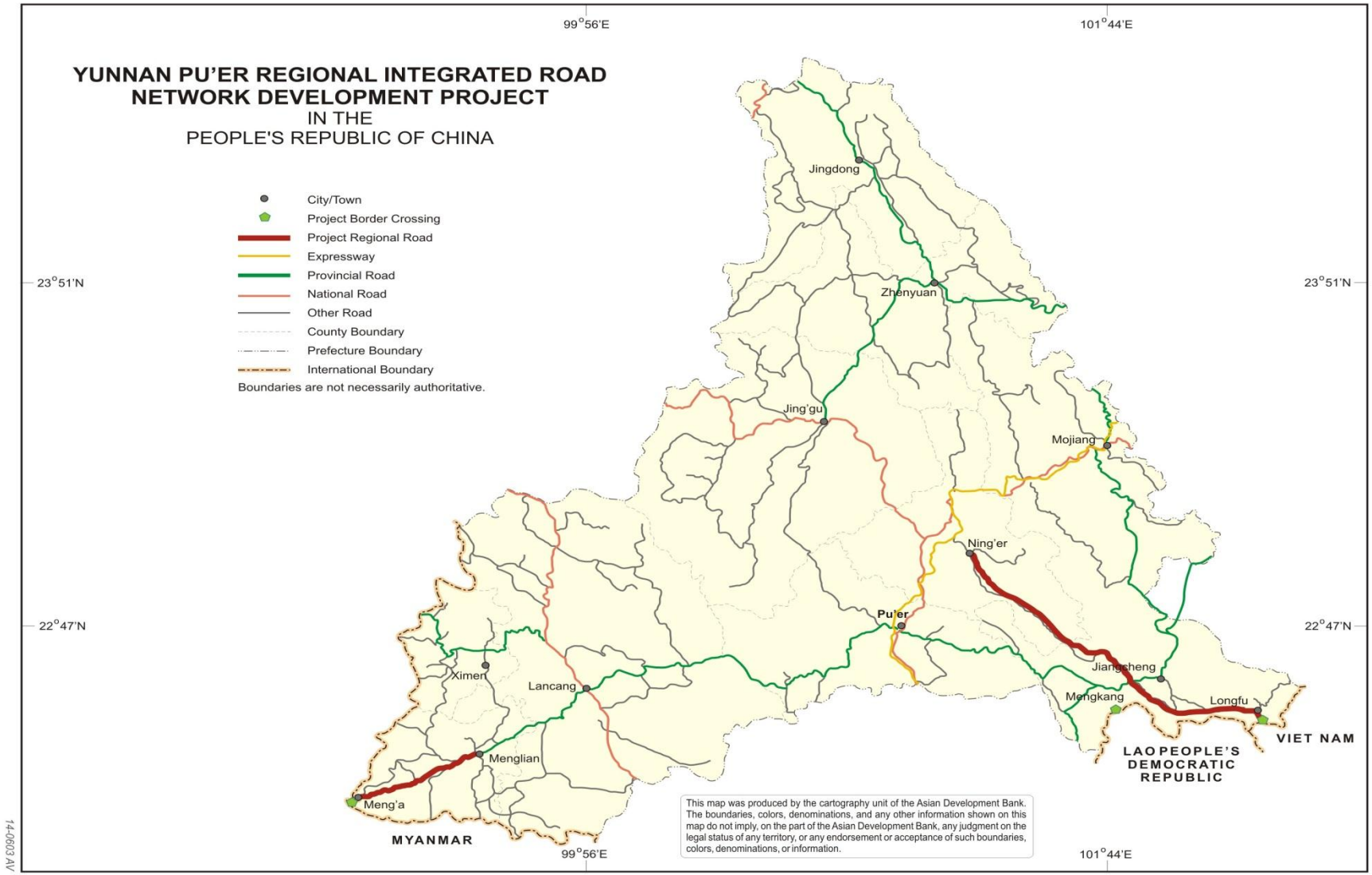


Figure 1: Project Components

B. Project Benefits

5. The proposed project will contribute to inclusive growth and regional integration by connecting isolated rural communities and border areas to the regional road network and providing infrastructure to support trade and regional cooperation between the People's Republic of China (PRC), Viet Nam, Lao People's Democratic Republic (Lao PDR), and Myanmar.

6. The proposed project road components will help to link the wider area of Pu'er to this vital economic corridor and promote regional cooperation. The Western Sub-corridor involves the following border crossing points in the project area: Mohan–Boten (Yunnan Province and the Lao PDR), and Daluo–Meng'a (Yunnan Province and Myanmar). The border area hosts an active local trade in agricultural products, farm machinery, electronic products and small vehicles. The project will provide infrastructure and support facilities to enable the expansion and development of the border areas.

7. The rural access improvement component aims to ensure that the project better serves the key strategic goal of reducing poverty. Proposed village access road improvements and public transport services will significantly improve access to the administrative village and any village groups located along the rural roads and rural road maintenance proposals will provide skills training and employment for local people.

8. The project will also benefit agricultural production and marketing. Farmers can plant higher earning cash crops, such as flowers, with improved transport time to market. Also the reduced difficulties of access during rainy season, and a smoother pavement surface will reduce damage to fragile or perishable goods.

9. In summary, the major project benefits include: (i) shorten travel distance in the case of Ning'er-Longfu Road; (ii) shorten travel time for all project roads including improved transport time to market for rural communities benefiting agricultural production; (iii) create smoother travel conditions with improved road surface of rural roads and Ning'er-Longfu Road; (iv) increase all season accessibility of the rural roads; (v) reduce traffic jams through the villages of Menglian-Jiangcheng road; (vi) improve rural road maintenance and public transport services (vii) improve regional road network, regional cooperation and cross-border trade; and (viii) provide direct job opportunities during project implementation and operation phases.

10. Overall the project will benefit a total population of about 405,000, including 287,000 ethnic minorities (71%) and 149,000 of the rural poor population (36.7%).

C. Project Legislation, Environmental Standards and Sensitive Receptors

11. The project conforms to PRC environmental laws, policy and guidelines and International agreements on environment to which the PRC is a signatory. It also adheres with the Asian Development Bank (ADB) Safeguard Policy Statement (2009).

12. Noise, air and surface water quality standards under the various assigned classes are presented along with PRC standards that apply and regulate the project. WHO guidelines on noise and air quality guidelines and the World Bank Group Environmental Health and Safety

(EHS) guidelines are based on best practice construction and operational procedures. The PRC standards, WHO and EHS guidelines will be used in the assessment.

13. The project area of influence, or assessment areas, for air, noise, surface water and ecological impacts are defined by the technical guidelines for environmental impact assessment in the PRC and SPS (2009). Each discipline was assessed from 200 to 300m from the proposed road centerline.

14. Sensitive receptors for noise, air and water quality were identified using the relevant assessment area guidelines. There are 16 sensitive receptors on the Menglian-Meng'a Road. The Ning'er-Longfu Road has 36 sensitive receptors including four schools, nine rivers and two reservoirs. Sensitive receptors associated with the rural roads that have been assessed include 221 communities, seven schools and 36 water bodies. Detailed descriptions of all identified sensitive receptors can be found in the tables in Appendix 5.

15. Improved road safety is an important component of the project that will also result in social and environmental benefits. The PPTA study conducted a safety audit of all project roads, and recommended measures to improve traffic and pedestrian safety. Proposed measures include: traffic calming through villages with the provision of speed bumps, better road markings, speed limit signage, and marked and signaled pedestrian crossings (this was an important issue raised by residents in the household surveys–73% said excessive speeding was an issue and 97% wanted speed controls). An improved ditch design will improve drainage from the road surface thereby reducing ponding which creates a hydro-planning hazard and reduce erosion and sedimentation. The enhancement of the road corridors through the integration of landscape features and planting will also improve the quality of environment along the road corridor. A road safety action plan was developed, consisting of accident monitoring and road safety audit; programs to inspect, improve (through design) and enforce road safety; and education, community and capacity building programs.

D. Project Impacts and Mitigation Measures

16. The Project was classified as Category A based on anticipated construction related adverse environmental impacts and resettlement requirements. The main construction activities will be earthworks, culvert and bridge installation and paving. These activities will result in permanent loss of 925ha of land and temporary loss of 136 ha of land. Most of the habitats in the assessment areas were described in the EIRs as secondary vegetation due to human disturbance and development. Land acquisition will affect 3327 persons and require resettlement of 161 households.

17. Other negative construction impacts are short-term such as noise, dust, sedimentation and erosion. There are engineering solutions and best practice methods that have been specified in the EMP to ensure that these impacts are avoided where possible and/or minimized.

18. The improvement of the two regional roads and the paving of rural roads will not result in significant impacts on critical, natural or modified habitats of value or associated species. Habitats are dominated by existing carriageway. No critical habitat was apparent and woodlands were secondary woodlands influenced by human activities. However, intact secondary woodlands were identified along sections K0+500-K5+500、K55+200-K65+500、

K70+100-K72+300、K75+300-K77+200 of the Menglian-Meng'a Road and the EMP requires that permanent and temporary land take to avoid these intact woodlands.

19. The regional road improvements will enhance access to PRC borders with Vietnam and Myanmar. The Wildlife Conservation Society has carried out a specialist wildlife trafficking due diligence study, increased wildlife trafficking could be an induced impact from this project. The study recommended institutional strengthening of CITES[1] enforcement for border control staff, raising awareness and improved co-ordination between government agencies at a prefecture and county level and with neighbouring countries to control wildlife trafficking. These recommendations will be implemented through the institutional development component of this project (see Project Administration Manual, Appendix 2 Consultants' Terms of Reference). Cross border wildlife trafficking could also increase the occurrence of vector borne diseases and strengthening health inspection and disease control at border crossings should also be considered.

20. The improvement of the regional roads and paving of the rural roads will contribute to an improvement in local environmental conditions by alleviating issues associated with dust mobilization and current poor road conditions that lead to congestion and inefficient driving practices that can result in higher levels of pollutant emissions.

21. There will be a negative impact from increased traffic noise during operation. Projected noise levels indicate mitigation measures are required for schools and other sensitive receptors on the regional roads. Road side noise barriers have been specified for the Ning'er-Jiangcheng-Longfu road. In addition, the highway will be provided with adequate easements at Bani Village, Manlian Village, Sanjia Village, Longtanba, Xishitou Village and Baozang Township. On the Menglian to Meng'a Highway a single road side noise barrier will be provided at Mangi Primary School. Details and costs are provided in the EMP. With mitigation, increases in noise levels can be reduced to acceptable levels.

22. The need for pollution interceptors, particularly at and close to river crossings will be considered during detailed design. The detailed design will also need to consider whether design standards adequately take into account potential risks and impacts associated with earthquakes and climate change. A specialist climate change and risk vulnerability analyses study has been carried out and recommendations for the detailed design have been specified in the EMP. The detailed report is included in Appendix 6.

23. The rural road component involves grading and paving work that is expected to have generally minor, localized negative impacts that are temporary in nature because the work will be confined to the existing right-of-way (RoW). Twenty-seven of the roads will be paved with concrete-cement and one with cement blocks. This work involves less noise, dust and emissions than asphalt paving. However, more stockpile sites (gravel, cement and mixers) and water will be required and access may be restricted while the pavement cures. Planned detours and posted information (days and hours expected) on the road closures will help alleviate the impact for local residents. Water use and its availability must be approved by the local residents and all stockpile sites be cleaned-up, re-claimed and re-vegetated. Three of the rural roads will utilise asphalt paving. The contractors will ensure that the plants are 500m from residences and access is available. To accommodate possible future changes to

[1] CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. PRC is party to CITES.

selected rural road sections, an Environmental Assessment and Review Framework (EARF) has been prepared (see Appendix 2) to guide the EA in preparing environmental assessment studies and reports for any additional rural roads.

24. Rural road #11 passes through 3.5 km of the experimental zone of the Ailao Mountain National Nature Reserve. The reserve supports highly biodiverse remnant primary forest and secondary pine forest and important gibbon and bird populations. Forest habitat for the endangered Black-crested Gibbon (*Nomascus concolor)* occurs at higher altitudes than rural road #11 and potential impact to this species is not expected. Works will be restricted to paving and the ROW. The Ailou Mountain Jingdong Management Bureau, who is responsible for managing this part of the nature reserve where the 3.5 km rural road #11 is located, was consulted. The Bureau confirmed that no special permission or approval is needed for just paving an existing rural road within the experimental zone of the nature reserve. However, no tree felling and cement batching within this section of rural road #11 will be permitted. This 3.5 km section of rural road #11 will also be demarcated to alert construction workers that they are working within the boundary of the Ailao Mountain National Nature Reserve. All works will be carried out in close co-ordination with the Ailao Mountain Jingdong Management Bureau staff.

25. Carbon dioxide (CO_2) emissions from traffic travelling on individual project roads (45 km Menglian-Meng'a Road, 257 km Ning'er-Longfu Road, and 600 km of rural roads) have been estimated to be less than the ADB threshold of 100,000 t/a except the Ning'er-Longfu Road which is projected to have emissions of 213,453 tonnes per annum (t/a) in 2030. Total CO_2 emissions from existing traffic on all the project roads combined were estimated to be 138,995 t/a, which already exceeds the ADB SPS (2009) threshold. Based on traffic demand forecasts, total CO_2 emissions from projected traffic on all the project roads combined would total 278,375 t/a by 2030. Annual reporting of CO_2 emissions to ADB during the operational phase will be required.

E. Alternatives

26. The Feasibility Studies examined a number of alignment alternatives. Preferred alternatives have been selected as they minimize resettlement impacts on villages and avoid poor road geometry (switchbacks) and excessive grades. This assessment identified that one of the proposed new alignments of the Ning'er-Longfu Road encroached into the planned Wenquan River Reservoir, a centralized drinking water source and traversed through Protection Zone 1 (from K25+200 to K44+500) and Zone 2 (K44+500 to K45+200). This alignment has now been replaced with the Xishitou to Shanshen Temple Pass alignment option to avoid Protection Zones 1 and 2. This alternative alignment has been considered in the FSR and assessed in the EIR.

27. The do-nothing or do-minimum option is without merit. The failure to implement the project will result in continued poverty for many of the ethnic minorities that reside along the project roads.

F. Information Disclosure, Consultation and Participation

28. Public consultation and disclosure has been, and continues to be, an important cornerstone of the Project. The PMG disclosed the project concept with government agencies in Pu'er and in the affected counties. There have been five rounds of consultation

to-date. There were three (one for the Ning'er-Longfu Road EIR and two (EIR and Supplementary EIR) for the Lancang-Menglian-Meng'a Highway EIR. There were two under the PPTA: Social Assessment and Household Survey for the rural roads.

29. Concerns expressed in all sessions have been related to excessive air and noise quality levels during construction. There is overwhelming support for the project(s) based on the expected improved access and time travel savings.

30. Under the social assessment and household survey, participants indicated that some roads, which have stretches through towns were unsafe for children as there were no sidewalks and speeds were excessive. It is evident that improved safety is a key priority.

31. Public concerns relating to construction air and noise impacts have been addressed in the EMP, requiring the implementation of mitigation measures during the detailed design, pre-construction and construction stages. The project GRM will deal with affected persons' environmental concerns throughout implementation.

32. Pu'er Municipal Transport Bureau (PMTB) has committed to continue to keep the public informed about the project and consultation in local languages will be carried out at intervals during implementation. The EMP includes a consultation plan for such activities.

G. Grievance Redress Mechanism

33. A project Grievance Redress Mechanism (GRM) will be established to deal with affected persons' environmental concerns as described in detail in the EMP. The GRM will be accessible to diverse members of the community, including more vulnerable groups such as women and youth. Multiple points of entry and modes of access, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available. Opportunities for confidentiality and privacy for complainants will be honored where requested.

H. Key EMP Implementation Responsibilities

34. The EMP describes mitigation measures for the pre-construction, construction and operating period based on the predicted impacts of construction activities. The Pu'er Municipal Government (PMG), through the PPMO, will be responsible for the day-to-day management of the Project. The PPMO has overall responsibility delegated by PMG for supervising the implementation of environment mitigation measures, coordinating the project level GRM and reporting to ADB.

35. The environmental management plan (EMP) will be included in all civil works bid and contract documents for the Project.

36. Compliance and effects monitoring will be carried out on all project roads in accordance with EMP requirements. Air and water quality and noise monitoring sites have been identified and documented in the EMP. These sites are all located in the vicinity of sensitive receiver sites such as village community facilities, schools and water crossings.

37. Environmental effects and project performance monitoring criteria have been developed to ensure effective implementation during construction. Monitoring costs will cover

2 years of construction and 1 year of post-construction and are estimated at USD444,000 (excluding soil erosion monitoring cost).

38. Monitoring and reporting responsibilities have been identified in the EMP. As this is an environmental category A project, PMTB shall engage and retain a qualified and experienced Loan Implementation Environmental Consultant as part of the Loan Consulting Services to verify compliance, review environmental monitoring information and to prepare semi-annual environmental monitoring reports to submit to ADB. The terms of reference and has been prepared and is included in the Project Administration Manual. A budget of about USD98,800 is estimated for a 3 year period (2 years of construction and 1 year post construction). In addition, the PMTB will contract an external environmental supervision engineer (ESE) to undertake independent compliance monitoring of EMP implementation. The budget for engaging the ESE is estimated at USD485,000.

39. Prior to commencement of site works, the contractors shall be required to prepare environmental construction work plans in the form of specific management plans for spoil disposal, waste management, traffic management, occupational and public health and safety, emergency response and spill management.

I. Overall Conclusion

40. This EIA and EMP provide a comprehensive assessment of environmental impacts associated with all project components and sets out all necessary environmental management measures for design and implementation.

41. The overall finding of this EIA is that there will be limited, generally localized adverse environmental impacts that can be readily addressed with mitigation and compensation measures. Carbon dioxide emissions from all the project roads combined would exceed the ADB threshold and annual reporting of CO_2 emissions to ADB will be required during the operational phase. The project will result in long-term socio-economic benefits resulting from improved travel time and accessibility for ethnic minority communities associated with the road corridors.

42. The EMP has specified the consideration of climate change, in particular, extreme weather events in the design of road paving, drainage systems and slope protection during the detailed design stage. The wildlife trafficking study also recommended institutional strengthening, public awareness measures and regional cooperation to mitigate the induced impact of increased wildlife trafficking. With the implementation of the institutional development component of the project and the EMP measures on mitigation, monitoring, public consultation, training and project specific grievance redress, potential environmental impacts during the construction and operation of this project would be reduced to acceptable levels.

I. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Policy Framework

1. Transport sector policy is guided by the 12th Five-Year Plan (FYP), which takes forward the agenda of sustainable development initiated by the 11th FYP. Yunnan Province aims to have 100% of townships and 70% of administrative villages connected by paved roads by 2015 at the end of the 12th FYP. The rural road network is planned to increase by 12,000 km to a total of 186,000 km during this period.

2. According to the prefecture-level 12th FYP, Pu'er aims to construct four class II roads and four class III roads with a total length of 920 km (this includes the Ning'er-Longfu road). In addition, the reconstruction of 600 km of county roads), the opening of 1,200 km of township roads, the paving of 6,530 km of township roads and the reconstruction of 1,800 km of village roads. All township roads are to be Class IV asphalt or cement concrete paved.

3. A State Council policy issued in 2005 and subsequent policy documents issued by the Ministry of Transport, the National Development and Reform Commission and the Ministry of Finance made the county transport bureaus responsible for the maintenance of the rural road network with support of the township and village levels, and introduced provincial maintenance subsidies. These were initially financed from vehicle registration fees, but later this was replaced by a fuel tax allocation. Provincial subsidies are still at the 2005 level of CNY7,000/km for county roads, CNY3,500/km for township roads and CNY1,000/km for village roads. These policies also called for maintenance implementation to be transferred from in-house units to companies having private contracts with their employees, setting limits on the number of government staff involved in maintenance management.

4. The proposed Project is a priority project in the government's 12th FYP. It supports the government's regional cooperation objectives and helps connect rural villages to the growing regional transport and trade systems. It is also aligned with the key thrusts of ADB's assistance to the PRC under the 2011-2015 country partnership strategy in the areas of: (i) inclusive growth and balanced development, and (ii) regional cooperation and integration. The project fits well with ADB's Sustainable Transport Initiative (STI), which identifies regional cooperation and integration, road safety and social sustainability as key opportunities.

5. This project, together with the proposed Yunnan Sustainable Road Maintenance (YSRM) project, represents a new direction for ADB's support for the PRC road sector that focuses on rural accessibility rather than expressways. This project will help to ensure that the benefits of past ADB-financed projects in Yunnan extend to rural areas that have been isolated from the expanding regional transport network.

B. The Legal Framework for Environmental Management

6. PRC has established a legal system to regulate environmental management. The Environmental Protection Law of PRC (1989) defines general principles for environmental protection, institutions for environmental management and supervision, requirements for protection and improvement, prevention and mitigation of pollutions and liabilities. To supplement the basic law and set supporting laws, ordinances, ministry decrees, governmental regulations, norms, and standards, are in place and in use across the country.

7. In PRC, National People's Congress (NPC) and its standing committee are the empowered national legislation institutions. Under NPC, the State Council (the cabinet of the central government) is entitled to issue environmental ordinances. The Ministry of Environmental Protection (MEP) plays a leading role in environmental management, preparing environmental legislation, and encouraging the enforcement of environmental statutes. MEP also publishes specific ministry decrees to regulate environmental issues. Other ministries or administration agencies directly under the State Council are responsible for sectoral environmental management in related fields. They also issue ministry decrees related to environmental protection and conservation of natural resources. Some of the more prominent agencies are the State Forestry Administration which manages most nature reserves and the Ministry of Housing and Urban-Rural Development which has authority over designated scenic regions.

8. PRC's EIA legal system is only applicable to commercial and industrial development planning and construction projects. For the proposed rural roads component, where works are limited to rehabilitation, there is no domestic requirement for environmental impact assessment. The following PRC legislation is applicable to this project:

- The Environmental Protection Law of PRC (1989), fundamental law;
- Management Directory of EIA Classification for Construction Project (MEP, 2008);
- Regulations on Review and Approval of EIAs for Construction Project (MEP, 2009);
- Regulation on Hierarchical Review and Approval of EIAs for Construction Project in Yunnan Province (2010), covering management of the whole EIA process;
- Environmental Protection Management Ordinance for Construction Project (1998);
- Environmental Protection Management Regulation for Transport Construction Project (MOT, 2003);
- Environmental Protection Ordinance of Yunnan Province (2004);
- Notice on Enforcement of Environmental Supervision in Transport Construction Project (MOT, 2004), covering environmental management for the life cycle of the transport construction project;
- Water Pollution Prevention Law of PRC (2008) and relevant regulations, mandatory requirements for water pollution prevention and mitigation;
- Air Pollution Prevention Law of PRC (2000) and relevant regulations, mandatory requirements for air pollution prevention and mitigation;
- Environmental Noise Pollution Control Law of PRC (1996) and relevant regulations, mandatory requirements for noise pollution prevention and mitigation;
- Solid Waste Pollution Control Law of PRC (2005) and relevant regulations, mandatory requirements for solid wastes pollution control and recycling;
- Water and Soil Conservation Law of PRC (2010) and relevant regulations, mandatory requirements for soil erosion control;
- Land Management Law of PRC (2004);
- Highway Safety Ordinance of PRC (2011);
- Quota for Land Use of Highway Construction Project (Ministry of Construction combined with Ministry of Land and Resources,1999), regulatory requirements for land acquisition of the highways;

- Nature Reserve Ordinance of PRC (1994), Ordinance for Scenic Resorts and Historic Sites of PRC (2006);
- Ordinance for Management of Nature Reserves in Yunnan Province (1998), mandatory requirements for conservation of the protected areas;
- Ordinance for Redress of Public Complaints (the State Council, 2005), Interim Procedures for Public Consultation in EIA (SEPA, 2006), and Environmental Complaints Management Regulation (SEPA, 2006), requirements for EIA public consultation and environmental grievance redress;
- Notice on Strengthening EIA Management to Control Environmental Risks (SEPA, 2003);
- Interim Management Regulation for Contingency Plan of Environmental Incidents (MEP, 2010), management requirements for environmental risks control, preparation and implementation of environmental contingency plan;
- Environmental standards and guidelines, including environmental quality standards for surface water, air, and ambient noise; emission standards for polluting sources of wastewater, air pollutants, and noise; as well as EIA guidelines such as Technical Guideline on EIA published by MEP; and
- PRC guideline HJ/T169-2004, National Inventory of Hazardous Goods & MEP Dec.1, 2008.

C. The Administrative Framework for Environmental Management

9. The administrative framework for environmental impact assessment in the PRC consists of national, provincial and local (city) environmental protection authorities. At a national level MEP promulgates laws, regulations and technical guidelines on environmental impact assessment and pollution prevention and control. At the provincial level, Environmental Protection Departments (EPDs) are mandated with control and regulation of environmental impact assessment and pollution prevention and control in the province. They are also often delegated the authority by MEP to approve environmental impact assessment reports for construction projects in the provinces, except those with national interest and those that cross provincial boundaries that would need MEP approval. The local or city-level Environmental Protection Bureaus (EPBs) enforce environmental laws and conduct environmental monitoring within city limits. Local EPBs could be delegated the authority to approve environmental impact assessments by the provincial EPDs.

10. The two domestic project EIRs have been prepared by the Guangxi Transportation Science Institute, in accordance with the provisions of PRC's *Environmental Impact Assessment Law of 2003* and the *Directory for the Management of Different Categories of Construction Project Environmental Impact Assessment, (MEP Order No. 2), October 1, 2008*. The release of the *Environmental Impact Assessment Public Participation Interim Guideline in 2006* also requires that the public be involved in the EIA process. The Lancang-Menglian-Meng'a Highway Project EIR (and supplementary EIR) and the Ning'er-Longfu Road EIR were approved by the Yunnan Provincial Environmental Protection Department (YEPD). The former and its supplementary were approved on 3 November 2009 and 14 February 2012 respectively. The latter was approved on 17 September 2013. For the rural roads, an Environmental Impact Table (EIT) was prepared by the Guangxi Transportation Science Institute. The EIT was approved by the Pu'er Environmental Protection Bureau (PEPB) on 3 March 2014. Since then, three rural roads have been excluded and substituted with five other rural roads. A supplementary EIT for the five substitute rural roads was

prepared by the Guangxi Transportation Science Institute in May 2014 and submitted to PEPB for approval, which is expected in June 2014. The soil and water conservation report (SWCR) and supplementary report for the Lancang-Menglian-Meng'a Highway were approved on 29 September 2009 and 11 October 2011 respectively. The SWCR for Ning'er-Longfu was approved on 8 August 2012. No soil and water conservation report is required for the rural roads.This EIA is based on information and findings provided in the EIRs, the EIT and the soil and water conservation reports.

D. ADB Environmental Requirements

11. This Project is classified as Category A for environmental assessment on the basis that the construction of the regional roads, Menglian-Meng'a and the Ning'er-Longfu Road projects could create significant negative impacts and; moreover, result in a significant number of re-settlements. The submission of a comprehensive environmental impact assessment (EIA) report under ADB's Safeguard Policy Statement (SPS) 2009 requires a number of considerations that are over and above the domestic EIR requirements. These include, amongst others: (i) project risks and respective mitigation measures and project assurances; (ii) project level Grievance Redress Mechanism (GRM); (iii) definition of the project area of influence; (iv) physical cultural resources damage prevention analysis; (v)climate change mitigation and adaptation; (vi) occupational and community health and safety requirements (including emergency preparedness and response); (vii) economic displacement that is not part of land acquisition; (viii) biodiversity conservation and natural resources management requirements; (ix) provision of extensive sufficient justification if local standards are used; (x) meaningful consultation and participation; and (xi) implementation schedule and (measurable) performance indicators in the EMP.

E. Relevant International Agreements

12. The PRC is a signatory to a number of international agreements relevant to environment protection. Those relevant to the Project, along with the date of signing by the PRC, include:

- *Convention on Biological Diversity, 29 December 1993.* To develop national strategies for the conservation and sustainable use of biological diversity;
- Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat, 21 December 1975. To stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value;
- *Kyoto Protocol to the United Nations Framework Convention on Climate Change, 23 February 2005.* To further reduce greenhouse gas emissions by enhancing the national programs of developed countries aimed at this goal and by establishing percentage reduction targets for the developed countries;
- *Montreal Protocol on Substances That Deplete the Ozone Layer, 1 January 1989*. To protect the ozone layer by controlling emissions of substances that deplete it;
- *United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, 26 December 1996.* To combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements; and

- *United Nations Framework Convention on Climate Change, 21 March 1994*. To achieve stabilization of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system.

F. Chinese and Yunnan Environmental Guidelines

13. The PRC EIA process requires the establishment of ambient conditions of air, noise and water quality in the project area in order to determine the appropriate category of standards for the construction and operational phases ofany project. However, the World Bank Group Environmental Health and Safety (EHS) guidelines[2] (see below) are based on best practice construction and operational procedures. Both the PRC standards and EHS guidelines will be used in the assessment.

1. Air Quality

14. The PRC ranks air quality into three classes according to its Ambient Air Quality Standard (GB 3095-1996), with Class I having the best air quality and Class III the poorest air quality. The ambient air quality in the assessment area of this project has been assigned to meet GB 3095-1996 Class II standards. A new standard was issued in 2012 (GB 3095-2012), which will become effective on January 1, 2016, replacing GB 3095-1996. The World Bank Group adopted the World Health Organization (WHO) standards[3] for its EHS standards for air quality.

15. The WHO set up air quality guideline (AQG) standards for various air quality parameters for the protection of public health. Yet recognizing that progressive actions are needed to achieve these standards and the financial and technological limitations of some countries, cities or localities especially in developing countries, the WHO also established interim targets as intermediate mile-stones towards achieving the AQG.

16. Table 1 compares the PRC's GB 3095-1996 Class II standards with the GB 3095-2012 standards and the World Bank Group's EHS standards.

Table 1: Comparison of the PRC's GB 3095-1996, GB 3095-2012, and World Bank Group EHS Ambient Air Quality Standards

Air Quality Parameter	Averaging Period	GB 3095-1996 Class II (mg/m$^{3)}$	GB 3095-2012 Class II (mg/m$^{3)}$	World Bank Group EHS[4] (mg/m$^{3)}$	
				Interim Targets	AQG
SO_2	1-year	0.06	0.06	n/a	n/a
	24-hour	0.15	0.15	0.050-0.125	0.020
	1-hour	0.50	0.50	n/a	n/a
PM_{10}	1-year	0.10	0.10	0.030-0.070	0.020
	24-hour	0.15	0.15	0.075-0.150	0.050
$PM_{2.5}$	1-year	n/a	n/a	0.015-0.035	0.010
	24-hr	n/a	0.15	0.0375-0.075	0.025

[2] World Bank Group. 2007. *Environmental, Health and Safety Guidelines–General EHS Guidelines*. Washington D.C.

[3] World Health Organization. 2005. *WHO Air Quality Guidelines Global Update 2005*. Report on a Working Group Meeting, Bonn, Germany, 18-20 October 2005.

[4] World Bank Group. 2007. Ibid.

Air Quality Parameter	Averaging Period	GB 3095-1996 Class II (mg/m$^{3)}$	GB 3095-2012 Class II (mg/m$^{3)}$	World Bank Group EHS^{4} (mg/m$^{3)}$	
				Interim Targets	AQG
	1-hour	n/a	0.35	n/a	n/a
NO_2	1-year	0.08	0.04	n/a	0.040
	24-hour	0.12	0.08	n/a	n/a
	1-hour	0.24	0.20	n/a	0.200
CO	24-hour	4.0	4.0	n/a	n/a
	1-hour	10.0	10.0	n/a	n/a

17. Longer averaging period such as 1-year as shown in Table 1 is more applicable to assessing impacts from multiple as well as regional sources; while shorter averaging periods such as 24-hour and 1-hour are more applicable to assessing short term impacts from project related activities, such as from peak hour traffic or daily or peak construction activities.

18. Comparing the PRC's GB 3095-1996 Class II standards with the World Bank Group's EHS standards, Table 1 shows that the PRC's 24-hour SO2 standard (0.15 mg/m3) is higher than the upper limit of World Bank Group's interim standard (0.125 mg/m3); 1-hour NO2 standard (0.24 mg/m3) is higher than the World Bank Group's guideline standard (0.200 mg/m3); and 24-hour PM10 standard (0.15 mg/m3) is the same as the upper limit of the World Bank Group's interim standard.

19. When GB 3095-2012 replaces GB3095-1996 on January 1, 2016, Class II standards of 24-hour SO2 (0.15 mg/m3) and PM2.5 (0.15 mg/m3) are higher than the upper limit of the World Bank Group's interim standards (0.125 mg/m3 and 0.075 mg/m3 respectively); while 24-hour PM10 (0.15 mg/m3) and 1-hour NO2 (0.20 mg/m3) are the same as the upper limit of the World Bank Group's upper limit of interim standard and guideline standard, respectively.

2. Noise

20. According to the Technical Specifications to Determine the Suitable Areas for Environmental Noise of Urban Area (GB/T 15190-94), the area within 200 m on both sides of road or road junction should comply with the corresponding provisions in Environmental Quality Standard for Noise (GB 3096-2008). GB 3096-2008 categorizes five functional areas based on their tolerance to noise pollution from Category 0 to Category 4:

- **Category 0** is for areas with convalescent facilities that are the least tolerant to noisy environments and therefore has the most stringent day and night time noise standards.
- **Category 1** is for areas dominated by residential areas, hospitals and clinics, educational institutions and research centers.
- **Category 2** is for areas with mixed residential and commercial functions.
- **Category 3** is for areas with industrial production and storage and logistics functions.
- **Category 4** is for regions adjacent to traffic noise sources such as major roads and highways, and is subdivided into **4a and 4b** with the former applicable to road and marine traffic noise and the latter applicable to rail noise.

21. Standards for various functional area categories are compared with the World Bank Group's EHS guidelines as listed in Table 2, this shows that the World Bank Group has lower noise limits for residential, commercial and industrial mixed areas but higher noise limits for industrial areas and nighttime noise near trunk roads.

Table 2: Environmental Quality Standards for Noise (dB)

Noise Functional Area Category	Applicable Area	GB 3096-2008 Standards		World Bank Group EHS[5]	
		Day	Night	Day	Night
0	Areas needing extreme quiet, such as convalescence areas	50	40	55	45
1	Area mainly for residence, cultural and educational institutions	55	45		
2	Residential, commercial and industrial mixed area	60	50		
3	Industrial area	65	55	70	70
4a	Area on both sides of urban road traffic trunk line	70	55		

Note: Functional Area 4 is divided into 4a for trunk roads and 4b for railway lines.

3. Surface Water Quality

22. For water quality assessment, the determining standard is PRC's Environmental Quality Standards for Surface Water (GB 3838-2002). There are five water quality categories for different environmental functions:

- **Category I** is the best, suitable for head waters and National Nature Reserves.
- **Category II** is suitable for drinking water sources in Class I protection areas, habitats for rare aquatic organisms, breeding grounds for fish and crustaceans and feeding grounds for juvenile fish.
- **Category III** is suitable for drinking water sources in Class II protection areas, wintering grounds for fish and crustaceans, migration routes, water bodies for aquaculture and capture fishery, and swimming activities.
- **Category IV** is suitable for general industrial use and non-contact recreational activities.
- **Category V** is the poorest which is only suitable for agricultural and scenic water uses. This standard is set out in Table 3.

23. The Category IV is the minimum required run-off standard for road construction and operation in an urban environment. There is no EHS guideline or target for water quality in this category.

Table 3: Environmental Quality Standards for Surface Water (Unit: mg/l)

GB 3838-2002	Dissolved Oxygen (DO)	Permanganate index (I_{Mn})	Biochemical Oxygen Demand ($BOD_{5)}$	Chemical Oxygen Demand (COD)	Ammoniacal Nitrogen (NH_3-N)
Category I	90% saturation or ≥7.5	≤2	≤3	≤15	≤0.15

[5] World Bank Group. 2007. Ibid.

GB 3838-2002	Dissolved Oxygen (DO)	Permanganate index (I_{Mn})	Biochemical Oxygen Demand (BOD_{5})	Chemical Oxygen Demand (COD)	Ammoniacal Nitrogen (NH_3-N)
Category II	≥6	≤4	≤3	≤15	≤0.5
Category III	≥5	≤6	≤4	≤20	≤1.0
Category IV	≥3	≤10	≤6	≤30	≤1.5
Category V	≥2	≤15	≤10t	≤40	≤2.0

4. Evaluation Standards for the Project

24. The following PRC evaluation standards were adopted for this project in the domestic EIRs in accordance with the requirements set forth by the YEPD (Table 4).

Table 4: PRC Evaluation Standards for the Project

Environmental Parameter	PRC Evaluation Standard	
Ambient air quality	*Ambient Air Quality Standard* (GB 3095-1996)	Daily average: Total Suspended Particulates (TSP): 0.30 mg/m^3 Particulate Matter (PM_{10}): 0.15 mg/m^3 Nitrogen dioxide (NO_2): 0.12 mg/m^3 Carbon monoxide (CO): 4.0 mg/m^3 Hourly average: Nitrogen dioxide (NO_2): 0.24 mg/m^3 Carbon monoxide (CO): 10.0 mg/m^3
Construction air pollutant emission	*Air Pollutant Integrated Emission Standard* (GB 16297-1996)	Maximum allowable emission concentration: Particulate matter (PM): 120 mg/m^3 Fumes from asphalt plant: 40 mg/m^3 during production and 75 mg/m^3 during mixing Limits for fugitive emission: PM: ≤1.0 mg/m^3 at construction site boundary Fumes from asphalt plant: no obvious emission at asphalt production plant
Environmental noise	*Environmental Quality Standard for Noise* (GB 3096-2008): • Function Area Category 4a for areas within 35 m from the road redline, and • Functional Area Category 2 for areas between 35 m to 200 m from the road redline.	Functional Area 4a: Day time: 70 dB(A) Night time: 55 dB(A) Functional Area 2: Day time: 60 dB(A) Night time: 50 dB(A)
Construction noise	*Emission Standard of Environmental Noise for Boundary of Construction Site* (GB 12523-2011)	Noise level at construction site boundary: Day time: 70 dB(A) Night time: 55 dB(A)
Surface water quality	*Environmental Quality Standards for Surface Water* (GB 3838-2002): • Category Il to Category IV standard	See Table 3

Environmental Parameter	PRC Evaluation Standard	
	were applied.	
Wastewater discharge	*Integrated Wastewater Discharge Standard* (GB 8978-1996)	Discharge into Category III water body: Chemical Oxygen Demand (COD): ≤100 mg/l Biochemical Oxygen Demand $(BOD)_5$: ≤20 mg/l Suspended Solids (SS): ≤70 mg/l Total petroleum hydrocarbon (TPH): ≤5 mg/l Ammonical Nitrogen (NH_3-N): ≤15 mg/l Discharge into Category IV water body COD: ≤150 mg/l BOD_5: ≤30 mg/l SS: ≤150 mg/l TPH: ≤10 mg/l NH_3-N: ≤25 mg/l

Source: PRC EIRs.

5. Assessment Areas

25. The project area of influence, or assessment areas, for air, noise, surface water and ecological impacts are defined by the technical guidelines for environmental impact assessment in the PRC based on the environmental sensitivity of the project areas and the nature of the project and its components as well as by SPS (2009). The assessment areas for various environmental aspects of the project areas are shown in Table 5, with the physical cultural resource, occupational health and safety, and community health and safety assessment areas added for this EIA. Ecology and physical cultural resources are within the 'construction footprint' including both permanent and temporary land take areas.

Table 5: Assessment Areas

Environmental Aspect	Assessment Area
Air quality	Within 200m on both sides from the road center line
Noise	Within 200m on both sides from the road center line
Surface water quality	1. Within 200m on both sides from the road center line. 2. 100 m upstream to 100 m downstream of the road bridge crossing
Ground water quality	Ground water wells
Ecology	Within 300m on both sides from the road center line
Physical cultural resource	Construction footprint
Occupational health & safety	Construction footprint
Community health & safety	Within 200 m on both sides from the road red line

Source: PRC EIRs.

6. Sensitive Receptors

26. Air quality, noise and surface water quality sensitive receptors are identified and shown in Appendix 5 for:

- Menglian-Meng'a Highway;
- Ning'er to Jiangcheng-Longfu Road and;

- Rural roads.

27. **Menglian-Meng'a Highway.** There are 16 sensitive receptors, of which two are schools (Mengma Primary School and Manghai Primary School), in the road section to be funded by ADB (see Appendix 5).

28. There is only one water body in the selected section, the Nanma River. The road parallels the river for 23 km and crosses twice at chainage K77+800 and K99+200.

29. **Ning'er-Longfu Road.** There are 36 sensitive receptors, of which four are schools (Banhai Primary School, Manliang Primary School, Yidegengsheng Primary School, Mengxian Middle School), along this road (see Appendix 5).

30. Eleven water bodies (nine rivers and two reservoirs) are affected by the Ning'er-Longfu Road (see Appendix 5).

31. **Ning'er-Longfu Road.** Table 6 lists the air quality, noise and water quality sensitive receptors along the proposed rural roads (more detail is provided in Appendix 5). Rural roads 1, 3 and 6 are no longer included in the Project so the information has been deleted. They were substituted by rural roads 32, 33, 34, 35 and 36 as shown in Table 6.

Table 6: Air, Noise and Water Quality Sensitive Receptors for the 31 Rural Roads

RR #	Air and Noise Sites	Schools	Rivers	Reservoir
1	No longer included in the Project			
2	7			
3	No longer included in the Project			
4	4		6	
5	4		3	
6	No longer included in the Project			
7	5			
8	10		2	
9	20			
10	11	1	3	
11	8	1	1	
12	6	1	1	
13	10		2	
14	7	1		
15	3		1	
16	11		3	1
17	7		2	
18	5	1		
19	3			
20	8	1		
21	7	1	1	
22	6			
23	3		1	

RR #	Air and Noise Sites	Schools	Rivers	Reservoir
24	6			
25	7		1	
26	3			
27	7		1	
28	6			
29	7		1	
30	3			
31	5			
32	2		1	
33	2			
34	4			
35	1			
36	3			

II. DESCRIPTION OF THE PROJECT

A. Project Location

32. Yunnan is in the south-west of the People's Republic of China (PRC), located in the area bounded by 21°08' N and 29°15' N, and 97°31' E and 106°11' E. The province has an area of 394,000 sq. km (4.1% of the nation's total area), with a span west to east span of 865 km and south to north of 980 km. Yunnan borders Guangxi and Guizhou to the east, Sichuan to the north, and Tibet to the northwest. It shares an international border with Myanmar to the west, Laos to the south, and Vietnam to the south-east.

B. Project Scope and Boundaries

33. The project is composed of three outputs: 1. Regional Roads Rehabilitation; 2. Rural Access Improvements; and 3. Institutional Strengthening.

34. Regional Road Rehabilitation consists of two roads and a border facility:

(i) Menglian-Meng'a section (44.85 km) of the Lancang-Menglian-Meng'a Highway involves the upgrading of this existing Class III/IV border road section to a Class II standard. (Figure 2).
(ii) Ning'er-Longfu Road (256.8 km): new construction and rehabilitation of existing road to mixed Class IV and Class III standards. The road sections (i) from Ning'er to Xuande would be upgraded to Class III standard, (ii) from Xuande to Baozang would be upgraded to a paved two-lane Class IV standard, (iii) from Baozang to Longfu would be upgraded or built to Class III standard, (Figure 3 through Figure 5).
(iii) The development of the Meng'a Port Material Transit Centre (located at the border gate of the Menglian-Meng'a road). The works would include the main building, associated housing and support facilities.

35. Rural access improvements involve 600 km of earthen or gravel rural roads rehabilitated through improved drainage and paving to a Class IV standard, safety measures, maintenance procedures and guidelines for implementation by local villagers, spot access roads and rural transit. The thirty-three rural roads (see Table 7 and Figure 1) will be upgraded using cement concrete, asphalt concrete or concrete block pavements.

36. The institutional strengthening component of the Project involves (i) community safety initiatives (education, enforcement and community awareness); and (ii) overseas and domestic training covering road maintenance, engineering, road safety, procurement and environmental and social safeguards. A project management consultant will assist the EA in supervision, environmental and social management and to liaise with ADB. All of these components will provide positive and beneficial improvement to the Pu'er road development sector.

37. The rural roads (see Table 7) will be upgraded using cement concrete, asphalt concrete or concrete block pavements at an estimated cost of CNY368.27 million.. All roads are in poor condition and have very low traffic. All are very winding and are in mountainous terrain. The paving of these roads is line with the 12th FYP of paving 6,530 km of township roads and the reconstruction of 1,800 km of connecting roads above village level. Collectively, the roads service 110 villages, 287 village groups, 16,280 households and

73,000 residents. Each have at least one minority group along the road and 20 roads have two or more minority groups. The roads contain 66 intersections, require no resettlement and require minimal roadbed widening. The primary reasons for selection of the roads are to provide paved access to administrative villages or to link higher-level roads.

Table 7: Proposed Rural Roads

Index	Name	From	To	County	Length (km)	Class	Lanes
1	No longer included in Project						
2	Tuanshan Road	K37+200 (Siyun Highway)	Tuanshan	Simao	27.70	IV	1
3	No longer included in Project						
4	Chahe Road	Tangliushu on Puniu highway	Lingfang point	Ning'er	14.85	IV	1
5	Minsheng Road	Meizi	Minsheng	Ning'er	17.75	IV	1
6	No longer included in Project						
7	Wafang Road	tree farm	Wafang	Mojiang	13.70	IV	1
8	Gongguan Road	Guzhuqing	Baha	Mojiang	21.50	IV	1
9	Banpo Road	K61+370 of Mojian highway	K24+090 of A'luo highway	Mojiang	25.20	IV	1
10	Longyan Road	Xiaolongjie	Yanjie (Nanhua County)	Jingdong	28.96	IV	1
11	Bangqing Road	Xiaolongjie	Xishe (Nanhua County)	Jingdong	24.46	IV	1
12	Yong'an Road	Dabaipo Mountain	Yong'an	Jinggu	13.97	IV	1
13	Qianjia Road	K12+080 of Wenhui Road	Lulaqingzhai	Jinggu	20.56	IV	1
14	Wenhui Road	K2361+800 of G323	border of Weiyang/ Fengshan	Jinggu	22.85	IV	1
15	Guihai Road	Luanhaihe River	Guihai	Zhenyuan	14.10	IV	1
16	Zhetie Road	Laojie	Zhetie	Zhenyuan	11.20	IV	1
17	Banghai Road	Nazhuangtian	Banghai	Zhenyuan	10.09	IV	1
18	Lianmeng Road	Rosin factory	Lianmeng	Zhenyuan	19.10	IV	1
19	Habo Road	Silicon Iron Factory	Habo	Jiangcheng	14.30	IV	1
20	Liangkeshu Road		Kapming Township	Jiangcheng	24.77	IV	1
21	Longtang Road	Tiaxin Road	Longtang	Jiangcheng	20.19	IV	1
22	Damannuo Road	K8+900 of Fumo highway	Gelangyang River	Menglian	17.00	IV	1
23	Gongliang Road	No.6 Rubber Group	Wongwuo	Menglian	14.30	IV	1
24	Hui'e Road	Jingxi	Mengbai	Menglian	11.80	IV	1
25	Dongnai Road	K47+050 of Mengmeng highway	Dongnai	Menglian	11.90	IV	1
26	Saihan Road	Mangnong	K2950+150 of G214	Lancang	21.50	IV	1
27	Mangnong Road	Nanling	Mangnong	Lancang	39.00	IV	1
28	Galou Road	K4+700 of Yongbulou highway	K16+690 of Woyang highway	Ximeng	13.20	IV	1
29	Yongbulou Road	Farmers Market, Zhongke	Yongbulou	Ximeng	15.00	IV	1
30	Yongbang Road	K10+700 of Ximo highway	A'mo village, Xingchang	Ximeng	14.00	IV	1
31	Momei Road	Yongye	Xinchanghe Power Station	Ximeng	11.60	IV	1
32	Side Road	Simao district Lianhua	Pu'er river	Simao district	17	IV	1
33	Tuanshan Road	Diao qiao	Tuanshan village committee	Mojiang	21.1	IV	1
34	Bangwai Road	Longjie	Bangwai village	Jingdong	22.7	IV	1
35	Nadong Road	Xiafu road K41+500	Nadong villiage	Lancan	12.6	IV	1
36	Nanlie Road	Na ka qing	Nan lie villiage	Lancan	13.6	IV	1

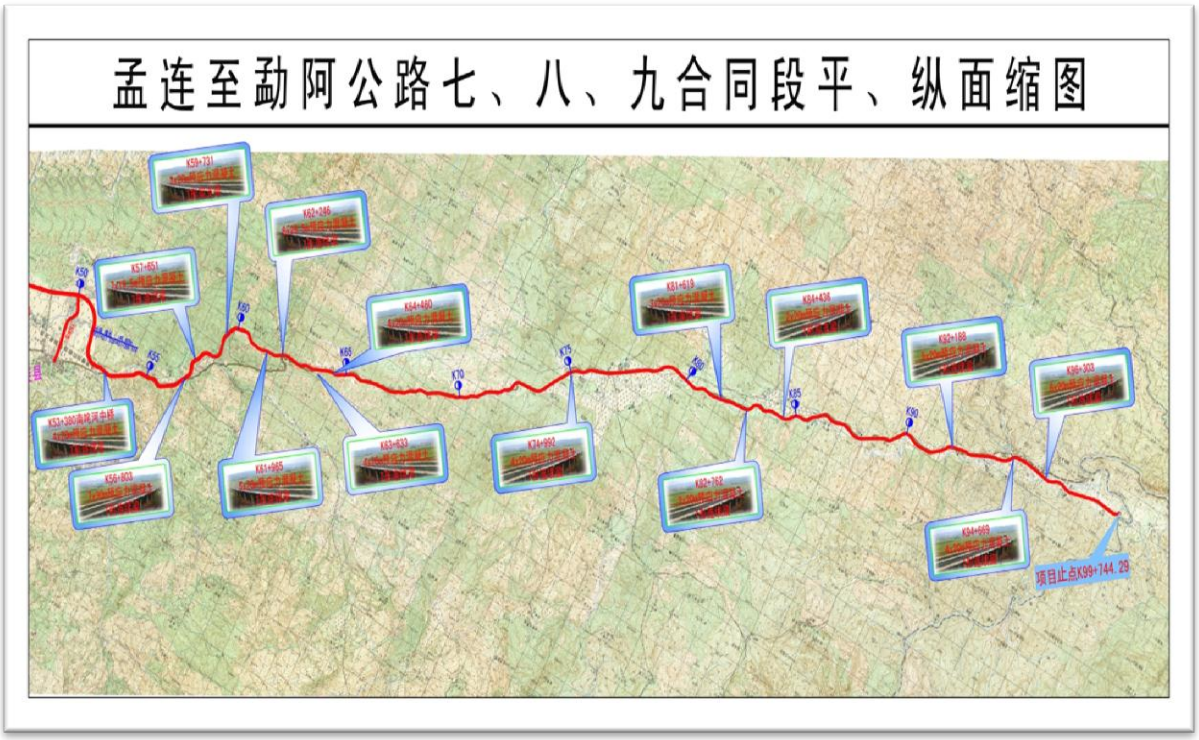
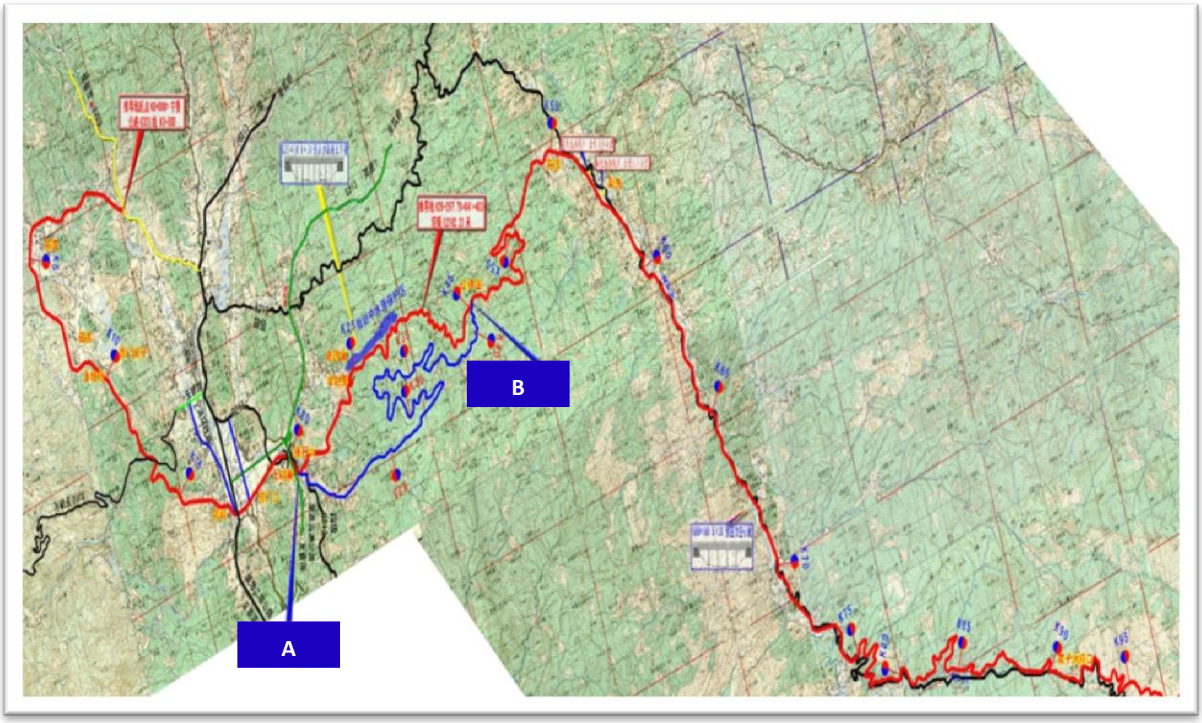


Figure 2: Menglian-Meng'a Road Section (K54+900-K99+744)

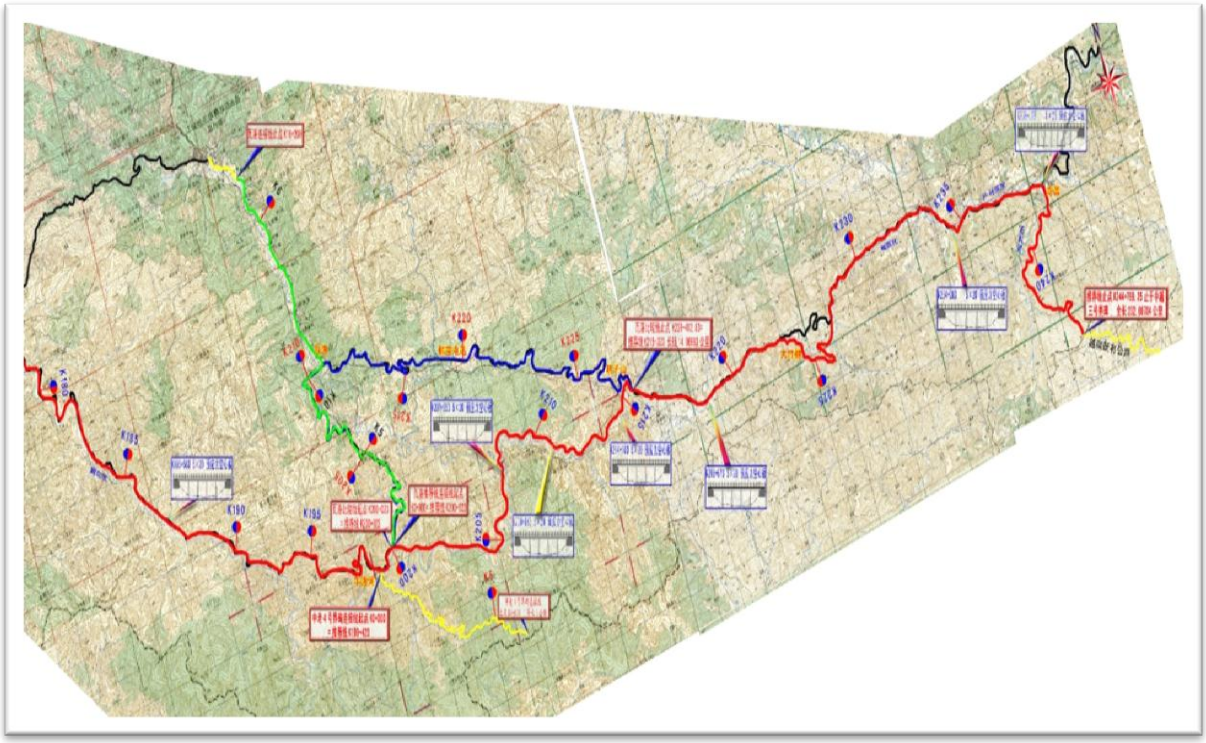


Notes: The red route was the original preferred alignment. Between points A and B the blue route was adopted to satisfy national regulation clearance distance requirements related to the proposed Wenquan water storage reservoir. Black route is the existing road.

Figure 3: Ning'er-Longfu Road–1 of 3

Notes: Red route is the new, preferred and selected alignment; Blue route is an alternate route studied and rejected; Black route is the existing road.

Figure 4: Ning'er-Longfu Road–2 of 3



Notes: Red route is the new, preferred and selected alignment; Blue route is an alternate route studied and rejected; Black route is the existing road; Green route is access road to Jiangcheng.

Figure 5: Ning'er-Longfu Road–3 of 3

C. Menglian-Meng'a Highway

38. The 2009 FSR proposed a 102 km Lancang-Menglian-Meng'a Class II and Class III road. The decision to up-grade the road to a Class II and a 60 kmph standard involved a revised FSR and environmental assessment in 2011. The addition of 2 long tunnels and improved geometric sections reduced the length of the road to 100 km. This road is defined as an important international trade corridor for the local economy as well as an important tourism access route. The first section of the road up to K54+900 from Lancang to Menglian is currently under construction using PMG funding and the remaining portion from Menglian to Meng'a (K54+900 to 99+744) will be financed under this ADB financed Yunnan Pu'er Regional Integrated Road Project.

39. The ADB financed portion of the road commences at K54+900 at the southwestern edge of the Menglian Urban Development Area. The road leaves the old road and runs to the south side of Menglian. At K55+600(H-960.00 m), it connects to the old road, then spans Nancha River at K59+550(H-990.00 m) and runs to the south side at ascending grade. At K67+450(H-1364.25m), it passes through the Pass and connects to the old road and then runs along the road at descending grade. At K79+800(H-920.00 m), it passes through Mengma and runs along the old road at descending grade to K98+800(H-525.75 m), then at K99+150(H-520.00 m) spans Nanma River and runs along the foot of the hill at north side of Meng'a, and stops at Meng'a Port. The proposed standard will generally be Class II with two 3.5m lanes and a 2.5m shoulder on each side, within an overall formation width of 12 m. The final 4.1 km to the border will be designed to Class I standards, with dual 2-lanes and an overall formation width of 23 m. The design speed throughout will be 60 km/h.

40. **Traffic volumes.** The following tables show the traffic volumes of the Menglian-Meng'a road from 2001 to 2026:

Table 8: Traffic Volumes for the Menglian-Meng'a Road

Year	Passenger car	Minivan	Medium truck	Large truck	Minibus	Large bus	Total	Converted traffic volume
2001	458	34	45	18	215	162	474	595
2003	472	76	84	42	198	183	583	758
2006	466	88	105	87	176	193	649	885

Source: Compilation of Survey Data of Yunnan Province Road Traffic.

Table 9: Traffic Forecast for the Menglian-Meng'a Road

Year	Menglian-Meng'a		
	Total	Passenger car	Truck
2015	2273	1207	1066
2020	3683	1979	1704
2026	5474	3031	2444

Source: FSR 2009/11.

41. **Design standards.** Key parameters from the 2009 FSR are shown in Table 10.

Table 10: Design Parameters for the Menglian-Meng'a Road

Parameter	Unit	2009 FSR
Road Class		II
Length	Km	48.85
Roadbed Width	M	12
Pavement Width	M	2 * 3.5m
Shoulders	M	2 * 2.5m
Design Speed	Km/h	60
Traffic (2015)	Pcu/d	1718
Limit value of radius of circular curve	M	125
Maximum longitudinal gradient	%	6
Bridge Width	M	10

Source: 2009/2011 FSR. Pcu/d: Passenger Car Units per day.

42. **Pavement design.** The 2011 FSR proposes:

- aggregate thickness of 59 cm of which:
  - 4 cm for Type AC-13 medium-grain modified asphalt concrete,
  - 5 cm for Type AC-16 coarse-grain modified asphalt concrete, and
  - 0.6 cm for Type ES-2 slurry seal;
- 30 cm for cement stabilization base course; and
- 20 cm for graded broken stone sub-base.

43. **Bridges and culverts.** Design loads for new bridges are Class II level with large-middle bridges designed for 1:100 year flood levels and smaller bridges and culverts at 1:50 year flood levels. The 2009 FSR indicates that for the ADB funded section there will be 24 large and medium bridges as shown in Table 11.

Table 11: Bridge Requirements for the Selection Section K54+900-K99+744

SN	No. of Central Pile	Across Landform	Structure	Holes and Span (hole-meter)	Length of bridge (meter)	Width of bridge (meter)
1	K59+540	Bamboo forest	T-beam	6-30	200	10
2	K60+735	Bamboo forest	T-beam	5-30	170	10
3	K61+140	Bamboo forest	T-beam	5-30	170	10
4	K62+255	Bamboo forest	T-beam	4-30	140	10
5	K55+540	Bamboo forest	Prestressed hollow slab Bridge	2-20	60	10
6	K61+900	Bamboo forest	Prestressed hollow slab Bridge	2-20	60	10
7	K62+010	Bamboo forest	T-beam	3-30	110	10
8	K64+585	Bamboo forest	T-beam	2-30	80	10

SN	No. of Central Pile	Across Landform	Structure	Holes and Span (hole-meter)	Length of bridge (meter)	Width of bridge (meter)
9	K64+940	Bamboo forest	T-beam	3-30	110	10
10	K65+505	Bamboo forest	T-beam	3-30	110	10
11	K65+905	Bamboo forest	T-beam	3-30	110	10
12	K66+100	Bamboo forest	T-beam	3-30	110	10
13	K70+190	Bamboo forest	T-beam	3-30	110	10
14	K77+800	Nanma river	T-beam	3-30	110	10
15	K83+580	Bamboo forest	T-beam	2-30	80	10
16	K84+405	Bamboo forest	T-beam	3-30	110	10
17	K86+400	Bamboo forest	Prestressed hollow slab Bridge	2-20	60	10
18	K87+245	Bamboo forest	T-beam	3-30	110	10
19	K89+010	Bamboo forest	T-beam	2-30	80	10
20	K90+538	Bamboo forest	T-beam	3-30	110	10
21	K92+970	Bamboo forest	Prestressed hollow slabs Bridge	2-20	60	10
22	K95+050	Bamboo forest	Prestressed hollow slab Bridge	2-20	60	10
23	K97+600	Bamboo forest	T-beam	3-30	110	10
24	K99+150	Nanma River	T-beam	3-30	110	10

Source PRC EIR, 2009.

44. **Drainage and slope protection.** Detailed design will integrate with local irrigation and drainage systems. With respect to embankment drainage, water from pavement and slope is collected by the side ditch at both sides and drained into a ditch, stream or river. The side ditch parallels the road and forms an independent drainage system. Slope intercepting drain, drainage chute and channels are arranged to collect and drain slopes and hillsides into natural ditches and streams to protect the cut slope.

45. **Road maintenance.** Road maintenance will need to be improved to keep the upgraded road from quickly falling into disrepair. Specifically, drainage, culverts and slope protection need regular checking and clearing to reduce safety hazards and increase longevity of the pavement.

46. **Implementation period.** PMTB proposes to implement this component over a period of 24 months, from June 2015 to July 2017. The implementation period is considered adequate.

D. Ning'er-Longfu Road

47. The original FSR indicated a 252.8 km Class III-IV road. The August revision of the FSR presented a 256.89 km Class III-IV-III design. The length change results from: (i) removing 8 km (the Longfu–Qushui section), and (ii) adding 12 km as a result of the Class change necessitating removal of some of the previous Class III realignments. The road is currently in very poor condition and is a combination of Class IV and unclassified roads. The rehabilitation of this road at Class III is in line with the 12th FYP which includes construction of four Class III highways and the development of Pu'er as the 'gateway' to the southwest to increase trade potential with neighboring countries.

48. The Ning'er-Longfu road commences at its junction with the national highway G323 Ning'er–Jinggu Road to the north of the urban area of Ning'er. Between K0 and K20, it runs along the northwest, west and south of Ning'er. Between K20 and K56, the road runs from west to east across mountainous terrains. Thereafter the road runs in a roughly northwest to southeast direction across mountainous terrain towards Longfu at K238. From Longfu the road runs southwards towards the border with Viet Nam at K244+799. The road is connected to Jiangcheng urban area at K175 via a 17 km linkage along S214. Much of the route is lacking good pavement surface. Furthermore, it is often narrow and has serious issues with slope stability, sightlines and lack of safety barriers.

49. **Design standards.** The road was originally built according to two-lane standard of Class IV road. The May FSR reports that through many recent 'upgrades' of the road, the subgrade width now meets the lower limit Class III subgrade width. Table 12 shows the traffic forecast. The key design parameters of the two FSRs are shown in Table 13.

Table 12: May 2013 FSR Traffic Forecast

Year	2015	2020	2025	2030
Mandan-Kesa	2607	3571	4558	5680
Kesa-Baka	2488	3409	4351	5422
Baka-Niuluohe	2084	2855	3644	4541
Niuluohe-Longfu	1941	2660	3394	4230
Average	2264	3102	3959	4934

Source: FSR May, 2013.

Table 13: Design Criteria for Ning'er-Longfu Road

Road Section	Class	Length (Km)	Roadbed Width (m)	Pavement Width (m)	Design Speed (Km/h)	Radius of curves	Gradient	pcu/day (2015)
Mandan to Baka	III	25	8.5	2 * 3.5	40	30m	8%	1632-664
Baka to Jiangcheng	IV	86.5	6.5	2 * 3.0	20	30m	8%	664-639
Jiangcheng to Longfu	III	145.397	7.5	2 * 3.5	30	30m	8%	639-1027
Total FSR 2		***256.897***						
May FSR parameters	*III*	*252.8*	*7.5*	*6.5*	*30*			*2264*

Source: FSRs from May and August. Pcu/day: Passenger Car Units per day.

50. **Road pavement.** The FSR indicates that the road is considered to be almost Class III road standard. Horizontal and vertical alignment are reasonable, the pavement structure is asphalt pavement, blended with some mud agglomerate stone pavements and cement concrete pavements. Due to its age, increasing traffic volumes and a lack of adequate drainage and poor maintenance over recent years, most of the pavement is now quite damaged. The new road is proposed to be paved using asphalt concrete as required for Class III roads (in accordance with the 12th FYP). The FSR proposes a pavement design of: 16 cm crushed stone sub-base, 28 cm cement treated gravel, 0.6 cm slurry seal, 6 cm medium grade asphalt concrete and 4 cm fine grade asphalt concrete.

51. **Bridges and culverts.** The FSR reports that the existing bridges along the route are generally in good condition with main arches being free of cracks, deformation and seepage. Arch footings are free of cracks and can be still used. At present, most of the existing culverts are in good useable state, though they need to be cleaned and new ones added as necessary. Design loads for new bridges are at Class II level with large-middle bridges designed for 1:100 year flood levels and smaller bridges at 1:50 year flood levels. While total bridge numbers and lengths are shown in the FSR, the number of other new structures is not identified.

52. **Drainage and slope protection.** The majority of the subgrade is stable, but many road sections show slope collapses and subgrade subsidence. Embankment slope collapse is mainly due to the lower slope gradient and the lack of retaining structures. Such structures exist in only a few sections along the road. Generally, drainage facilities are inadequate. Some rectangular stone masonry side ditches of mortar rubble are present (though these present a road safety hazard and should be replaced with L-shaped, triangular or trapezoidal channels). Earthen ditches are provided on most road sections. However due to a lack of maintenance, the majority is blocked. Slope ditches will require clearing or dredging to meet the minimum standards. Proper slope protection will be required to avoid on-going damage to the improved road. This may include stone masonry or gabion retention walls as well as bioengineering.

53. **Road maintenance.** Road maintenance will be improved to keep the upgraded road from quickly falling into disrepair. Specifically, drainage, culverts and slope protection need regular checking and clearing to reduce safety hazards and increase longevity of the pavement.

54. **Implementation period.** PMTB proposed to implement this component over a period of 36 months from June 2015 to July 2018. The implementation period is adequate.

E. Rural Access Improvement

55. This component includes the rehabilitation and paving of 33 rural roads to a Class IV standard, development of procedures for local people to maintain their improved road, village access road spot improvements and rural transport services.

56. The village road spot improvements will be undertaken on village roads that connect more remote village groups to the project rural roads, thus extending the benefit of the rural roads improvements. The spot improvements will be carried out through community contracts with the village groups linked by the village roads concerned (one contract for each village road). Local people with minimal training and supervision, using local materials, will carry out most improvements. These might include construction of drains, culverts, retaining walls, improvement of subgrade, gravelling or paving of road surface and bioengineering.

57. The rural transport services component involves bringing public transport services to villages along the rural roads. Most unpaved rural roads linking administrative villages do not have public transport services however, with sealed roads a bus service may become viable Support through the project management consultancy during loan implementation will focus on improved transport planning, including the selection of an appropriate commercial model and the provision of transport services for school children. The assistance will also support the piloting of township-based bus services and village-based pilot initiatives.

58. All rural roads are in poor condition and have very low traffic. All are very winding and are in mountainous terrain. The paving of these roads is in line with the 12th FYP of paving 6,530 km of township roads and the reconstruction of 1,800 km of connecting roads above village level. Collectively, the roads service 110 villages, 287 village groups, 16,280 households and 73,000 residents. Each have at least one minority group along the road and 20 roads have two or more minority groups. The roads contain 66 intersections, require no resettlement and require minimal roadbed widening. The primary reasons for selection of the roads are to provide paved access to administrative villages or to link higher-level roads.

59. The proposed component will contribute to inclusive growth and regional integration by connecting isolated rural communities and border areas to the regional road network and providing infrastructure to support trade and regional cooperation between the People's Republic of China (PRC), Vietnam, Lao People's Democratic Republic (Lao PDR) and Myanmar. The proposed component is a priority in the governments 12th FYP by supporting the governments' regional cooperation objectives and helps connect rural villages to the growing regional transport and trade systems. It is also aligned with the key thrusts of Asian Development Bank (ADB's) assistance to the PRC under the 2011-2015 country partnerships strategy in the areas of: (i) inclusive growth and balanced development, and (ii) regional cooperation and integration. The project fits well with ADB's Sustainable Transport Initiative (STI) which identifies regional cooperation and integration, road safety and social sustainability as key opportunities.

60. **Selection criteria.** The roads have been prioritized by the CTBs. Selection criteria used were:

- that the road should connect multiple village groups and administrative villages,
- that the road should connect to a national or provincial highway or an important county road,
- that there should be a balance between the 9 counties and 1 district, and

- that there should be no dead-end roads (roads should not end in the middle of nowhere, but should connect to higher level roads on both sides or end at an administrative village).

61. Most project roads are township roads (96%) connecting one or more administrative villages and surrounding village groups to the higher level sealed road network (county, provincial or national roads). One village road (#3) connects two township roads, and will likely be upgraded to a township road after improvement. One unpaved county road (#22) has been selected.

62. **Road data inventory.** A complete rural road data inventory was carried out, however, given proposed substitution of roads, this will need to be updated (Appendix 4). Table 8 below contains an abbreviated version with data applicable to the environmental assessment. If some roads are replaced then there will be requirement for environmental assessment in order to meet ADB requirements. An Environmental Assessment and Review Framework (EARF) has been prepared (Appendix 2), to provide guidance to the PPMO for selection, screening, categorisation and environmental assessment of substitute rural roads, as required.

Table 14: Proposed Rural Road Component Inventory

Road #	Name	County	Population	Year constructed	Width (m)	Length (km)	Township road (km)	Class IV (km)	Pavement	Passing sites	Villages traversed	Households	Schools	Clinics	Agricultural produce	Resettlement
1	Not included															
2	Tuanshan	Simao	2,230	2010	4.5	27.70	27.70	-	AC	80	2	568	No	Yes	Tea, coffee, corn, rice	No
3	Not included															
4	Chahe	Ning'er	1,251	2008	4.5	14.85	14.85	14.85	CC	30	1	395	No	Yes	Coffee, rice	No
5	Minsheng		950	2009	4.5	15.75	15.75	15.75	CC	42	1	237	No	Yes	Tea, rice	No
6	Not included															
7	Wafang	Mojiang	1,400	1996	4.5	13.70	13.70	13.70	CC	13	2	350	No	Yes	Tea, rubber, tobacco, coffee, rice, corn, wheat	No
8	Gongguan		1,200	1987	4.5	21.50	21.50	21.50	CC	22	2	450	no	Yes	Tea, sugarcane, tobacco, corn, wheat, rice	No
9	Banpo/Aluo		1,040	1979	4.5	25.20	25.20	25.20	CB	24	3	327	No	Yes	Tea, sugarcane, tobacco, corn	No
10	Longyan	Jingdong	5,780	1995	4.5	28.96	28.96	28.96	CC		2	427	Yes	Yes	Tea, walnut, tobacco, corn, wheat, beans, peas	No
11	Bangqing		3,764	1995	4.5	24.46	24.46	24.46	CC		3	461	Yes	Yes	Tea, walnut, tobacco, corn, wheat, beans, peas	No
12	Yong'an	Jinggu	3,287	2009	6.5	13.97	13.97	13.97	CC		4	844	Yes	Yes	Forestry, livestock, rice, corn	No
13	Qianjia		3,973	2009	6.5	20.56	20.56	20.56	CC		5	930	Yes	Yes	Forestry, livestock, rice, corn	No
14	Wenhui		2,957	2009	6.5	22.85	22.85	22.85	CC		8	708	Yes	Yes	Forestry, livestock, rice, corn	No
15	Guihai	Zhenyuan	1,783	1997	4.5	14.10	14.10	14.10	CC	46	8	455	Yes	Yes	Tobacco, walnut, rice, corn	No
16	Zhetie		1,247	1992	4.5	11.20	11.20	11.20	CC	18	4	367	yes	Yes	Tobacco, walnut, rice, corn	No
17	Banghai		1,563	1993	4.5	10.09	10.09	10.09	CC	23	3	489	No	Yes	Tobacco, walnut, rice, corn	No
18	Lianmeng		3,000	1969	4.5	19.10	19.10	19.10	CC	25	3	300	Yes	Yes	Tobacco, rice, corn	No
19	Habo	Jiangcheng	1,916	2009	6.5	14.30	14.30	14.30	CC	24	8	458	No	Yes	Sugarcane, tea, rice, corn	No
20	Liangkeshu		3,374	2009	6.5	24.77	24.77	24.77	AC	41	1	828	Yes	Yes	Tea, coffee, potato, corn, rice	No
21	Longtang		764	2009	6.5	20.19	20.19	20.19	CC	35	0	157	No	no	Rubber, corn, rice	No
22	Damannuo	Menglian	2,372	2009	6.5	17.00	-	17.00	CC	51	11	692	Yes	Yes	Rubber, coffee, rice	No
23	Gongliang		4,059	2009	6.5	14.30	14.30	14.30	CC	43	7	936	Yes	Yes	Rubber, rice	No
24	Hui'e		4,300	2008	6.5	11.80	11.80	1.00	CC	36	2	679	yes	Yes	Coffee, sugarcane, rice	No
25	Dongnai		3,207	2009	6.5	11.90	11.90	11.90	CC	36	4	752	Yes	Yes	Rubber, rice	No
26	Saihan	Lancang	2,128	1992	4.5	21.50	21.50	21.50	CC		2	50	Yes	Yes	Tea, sugarcane, coffee ,rice	No
27	Mangnong		2,317	1991	4.5	39.00	39.00	39.00	CC		3	680	Yes	Yes	Tea, sugarcane, coffee ,rice	No
28	Galou	Ximeng	1,034	1996	4.5	13.20	13.20	13.20	CC	0	2	248	Yes	Yes	Tea, rubber, rice	No
29	Yongbulou		1,233	1998	4.5	15.00	15.00	15.00	CC	0	1	298	Yes	Yes	Tea, rubber, rice	No
30	Yongbang		1,256	1986	4.5	14.00	14.00	14.00	CC	0	3	331	Yes	Yes	Tea, rubber, rice	No
31	Momei		1,182	1987	4.5	11.60	11.60	11.60	CC	0	3	276	Yes	Yes	Tea, rubber, rice	No
32	Side Road*	Simao	1,900		4.5	17.0		17.0	AC		2	380	No	No		No
33	Tuanshan Road*	Mojiang	1,750		4.5	21.1		21.1	CC		2	350	No	No		No
34	Bangwai Road*	Jingdong	1,050		4.5	22.7		22.7	CC		4	210	No	No		No
35	Nadong Road*	Lancang	900		4.5	12.6		12.6	CC		1	180	No	No		No
36	Nanlie Road*	Lancang	950		4.5	13.6		13.6	CC		3	190	No	No		No

Note: In March 2014, the PMO substituted rural roads #32 to #36 for the previously considered #1, #3 & #6.
Source: PPTA processing of PMTB data: AC: Asphalt Concrete, CC: Cement Concrete, CB: Concrete Block.

63. **Required works.** The roads are existing unsealed roads in fair to poor condition. There may be some minor sections requiring realignment or widening, most roads are 4.5 m to 6 m wide. Most of the work involves the improvement of the road base and drainage system and subsequent paving.

64. **Design standards.** The design standards for the rural roads are given in Table 15. These are generally considered appropriate for the roads with their low traffic levels.

Table 15: Rural Road Design Criteria

Standard	Unit	PRC standard
Design speed	Km/h	20
Pavement width	M	3.5
Roadbed width	M	4.5
Minimum curve radius	M	15
Maximum gradient	%	9
Stopping sight distance	M	20
Shoulder at cutting	M	0.5
Shoulder at embankment	M	0.5
Design load		Class II highway

Source: FSR and PRC Technical Standards.

65. **Road width.** The proposed pavement width is 3.5 m single lane class IV for all roads, with a 4.5 m roadbed. This is considered adequate given the low traffic volumes, although passing bays will be required at regular intervals. Most road sections (392.1 km) already have the 4.5 m roadbed width required, while in some roads the existing roadbed width is 6.5 m (171.6 km). A reported total of 35.4 km of road will require widening of the roadbed to achieve this width (usually from 3.5 m to 4.5 m). This is not expected to lead to resettlement, but will increase the costs for these sections.

66. **Pavement treatment.** All project roads are currently unsealed (stone paving, gravel or earth), apart from some short sections of cement concrete in villages or on steep slopes. All roads will be improved to either cement concrete (504 km) or asphalt concrete (AC) standard (70 km).

67. The proposed pavement design for AC roads is 12 cm of graded gravel sub-base; 25 cm cement treated gravel base, 0.6 cm slurry seal and 4 cm fine-grade AC. For cement concrete roads the pavement design involves 18 cm of stones or brick base, 18 cm C25 cement concrete with natural gravel and 3 cm joints with sealing material. For the concrete block pavement, a 20 cm graded crushed stone sub-base is proposed, with a 3 cm sand bed and 12 cm precast cement concrete hexagonal blocks. These design standards are considered adequate in light of the low traffic volumes.

68. The proposed designs are indicated in Figure 6 below. Stone masonry curbing for AC roads is used to avoid edge break (common when unpaved road shoulders are not properly maintained). Where such curbs are used, they should still be combined with a shoulder to improve road safety and facilitate passing (the effective passing width in the design is only 4.0 m compared to 4.5 m for the cement concrete roads–for safety it is recommended to have wider shoulders allowing at least 5.0 m effective passing width, a decision to be undertaken by the

PMTB). In case of side drains, the curb should be angled to form a trapezoidal, L- or V-shaped drain that is less of a safety hazard to vehicles.

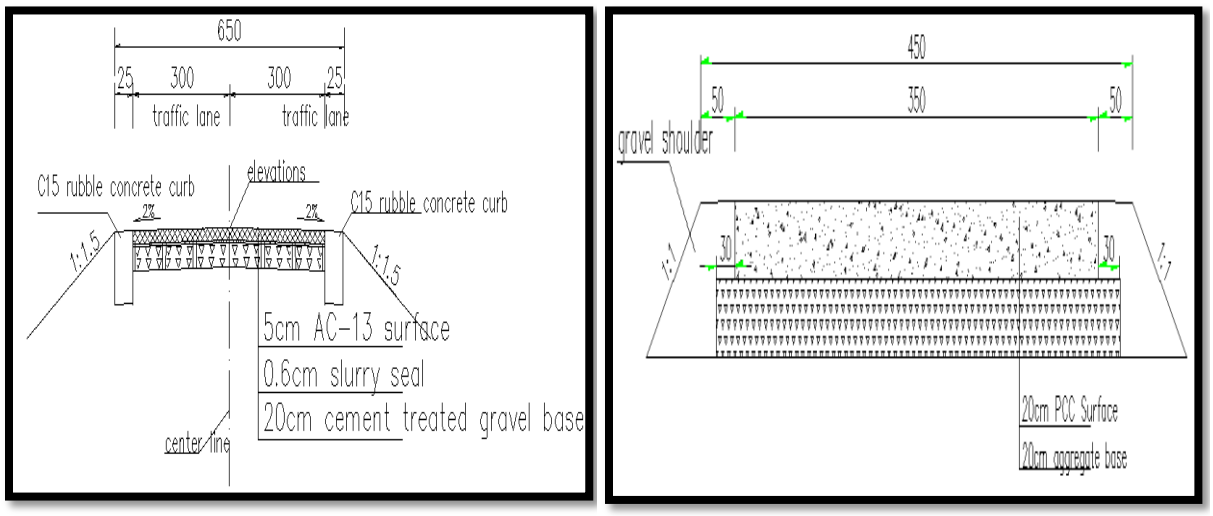


Figure 6: Asphalt Concrete and Cement Concrete Road Design

69. **Drainage and slope protection.** A review of a sample of the project roads under this component has shown that there is currently a severe lack of appropriate drainage and slope protection works. Cross drainage is not present in sufficient quantities and side drains are lacking in large lengths of roads causing water to run over the road surface and cause damage. The excavation of side drains[6] along the length of the road should be included in the design, ensuring proper outlets and cross drainage.[7]

70. Cut slope failures are common along the roads. Although these generally involve minor slides, they block the drainage system and cause water to run over the road, in some cases blocking (part of) the road surface and causing a safety hazard for traffic. Proper slope protection will be required to avoid costly damage to improved roads. This may include stone masonry or gabion retention walls as well as bioengineering. Dry stone retention walls may be used for embankment strengthening in certain locations. Coronation drains at the top of the slopes are recommended to avoid water flowing over the slope. These should be properly maintained to ensure water is guided away from the slope and to avoid them becoming a cause of landslides due to water seeping into the slope.

71. **Road maintenance.** Because slope protection measures cannot be applied along the entire length of the project roads due to the costs involved, and to ensure the proper working of the drainage system and the free passage for traffic, proper routine maintenance is required. Some of the project roads currently have maintenance systems in place with local people contracted to carry out maintenance activities, but the investment levels are too low to ensure proper protection of the road (approximately 10 working days per kilometer). With the paving of the project roads, proper maintenance becomes more important as damage becomes more

[6] These may largely be unlined. Trapezoidal or V-shaped side drains should be applied to avoid becoming a safety hazard.

[7] In valleys where considerable amounts of water cross the road, the slab-culverts proposed in the FSR seem appropriate. Where runoff from side drains and possibly irrigation canals is concerned, normal culverts may be used. These should be at least 40cm in diameter to facilitate cleaning.

costly to repair and side drains cannot simply be excavated around a landslide (landslides have to be removed to ensure proper drainage). An improved maintenance system will be developed and implemented for all Project rural roads for a period of two years following the completion of paving. As part of the Rural Road Access Improvement locals will be trained to maintain local roads. In addition, the Village Access Road Spot Improvement component should also result in the improvement of the project roads.

72. **Implementation period.** PMTB proposes to implement this component over a period of 24 months, from January 2016 to December 2017. The implementation period is considered adequate, considering the length of road upgraded by PMTB annually over the past few years (an implementation period of one year has been suggested by PMTB, but this is deemed insufficient).

F. Project Construction

73. All three components will have staggered starts depending on their design readiness and their preparations related to land acquisition and resettlement..

- **Menglian-Meng'a Highway**

74. Construction is expected to start in 2015 and be completed in 2017, with a construction period of 24 months.

- **Ning'er -Jiangcheng-Longfu Highway**

75. Construction is expected to start in 2015 and be completed by 2018, with a construction period of 36 months.

- **Rural Road Rehabilitation**

76. Construction is expected to start in 2016 and be completed by end 2017, with a construction period of 24 months.

77. **Earthwork and spoil excavation and management.** Following clearing and grubbing all topsoil should be excavated and stockpiled for future use in re-vegetation of cut and fill slopes on the two road projects.

78. Although road designers strive to balance the quantities of cut and fill from earthworks, mountain road construction always results in a significant quantity of surplus earth from cut slope construction. This earth (often termed waste or spoil) can be used to fill-in depressions, added to raise and improve agricultural fields, used as berms for flood protection. Excess should be stockpiled and re-vegetated.

79. The two regional road projects are expected to involve the following earthworks (Table 16).

Table 16: Calculated Earthwork Quantities

Project Component	Earthwork Quantities m^3	Rockwork Quantities m^3	Total earthwork m^3	Excess Earthwork-Spoil- m^3
Menglian-Meng'a Highway	2,700,800	4,051,200	6,752,000	1,766,800

Project Component	Earthwork Quantities m^3	Rockwork Quantities m^3	Total earthwork m^3	Excess Earthwork-Spoil- m^3
Ning'er-Longfu Road	2,407,005	802,335	3,209340	2,730,900
Rural Roads	0	0	0	0

Source FSR, 2009, 2013.

80. The preparation for paving the rural roads will involve grading the roads and shoulders. The result will be an accumulation of soil and vegetation, referred to as "stripping," this material can be used for shoulder dressing following paving on the AC paved roads.

81. Preparation of the CC paved roads can follow two methods: one, grade the road for the framing and paving on the existing road grade elevation or; two, excavate a 20-30 cm sub-cut and install the frames. The second method will result in spoil, although in small amounts, that can be given to local farmers for use in fields or as building foundation.

82. The 2013 FSR indicates that up to 500,000 m3 of spoil (equivalent to 800,000 tons) will be removed as part of the excavation. The potential for on-site reuse of this soil is feasible if the contractors work with local farmers to enhance agricultural fields.

83. **Construction traffic management.** To date there is very little information available on construction traffic volumes or proposed management measures. Construction traffic management will be an important element given the potential for disruption to the local road network and associated amenity impacts for nearby receivers. The two regional road components will have the opportunity to develop temporary access. In fact, the Menglian-Meng'a Highway and the Ning'er-Longfu Road can use the existing road in the areas of new construction thereby relieving significant delays.

84. The rural roads however present a different concern based on whether it is an AC or CC paved road. The roads that will be AC paved can allow traffic to use the new surface once it is rolled minimizing traffic delays.

85. However, the CC paved roads require 24 hours for the pavement to cure before traffic can use the new surface. This will result in holding-up traffic for 24 hours at a time or for the construction of many temporary detours that will likely encroach into agricultural areas creating a loss of access and crops to local farmers.

86. The contractors shall develop traffic management plans to allow traffic flow and pedestrian access through the construction sites for each of the rural roads. The PMO and the contractors should meet with village officials and residents present the plan and highlight the construction timing, potential closures, and detours.

87. **Services and utilities.** Construction works will require a range of services and utilities including electricity, telecommunications, water supply (potable and non-potable), wastewater treatment and disposal, and solid waste storage and disposal.

88. Based on discussions with PMTB, electricity, telecommunications and water supply are to be drawn from existing services. Temporary wastewater treatment systems will be developed at batch plants, pre-cast yards or at bridge and culvert construction sites to ensure meeting wastewater standards. Solid waste will be sorted and stored on site in temporary facilities prior to regular collection for recycling and reuse (salvageable materials from site clearing and

earthworks) or disposal at suitable facilities (hazardous or putrescible materials) approved by local authorities.

89. **Construction workforce.** Information available to date on the magnitude of the construction workforce is unknown. A maximum workforce of 100 persons is usual per contract. It is considered likely that the actual construction workforce size might greatly exceed this number depending on the size of each contract. Management measures for construction workers' accommodation and services have not yet been finalized. While priority will be given to hiring local construction workers, it is likely that a large proportion of the workforce will be from other parts of the Prefecture or surrounding Prefectures.

90. **Ancillary construction facilities.** A range of ancillary and support facilities for construction works will be required and will include:

- Concrete batching plants and casting yards
- Pre-cast yards for bridge and culvert components
- Materials storage areas
- Truck/vehicle parking and servicing areas
- Waste storage areas
- Temporary road diversions
- Worker camps

91. The PMTB indicates that construction worker camps will not be used, with preference being given to use of locally based workers, or housing of workers in the local communities.

92. The number and size of these facilities will affect the size of the overall construction footprint and the land acquisition requirements for the project. Tables 18 and 20 provide the anticipated land requirements for both regional road projects.

G. Associated Facilities

93. SPS (2009) defines associated facilities as "facilities that are not funded as part of a project but whose viability and existence depend exclusively on the project, or whose goods or services are essential for successful operation of the project." In this context, this project has no associated facility.

III. DESCRIPTION OF THE ENVIRONMENT

A. Introduction

94. This chapter describes relevant physical, biological and socioeconomic and physical cultural within the project area of influence. Much of the information was compiled from a range of secondary data sources presented in the EIRs for the regional roads and the EIT for the rural roads. This chapter also assesses the adequacy of existing datasets and identifies information deficiencies.

B. Physical Resources

1. Climate

95. The climate of Yunnan province varies across regions, and features low-latitude, monsoon, and mountain plateau characteristics. Seven regional climatic zones are recognized; from south to north, these are: north tropics, south subtropics, middle subtropics, north subtropics, south temperate, middle temperate, and plateau. The differentiation of regional climatic zones is heavily influenced by variation in latitude and elevation. Generally, temperatures decline from south to north, as elevations rise along with latitudes, the exceptions being high mountains and deep valleys, where sharp temperature gradients are often observed. High mountains surround the province to the west, north, and east, protecting it from cold fronts moving in from the north. The warm front coming up from South Asia also helps counter the cold wind in winter. Thus the province enjoys a mild spring-like climate year round.

96. Rainfall distribution is uneven both geographically and seasonally. Annual precipitation varies from up to 1,500 mm in the southern regions to 500-700 mm in the Jinshajiang River valley on the northern face of the plateau. Sixty percent or more of annual precipitation occurs in the rainy season from May to October. During the long dry season from November to April, serious drought is common in large areas of the province. Most parts of Yunnan province have long frost free periods of more than 300 days.

97. **Project area.** Pu'er is situated in the subtropical humid monsoon climate zone, with mild climate, distinct seasons, rainy summer, dry autumn and mild winter. The climate of Pu'er is very mild, not severely cold in winter nor unbearably hot in summer. The annual mean temperature is 17.7ºC and extreme maximum temperature is 33.8ºC, while the extreme minimum temperature is -2.3, and the yearly average rainfall 1,535.4 mm, May~October period is the rainy season and amount of precipitation in this period accounts for 86.2% of annual precipitation. November~April of the next year period is the dry season and precipitation amount of precipitation in this period only accounts for 13.8%, with a frostless period of 325 days. The annual average sunshine duration is 1940.4 hours, while the annual percentage of sunshine is 44%. Amount of annual solar radiation is 119 kilocalorie/ cm2. May~October period is the rainy season and amount of precipitation in this period accounts for 86.2% of annual precipitation. November~April of the next year period is the dry season and precipitation amount of precipitation in this period only accounts for 13.8%. The annual average evaporation capacity is 1566.5mm. Mean annual relative humidity is 80%. Changes in the frequency and/or intensity of extreme weather events, as well as gradual changes in climate parameters (such as temperature and precipitation) are occurring as a result of climate change. The Design Institutes appointed for detailed design will need to take account of climate change risks in Yunnan Province and Pu'er Municipality as highlighted in the specialist climate risk and

vulnerability analyses and consider whether current design standards need to incorporate an additional factor of safety to increase resilience to future climate change impacts.

98. **Climate Change**. Climate change in Yunnan Province in the last 50 years basically follows the national trend but with a slower warming rate. From 1961 to 2008, the annual average temperature has risen 0.66 ^{o}C (Duan and Tao, 2012),[8] lower than the national average of 1.3 ^{o}C for the last 50 years. The rate of increase was approximately 0.14 ^{o}C per decade, lower than the national average of 0.25 ^{o}C per decade. Although most regions in the province experienced temperature increase, some areas especially in low altitude river valleys experienced a temperature decrease. The biggest temperature increase occurred in the winter season (1.128 ^{o}C), followed by autumn (0.682 ^{o}C), summer (0.566 ^{o}C) and spring (0.312 ^{o}C). There have also been conspicuous changes in the sizes of the climatic zones, with the northern tropical and south sub-tropical zones becoming larger and the central sub-tropical, northern sub-tropical and temperate zones becoming smaller.

99. According to Duan and Tao (2012), Yunnan in the last 50 years experienced a minor decrease in precipitation at a rate of -2.8 mm per decade. During the major flood period of June to August the largest decrease in precipitation was experienced (-11 mm per decade), followed by the rainy season (May to October, -5.4 mm per decade). During the dry season (November to April), however, an increase in precipitation at a rate of 2.6 mm per decade was experienced.

100. A detailed climate risk and vulnerability analyses study was carried out for the project in October 2014, a summary of the results is included in the Report and Recommendation to the President, Supplementary Appendix 21: Project Climate Risk Assessment and Management and the full report is included in Appendix 6 of this EIA. The study found that annual rainfall change will be minor but severe, intense rainfall events are expected to significantly increase. As intense rainfall will become more frequent in the future, the landslide/debris flow risk will significantly increase. There will be a minor increase in the minimum and maximum temperature. Heat waves will become more intensified and frequent.

2. Air Quality

101. Yunnan has 16 municipal environmental monitoring stations. However, there are no air quality and traffic noise monitoring data available for existing roads in Yunnan. Monitoring of air quality and noise was conducted during EIR development for the regional road projects, but no monitoring was undertaken on the rural roads. Noise and air quality sensitive receptors were identified on the regional roads and the rural roads and are presented in Appendix 5.

102. For the Menglian-Meng'a Road, ambient 24-hr average concentrations of TSP and NO_2 were monitored for seven days in Manglang at K95+200, showing results of 0.031 to 0.051 mg/m^3 for TSP and 0.003 to 0.004 mg/m^3 for NO_2. Both complied with Class II air quality standard under GB 3095-1996 (0.30 mg/m^3 for TSP and 0.12 mg/m^3 for NO_2). The World Bank Group has no EHS standard for 24-hr average TSP and NO_2.

103. Seven-day baseline ambient air quality monitoring was also conducted at two locations for the Ning'er-Longfu Road.

[8] Duan, X and Tao Y. 2012. *Climate Change in Yunnan in the Last Fifty Years*. Journal of Tropical Meteorology 28(2): 243-250.

104. Table 17 shows that the baseline monitoring results for TSP and NO_2 complied with GB 3095-1996 Class II standards. Under future standards (GB 3095-2002) to be applied in 2016 the 24-hr concentrations for TSP and NO_2 are 0.30 mg/m^3 and 0.08 mg/m^3 respectively. The values recorded would comply with the future more stringent standards.

Table 17: Baseline Ambient Air Quality–Ning'er-Longfu Road

Monitoring Location	Monitoring Dates	24-hr Average Concentration of Air Quality Parameter in mg/m^3		
		TSP		NO_2
		Minimum	Maximum	
Liming Township in Ning'er County	11-17 OCT 2012	0.21	0.28	≤ 0.015
Niuluohe Village in Jiangcheng County	11-17 OCT 2012	0.018	0.035	≤ 0.015
GB 3095-1996 Class II standard		0.30		0.12
GB 3095-2002 Class II standard		0.30		0.08
World Bank Group EHS standard		no standard		no standard
Notes: **TSP** = total suspended particulates; **NO_2** = nitrogen dioxide; **EHS** = environmental, health & safety; **mg/m^3** = milligram per cubic meter				

Source: EIR.

3. Noise

105. Baseline noise monitoring results for the Menglian-Meng'a Road show that the measured day time and night time noise levels at the six selected monitoring locations met the noise standards for their respective noise functional area categories under GB 3096-2008, as well as World Bank Group's EHS standards (Table 18).

Table 18: Baseline Ambient Noise Levels–Menglian-Meng'a

No.	Monitoring Location		Noise Level (L_{eq}) in dB(A)			
			Noise Functional Area Category 4a		Noise Functional Area Category 2	
			Day Time	Night Time	Day Time	Night Time
1	Hegelaozhai		---	---	48.1	36.7
2	Mengma Town		64.8	42.6	---	---
3	Mengma Primary School	Ground floor	---	---	50.2	39.9
		Top floor	---	---	50.1	36.9
4	Manghai Primary School	Ground floor	---	---	52.4	37.0
		Top floor	---	---	51.8	35.9
5	Manglang		---	---	53.0	37.8
6	Anma		---	---	52.0	37.0
GB 3096-2008 standard			70	55	60	50
World Bank Group EHS standard			70	70	55	45

Source: Project EIR.

106. Baseline noise monitoring on the Ning'er-Longfu Road was conducted at 23 locations on two consecutive days. Table 19 presents the monitoring results, indicating four exceedances of the night time noise standard under GB 3096-2008 at the Mengxian Township and the Baozang Township, out of 138 measured results (exceedance rate of <3%). However, approximately 28% of the measured noise levels did not meet the more stringent World Bank Group's EHS

standards, especially night time noise. Noise levels at these locations are influenced by human activities and local road traffic.

Table 19: Baseline Noise Monitoring–Ning'er-Longfu

No.	Monitoring Location	Noise Level (L_{eq}) in dB(A)					
		Day Time				Night Time	
		Day One		Day Two		Night One	Night Two
1	Longtangba龙塘坝	48.1	45.9	46.7	46.9	42.7	44.2
2	Manlian Village Primary School曼连村小学	50.4	49.8	50.3	49.8	33.2	42.9
3	Xin Village新村	45.4	42.8	48.7	49.4	39.5	40.2
4	Banhai Village Committee般海村村委会	48.5	49.6	50.5	43.9	40.7	41.0
5	Banhai Primary School般海小学	47.3	46.5	48.5	51.6	40.0	39.8
6	Minzheng Village民政村	53.0	51.4	53.1	52.7	46.8	46.2
7	Wenquan Village温泉村	44.8	46.0	44.1	44.8	43.0	42.2
8	Kesa Village克洒村	54.8	55.2	56.8	55.7	48.1	47.8
9	Mengxian Township勐先乡	51.0	56.2	53.2	56.3	54.2	54.0
10	Sandaoqiao Village三道桥村	49.6	51.3	51.2	50.1	43.7	42.6
11	Xuande Village宣德村	57.4	58.0	57.1	57.8	46.9	46.2
12	Xuande Genshengbo'ai Primary School宣德根生博爱小学	56.9	54.7	55.0	55.3	49.2	48.8
13	Cailzidi Iron Factory菜子地铁厂	42.8	42.4	43.5	42.5	40.1	39.7
14	Xianren Village仙人村	42.1	42.4	41.7	41.5	43.2	42.6
15	Liming Township黎明乡	48.5	49.2	48.0	48.7	44.7	44.5
16	Muhuazhai沐化寨	47.7	48.2	48.0	47.2	43.2	42.8
17	Shuicheng Village水城村	46.5	46.1	47.0	46.6	40.1	39.8
18	Baozang Township宝藏乡	55.7	56.8	57.2	57.7	55.2	55.0
19	Banhe Village板河村	52.1	52.9	52.5	51.7	47.8	47.3
20	Qiyi Bridge七一桥	48.6	53.5	48.2	49.1	46.7	46.3
21	Hebian Village Committee河边村委会	55.1	53.7	54.7	52.4	45.7	44.9
22	Dazhupengzhai大竹棚寨	52.4	51.2	51.5	52.8	47.1	47.5
23	Niuluohe Village牛倮河村	56.3	57.0	55.0	54.7	47.4	47.2
GB 3096-2008 Category 2 Noise Functional Area standard		60				50	
World Bank Group EHS standard		55				45	

Note:
Exceeded GB 3096-2008 Category 2 standard and World Bank Group EHS standard
Exceeded World Bank Group EHS standard

Source: Project EIR.

4. Topographical and Geological Conditions

107. Yunnan province is located in the southern zone of the Qinghai-Tibet plateau. The terrain is hilly and mountainous, and slopes generally from the northwest to the southeast. The average elevation of the province is over 2,000 metres above sea level (masl). Moving from northwest to southeast, three scarped terraces are encountered; these are the Diqing Plateau

(peaks over 5,000 masl), the Central Plateau (general altitude about 2,000 masl), and the Southern Plateau (altitude under 1,000 masl).

108. Divided by the Yuanjiang River valley and a broad ravine between the southern ridges of the Yunling Mountains, the eastern part of the province is dominated by medium-depth valleys and various karst landforms. The west is mostly mountainous, with steep slopes and deep valleys in the north and a more gentle landscape in the south. Mountainous areas comprise 84% of the province's area, with plateau and hilly areas (10%) and broad valleys (6%) making up the rest.

109. **Project area.** Pu'er Prefecture has an area of 45,385 km2. Mountainous areas comprise 98.3% of the area and the altitude ranges between 376 and 3,306 masl.

110. Pu'er is located at the southwest border of the Yunnan-Guizhou plateau, which belongs to the mountainous region of the south section of Hengduan cordillera. Pu'er terrain is higher in altitude in the north and lower in the south. The mountains and rivers trend west to east. There are three mountain chains: Ailao, Wuliang and Nu, which are bisected by three major water systems, Lancang River, Red River and Nu River. The highest peak is Wuliang mountain-Maotou Mountain at 3370 masl; the lowest point is the exit of Lixian River in Jiangcheng city at 317 masl.

111. The sedimentary and alluvial formations are common to the Pu'er area.

112. With laterite soils in the north and sedimentary and alluvial formations in the south and east, the entire project area is highly erosion prone. Consequently, extreme care must be taken whenever vegetative cover is removed or disturbed during construction.

5. Seismic Activity and Risks

113. Yunnan province is a very active seismic area in China. It is within a tectonically complex zone affected by the broad zone of deformation associated with the ongoing collision between the Indian Plate and the Eurasian Plate. A rhomb-shaped fault-bounded block, known as the Sichuan-Yunnan Block is bounded by the active left-lateral strike-slip faults the Xianshuihe fault system and the currently right lateral Red River Fault and Jinshajiang Fault.

114. The province has had historic large earthquakes, the Dali earthquake of 1925 killed over 5,000 people. Moderate to strong earthquakes occur frequently in the Sichuan-Yunnan region raising the risk to road infrastructure. The greatest risk is to structures-bridges and culverts followed by geotechnical effects-landslides, fill slumps and pavement cracking.

115. PRC has a seismic code governing the design and construction of structures in seismically active zones. All bridges and large culverts on the two regional roads will be designed to meet the code and should withstand moderate to strong. There is no construction code to mitigate geotechnical risks from earthquakes.

6. Soil and Water Conservation

116. **Soil loss along Menglian-Meng'a Road.** Table 20 presents erosion data for Lancang and Menglian County based on the Investigation Report of the Current Status of Soil Erosion of Yunnan Province in 2004 issued by Yunnan Water Resources Department in February 2006.

Table 20: Erosion Status in Lancang and Menglian

Index \ Administrative area			Lancang County	Menglian County
Total land area			8740.81	1892.23
Slight erosion		Area	6513.62	1442.24
		（%）	74.52	76.23
Soil erosion		Area （km^2）	2227.19	449.73
		（%）	25.48	23.77
Classification of intensity	Slight	Area （km^2）	1424.51	183.65
		（%）	63.96	40.84
	Medium	Area （km^2）	703.89	249.16
		（%）	31.60	55.40
	Serious	Area （km^2）	98.65	16.92
		（%）	4.43	3.76
	Extremely Serious	Area （km^2）	0.09	0.00
		（%）	0.00	0.00
	Violent	Area （km^2）	0.05	0.00
		（%）	0.00	0.00
Average erosion for the whole County(District)（$t/km^2 \cdot a$）			951	1012

Source PRC EIR, 2009.

117. The provincial assessment indicates that only slight and moderate erosion occurs in Menglian County as plantations along the proposed road have been well preserved. Water and soil loss in the area is mainly due to water erosion of upland slopes. The main causes of water and soil loss are destruction of the ground plantation and man-made influences. Rainfall is concentrated in the rainy season and annual precipitation in the area shows significant variation. Moreover, high intensity rainfall events have increased soil erosion and water and soil loss.

118. **Soil loss for the Ning'er-Longfu Road.** Table 21 presents erosion data for Ning'er and Jiangcheng counties based on the Investigation Report of the Current Status of Soil Erosion of Yunnan Province in 2004 issued by Yunnan Water Resources Department in February 2006.

Table 21: Erosion Status in Ning'er Longfu Road

Index \ Administrative area			Ning'er County	Jiancheng County
Total land area			3669.06	3485.07
Slight erosion		Area	2632.84	3005.65
		（%）	71.76	86.24
Soil erosion		Area （km^2）	1036.22	479.42
		（%）	28.24	13.76
Classification of intensity	Slight	Area （km^2）	734.17	318.86
		（%）	20	9.1
	Medium	Area （km^2）	298.39	138.20
		（%）	8.1	4%
	Serious	Area （km^2）	3.66	22.24
		（%）	Less 0.1 %	0.6%
	Extremely Serious	Area （km^2）	0.00	0.12
		（%）	0.00	0.00
	Violent	Area （km^2）	0.00	0.00
		（%）	0.00	0.00

119. The provincial assessment indicates that only slight and moderate erosion was found along the proposed road, most of which was non-obvious and slight erosion. Plantations along the proposed road have been well preserved. Water and soil loss in the area is due to erosion of slopes and man-made influences. High intensity rainfall events can aggravate soil erosion.

7. Hydrology and Water Quality

120. There are about 10,000 rivers and creeks in Yunnan, of which more than 600 have year-round flow. These watercourses are tributaries of the Irrawaddy, Nujiang, Langsang, Honghe, and Zhujiang Rivers. The Jinshajiang River (the upstream portion of the Yangtze River) and Nanpanjiang River (the upstream portion of the Zhujiang River) also run through Yunnan.

121. **Project area.** Pu'er has many rivers, major watercourses include the Lancang River, Red River, Nujian River and Yuanjian River. Also significant are the Simao River, Lixiang River, Weiyuan River, Nanlang River, Nanlei River and Nanma River.

122. The annual average total water resource is 240.9 billion m3. There are 13 medium reservoirs and 277 small reservoirs. 12 major rivers of a length of 1293 km in Pu'er were monitored and water quality assessed. The water quality of 1293 of 12 major rivers meet national category II-III.

123. The regional roads and the rural roads cross a number of rivers and streams. These crossings have been identified as sensitive receptors and are identified in Appendix 5.

124. **Surface water quality.** Baseline surface water quality monitoring for the Menglian-Meng'a Road was conducted where the proposed bridge crosses the Nanma River. Monitoring results shown in Table 22 indicate that the water quality parameters measured comply with GB 3838-2002 Category III standards on the days of monitoring.

Table 22: Baseline Surface Water Quality Results for Menglian-Meng'a

Monitoring		Surface Water Quality Parameter				
Location	**Date**	**pH (no unit)**	**SS mg/L**	**COD mg/L**	**BOD_5 mg/L**	**TPH mg/L**
Nanma River (K77+800)	2009.09.01	7.67	17	7	0.9	≤.0.05
	2009.09.03	7.66	15	8	1.2	≤.0.05
GB 3838-2002 Category III standard		6～9	—	20	4	0.05
Note: **pH** = degree of acidity/alkalinity; **SS** = suspended solids; **COD** = chemical oxygen demand; **BOD_5** = 5-day biochemical oxygen demand; **TPH** = total petroleum hydrocarbon; **mg/L** = milligram per liter						

Source: EIR.

125. Baseline surface water quality monitoring was also conducted at eight locations for the Ning'er-Longfu Road. Table 23 presents the monitoring results, indicating GB 3838-2002 Category III water quality standard for the parameters measured on the monitoring days at these locations.

Table 23: Baseline Surface Water Quality Results for Ning'er-Longfu

Monitoring		Surface Water Quality Parameter						
Location	Date	pH (no unit)	SS mg/L	COD mg/L	BOD_5 mg/L	NH_3-N mg/L	TP mg/L	TPH mg/L
Xishitou River	2012.10.15	7.6	23	≤ 5	≤ 1	0.21	0.034	≤ 0.004
	2012.10.16	7.6	19	≤ 5	≤ 1	0.2	0.026	≤ 0.004
	2012.10.17	7.4	22	≤ 5	≤ 1	0.21	0.022	≤ 0.004
Dong'er River	2012.10.15	7.5	24	≤ 5	≤ 1	0.39	0.034	≤ 0.004
	2012.10.16	7.4	20	≤ 5	≤ 1	0.4	0.034	≤ 0.004
	2012.10.17	7.6	22	≤ 5	≤ 1	0.39	0.030	≤ 0.004
Mengxian River at K68+160	2012.10.15	8.3	16	≤ 5	≤ 1	0.31	0.011	≤ 0.004
	2012.10.16	8.2	25	≤ 5	≤ 1	0.32	0.015	≤ 0.004
	2012.10.17	8.3	14	≤ 5	≤ 1	0.30	0.015	≤ 0.004
Tiechang River at K78+300	2012.10.15	7.4	22	≤ 5	≤ 1	0.12	0.011	≤ 0.004
	2012.10.16	7.5	29	≤ 5	≤ 1	0.13	0.011	≤ 0.004
	2012.10.17	7.6	18	≤ 5	≤ 1	0.13	0.007	≤ 0.004
Nanyin River at K140+723	2012.10.15	7.6	28	≤ 5	≤ 1	0.39	0.015	≤ 0.004
	2012.10.16	7.5	23	≤ 5	≤ 1	0.38	0.018	≤ 0.004
	2012.10.17	7.5	20	≤ 5	≤ 1	0.38	0.015	≤ 0.004
Mengye River 100 m from Lahu River confluence	2012.10.15	7.6	28	≤ 5	≤ 1	0.44	0.011	≤ 0.004
	2012.10.16	7.7	26	≤ 5	≤ 1	0.43	0.022	≤ 0.004
	2012.10.17	7.5	28	≤ 5	≤ 1	0.43	0.018	≤ 0.004
Lahu River	2012.10.15	7.6	35	≤ 5	≤ 1	0.52	0.022	≤ 0.004
	2012.10.16	7.7	37	≤ 5	≤ 1	0.51	0.015	≤ 0.004
	2012.10.17	7.6	26	≤ 5	≤ 1	0.5	0.022	≤ 0.004
Shili River at K234+283	2012.10.15	7.7	32	≤ 5	≤ 1	0.15	0.011	≤ 0.004
	2012.10.16	7.7	27	≤ 5	≤ 1	0.15	0.010	≤ 0.004
	2012.10.17	7.6	21	≤ 5	≤ 1	0.16	0.011	≤ 0.004
GB 3838-2002 Category III standard		6～9	—	20	4	1.0	0.2	0.05

Note: **pH** = degree of acidity/alkalinity; **SS** = suspended solids; **COD** = chemical oxygen demand; **BOD_5** = 5-day biochemical oxygen demand;
NH_3-N = ammonia nitrogen; **TP** = total phosphorus; **TPH** = total petroleum hydrocarbon; **mg/L** = milligram per liter

Source: Project EIR.

126. **Groundwater resources.** The complex geological structures and diverse climate types in Yunnan make groundwater distribution very uneven, both spatially and seasonally. Most of the groundwater (about 70%) is impounded in sedimentary rock beds. The groundwater has hydrological linkages to the surface water, being replenished by precipitation and runoff via recharge areas, supplemented by glacier and snowmelt runoff from the high mountain areas. The groundwater distribution is similar to that for surface water; the western and southern parts of Yunnan have richer reserves than do the eastern and northern regions of the province.[9]

127. Groundwater resources are usually developed and used for industrial developments and not for domestic or irrigation purposes. As there are a limited number of industrial enterprises in Pu'er, groundwater sources are not well developed in the vicinity of the three projects. There is no groundwater developed in urban areas. PMG staff indicates that rural groundwater quality for BOD and COD meets nationalcategory III standard.

C. Ecological Resources

128. Yunnan is a mountainous province, lying at the southwest of PRC. It has a particular geological and complicated topography. There are 7 climatic zones in Yunnan, from north tropical, south subtropical to the mid-temperate zone and plateau climate. Although the total land area of Yunnan accounts for only 4.1% of the PRC, it has twelve vegetation types and 34 vegetation sub types supporting biodiverse ecosystems. There are about 445 natural ecosystems in Yunnan. They belong to 12 vegetation types or subtypes, namely the tropical rainforest, the monsoon rainforest, the evergreen broadleaf forest, the hard-leaf evergreen broadleaf forest, the deciduous broadleaf forest, the warm coniferous forest, the temperate coniferous forest, the bamboo forest, the savanna, the shrubs, the meadow and the wetland.

129. Yunnan has the richest biodiversity in the PRC, with a high proportion of new taxa. More than 30% of the floral and faunal species belong to new taxa, ranking the first in PRC. Based on information provided by Yunnan Forestry Bureau, there are a total of 20312 floral and faunal species, and over 7000 species of fungi. There are 1972 species of higher vertebrate, 305 mammal species, 848 bird species, 174 reptile species, 123 amphibian species and 522 fish species.

130. There are 114 species of national protected plants found in Yunnan. In addition, 46.3% of the 246 species listed in Important National Protected Wild Plants List (the first batch) occur in Yunnan.

131. The forestry area of Yunnan is about 363 million mu[9] (24.2 million ha), covering 63.4% of the total land area of the province. More than 90% of it is the forest area, with only a small portion (9.7%) of the economic forest and bamboo. About 140 million mu (9.3 million ha) is middle aged to young forest, accounting for 68.7%; the remainder is mature or over-mature forest. There are more than 150 nature reserves in Yunnan, covering a total of 2.8 million ha or 7.6% of the total land area of the province. There is about 170 million mu (11.3 million ha) of secondary forest in Yunnan.

1. Flora and Fauna

132. **Vegetation types and flora in the project area.** Vegetation types and dominant plant species in the assessment areas for the Menglian-Meng'a Road and the Ning'er-Longfu Road are listed in Table 24. Most of the habitats in the assessment areas were described in the EIRs as secondary vegetation due to human disturbance and tree felling for developments. No critical habitat areas were identified in the EIRs.

Table 24: Vegetation Types and Dominant Plant Species in Assessment Area

Vegetation Type		Dominant Species	
Type	**Sub-type**	**Menglian-Meng'a Road**	**Ning'er-Longfu Road**
Rain forest 雨林	Seasonal rain forest 季节雨林	*Terminalia myriocarpa*千果榄仁 *Pometia tomentosa*绒毛番龙眼 *Ulmus tonkinensis*东京榆 *Duabanga grandiflora*八宝树 *Mangifera sylvatica*林生芒果 *Artocarpus chama*野树菠萝 *Ficus racemosa*聚果榕	*Colona floribunda*一担柴 *Litsea glutinosa*潺槁木姜子 *Litsea panamonja*香花木姜子 *Albizia julibrissin*合欢 *Artocarpus lacucha*野波萝蜜 *Mallotus philippensis*粗糠柴 *Ficus semicordata*偏叶榕

[9] 1 ha = 15 mu.

Vegetation Type		Dominant Species	
Type	**Sub-type**	**Menglian-Meng'a Road**	**Ning'er-Longfu Road**
		*Acrocarpus fraxinifolius*顶果木 *Lithocarpus grandifolius*粗穗石栎 *Dysoxylum laxiracemosum*葱臭木 木奶果*Baccaurea ramilfora*葱臭木 *Ficus cyrtophylla*歪叶榕 *Pterospermum acerifolium*翅子树 *Syzygium latilimbum*阔叶蒲桃 *Garcinia cowa*云树 *Saurauia napaulensis*尼泊尔水东哥 *Litsea glutinosa*潺槁木姜子 *Trichilia connaroides*鹧鸪花 *Sterculia lanceolata*假苹婆 Generally distributed in altitudes below 1000 m in river valleys	*Wrightia pubescens*倒吊笔 *Dolichandrone cauda-felina*猫尾木 *Bombax malabaricum*木棉 *Schima wallichii*红木荷 *Meliosma simplicifolia*单叶泡花树 *Morus macroura*光叶桑 *Bauhinia variegata*白花羊蹄甲 *Engelhardtia roxburghiana*印缅黄杞 *Lithocarpus elegans*粗穗石栎 *Beilsc hmiedia robusta*粗壮琼楠 *Machilus shweliensis*瑞丽润楠 *Trigonostemon thyrsoideus*锥花三宝木 *Sterculia lanceolata*假苹婆 *Oreocnide rubescens*红紫麻 *Dalbergia hupeana*黄檀 Distributed from altitudes 760m to 1200 m, mainly on slopes to the southeast of K5 to K15+200.
Tropical transitional seasonal rain forest 季雨林	Semi-evergreen seasonal rain forest 半常绿季雨林	*Duabanga grandiflora*八宝树 *Chukrasia tabularis var. velutin*毛麻楝 *Bischofia javanica*重阳木 *Artocarpus chama*野树菠萝 *Dysoxylum laxiracemosum*葱臭木 *Toona ciliata* var. *pubescens*红椿 *Ficus racemosa*聚果榕 *Lithocarpus grandifolius*粗穗石栎 *Ficus semicordata*鸡嗉子榕 *Baccaurea ramilfora*木奶果 *Mallotus philippensis*粗糠柴 *Syzygium sp*. 蒲桃 *Aporusa yunnanensis*云南银柴 *Bauhinia variegata*粉花羊蹄甲 *Oroxylum indicum*千张纸 *Pterospermum acerifolium*翅子树、 *Stereospermum colais*羽叶楸 Generally distributed in altitudes below 1000-1200 m. This is the main vegetation type for the road section from Mengma to Meng'a.	*Alsophila spimulosa*桫椤 *Phoebe puwenensis*普文楠 *Schima wallichii*红木荷 *Stereospermum tetragonum*羽叶楸 *Colona floribunda*一担柴 *Elaeocarpus austro-yunnanensis*滇南杜英 *Itea macrophylla*大叶鼠刺 *Litsea monopetala*假柿木姜子 *Castanopsis indica*印度栲 *Sterculia villosa*海南蒲桃 *Syzygium cumini*绒毛萍婆 *Ilex rotunda*铁冬青 *Vernonia veolkameriifolia*大叶斑鸠菊 Along K23 to K55 and K70 to K90 of the Ning'er section, and K200 to K220 of the Jiangcheng section at altitudes 760-1300 m
	Deciduous rain forest 落叶季雨林	*Bauhinia variegate* dominated woodland *Bauhinia variegata*白花羊蹄甲 *Eriolaena spectabilis*火绳树 *Broussonetia papyifera*构树 *Colona floribunda*一担柴 *Mallotus philippensis*粗糠柴 *Duabanga grandiflora*八宝树	*Quercus acutissima*麻栎 *Betula alnoides*西南桦 *Engelhardtia spicata*云南黄杞 *Broussonetia papyrifera*构树 *Ficus semicordata*偏叶榕 *Phyllanthus emblica*余甘子 *Rhus chinensis*盐肤木

Vegetation Type		Dominant Species	
Type	**Sub-type**	**Menglian-Meng'a Road**	**Ning'er-Longfu Road**
		*Pistacia weinmannifolia*清香木 *Dalbergia obtusifolia*钝叶黄檀 *Callicarpa arborea*乔木紫珠 *Bombax malabaricum* dominated woodland *Bombax malabaricum*木棉 *Albizia kalkora*山合欢 *Stereospermum colais*羽叶楸 *Eriolaena spectabilis*火绳树 *Ficus semicordata*鸡嗉子榕 *Grewia* spp.扁担杆 *Mallotus philippensis*粗糠柴 *Trema tomentosa*山黄麻 *Phyllanthus emblica*余甘子 *Mayodendron igneum*火烧花 *Dalbergia obtusifolia*钝叶黄檀 Distributed along the northern edge of the tropical zone with longer dry season.	Distributed from altitudes 850 m to 950 m on hilly plains between Ning'er and Jiangcheng.
Evergreen broad-leaf forest 常绿阔叶林	Monsoon evergreen broad-leaf forest 季风常绿阔叶林	*Castanopsis hystrix*刺栲、 *Schima wallichii*红木荷 *Wendlandia tinctoria*红皮水锦树 *Anneslea fragrans*茶梨 *Helicia nilagirica*母猪果 *Engelhardia colebrookiana*毛叶黄杞 *Dalbergia assamica*紫花黄檀 *Dalbergia obtusifolia*钝叶黄檀 *Vaccinium exaristatum*隐距越桔 *Rhus chinensis*盐肤木 *Betula alnoides*西南桦 Usually occurs in altitudes above 1000 m.	*Castanopsis hystrix*刺栲 *Anneslea fragrans*茶梨 *Betula alnoides*西南桦 *Toxicodendron succedaneum*野漆 *Aporusa octandra*银柴 *Cryptocarya yunnanensis*云南厚壳桂 *Paramichelia baillonii*合果木 *Pittosporum kerrii*杨翠木 *Litsea monopetala*假柿木姜子 *Castanopsis indica*印度栲 *Eurya groffii* var. *groffii*岗柃 *Saurauia macrotricha*潺槁木姜子 *Litsea glutinosa*长毛水东哥 *Phoebe tavoyana*乌心楠 *Caryota ochlandra*鱼尾葵 *Pittosporum podocarpum*柄果海桐 Distributed from altitudes 800 m to1500 m, mainly on both sides of mountain-winding sections from K43 to K45.
Warm climate coniferous forest 暖性针叶林	Warm & hot climate coniferous forest 暖热性针叶林	*Pinus kesiya*思茅松 *Schima wallichii*红木荷 *Betula alnoides*西南桦 *Wendlandia tinctoria*红皮水锦树 *Lithocarpus fenestratus*华南石栎 *Engelhardia spicata*云南黄杞 *Engelhardia colebrookiana*毛叶黄杞	*Pinus khasya* var. *lanbianensis*思茅松 *Schima wallichii*红木荷 *Toona ciliata*红椿 *Cunninghamia lanceolata*杉木 *Betula alnoides*西南桦 *Albizia chinensis*楹树 *Chukrasia tabularis* var. *velutina*毛

Vegetation Type		Dominant Species	
Type	**Sub-type**	**Menglian-Meng'a Road**	**Ning'er-Longfu Road**
		Distributed from altitudes 800 m to 2,000 m.	麻楝 *Toxicodendron succedaneum*野漆 *Illicium verum*八角 Distributed from altitudes 800 m to 1200 m along the alignment.
Shrubbery and grass land with few trees 稀树灌木草丛	Hot climate shrubbery and grass land with few trees 热性稀树灌木草丛	*Neyraudia reynaudiana* and *Thysanolaena maxima* dominated shrubbery *Neyraudia reynaudiana*类芦 *Thysanolaena maxima*棕叶芦 *Chromolaena odoratum*飞机草 *Pogonatherum paniceum*金发草 *Imperata cylindrica*白茅 *Dryopteris cochleata*二型鳞毛蕨 *Pogonatherum paniceum*金发草 *Inula cappa*羊耳菊 *Stereospermum colais* and *Oroxylum indicum* dominated shrubbery *Stereospermum colais*羽叶楸 *Oroxylum indicum*千张纸 *Bauhinia variegata*白花羊蹄甲 *Macaranga denticulata*中平树 *Debregeasia squamata*鳞片水麻 *Dalbergia obtusifolia*钝叶黄檀 *Tithonia diversifolia*肿柄菊	*Rubus multibracteatus*大乌泡 *Rubus obcordatus*卵叶悬钩子 *Eurya groffii*var. *groffii*岗柃 *Rhus chinensis*盐肤木 *Viburnum foetidum*臭荚蒾 *Eurya tsaii*怒江柃 *Hypericum angustinii*无柄金丝桃 *Lyonia ovalifolia*卵叶南烛 *Gaultheria forrestii*地檀香 *Neillia thyrsiflora*绣线梅 *Osbeckia crinita*假朝天罐 *Buddleja asiatica*七里香 *Solanum torvum*水茄 *Solanum verbascifolium*洗碗叶 *Phyllanthus emblica*余甘子 Near K25 to K30, K40, K103 and K185
Plantation 人工植被	Farmland 农田植被	Dry cultivation land and paddy fields	Dry cultivated land: Scattered near villages along the alignment in areas with poor irrigation water supply. Mainly consisted of corn, vegetables and fruits. Paddy fields: Scattered near urban areas and villages along the alignment in areas with good irrigation water supply, for growing rice
	Economic plantation 人工林（经济林）	Plantations for rubber (*Hevea brasiliensis*), tea, banana (*Musa paradisiaca*) and *Betula alnoides* (西南桦)	Tea plantations: Large areas of tea plantations in both Ning'er and Jiangcheng Counties. Coffee plantations: Mainly near Liming Township, with scattered distribution in other areas. Rubber plantations: In villages in and near Jiangcheng County Banana plantations:

Vegetation Type		Dominant Species	
Type	**Sub-type**	**Menglian-Meng'a Road**	**Ning'er-Longfu Road**
			In villages in and near Jiangcheng County

Source: EIRs.

133. **Fauna.** Based on the information provided by Kunming Institute of Zoology, (Chinese Academy of Science,) provided to the PPTA's national environmental specialist there are: 183 species of birds observed in the project area. They belong to 16 orders and 183 families. Species recorded in literature and collected by Kunming Institute of Zoology in former expeditions, total 226 species. These 226 species, which account for 28.5% of the total species in Yunnan, belong to 17 orders and 44 families. Among them, 185 species are year round residents, 19 species are winter residents, and 22 species are summer residents.

134. Dominant bird species identified in the project area are the following: *Francolinus pintadeanus* (Chinese Francolin), *Bambusicola fytchii* (Mountain Bamboo Partridge), *Arborophila rufogularis* (Rufous-throated Partridge), *Gallus gallus* (Red Junglefowl), *Treron sphenura* (Wedge Tailed Green Pigeon), *Streptopelia orientalis* (Oriental Turtle Dove), *Oenopopelia tranquebarica*, *Psittacula derbiana* (Indian Red Turtle Dove), *Megalaima asiatic*a (Blue-throated Barbet), *Dendrocopos cathpharius* (Crimson-breasted Woodpecker), *Pycnonotus jocosus* (Red-wiskered Bulbul), *Pycnonotus xanthorrhou*s (Brown-breasted Bulbul) and *Urocissa erythrorhyncha* (Red-billed Blue Magpie).

135. Based on the information given by Kunming Institute of Zoology, Chinese Academy of Science, 100 species of mammals were identified in the project area (excluding tiger and *Neofelis nebulosa* Gaur, (Indian bison) which disappeared in the project area 37 years ago). They belong to 9 orders, 30 families and 74 genuses.

136. Dominant mammal species in the project area are the following: *Rousettus leschenaulti* (Fruit Bat, Leschenault's Rousette), Rhinolophus macrotis siamensis (Horseshoe Bat), *Aselliscus stoliczkanus* (Stoliczka's Trident Bat), *Nycticebus coucang* (Sunda Slow Loris), *Macaca nemestrina* (Southern Pig-tailed Macaque), *Macaca arctoides jingdongensis* (Stump-tailed Macaque), *Semnopithecus phayrei crepusculo* (Phayre's Leaf Monkey), *Parardoxurus hermaphroditu*s (Asian Palm Civet), *Felis marmorata* (Marbled Cat), *Tamiops maritimus* (Maritime Striped Squirrel), *Dremomys gularis* (Red-throated Squirrel), *Dremomys rufigenis* ornatus (Asian Red-cheeked Squirrel), Ratufa bicolor gigantea (Black Giant Squirrel), *Niviventer fulvescens* (Chestnut White-bellied Rat), *Mus caroli* (Ricefield Mouse) and *Atherurus macrourus stevensi* (Asiatic Brush-tailed Porcupine).

137. Aquatic Ecology. Aquatic flora communities of Pu'er reportedly include 18 high level species, 122 ephemeral and 16 benthic species.

2. Environmentally Sensitive Areas, Rare and Endangered Species

138. Yunnan province has rich flora and fauna resources with high biodiversity; unfortunately, these are in rapid decline. The province has established numerous protected areas of varied types and levels of protection, with the intention of ensuring protection of 80% of the remaining old-growth forest and 90% of its species. According to the Yunnan Provincial Forest Department, the province has set up 158 nature reserves with a total area of 29,574 sq. km, or 7.5% of the total provincial land.

139. **Provincial nature reserves**. The Menglian-Menga Road is situated 2.0 km from the Menglian Longshan Natural Reserve. This nature reserve protects medicinally important flora. There are two nature reserves located close to the Ning'er-Longfu Road. The Luo River Nature Reserve (to protect monsoon and tropical forest) is 2 km away. The Songshan Nature Reserve (protects broadleaf forest) is 4.8 km from the alignment.

140. **Ailao Mountain National Nature Reserve**. The last 3.5 km of rural road #11 (Bangqing Road) that is proposed for paving passes through the experimental zone of Ailao Mountain National Nature Reserve. The Nature Reserve is one of six biodiversity protection regions in Yunnan Province. It was established to protect broadleaf evergreen remnant primary forest ecosystem. It covers an area of 67,700 km^2 and is divided into three zones: core zone, buffer zone and experimental zone. Pursuant to Nature Protection Regulations of the PRC, the experimental zone "can be entered and engaged in scientific test, practice teaching, visit and inspection, tourism as well as domestication, breeding rare and endangered wildlife and other activities." The project area of 3.5 km of rural road #11 within the Nature Reserve is located in Jingdong County, and is under the jurisdication of the Ailao Mountain Jindong Management Bureau.

141. The Northern Ailao Mountains support a large diversity of bird species both in the reserve and in the wider area.[10] . It also supports an important population of Black-crested Gibbon (*Nomascus concolor concolor*), endemic to Yunnan. The Black-crested Gibbon is described by IUCN as probably the most Critically Endangered mammal species on earth, with an estimated global population of 1,300-2,000. It is also listed on CITES Appendix 1. The Black-crested Gibbon usually occurs in groups with an average of five individuals. The IUCN estimated the Yunnan population at 74-106 groups with 370-530 individuals. Population in the northern part of the Nature Reserve was estimated at 200 to 250 individuals. The Black-crested Gibbon habitat in the PRC is restricted to broadleaf evergreen forests at altitudes ranging from 1,900 m to 2,700 m. The altitude of the section of rural road #11 within the Nature Reserve is approximately 1,000 m, which is considerably lower than the distribution range of the Black-crested Gibbon.

142. Other nationally protected species recorded in the Ailao Mountain National Nature Reserve include three tree species and 10 animal species. The three trees speces are the Maidenhair Tree (Ginkgo biloba), Spur Leaf (*Tetracentron sinense*) and Chinese Incense-cedar (*Calocedrus macrolepis*). The ten animal species are the Clouded Leopard (*Neofelis nebulosa*), Asian Black Bear (*Selenarctos thibetanus*), Large Indian Civet (*Viverra zibetha*), Small Indian Civet (*Viverricula indica*), Small Linsang (*Prionodon pardicolor*), Chinese Pangolin (*Prionodon pardicolor*), Sambar Deer (*Cervus unicolor*), Himalayan Goral (*Naemorhedus goral*), Phavre's Leaf Monkey (*Presbytis phayrei*) and Asian Golden Cat (*Felis temmincki*). The Chinese Pangolin, Large Indian Civet and Small Indian Civet have also been recorded in the assessment area of this project (see below).

143. **Rare and endangered species.** The national protection status is divided into 3 classes with Class I being the highest protection status. The International Union for Conservation of Nature (IUCN) red list classifies threatened status into 6 categories (other than Extinct) in descending order of protection importance: Extinct in the Wild (EW), Critically Endangered (CR),

[10] Wang, et al. 1999. *Bird Distribution and Conservation in the Ailao Mountains, Yunnan, China, Biological Conservation 92 (2000) 45±57*. http://als.xtbg.ac.cn/files/1981-2011/[SCI]2000-Bird%20distribution%20and%20conservation%20in%20the%20Ailao%20Mountains,%20Yunnan,.pdf.

Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). Those that are EW, CR, EN and VU are deemed to warrant protection.

144. The EIRs identified 17 plant species in the assessment area of Ning'er-Longfu Road and 3 plant species in the assessment area of Menglian-Meng'a Road that are on PRC's protection list (Table 25). Two species that are native to Yunnan are on the IUCN red list as Endangered, and two species as Vulnerable. All four species occur in the Ning'er-Longfu Road assessment area. There was one old Ficus tree identified in the assessment of Menglian-Meng'a Road (Table 26).

145. For fauna in the assessment areas, the EIRs identified 14 species (6 birds, 1 reptile and 7 mammals) in the assessment area of the Ning'er-Longfu Road and 17 species (16 birds and 1 reptile) that are on PRC's protection list in Table 25. Three mammal species are also under protection status on the IUCN red list: Chinese Pangolin as Endangered and the Gaur as Vulnerable.

Table 25: Protected Plant Species in Component Assessment Areas

No.	Species	Protection Status		Habitat and Distribution in Yunnan	Location in Assessment Area	Status
		PRC	IUCN			
Ning'er-Longfu Road						
1	*Alsophila spinulosa*桫椤	I	---	In moist areas underneath evergreen broad-leaf plants. Distributed in Simao, Lancang, Menglian, Jiancheng, Pu'er and Jinggu Counties.	55 trees in Liming Township to the right of chainage K82+800, approximately 200 m from road center line. 1 tree in Qushui Township to the right of chainage K208+500, approximately 55 m from road center line.	No tag
2	*Panax zingiberensis*姜状三七	I	EN	Native to Yunnan. Underneath evergreen broad-leaf plants in altitudes 1000-1800 m. Distributed in the southern and southeastern counties of Simao, Wenshan and Wenla.	20 trees in Liming Township scattered along chainage K80 to K85.	No tag
3	*Cibotium barometz*金毛狗	II	---	Grows near foothill ditches and in shaded acidic soil in woodlands. Distributed in Simao, Jiangcheng, Menglian, Lancang, Ximeng, Pu'er and Jinggu Counties.	54 trees scattered along chainage K40 to K45, and K80 to K90.	No tag
4	*Ophioglossum thermale*狭叶瓶尔小草	II	---	On shaded and moist foothill grassy slopes. Distributed in Banshang, Zhengyuan and Simao Counties.	35 trees scattered along chainage K40 to K45, K 80 to K90 and K205 to K210.	No tag
5	*Caryala urehs*董棕	II	---	Common cultivated species for landscaping with nurseries in the	1 tree in Xuande County at 3 m to the right of chainage K75 center line.	No tag

No.	Species	Protection Status		Habitat and Distribution in Yunnan	Location in Assessment Area	Status
		PRC	IUCN			
				southern counties of Jiangcheng, Menglian and Simao.		
6	*Calocedius macrotopis*翠柏	II	---	Cultivated species used for landscaping and building material	125 trees in Mengxian Township on both sides of chainage K40+500, approximately 3 m from road center line.	Has established the Ning'er Quality Seed Depository
7	*Cinnamomum camphora*香樟	II	---	Generally grows in valleys and along road side	52 trees in Liming Township scattered along chainage K80 to K90.	No tag
8	*Phoebe nanmu* 滇楠	II	EN	Endemic to the PRC and endangered. Native to Tibet and Yunnan. Scarcely distributed in Simao County in broad-leaf woodlands at altitudes 900-1500 m.	3 trees in Liming Township approximately 200 m to the right of road center line at chainage K85+100 and in Qushui Township approximately 55 m to the right of road center line at chainage K200+800	No tag
9	*Magnolia henryi* 大叶木兰	II	---	Distributed at altitudes 300-1300 m upland areas and limestone trenches in southern Yunnan.	6 trees in Mengxian Township, approximately 3 m from road center line on both sides of chainage K45+500	No tag
10	*Toona ciliata*红椿	II	---	Grows near valley streams in woodlands or near villages at altitudes 560-1550 m in southern, southeastern and southwestern Yunnan.	25 trees in Xuande Township approximately 3 m to the right of road center line at chainage K80	No tag
11	*Terminalia myriocarpa*千果榄仁	II	---	Grows in rain forests in river valleys at altitudes 500-1000 m in Jingdong, Jiangcheng, Pu'er and Menglian Counties.	15 trees in Liming Township approximately 200 m to the right of road center line at chainage 75+400	No tag
12	*Dalbergia retusa*黑黄檀	II	VU	Scarcely distributed at altitudes 900-1400 m in Simao, Maijiang and Jiangcheng Counties	1 tree in Mengxian Township approximately 100 m to the left of road center line at chainage K48+800.	No tag
13	*Camptotheca acuminata*喜树	II	---	Cultivated species for road side planting with nurseries in Simao, and generally grows in altitudes below 1500 m.	3 trees in Liming Township approximately 200 m to the right of road center line at chainage K84+100	No tag
14	*Paramichelia baillonii*合果木	III	---	Grows in mountainous rain forest at altitudes 700-1500 m. In the PRC, only found in Yunnan, but the species is also distributed in India, Vietnam, Thailand and	16 trees in Liming Township approximately 200 m to the right of road center line at chainage K86+800.	No tag

No.	Species	Protection Status		Habitat and Distribution in Yunnan	Location in Assessment Area	Status
		PRC	IUCN			
				Myanmar.		
15	*Aesculus wangii* 云南七叶树	III	VU	Endemic to the PRC and only found in the southeastern region of Yunnan in broad-leaf woodlands in limestone mountainous areas at altitudes 900-1800 m.	5 trees in Qushui Township approximately 50 m to the right of road center line at chainage K215+800.	No tag
16	*Litsea pierrei var. szemois*思茅木姜子	III	---	Grows in shrubbery or mixed woodlands on sun-facing slopes. Distributed in Simao and Jiangcheng Counties.	18 trees in Liming Township approximately 50 m to the right of road center line at chainage K88+400.	No tag
17	*Tacca chantrieri* 箭根薯	III	---	Distributed in Simao, Jiangcheng and Menglian Counties	20 trees in Mengxian Township approximately 45 m to the left of road center line at chainage K45+600.	No tag
Menglian-Meng'a Road						
1	*Terminalia myriocarpa*千果榄仁	II	---	Distributed below 1500 m altitude in river valley forests in southern Yunnan.	10 trees at K65+000, right 30m	Good condition
2	*Toona ciliata*红椿	II	---	Grows near valley streams in woodlands or near villages at altitudes 560-1550 m in southern, southeastern and southwestern Yunnan.	8 trees from Lancang to Meng'a (no number provided for the Menglian to Meng'a section).	---
3	*Cibotium barometz*金毛狗	II	---	Grows near foothill ditches and in shaded acidic soil in woodlands.	37 trees from Lancang to Meng'a (no number provided for the Menglian to Meng'a section).	Good condition

Source: EIRs.

Table 26: Old Tree in Menglian-Meng'a Assessment Area

Species	Road Chainage	Longitude	Latitude	Number	Remark
Ficus altissima 高榕	K79+850, 10 m from the right road side	E 99° 40' 26"	N 22° 25' 12"	1	In village, tree age about 100 years

Source: EIR.

Table 27: Protected Fauna in Component Assessment Area

No.	Species	Road		Protection Stauts		Remarks
		M-M	N-J-L	PRC	IUCN	
Birds						
1	*Falco tinnunculus* 红	√	√	II	---	Common Kestrel. Occurs at woodland edges,

No.	Species	Road		Protection Stauts		Remarks
		M-M	N-J-L	PRC	IUCN	
	隼					shrubberies and in open fields near villages
2	*Accipiter nisus* 雀鹰	√	√	II	---	Eurasian Sparrowhawk. A common forest species occurring in hilly woodlands and at woodland edges.
3	*Accipiter buteo* 普通鵟	√	√	II	---	Common Buzzard. Distribution ranges from broad-leaf woodland at 400 m altitude to mixed or coniferous woodlands at 2000 m altitude.
4	*Accipiter virgatus*松雀鹰	√	√	II	---	Besra. Occurs in mountainous woodlands
5	*Accipiter trivirgatus* 凤头鹰	√		II	---	Crested Goshawk. Occurs in forests in mountainous areas at altitudes 200-1600 m, sometimes seen around villages.
6	*Lophura nycthemera* 白鹇	√	√	II	---	Silver Pheasant. Occurs in mountainous areas covered by extensive woodlands from foothill to 1500 m altitude. Active during dawn and dusk among thick bamboo shrubs
7	*Chrysolophus amherstiae*白腹锦鸡	√	√	II	---	Lady Amherst's Pheasant. Mainly occurs in coniferous and broad-leaf woodlands. Occasionally found feeding in open grass meadows and farmland.
8	*Gallus gallus*原鸡	√		II	---	Red Junglefowl. Occurs in rain forests and shrubberies at altitudes 50-2000 m. Population decreasing due to disappearance of rain forests and over-hunting.
9	*Treron sphenura*楔尾绿鸠	√		II	---	Wedge-tailed Green-pigeon. Occurs in mountainous broad-leaf forests at altitudes 100-2600 m.
10	*Psittacula alexandri* 绯胸鹦鹉	√		II	---	Red-breasted Parakeet. Occurs at altitudes 100-=1400 m near foot hills and low mountain slopes.
11	*Psittacula himalayana*灰头鹦鹉	√		II	---	Slaty-headed Parakeet. Occurs at altitudes 600-3000 m in rain forests and broad-leaf forests in valleys.
12	*Centropus sinensis* 褐翅鸦鹃	√		II	---	Greater Coucal. Occurs at altitudes 500-1200 m near edges of shrubberies and bamboo bushes. Sometimes found in tea plantations and nurseries.
13	*Tyto capensis*草鸮	√		II	---	African Grass-owl. Occurs at altitudes 300-2100 m on hilly slope and open field grass meadows.
14	*Glaucidium brodiei* 领鸺鹠	√		II	---	Collared Owlet. Occurs at altitudes 740-3000 m in mixed coniferous and broad-leaf forests.
15	*Glaucidium cuculoides*斑头鸺鹠	√		II	---	Asian Barred Owlet. Occurs at altitudes 300-2500 m resting on trees and bamboo bushes on farmland and residential areas.
16	*Otus bakkamoena*领角鸮	√		II	---	Collared Scops-owl. Occurs at altitudes 300-1400 m resting in thick tree crowns during day time and becomes active nocturnally.
Reptiles						
1	*Trimeresurus stejnegeri*竹叶青		√	II	---	

No.	Species	Road		Protection Stauts		Remarks
		M-M	N-J-L	PRC	IUCN	
2	*Varanus salvator*巨蜥	√		I	---	Common Water Monitor. Occurs in streams in mountainous regions and listed as Endangered in *PRC Endangered Species Red Book* due to excessive capture by humans.
Mammals						
1	*Bos gaurus*野牛		√	I	VU	Gaur. Listed in the *PRC Endangered Species Red Book*
2	*Ursus thibetanus* 黑熊		√	I	VU	Asiatic Black Bear. Resides in forests. Listed in the *PRC Endangered Species Red Book*
3	*Manis pentadactyla* 穿山甲		√	II	EN	Chinese Pangolin. Nocturnal feeder resting in caves in moist mixed woodlands in hills or plains. Listed in the *PRC Endangered Species Red Book*
4	*Macaca mulatta*猕猴		√	II	---	Rhesus Monkey
5	*Viverricula indica*小灵猫		√	II	---	Small Indian Civet
6	*Viverra zibetha*大灵猫		√	II	---	Large Indian Civet
7	*Sus scrofa*野猪		√	II	---	Wild Boar

Note:
M-M = Menglian-Meng'a Road; N-J-L = Ning'er-Longfu Road; IUCN = International Union for Conservation of Nature; I = Class I status; II = Class II status; III = Class III status; EN = endangered; VU = vulnerable.

Source: EIRs.

3. Critical, Natural and Modified Habitats

146. The project mainly involves improvements or rehabilitation of existing roads dominated by modified habitats and secondary woodlands. Field study and literature review did not reveal the presence of critical habitats in the project area of influence. There are intact secondary woodlands in the vicinity of the Menglian-Meng'a Road at sections K0+500-K5+500、K55+200-K65+500、K70+100-K72+300、K75+300-K77+200.

4. Wildlife Trafficking

147. A wildlife trafficking study[11] was carried out in late February 2014 as part of the PPTA study. The results show that there is limited control of international wildlife trafficking in Jiangcheng County bordering Vietnam and Lao PDR. Two stores at the border area with Vietnam were observed selling live wildlife and wildlife products. The Forest Police, Customs, and Border Army are the key enforcement agencies and their focus is on illegal imports of weapons and drugs, not on illegal international wildlife trafficking and trading. The Lancang County Forest Police signed commitment contracts with 343 local restaurants in June 2013 on not selling or cooking wildlife for food. Yet there seems to be a lack of monitoring of compliance, and enforcement by these agencies. They are generally reactive, with limited pro-active

[11] Zhang, L. 2014. *Rapid Assessment of the Potential Impact of the Yunnan Pu'er Regional Integrated Road Network Development Project on Wildlife Trafficking*. Wildlife Conservation Society. Prepared for the Asian Development Bank.

enforcement action on wildlife trade. These agencies were also observed to be under-staffed, and the staff had inadequate training on wildlife legislation and identification.

D. Economic Development

1. Agriculture

148. Yunnan has more than 6.2 million hectares under cultivation, of which 55% are sloping farmlands with steep grades of 15 degrees or more; farming on such steep slopes is generally discouraged by the Department of Agriculture and YEPD. There are about 1.4 million hectares of high quality farmland in the province. Generally Yunnan has not been self-sufficient in terms of food production. Staple agricultural products of Yunnan include corn, potato, rice, rape, garden vegetables, sugarcane, tobacco, rubber, tea, and flowers. By both planting area and outputs, Yunnan is ranked first in the country in tobacco and flowers, and second in sugarcane and rubber.

149. Agriculture in the Project Area. Apart from the main products such as rice and corn, Pu'er is famous for its production of tea, sugar cane, tropical fruits, rubber, peanuts and coffee. Many of these agricultural crops grow in close proximity to the road RoW boundary.

150. Located at the center of the world's origin of tea, Simao is a world-famous place for the origin and distribution center of Pu'er tea, which is very popular around the world.

2. Mineral Development

151. Qujing, Kunming and Yuxi Prefectures are rich in deposits of coal, iron, phosphorous, copper, and manganese. Dehong Prefecture mines a number of minerals, including tin, lead, zinc, copper, coal, and mica. Wenshan has nonferrous minerals such as antimony, tin, alumina, and manganese. The prefecture also possesses plentiful coal, tungsten, and nickel deposits. Mines in Lincang Prefecture extract diatomite, antimony, germanium, and grammite. Dali Prefecture is rich in coal, barium carbonate, gold, silver, quartz sandstone, limestone, clay, and kaolin.

152. **Mineral development in the project areas.** Lancang County has more than 30 kinds of metal and non-metal ores for exploration, of which, the iron, lead, zinc and lignite reserve are especially abundant—the iron ore deposit of 2.18 billion tons takes up over 50% of the total reserve in Yunnan, ranking the first across the Province; the lignite deposit is 103 million tons, and the lead zinc ore deposit more than 400,000 tons.

153. **Land use.** Agriculture is the dominant land use in the project areas, making up about 90% of the road corridor land use.

154. There are four main types of cultivation in the surveyed areas: paddy land, dry land vegetables, orchards, and plantation forest. Paddy land is used for growing rice and wheat. Per capita the paddy land parcel size is 0.78 mu (405.6m^2). The paddy land with easy access to roads is increasingly being converted to cash crops such as sugarcane, flowers and vegetables.

3. Employment and Livelihood

155. All of the proposed road components pass through intensively cultivated agricultural areas. The people are principally farmers, or workers in larger farming and greenhouse agribusiness operations.

156. If one includes subsistence farming, employment is nearly 100%, with the average annual income around RMB 3,900. More than 82% of the people are either self-employed or work in the agricultural sector. The living space for a family of four to five is currently 29 m^2, an increase of 3 m^2 over the past six years.

E. Social and Cultural Resources

1. Population and Communities

157. The population in Yunnan is characterized by multiple ethnic minority groups and a large proportion of rural residents. In 2010, Yunnan Province had 46.02 million people, accounting for 3.4% of PRC's total population and ranking the province twelfth among PRC's 31 provinces and regions. Of the total population of Yunnan, 51.8% are male and 48.2% female; 66.6% are Han people and 33.4% are members of an ethnic minority; 83% make their living in agriculture and 17% in other areas. Average household size is four people. The population density is 115.3 people per km2. Based on the surveyed households (see Social and Poverty Analysis Report, MMM Consultant, 2012), 54.2% of the three to four-member households include a husband, wife and two children, and 24.9% of five to six member households included a husband, wife, two children, and grandparents. Heads of household are dominated by men, accounting for 86.6% of those surveyed. The percentage of ethnic minority headed households is 46.8%. The household survey indicated that 22% of respondents have not attended school, 40% completed their primary school (six education years), and 30% completed junior middle school (nine education years). Only 2% of respondents obtained higher education (over twelve years).

158. Among adults aged 16-60, 67% of respondents reported that they are farmers working on the land. The other occupations reported were 11% migrant laborers (both long-term and seasonal), 7% private enterprise owners, 6% students, 5.6% small business managers, and 3.4% working in either government or government enterprises.

2. Socioeconomic Profile

159. Cash crops, long term and seasonal migrant labor earnings make up 70% of total household incomes. Traditional livestock farming makes up only 6.4% of the household income. Income from providing collective informal transportation services is close behind at 5.9% of household income. The household survey showed that demand for more cash among rural households has led to a need for greater mobility, which translates to a need for better roads and public transport services.

160. Household consumption comprised 53.1% of all expenditures, followed by investments and house construction (34.6%) and agriculture inputs such as seed, fertilizer and pesticide. Household consumption consists of food (36%), social and cultural activities (28%), health care (13.8%), education (11%), travel cost (8%), and domestic use of water and electricity (3.2%).

3. Community Safety

161. During the public consultation meetings community safety, particularly where roads passed through urban areas, was raised as an issue (see section 7). Participants indicated that

some roads, which have stretches through towns were unsafe for children as there were no sidewalks and speeds were excessive. It is evident that improved safety is a key priority.

4. Archaeological, Historical Treasures and Scenic Areas

162. No archaeological, historical or cultural resources of particular significance are associated with any of the road corridor areas, nor for 200 m either side of the road RoW.

5. Infrastructure Facilities and Transport Conditions

163. Pu'er covers a total area of 42,221.34 km2, and has a population of 2,590,900 as of the end of 2011. Pu'er, covering 1 district and 9 autonomous counties, is the largest area in Yunnan Province. Situated in Simao District, Pu'er is 420 Km away from Kunming (the Capital) by road and is connected to the G213 National trunk highway and the Kunming-Bangkok Expressway Highway. In general, rural public facilities in Yunnan are insufficient to meet people's livelihood and development needs. Provincial data suggest that the rural population has good access to primary education, but the roads leading to these schools are very poor. Half of rural households have access only to earth-surfaced roads, which are often impassable in the rainy season.

164. Pu'er has an airport with many flights of large and medium-sized aircraft to cities throughout PRC.

165. **Railway.** The Pan-Asia Railway is still undergoing planning, but with construction estimated to open by the end of the 12th FYP period.

166. **Waterway.** The Lancang River/Mekong River flows through the city. An international shipping terminal has been constructed in Simaogang Town. The waterway provides a trading artery to countries in SE Asia.

6. Ethnic Minority Groups

167. Yunnan has the largest number of minority groups, it is the origin for 26 nationalities, with 25 ethnic minorities accounting for 15 million people, some 33.4% of the total population. Of these minority nationalities, the Yi is the largest group, with a population of 5.03 million (or 11% of the total population). However, other ethnic groups with a population exceeding one million include the Bai, Hani, Zhuang, Dai and Miao. There are 24 ethnic minority groups with population over 10,000. Among its 16 prefectures, 128 counties/districts and 1376 towns/townships, eight are ethnic minority autonomous prefectures, 29 ethnic minority autonomous counties and 197 ethnic minority townships.

168. The population of Pu'er Prefecture is characterized by multiple ethnic minority groups in rural areas (Table 28). Out of its 10 district and counties, except the capital city Simao, all nine counties are ethnic minority autonomous counties. The total non-Han ethnic minority population represents 63.4% of the total population. Hani is the biggest group with population of 4.68 million (or 18.3% of the total population), followed by Yi (17.5%), Lahu (12.3%), Wa (6.3%) and Dai (5.9%).

Table 28: Yunnan (2010) and Pu'er (2011) Population by Nationality

Yunnan (2010)			Pu'er (2011)		
Ethnicity	**Population**	**%**	**Ethnicity**	**Population**	**%**
Total	4,601.6	100	Total	2,556,881	100
Han	3,066.2	66.6	Han	935,377	36.6
Yi	503.3	10.9	Yi	448,712	17.5
Bai	156.3	3.4	Bai	12,589	0.5
Hani	163.1	3.5	Hani	467,546	18.3
Zhuang	121.6	2.6	Bulang	16,683	0.7
Dai	122.4	2.7	Dai	150,499	5.9
Miao	120.4	2.6	Miao	12,711	0.5
Hui	69.9	1.5	Hui	13,776	0.5
Lisu	66.8	1.5	Lisu	6,953	0.3
Lahu	47.6	1.0	Lahu	313,746	12.3
Wa	40.1	0.9	Wa	160,992	6.3
Naxi	31	0.7	Mongolia	994	0.0
Yao	22	0.5	Yao	10,863	0.4
Others	70.7	1.6	Others	5,440	0.2

Sources: Yunnan Statistics Year Book 2011 and Pu'er PMO.

169. Table 29 shows the ethnic minority population in the project area by counties. Ximeng county has the highest ethnic minority population percentages of 94.4% with Wa as the majority group (71.1% of its total population), followed by Menglian county of 86.1% with Lahu (30.2%), Wa (24.6%) and Dai (20.5%) as the majority groups, and Jiangcheng county of 81.3% with Hani as the majority group (50.3%). The other counties with ethnic minority population over 50% include Lancang (79.3%) with Lahua (43.2%) as the majority, and Zhengyuan (76.6%) with Hani as the majority (62.2%). Ning'er and Mojiang have ethnic minority populations slightly less than 50% (Ning'er 49.8% and Mojiang 47.6%), and Simao district has 35.2%.

Table 29: Ethnic Minority Distribution by District/County (2011)

Area		Pu'er	Simao	Ning'er	Mojiang	Jingdong	Jinggu	Zhenyuan	Jiangcheng	Lancang	Menglian	Ximeng
Han	No.	935,377	171,790	183,408	161,030	95,293	87,900	86,991	23,188	102,894	17,723	5,160
	%	36.6	64.8	50.2	52.4	44.8	45.2	23.4	18.7	20.7	13.9	5.6
Total EMs	No.	1,621,504	93,158	182,057	146,253	117,414	106,590	284,404	100,812	393,956	110,147	87,077
	%	63.4	35.2	49.8	47.6	55.2	54.8	76.6	81.3	79.3	86.1	94.4
Hani	No.	467,546	17,850	13,481	3,349	26,483	50,831	231,116	62,384	52,024	9,243	785
	%	18.3	6.7	3.7	1.1	12.5	26.1	62.2	50.3	10.5	7.2	0.9
Yi	No.	448,712	37,960	154,547	66,031	58,537	38,829	36,916	17,162	34,378	3,347	1,005
	%	17.5	14.3	42.3	21.5	27.5	20	9.9	13.8	6.9	2.6	1.1
Lahu	No.	313,746	4,050	1,554	12,299	18,318	1,941	4,723	1,848	214,802	38,671	15,540
	%	12.3	1.5	0.4	4	8.6	1	1.3	1.5	43.2	30.2	16.8
Wa	No.	160,992	3,180	140	110	96	320	126	0	60,056	31,418	65,546
	%	6.3	1.2	0	0	0	0.2	0	0	12.1	24.6	71.1
Dai	No.	150,499	9,430	3,155	57,625	9,072	7,091	5,388	9,139	19,887	26,169	3,543
	%	5.9	3.6	0.9	18.8	4.3	3.6	1.5	7.4	4	20.5	3.8
Bulang	No.	16,683	950	525	2,807	66	246	3,510	223	8,280	76	0
	%	0.7	0.4	0.1	0.9	0	0.1	0.9	0.2	1.7	0.1	0
Bai	No.	12,589	2,996	682	865	1,544	4,519	372	583	675	229	124
	%	0.5	1.1	0.2	0.3	0.7	2.3	0.1	0.5	0.1	0.2	0.1
Hui	No.	13,776	1,850	1,710	2,439	2,190	1,437	569	363	2,891	265	62
	%	0.5	0.7	0.5	0.8	1	0.7	0.2	0.3	0.6	0.2	0.1
Yao	No.	10,863	189	4,707	292	48	141	620	4,786	51	17	12
	%	0.4	0.1	1.3	0.1	0	0.1	0.2	3.9	0	0	0
Lisu	No.	6,953	6,040	131	29	34	226	38	12	35	334	74
	%	0.3	2.3	0	0	0	0.1	0	0	0	0.3	0.1
Miao	No.	12,711	8,037	617	81	173	89	55	3,509	92	58	0
	%	0.5	3	0.2	0	0.1	0	0	2.8	0	0	0
Mongolia	No.	994	164	12	2	382	187	150	26	54	17	0
	%	0.04	0.06	0	0	0.18	0.1	0.04	0.02	0.01	0.01	0
Others*	No	5,440	462	796	324	471	733	821	777	731	303	386

Area		Pu'er	Simao	Ning'er	Mojiang	Jingdong	Jinggu	Zhenyuan	Jiangcheng	Lancang	Menglian	Ximeng
	.											
	%	0.21	0.17	0.22	0.11	0.22	0.38	0.22	0.63	0.15	0.24	0.42

Sources: Yunnan Statistics Year Book 2011 and Pu'er PMO.

IV. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Introduction

170. This section reviews the anticipated environmental impacts in the pre-construction, construction and operational phases of the Project components and provides mitigation measures to offset negative impacts and concludes with an assessment of the long-term residual environmental effects. The assessment considers impacts relative to their geographical (spatial) extent; magnitude; duration (temporal); reversibility; and frequency.

171. Negative environmental effects can either be avoided or mitigated through design and construction measures, or where mitigation measures are not appropriate, offset and compensation measures are considered. An assessment of any residual environmental effects that are expected to remain after the application of mitigation measures and the expected significance of those effects are presented. A project can be considered environmentally sustainable if there are no, or minimal, residual long-term negative effects and there are in fact positive long-term benefits.

B. Project Benefits

172. The proposed project will contribute to inclusive growth and regional integration by connecting isolated rural communities and border areas to the regional road network and providing infrastructure to support trade and regional cooperation between the People's Republic of China (PRC), Viet Nam, Lao People's Democratic Republic (Lao PDR), and Myanmar.

173. The proposed project road components will help to link the wider area of Pu'er to this vital economic corridor and promote regional cooperation. The Western Sub-corridor involves the following border crossing points in the project area: Mohan–Boten (Yunnan Province and the Lao PDR), and Daluo–Meng'a (Yunnan Province and Myanmar). The border area hosts an active local trade in agricultural products, farm machinery, electronic products and small vehicles. The project will provide infrastructure and support facilities to enable the expansion and development of the border areas.

174. The proposed project components will improve the road condition and traffic flow on existing operating roads. Increased speeds on the roads will be mitigated by village traffic calming, enforcement and community safety measures. Improved traffic flow will minimize idling and the emissions of pollutants and GHGs.

175. In some cases, the proposed sealed roadways will improve local environmental conditions by alleviating issues associated with dust mobilization and current poor road conditions which will result in benefits for road users and local residents, with the greatest benefits coming from:

- reduced travel times on all project roads;
- dust suppression and better air quality;
- less flooding due to improved culverts and drains;
- reduced vehicle operating costs, reduced congestion and vehicle wear and tear on all project roads;
- safer roads and reduced accidents due to improved: road geometry, sight distance, signage, markings, and traffic calming through villages, on all project roads; and

- improvements by enhancing public transportation services, which should arise as the quality of roads improves.

176. A number of project sub-components (see paragraph 1) on the Rural Road Access Improvement component are aimed at ensuring that the project better serves the key strategic goal of reducing poverty. These are:

a.) Village Transportation Infrastructure: will significantly improve access to the administrative village and any village groups located along the rural roads;
b.) Public Transport Services: most rural roads do not have public transport services. It is expected that bus services will be introduced on the project roads once the improvement works have been completed; and
c.) Road Maintenance: to develop an improved approach to maintenance of the project roads (and other similar rural roads) by utilizing and training local people.

177. The project will also benefit agricultural production and marketing. Farmers can plant higher earning cash crops, such as flowers, with improved transport time to market. Also the reduced difficulties of access during rainy season, and a smoother pavement surface will reduce damage to fragile or perishable goods. Overall the project will benefit a total population of about 405,000, including 287,000 ethnic minorities (71%) and 149,000 of the rural poor population (36.7%). Indirectly the project will benefit the population of 2.6 million in Pu'er.

C. Pre-construction Impact and Mitigation

1. Land Acquisition and Resettlement

178. The FSR for the Ning'er-Longfu road contains preliminary data on land acquisition requirements for the Ning'er-Longfu Road. The Menglian-Meng'a Road EIR provides data on land acquisition and resettlement. Table 30 shows land acquisition from the project roads would total approximately 1,061 ha, with house demolition totaling approximately 178,000 m^3. The rural roads would not incur any land acquisition or house demolition. Total land acquisition and affected person numbers have been estimated based on the FSR and the sample surveys. The Resettlement Plan (RP) will be finalized during the detailed design when the alignments are finalized. Compensation will be in accordance with the RP and SPS (2009) requirements.

Table 30: Preliminary Estimate of Land Acquisition Requirements

Project Component	Land Acquisition (ha)	No. Relocated Households(m^2)
Menglian-Meng'a Highway	338.08	57,636
Ning'er-Longfu Road	723.16	120,250
Rural Road Rehabilitation	0	0
TOTAL	**1061.24**	**177,886**

Source: PRC EIRs, 2013.

179. Present assessment of the road components are as follows:

180. **Menglian-Meng'a Highway.** The proposed Menglian-Meng'a road project will pass through one county of Pu'er. Based on the resettlement impacts identified (physical and economic displacement) in the FSR, the project will affect 3,327 persons by permanent land

acquisition; and require the resettlement of 161 households and 675 persons due to the demolition of residential structures (Table 31).

Table 31: Menglian-Meng'a Affected People

City	County/district	Town	Affected population	Population needing to be resettled
Pu'er	Menglian	Narong	54	54
		Mengma	546	546
	Enterprise		**75**	**75**
Total		**2**	**675**	**675**

Source: Feasibility Study Report.

181. Table 32 shows the permanent and temporary land occupation required for the project. A total of 289.98ha of various land use types dominated by wooded land and old road will be permanently required for the road. Whereas, 48.10 ha of land dominated by dry cultivated land, wooded land and barren land will be temporarily required.

Table 32: Land Occupation of the Menglian-Meng'a Highway

Nature of land occupation	Project Areas	County	Land occupation area (ha)							
			Paddy land	Dry cultivated land	Wooded land	Garden plot	Barren land	Homestead	Old road	Subtotal
Permanent land occupation	Carriageway	Menglian County	28.85	34.86	103.60	40.89	10.21	0.67	70.90	289.98
Temporary land occupation	Borrow area			3.34	4.99		4.15			12.47
	Spoil disposal area			10.90	7.23		5.20			23.32
	Construction camp			1.12	1.82	0.28	3.00		0.77	6.98
	Access road			0.96	1.54	0.85	1.97			5.33
	Subtotal			**1.63 1**	**2.55 7**	**3. .13**	**4.43 2**		**5. .77**	**6.81 0**
Total			**7.88 5**	**8.11 7**	**9.19. 17**	**10.2.0 2**	**11.4.53**	**12. .67**	**13.1.67**	**14.38. 08**

Source: Feasibility Study Report.

182. **Ning'er-Longfu Road.** This road will affect two counties and 6 townships with a total population of 4,070 of which 405 will be resettled (Table 33). House demolition has been estimated at approximately 120,250 m^2.

Table 33: Ning'er-Longfu Affected People

City	County	Town or Township	Affected Population	Population needing to be resettled
Pu'er	Ning'er	Ning'er town	634	61

City	County	Town or Township	Affected Population	Population needing to be resettled
		Mengxian township	856	85
		Liming township	732	72
	Jiangcheng	Baozhang township	743	68
		Menglie town	657	73
		Qushui township	452	46
Total	**2**	**6**	**4,074**	**405**

Source: Feasibility Study Report.

183. The permanent and temporary land occupation for Ning'er-Longfu Road will be approximately 635 ha and 88 ha, respectively (Table 34) dominated by slope farmland, barren land and grass land.

Table 34: Land Occupation of the Ning'er-Longfu Road

Nature of land occupation	Project areas	Land occupation area (ha)								
		Paddy land	Terraced land	Wooded land	Grass land	Slope farmland	Traffic & transport land use	Constructed land	Barren land	Sub-total
Permanent	Carriageway	46.37	45.72	58.28	85.71	214.88	26.36	12.03	146.36	635.19
Temporary	Borrow area			1.56	6.82				4.49	12.87
	Spoil disposal area			6.42	11.87	1.25			14.38	33.92
	Construction staging area		1.10		7.40				2.45	10.95
	Construction camp		0.75		4.61				0.90	6.26
	Access road			0.53	2.45				2.35	5.33
	Topsoil storage area				13.76	0.73			4.15	18.64
	Sub-total		**1.85**	**8.51**	**46.91**	**1.98**			**28.72**	**87.97**
Total		**46.37**	**47.57**	**66.79**	**132.12**	**216.86**	**26.36**	**12.03**	**175.08**	**723.16**

Source: EIR.

184. **Rural roads.** The PMTB has indicated that there will be no requirements for permanent land acquisition or resettlement in the rehabilitation of the rural roads as shown in Table 30. No estimate has yet been made of temporary land acquisition that would be required during construction for ancillary works including materials and equipment storage sites, or concrete batching plants.

2. Vegetation Protection and Tree Cutting

185. The new sections of the Menglian-Meng'a Highway and the new re-aligned sections of the Ning'er-Longfu Road require clearance of vegetation, resulting in loss of trees. The two EIRs confirmed that there are no rare or valuable species within the ROW. A number of valued tree species occur outside the ROW (within 50 m), which are considered to have biodiversity and medicinal value (see Table 31 and 32). Two trees are also listed on the IUCN red list as

Endangered (*Panax zingiberensis* and *Phoebe nanmu*) and two are Vulnerable (*Dalbergia retusa* and *Aesculus wangii*).

186. There are intact secondary woodlands in the vicinity of the Menglian-Meng'a Road at sections K0+500-K5+500、K55+200-K65+500、K70+100-K72+300、K75+300-K77+200. Permanent and temporary land take for the Menglian-Meng'a Road shall avoid these woodlands.

187. **Mitigation.** The EMP specifies that these trees will be tagged and protected with fencing before construction. Overall large trees along roadsides and in the median provide value in terms of landscaping, shade and visual amenity as well as assisting in noise abatement and air pollution mitigation.

188. Several birds, reptiles and mammals are under national protection status (see Table 33) with the Chinese Pangolin also on the IUCN red list as endangered and two other mammals as Vulnerable. The EMP specifies that construction workers will be prohibited from hunting and capturing wildlife during construction.

189. There may be insufficient right-of way width to plant trees lost due to new construction and wideneing of the two regional roads. There is expected to be no trees lost or requiring replacement on the Rural Roads as all construction activities are confined within the existing right-of-way. The PMTB confirms that they have a 1:1 tree replacement policy and this will be implemented for the Project. PMTB indicated that it is also willing to plant more trees should landscaping opportunities exist.

3. Disruption to Community Utilities

190. Utility relocation on all three components poses only a short-term concern to residents affected by road construction and rehabilitation activities. Interruptions to power and communication, disruption of water supply, discoloration of water from re-located pipes are expected. To minimize impacts, the contractor shall implement the following measures:

- Water supply pipelines, power supply, communication lines and other utilities shall be re-provisioned before construction works commence.
- Provisions shall be made to preserve the operation of current facilities in sufficient quantity and in agreement with the local community.
- Re-provisioning shall be undertaken in coordination with the utility company.
- Affected households and establishments shall be notified well in advance of such disruption.

D. Air Quality Impacts and Mitigation

191. The principal air quality impacts of the Project are expected to occur in the immediate vicinity of the transportation corridor. The impacts and mitigation measures described apply to construction of all three project components. The two major sources of emissions from construction are: dust emissions from non-combustion sources and exhaust emissions from construction vehicles and stationary combustion sources.

192. Vehicle emissions including particulate matter, CO, SO_2 and NO_2 from movements and operation of construction vehicles and equipment, which are predominantly diesel-fuelled, will occur along all project components.

193. **Construction.** Road construction and truck hauling operations will create dust emissions. Emissions from construction equipment and dust generation are short-term and localised impacts. Dust emissions generally consist of large particles that settle out relatively close to the source, whereas exhaust emissions generally consist of fine particles that can drift further away from the source. The potential for dust emissions will occur primarily during road grade excavation, transport of road construction materials; and transfer of excavated material from dump trucks to spoil receiving site(s). Combustion emission sources typically associated with this type of project include: diesel exhaust emissions from mobile sources, including earth-moving equipment, and dump trucks; and exhaust from stationary combustion sources, including generators, heaters, and possibly off-site construction and fabrication (including concrete-casting and asphalt (hotmix) facilities.`Road paving works and bridge construction involving concrete batching and asphalt mixing will generate dust and asphalt fumes causing adverse impact to air quality. Asphalt paving will produce fumes containing small quantities of toxic and hazardous chemicals such as volatile organic compounds (VOC) and poly-aromatic hydrocarbons (PAH). Concrete batching for bridge structures will produce TSP. *Air Pollutant Integrated Emission Standard* (GB 16297-1996) controls the emission of air pollutants from these activities. Asphalt fumes generated during road paving would be considerably less than fumes generated during mixing, and once the paved asphalt is cooled to $<82^{o}$ C, asphalt fumes would be reduced substantially and then totally when the asphalt is solidified. The impact from asphalt fumes during road paving is therefore of short duration. However, asphalt fumes could affect construction workers doing the road paving and personal protective equipment is needed for their occupational health and safety. The EIRs estimated that fugitive dust from construction sites and haul roads would impact an area downwind of the dust source up to a distance of 50 m, dust from concrete batching would affect an area downwind of the source up to a distance of 150 m, and asphalt fumes would affect an area down wind of the asphalt mixing plant up to a distance of 100 m. Mitigation measures will be implemented during construction.

194. **Air quality mitigation measures during construction.** The Contractor shall include all necessary mitigation measures to reduce air pollution and dust and fume development that would impact public health, by implementing the following air quality control measures. Some of these measures are generic measures that are applicable to all construction sites and construction activities. Yet these are effective measures and are also described in WBG's EHS guidelines:

- Frequent watering of unpaved areas, backfill areas and haul roads to suppress dust.
- Pave frequently used haul roads.
- Limit the speed of vehicles travelling on unpaved areas and haul roads.
- Pay particular attention to dust suppression near sensitive receptors such as schools, hospitals, residential areas and natural areas.
- Erect hoarding/screens around dusty activities such as demolition.
- Manage stockpile areas to avoid mobilization of fine material, cover with tarpaulin and/or spray with water.
- Do not overload trucks transporting earth materials.
- Equip trucks transporting earth materials with covers or tarpaulin to cover loads during transport.
- Install wheel washing equipment or conduct wheel washing manually at each exit of each works area to prevent trucks from carrying muddy or dusty substance onto public roads.
- Immediately cleanup all muddy or dusty materials on public roads outside the exits of the works areas.

- Plan the transport routes and time to avoid busy traffic and heavily populated areas when transporting earthy materials.
- Immediately plant vegetation in all temporary land take areas upon completion of construction to prevent dust and soil erosion.
- Locate asphalt mixing plants and concrete batching plants at least 300m downwind from residential areas and other sensitive receptors.
- Enclose asphalt mixing plants and concrete batching plants, and equip them with bag house filter or similar air pollution control equipment.
- Regularly inspect and certify construction vehicle and equipment emissions and maintain to a high standard.

195. These measures are defined in the EMP. Contractors will be required to ensure compliance with relevant PRC emission standards. Air quality monitoring will be carried out by contractors (internal) and a licensed environmental monitoring entity (external) during the construction period.

196. The air quality impacts during the construction stage would be of short duration. Road construction is a linear activity. When a road section is constructed and paved, the construction activities move on and away from nearby sensitive receptors. Potential sensitive receptors will therefore be exposed to short term, localised impacts. With the above mitigation measures in place, potential air quality impacts during the construction stage would be reduced to acceptable levels.

197. **Operation.** The finished paved roads will reduce dust levels, particularly along the rural roads. However, other pollutant emissions will increase with ever increasing traffic over time. Only improved emission technology or a fleet move to LNG and electric will alleviate this cumulative impact. The EIRs estimated the long term (year 2030) NO_2[12] concentations along the regional roads. For the Ning'er-Longfu Road, the predicted maximum NO_2 levels would be 0.067 mg/m^3 for 1-hr (peak hour) average and 0.049 mg/m^3 for 24-hr (daily) average. For the Menglian-Meng'a Highway, the predicted maximum NO_2 levels would be 0.041 mg/m^3 for 1-hr (peak hour) average and 0,026 mg/m^3 for 24-hr average. Both comply with GB 3095-2012 Class II standards for 1-hr NO_2 (0.200 mg/m^3) and 24-hr NO_2 (0.080 mg/m^3). No air quality impact during the operation of the regional roads is expected. The rural roads will have relatively low traffic flow and no air quality impact is expected.

E. Noise Impacts and Mitigation

198. **Construction.** Noise is emitted by powered mechanical equipment (PME) used during construction. Based on the cumulative power levels of PMEs used for different construction activities, the EIRs predicted that noise impact from road construction would affect a distance of 50 m in the day time (based on 70 dB(A) according to GB 12523-2001) and a distance of 200 m at night (based on 55 dB(A) according to GB 12523-2001) from the noise source. Noise mitigation measures will be required. Night time construction shall be avoided and kept to a minimum recognizing that sometimes night time work is needed to take advantage of less traffic at night and to minimize disruption to day time traffic flow. Contractors will be required to implement the following mitigation measures for construction activities to meet PRC construction site and WBG recommended noise limits and to protect sensitive receptors. Some

[12] For vehicle emissions, NO_2 is often used at the indicator parameter. If NO_2 complies with the air quality standard, then CO and SO_2 should also comply.

measures are generic and are applicable to all construction sites and activities. Yet they are effective measures and are also in line with WBG's EHS guidelines.

- Sensibly schedule construction activities, avoid noisy equipment working concurrently.
- Select advanced quiet equipment and construction method, and tightly control the use of self-provided generators.
- Comply with local requirements in areas with sensitive receptors very close by.
- Avoid construction works, particularly noisy activities such as piling and compaction from 22:00 to 06:00 hr.
- If night time construction needed, consult nearby residents beforehand for their consensus.
- If night time construction needed, avoid using noisy equipment.
- If necessary, set up temporary noise barriers.
- Control speed of bulldozer, excavator, crusher and other transport vehicles travelling on site.
- Specify equipment and machinery that conforms to PRC noise standard GB12523-90 and ensure regular maintenance.
- Adopt noise reduction devices and measures for works in proximity to sensitive noise receptors to ensure required standards are maintained.
- Locate sites for rock crushing, concrete mixing and other noisy activities at least 1km away from sensitive noise receptors.
- Limit the speed of vehicles travelling on site and on haul roads (less than 8 km/hr).
- Minimize the use of whistles and horns.
- Maintain continual communication with schools along the road alignments to avoid noisy activities near the schools during examination periods and other noise-sensitive activities.

199. Noise impacts during the construction stage would be of short duration. Road construction is a linear activity. When a road section is constructed and paved, the construction activities move on and away from nearby sensitive receptors. Potential sensitive receptors will therefore be exposed to short term, localised impacts. With the above mitigation measures in place, potential noise impacts during the construction stage would be reduced to acceptable levels.

200. **Operation.** Projections of noise levels at existing receptors along the Ning'er-Longfu highway for year 2030 (Table 35), show night time noise exceedance at eight locations with most located 5 m from the road center line.

Table 35: Predicted Noise Levels at Existing Sensitive Receptors along the Ning'er-Longfu Road in 2030

Road chainage	Sensitive receptor	Distance from road center line (m)	Noise level (dB) in Noise Functional Area			
			Category 4a		Category 2	
			Day time	Night time	Day time	Night time
K1+300	Laizhangz和ai老张寨	50			55.0	49.9
K4+150	Banhai Village般海村	5	62.7	57.8		
K4+100	Banhai Primary School般海小学	25	56.1	50.0		
K7+300	Manlian Village曼连村	5	62.7	57.8		
K7+100	Manlian Primary School曼连小学	10	56.4	51.2		

Road chainage	Sensitive receptor	Distance from road center line (m)	Noise level (dB) in Noise Functional Area			
			Category 4a		Category 2	
			Day time	Night time	Day time	Night time
K8+000	Sanjia Village三家村	5	62.7	57.8		
K9+500	Longtangba龙塘坝	5	62.6	57.9		
K16+500	Babaoshu八抱树	20	57.0	51.1		
K16+850	Qun'e困峨	10	60.4	55.4		
K17+500	Manda曼达	15	58.0	53.0		
K18+300	Nanmenkou南门口	35	55.1	49.3		
K19+600	Tuguozhai土锅寨	20	57.6	51.9		
K20+200	Xishitou Village细石头村	5	62.7	57.8		
K21+000	Xia'nanla下南腊	50			53.7	47.3
K55+200	Kesa克洒	120			57.0	48.5
K56+200	Yangjia Village杨家村	15	54.8	49.3		
K56+800	Mengxian Township 勐先乡	110			56.5	54.3
K56+900	Mengxian Middle School勐先中学	25	54.6	47.8		
K57+800	Laojiezi老街子	40			52.5	45.8
K58+400	Xiaoxinzhai小新寨	110			57.0	48.5
K58+750	Dongsa东洒	130			57.0	48.5
K59+600	Manpian曼片	100			57.0	48.6
K61+200	Malilin了麻栗林	40			53.1	46.8
K62+800	Xitaiyang西太阳	150			48.1	41.8
K63+800	Anning Village安宁村	5	58.8	53.7		
K67+800	Sandaoqiao Village三道桥村	10	56.9	51.6		
K69+800	Xuande Village宣德村	5	61.1	54.3		
K70+000	Xuande Gensheng Bo'ai Primary School宣德根生博爱小学	120			57.1	49.5
K78+500	Laomazhai老马寨	10	57.1	49.5		
K80+900	Caizidi Tiechang Village 菜籽地铁厂村	12	57.1	49.5		
K106+500	Xianren Village仙人村	5	57.1	49.5		
K123+350	Liming Township黎明乡	5	57.1	49.5		
K131+900	Shangmuhuazhai上木化寨	15	57.1	49.5		
K132+000	Xiamuhuazhai下木化寨	20	57.1	49.5		
K135+450	Xiabalao下坝老	60			53.3	48.0
K136+100	Tuanshan Village团山村	10	54.6	48.7		
K139+100	Xiazhai下寨	10	55.9	50.3		
K141+100	Baka坝卡	5	56.7	52.4		
K154+800	Shuicheng Village水城村	120			48.2	41.9
K156+500	Baozang Township宝藏乡	5	60.1	56.7		
K174+600	Qiyiqiao七一桥	5	58.2	52.9		
K175+600	Hebian VillageCommitte Office Building河边村委会办公楼	20	56.5	49.0		
NK1+200	Niuluohe Village牛倮河村	5	59.7	53.1		
K224+800	Dazhupengzhai大竹棚寨	25	54.1	49.0		
K238+400	Longfu龙富	180			47.7	41.1
GB 3096-2008 standard			70	55	60	50

Road chainage	Sensitive receptor	Distance from road center line (m)	Noise level (dB) in Noise Functional Area			
			Category 4a		Category 2	
			Day time	Night time	Day time	Night time
Note:						
	Exceed noise standard					

Source: EIR.

201. Predicted noise levels at existing sensitive receptors along the Menglian-Meng'a Highway in year 2026 are shown in Table 36. All 13 existing sensitive receptors would experience night time noise exceedances in 2026. The Manghai Primary School would also experience day time noise exceedance.

Table 36: Predicted Noise Levels at Existing Sensitive Receptors along the Menglian-Meng'a Highway in 2026

Road chainage	Sensitive receptor	Distance from road center line (m)	Noise level (dB) in Noise Functional Area			
			Category 4a		Category 2	
			Day time	Night time	Day time	Night time
K76＋460	Hegelao贺格老	20	62.1	55.4		
K77＋060	Hegexinzhai贺格新寨	10	67.9	61.3		
K78＋050	Mang'le芒勒	120			53.1	41.4
K79＋800	Mengma Township勐马镇	左8	69.9	63.3		
K79＋900	Mengma Primary School勐马小学	40			56.9	49.6
K82＋550	Hehaxinzhai贺哈新寨	10	68.0	61.3		
K89＋060	Manghai Primary School芒海小学	8			66.0	59.3
K89＋800	Nanma Electricity Sub-station staff quarters 南马电站宿舍	20	62.3	55.4		
K90+650	Guangsan广伞	20	62.4	55.4		
K91+800	Bingsuo丙锁	10	68.0	61.3		
K95＋200	Manglang芒郎	8	69.9	63.3		
K97＋350	Anma安马	8	69.9	63.3		
K102+300	Longhai龙海	8	69.9	63.3		
GB 3096-2008 standard			70	55	60	50
Note:						
	Exceed noise standard					

Source: EIR.

202. Noise barriers have been proposed for the Ning'er-Longfu Road: at Banhai Village (100 m); Manlian Village (90 m); Sanjia Village (50 m); Longtangba (50 m); Xishitou Village (100 m); Baozang Township (250 m). Details on these sensitive receptors in the villages can be found in Appendix 5. Details of the costs are provided in the EMP (section IX and Appendix 6).

203. Table 37 shows the recommended mitigation measures consisting of provision of double glazed windows and noise barriers for the existing sensitive receptors along the Menglian-Meng'a road.

Table 37: Proposed Noise Mitigation Measures for Menglian-Meng'a

S/N	Sensitive point	Distance to median line (m)	Noise excess details	Noise control step	Noise control effect (dB)	Cost estimate, CNY 10,000
1	Mengma: K79＋800	8m on the left and right (crossing)	Near-term, nighttime: 3.3dB Medium-term, nighttime: 6.1 dB Long-term, nighttime: 8.3dB	Only storefronts may face the road. A total of 50m^2 of sound-proof windows shall be installed	6~8	5.0
2	Manghai Primary School: K89＋060	8m on the right	Near-term, daytime: 1.3dB Near-term, nighttime: 4.4dB Medium-term, daytime: 4.0dB Medium-term, nighttime: 7.1dB Long-term, nighttime: 6.0dB Long-term, daytime: 9.3dB	Noise barriers will be built (200m×3m)	5~10	72.0
3	Manglang: K95＋200	8m on the left and right (crossing)	Near-term, nighttime: 3.3dB Medium-term, nighttime: 6.1 dB Long-term, nighttime: 8.3dB	Private properties are grouped together such that the front row will form a noise barrier for the back row. The front row of houses will have a total of a 60m2 of sound-proof windows installed	6~8	6.0
4	Anma: K97＋350	8m on the right	Near-term, nighttime: 3.3dB Medium-term, nighttime: 6.1 dB Long-term, nighttime: 8.3dB	Private properties are grouped together. A total of 30m2 of sound-proof windows shall be installed	6~8	3.0
5	Longhai: K102＋300	8m on the right	Near-term, nighttime: 3.3dB Medium-term, nighttime: 6.1 dB Long-term, nighttime: 8.3dB	Private properties are grouped together. A total of 30m2 of sound-proof windows shall be installed	6~8	3.0
6	32 no-honking signs (for the sensitive points exceeding limits)					3.2
7	Sensitive points with an initial excess noise between 1dB and 3dB (i.e. Hegexinzhai, Hehaxinzhai and Bingsuo) will be tracked and monitored. Effective steps will be taken, depending on extent of exceedance and impacts. A CNY30,000 monitoring fund and a CNY200,000 noise control fund will be established.					23.0

Source PRC EIR, 2009.

F. Earthworks and Soil Erosion Impacts and Mitigation

204. Cut and fill slope areas where bare mineral soils or bedrock materials are exposed in order to achieve desired alignment and grades on a road or highway. In some cases, material must be excavated (cuts) and in others, it must be added (fill). The ideal grading project will result in a balance in cut and fill. However, mountain road construction always results in surplus fill (spoil) especially if the soils are poor. Surplus spoil will have to be taken to a designated environmentally approved site for stockpiling.

205. Erosion of the cut slopes occurs when the slope gradients are too steep, exposed slopes greater than 2:1 and where the soils are weak and friable are more likely to have erosion problems (see Figures 7a,c, e, g and i).

206. Many existing roads in the Pu'er Prefecture exhibit slope failure and erosion and require remediation measures. Various remediation measures are shown in Table 40 and can be considered for the design of the new sections on the two roads.

207. The two regional road projects involve new construction which will expose cuts of varying height. With conservative design measures, the risk of future slope failures can be reduced, for example (Figure 7a to 7i):

- Limiting slope gradients to less than 33º;
- Roughening slope surfaces;
- Blanketing short slopes with free draining, stable, granular materials;
- Terracing the top and bottom of long slopes;
- Re-vegetating established slopes;
- Installing silt fences and brush barriers; and
- Building up fill slopes to the desired grade with a series of shallow lifts.

Table 38: Main Engineering Functions of Structures with Examples of Civil and Bioengineering Techniques

Function	Civil engineering technique	Bio-engineering technique	Combination of both
Catch	Catch walls Catch fences	Contour grass lines or brush layers Shrubs and large bamboo clumps	Catch wall with densely planted shrubs Catch wall with bamboo clumps planted above
Armor	Revetments Surface rendering	Mixed plant storeys giving complete cover Grass carpet	Vegetated stone pitching Jute netting with planted grass
Reinforce	Reinforced earth Soil nailing (sodding)	Densely rooting grasses, shrubs and trees Most vegetation structures	Wire bolster cylinders and planted shrubs or trees Jute netting with planted grass
Anchor	Rock anchors Soil anchors	Deeply rooting trees	Combination of soil anchors and deeply rooting trees
Support	Retaining walls Prop walls	Large trees and large bamboo clumps	Retaining wall with a line of large bamboo clumps planted above
Drain	Masonry surface drains Gabion and French drains	Downslope and diagonal vegetation lines Angled fascines or brush layers	Herringbone pattern wire bolster cylinders and angled grass lines French drains and angled grass lines

Source: Copied from Howell, 1999 Figure 1.2.

208. The Contractor shall incorporate all permanent soil erosion control features into the project at the earliest practicable time, as outlined in the accepted work schedule, and shall be

responsible for temporary erosion and sediment control measures, including daily inspection of the integrity of such measures during adverse weather conditions or when construction operations are proceeding in any environmentally sensitive areas. The Contractor may have to provide temporary erosion and sediment control measures (the photos in Figures b, d and f below illustrate some common control measures).

209. These measures may include, but may not be limited to:

- Interceptor ditches or berms to direct runoff away from erodible areas;
- Sediment control measures, such as settling ponds;
- Slope protection measures such as mulches, hydro seeding, erosion mats, geotextiles, filter fabric, polyethylene covers, or riprap;
- Ditch blocks to reduce flow velocities;
- Silt fences; and
- Vegetative cover.

Figure 7a: Slope failure

Figure 7b: Slope benched and stabilized with vegetation

Figure 7c: Erosion of fill slope

Figure 7d: Using rock to stabilize fill slope

Figure 7e: Unstable fill slope

Figure 7f: Using silt fence to mitigate slope erosion

Figure 7g: Unprotected bridge end-fill

Figure 7h: Using .12mm plastic sheeting to prevent erosion

Figure 7i: Raw Graded fill slope

Figure 7j: Slope seeded with grass

Figure 7: Examples of Erosion Issues and Slope Protection Measures

210. **Soils/Spoil.** The widening and new alignments associated with the two regional roads will contribute a large amount of spoil to be transported to stockpile sites.

211. The grading works associated with the rural roads is expected to be limited so excess spoil will be minimal. No quantities have been estimated in the FSR or EIT.

212. The following outlines the measures to deal with siting, preparing and protecting these spoil sites until re-vegetation has been successfully established.

213. **Initial field assessment.** The sites should be traversed, photographed, assessed and documented as to the topographical characteristics: slope, aspect, evidence of drainage patterns, and wind direction. The boundary of the sites needs to be bermed, vegetated or fenced. Land use surrounding the sites should be assessed as to what resources are at risk from dust, concrete dust, noise and drainage with the potential to carry toxic material (concrete wastewater) or sediment.

214. The sites should be adequate to accept the quantity of spoil without alienating areas outside the site boundaries. Maps or design of the site(s) should be prepared and used to identify where protection measures are required.

215. Ideal spoil site construction should be as follows: waste or spoil sites should be designed and laid out keeping in mind that they should be set back 30 m from any water course. A good waste site should be scarified and top soil separated and stored for reuse during site rehabilitation. Silt fencing to contain erosion should be installed at the base of the first lift (lifts can be 2 to 3 m high) or, if not available, a rock dyke should be placed along the site boundary. A second line of stakes 2-3 m inside the silt fence or rock dyke should indicate the dump margin to the equipment operators (the 3 m leave strip provides for minor erosion occurrences to accumulate and to be contained by the silt fence or rock dyke). The first lift of material should be 2-3 m high with equipment shaping the dump face to a 2:1 slope or flatter. The face of the slopes should be seeded as soon as possible. The next lift follows set back 2 m from the face of the first and so on till the dump reaches expected capacity (see Figure 8b).

216. Spoil disposal sites have been identified for the Menglian-Meng'a Road (19 sites) and the Ning'er-Longfu Road (40). No sites have been identified for the Rural Roads. PMTB has indicated that it will be the responsibility of the contractor to nominate a site (s) for each project. However, the EIRs have identified acceptable sites which have been approved by the Pu'er EPB.

Figure 8a: How not to stockpile

Figure 8b: How to stockpile

Figure 8: Examples of Stockpiling Waste

217. **Predicted water and soil loss for constructing the Menglian-Meng'a Road.** The original vegetation of the area that will be disturbed and damaged by the construction of the road is 167.99 ha. The conservation facilities for soil and water and soil loss occupy 120.29 ha; and the natural volume of the permanent waste soil produced from construction is 1,249,800 m^3. It is predicted that the soil and water loss will last 3 years during which the total amount is predicted to be 378,529.74 tonnes and 376108.86 tonnes if no conservation measures are implemented.

218. The construction phase will cause the greatest loss of water and soil. During this period, the potential impact is the increase in sedimentation to water bodies caused by earth-rock removal and the large loss of spoil to farmland, vegetation areas and rivers. Table 39 provides

the mitigation measures recommended to reduce soil and water loss both during construction and post-construction.

Table 39: Water and Soil Conservation Mitigation Measures for Menglian-Meng'a

Sub-area	Engineering Measures	Plant Measures	Temporary Measures
Road area			3300 m sack-packed soil retaining wall, 19700 m^2 geotextile, 3800m simple drainage ditch, 7 simple sedimentation basins
Waste residue site	695 m debris retaining wall, 5470 m intercepting ditch, 2078 m drainage ditch on packway, 235 m Water drop step	Planting 26100 trees, broadcast sowing 1121.01 kg grass seeds , greening 14.29 ha , Rehabilitation 1.86ha ha	
Construction site		Planting 4860 trees, broadcast sowing 96.25 kg grass seeds, greening 2.75 ha Rehabilitation 0.3 ha	3290 m sack-packed soil retaining wall, 18400 m^2 geotextile, 6390 m simple drainage ditch, 4 simple sedimentation basins
Construction camp		Planting 3668 trees，broadcast sowing 60.50 kg grass seeds，greening 1.10 ha ^{2}，	920 m sack-packed soil retaining wall, 1790 m simple drainage ditch, 2 simple sedimentation basins
Construction access road	1000 m waste residue site access road, 60 m soil retaining wall	Planting 1066 trees，broadcast sowing 17.60 kg grass seeds，greening 0.32 ha ，	140 m sack-packed soil retaining wall, 820 m simple drainage ditch, 2 simple sedimentation basin
Topsoil yard		Planting 10736 trees，broadcast sowing 177 kg grass seeds， greening 3.22 ha ^{2}， Rehabilitation 0.3 ha	1560m sack-packed soil retaining wall
Total	695 m debris retaining wall, 5470 m intercepting ditch, 2078 m drainage ditch on packway, 235 m Water drop step, 1000 m waste residue site access road, 60 m soil retaining wall	Planting 47406 trees，broadcast sowing 1660.36 kg grass seeds， greening 21.68 ha ^{2}， Rehabilitation 2.36 ha ^{2}	9201m sack-packed soil retaining wall, 23000m^2 geotextile, 12800m simple drainage ditch, 15 simple sedimentation basin
Total cost for these measures are CNY142.6987 million (USD23.87 million USD)			

Source PRC EIR, 2009.

219. **Predicted water and soil loss for constructing the Ning'er-Longfu Road.** Vegetation disturbed and damaged by construction for the whole alignment is 292.85 ha and may cause water and soil loss of 292.85 ha. There are 157.08 ha in Ning'er County and 135.7 ha in Jiangcheng County.

220. **It** is predicted that water and soil loss will occur for 3 years during which the total amount is expected to reach 1128244.21 tonnes and 1011142.9 tonnes if no water and soil conservation measures are taken. The spoil sites and topsoil yards contribution to water and

soil loss amounts to 1006678.78 tonnes and accounts for 99.56% percent of the total of water and soil loss.

221. Construction earthworks account for most soil and water loss through sediment-loading in rivers and waste site run-off. Table 40 highlights the proposed mitigation measures required to limit soil and water loss and the estimated total cost.

Table 40: Summary of Water and Soil Conservation Mitigation Measures for Ning'er-Longfu Road

Sub-area	Engineering Measures	Plant Measures	Temporary Measures
Road area			31600 m sack-packed soil retaining wall, 259000 m^2 geotextile, 19500m simple drainage ditch, 25 simple sedimentation basins
Waste residue site	2047 m debris retaining wall, 15027 m intercepting ditch, 7206 m drainage ditch, 1495 m Water drop step	Planting 68422 trees，broadcast sowing 1865.85 kg grass seeds，greening 31.70 ha，Rehabilitation 2.24 ha	
Pave crash supply site	3150m drainage ditch		
Construction site		Planting 22982 trees, broadcast sowing 541.75 kg grass seeds, greening 9.85 ha, Rehabilitation 1.10 ha	11110 m sack-packed soil retaining wall, 69600 m^2 geotextile, 16990 m simple drainage ditch, 16 simple sedimentation basins
Construction camp		Planting 13070 trees，broadcast sowing 308 kg grass seeds，greening 5.6 ha，Rehabilitation 0.65 ha	5630 m sack-packed soil retaining wall, 8820 m simple drainage ditch, 6 simple sedimentation basins
Construction access road	7600 m waste residue site access road, 760 m soil retaining wall	Planting 6536 trees，broadcast sowing 154 kg grass seeds，greening 2.80 ha，	140 m sack-packed soil retaining wall, 820 m simple drainage ditch, 2 simple sedimentation basins
Topsoil yard		Planting 57434 trees，broadcast sowing 947.4 kg grass seeds，greening 17.22 ha，Rehabilitation 1.41 ha	9920m sack-packed soil retaining wall
Total	2047 m debris retaining wall, 21917 m intercepting ditch, 7206 m drainage ditch, 1495 m Water drop step, 7600 m waste residue site access road, 760 m soil retaining wall	Planting 200876 trees，broadcast sowing 4352.04 kg grass seeds，greening 79.92 ha，Rehabilitation 5.40 ha	60710 m sack-packed soil retaining wall, 328600 m^2 geotextile, 50250 m simple drainage ditch, 52 simple sedimentation basins
Total investment is CNY178.3203 million (USD26.61 million)			

Source PRC EIR, 2013.

222. The following mitigation measures shall also be implemented by the contractor during the construction phase to minimize impacts due to spoil generation and protection of soil resources:

- Strip and store topsoil in a stockpile for reuse in restoration.
- Use spoil disposal sites approved by PEPB and manage in accordance with approved plan.
- Avoid side casting of spoil on slopes.
- Co-ordinate with water resources bureau monitoring station on effectiveness of soil erosion prevention measures and any need for remedial action.
- Rehabilitate and restore spoil disposal sites in accordance with agreed plan.
- Conduct project completion audit to confirm that spoil disposal site rehabilitation meets required standard, contractor liable in case of non-compliance.
- Implement soil erosion protection measures as defined in the Soil and Water Conservation Report.
- Confirm location of the borrow pits and spoil storage and disposal sites; if these are different from those specified in the Soil and Water Conservation Report.
- Construct intercepting ditches and drains to prevent runoff entering construction sites, and diverting runoff from sites to existing drainage.
- Construct hoardings and sedimentation ponds to contain soil loss and runoff from the construction sites.
- Limit construction and material handling during periods of rains and high winds.
- Stabilize all cut slopes, embankments, and other erosion-prone working areas while works are ongoing.
- Stockpiles shall be short-term, placed in sheltered and guarded areas near the actual construction sites, covered with clean tarpaulins when not in use, and sprayed with water during dry and windy weather conditions.
- All cut areas shall be stabilized with thatch cover within 30 days after earthworks have ceased at the sites.
- Immediately restore and landscape temporarily occupied land upon completion of construction works.
- Unauthorized extraction or disposal at other sites would be subject to penalties.

223. There should be no operational concerns affecting soil resources along the rights-of-way and waste dumps assuming spoil rehabilitation, slope stabilization and drainage measures are completed to the required standard.

G. Water Resources Impacts and Mitigation

224. **Flooding.** Minor flooding events are common in Pu'er after heavy rain. Minor and localized flood events occur throughout the rainy season but are most common in July and August. Earthworks may cause clogging of drainage and localized flooding.

225. **Surface water.** Both the Menglian-Meng'a and Ning'er-Longfu Roads will have a number of river and ditch crossings requiring bridges and culvert installation. These sensitive receptors are identified in Appendix 5. Poor construction practices can lead to sedimentation and siltation (see Figure 9) negatively affecting water quality and irrigation water supplies.

226. The Contractor is responsible for minimizing erosion and adverse impacts to watercourses during all phases of construction. Temporary erosion control materials and devices must be available on-site for use in emergencies associated with adverse weather

conditions or other unforeseen circumstances. Site personnel must be prepared to efficiently implement the necessary erosion control strategies in the event of an emergency. Because the Contractor is liable for all construction-related damages that occur due to erosion, it is in his best interests to install reliable and effective control devices and to routinely monitor these structures. Site-specific factors such as microclimate, slope and aesthetics should be considered during the selection and installation of all erosion control devices.

Figure 9: Examples of Unacceptable Levels of Sedimentation without Mitigation Measures

227. There are simple measures that can be employed by the contractor to reduce sedimentation and siltation.Work isolation techniques using rock dykes, sand bags, silt fencing, silt curtains, plastic and gravel-filled bags (see Figure 10) If the Contractor has a large number of sensitive water crossings he can opt to develop a Work Isolation Plan in order to ensure environmental protection.

Figure 10: Examples of On-Site Mitigation Measures:
Use of gravel-filled bags and plastic to isolate the work area or a boom and silt curtain

228. **Drainage.** Earthworks and other construction activities may cause alteration to drainage patterns in the area and could cause localized flooding.

229. **Mitigation measures.** The contractor shall carry out the following mitigation measures during the construction stage.

- If possible, carry out bridge pier construction during the dry season.
- Erect berms or sandbags during bridge foundation works if necessary to contain runoff polluting the rivers.
- Maintain adequate flood flow during the rainy season.
- All construction camps, fuel and materials storage, refueling and maintenance areas to be located at least 500m from watercourses.
- Take all necessary measures to prevent construction materials and waste from entering drains and water bodies.
- All construction wastewater to be treated to appropriate PRC standard prior to discharge.
- Ensure timely cleanup of scattered materials on site, stockpiles must adopt measures to prevent being washed into water bodies by rain water.
- Reuse equipment and wheel wash wastewater for dust suppression.

230. All drains need to be cleaned out during the operational phase on a yearly basis to maintain their function.

H. Ecological Impacts and Mitigation

231. **Provincial nature reserves.** There are three nature reserves within 2 to 4 kilometres from the regional roads. The Menglian-Menga Road is 2 km from the Menglian Longshan Natural Reserve (a provincial nature reserve to protect medicinal plants). There are two nature reserves located close to the Ning'er-Longfu Road. The Luo River Nature Reserve (to protect monsoon and tropical forest) is 2 km away. The Songshan Nature Reserve (protects broadleaf forest) is 4.8 km from the alignment. None of these will be directly or indirectly impacted by road construction.

232. **Ailao Mountain National Natural Reserve.** Rural road #11 (Bangqing Road) passes through (chainage K21 to K24+459) the experimental zone of the Ailao Mountain National Nature Reserve. This section of the road is located at altitudes considerably below the primary evergreen broadleaf rain forest inhabitated by the Black-crested Gibbon and no impact on this critically endangered species is anticipated. The road is an existing road and all construction activity will be confined to the right-of-way. There would be no additional impact on wildlife crossing of the road except such crossing could potentially be disturbed during road paving activities. Such impact should be short-term and temporary. To protect the integrity of the reserve, the section of the road within the boundary of the nature reserve will be demarcated. Based on consultation with the Ailao Mountain Jingdong Management Bureau carried out during the preparation of this EIA, it was understood that no special permission or approval would be required for paving the section of the rural road within the experimental zone of the nature reserve, but tree felling, asphalt mixing and concrete batching within this section of the road will be strictly forbidden. The construction workers will also be prohibited from hunting and capturing wildlife on site during construction. Contractors will be required to closely co-ordinate with staff of the Ailao Mountain Jingdong Management Bureau to ensure that all necessary protection measures are implemented effectively.

233. **Construction.** Trees will be removed during clearing of the right-of-way and grading for the Menglian-Meng'a Highway and new sections of the Ning'er-Longfu Road. Impacts will be mitigated by protecting trees to be retained and replacing trees (PMG has indicated a 1:1 replacement), where possible, along the alignment. The assessment identified 29 valuable trees associated with the Ninger-Longfu regional road corridor that will be conspicuously marked and fenced off prior to commencement of construction activities for protection. The tree species and locations are listed in the EMP.

234. The tender documents will include specific requirements for wildlife protection where there is the potential for protected plant and animal species to occur. In addition, construction workers will be prohibited from catching or trading in flora and fauna and will immediately report any fauna found trapped in project sites eg. pits/ditches. Where this is found to be a repetitive problem, 'ladders' such as long branches should be provided to allow animals to escape.

235. During construction, habitats of potential value for nesting birds in areas adjacent to the road corridors should be monitored. If birds of conservation significance are found to be nesting in trees close to the road corridor additional protection and control measures may be required. Contractors in co-ordination with PMO/PEPB should fence off these areas so that there is no encroachment by equipment and workers during the breeding and nesting season.

236. **Operation.** Wildlife and domestic animal collisions may occur during operation of regional and rural roads especially if road speeds increase. Collisions are expected to be more frequent where alignments traverse woodlands, grasslands and agricultural areas. Signing to warn motorists of the need to reduce speeds and potential for collisions is strongly recommended. This is particularly relevant for wild Asian elephants and the Wildlife Conservation Society will work closely with PMTB to identify locations where the elephants would cross the project roads and erect warning signs for motorists.

I. Agriculture/Land Use

237. Road development can adversely affect agricultural land or farm operations in several ways. Most obviously, the land on which the road is built is no longer productive for agricultural purposes. In addition, an agricultural parcel large enough to support an economically viable farm may be split by the road into two or more non-viable, small parcels; drainage and irrigation systems may be damaged; access roads to and within the farm may be altered, resulting in less efficient movement of farm equipment; and buildings, fences and other facilities may be removed.

238. **Construction.** PMTB and their contractors can minimize and mitigate these impacts by the following:

- Ensure to preserve natural hydrologic conditions, maintain water quality, restore on-farm or regional drainage conditions, maintain farm access, protect existing farm utilities, realign livestock pastures and replace fencing.
- Make sure that the Supervision Consultants and Contractor are aware that no one is allowed to remove soil or gravel from, or place fill on, protected land; and are aware of any agriculture conditions or mitigation measures relating to on-site practices.
- In particular, drainage, maintenance of farm access and operations, fencing requirements and stockpiling of materials on agricultural lands should be discussed with local farmers.

- Most importantly the IA and the Contractor need to communicate with the farmers to ensure that their need to access their production area(s) is available during construction and that they are familiar with the opportunity to utilize the GRM should they be obstructed.

239. **Operation.** Improved access will benefit farmers in reduced travel time to markets and services; improved public transport due to the attraction of providers to an improved road network; and significant reduction of road dust, resulting in less crop damage and fewer respiratory problems.

J. Solid Waste, Hazardous Waste, Petroleum Products and Recycling

240. **Pre-Construction.** Prior to commencing construction the contractor will prepare a Waste Management Plan detailing how waste (solid and hazardous), and petroleum products will be managed (including waste minimization and re-use) to protect construction workers, public and the environment. The plan should also identify the waste streams: asphalt, waste oil, oil filters and other acceptable materials. In addition, the contractor should prepare a Spill Management Plan. The plan shall provide details of procedures, responsibilities, resources, documentation and reporting requirements and training provisions for relevant staff to avoid spills of hazardous substances and to effectively respond to such incidents, in case these occur.

241. **Construction.** If not properly handled and disposed of, solid wastes pose health and safety hazards and are likely to cause nuisance to surrounding communities and the workforce. To avoid such impacts, the contractor shall implement the following:

- Set up centralized domestic waste collection point and transport offsite for disposal at licensed municipal waste facility;
- Prohibit burning of waste;
- Maximize the re-use of excavated spoil and existing pavement materials.

242. **Petroleum products and hazardous materials**. Accidental spillage of these materials during construction could potentially cause water and soil contamination. The following mitigation measures shall be implemented by the contractor.

- Properly store petroleum products, hazardous materials and wastes on an impervious surface.
- Develop spill response plan. Keep a stock of absorbent materials (e.g. sand, earth or commercial products) on site to deal with spillages and train staff in their use.
- If there is a spill take immediate action to prevent entering drains, watercourses, unmade ground or porous surfaces. Do not hose the spillage down or use any detergents. Use oil absorbent materials and dispose at a licensed waste management facility.
- Record any spill events and actions taken in environmental monitoring logs and report to Loan Implementation Environmental Consultant.
- Properly store petroleum products, hazardous materials and waste in clearly labeled containers on an impermeable surface in secure and covered areas, preferably with bund and/or containment tray for any leaks.
- Remove all construction waste from the site to approved waste disposal sites.

243. Regular maintenance servicing of the roads will collect solid waste discarded in the right-of-way during operation.

K. Damage to Community Facilities

244. **Construction.** Although the EIR and the EIT did not identify any sensitive locations, construction equipment and excavation activities can easily create damage to community facilities such as access roads, not in the construction envelope, sidewalks and utilities.

245. Transport of materials, operation of construction equipment and various construction activities may damage community facilities. The contractor shall implement the following measures to address this impact:

- The Contractor shall immediately repair any damage caused by the Project to community facilities such as water supply, power supply, communication facilities and the like.
- Access roads damaged during transport of construction materials and other project-related activities shall be reinstated upon completion of construction works.

246. **Operation.** Adverse impacts to community facilities are not anticipated during operation phase of any of the components.

L. Traffic Concerns

247. **Construction.** Construction activities may cause traffic congestion along the roads due to transport of materials and operation of other project-related vehicles. To minimize traffic disturbance and access to properties, the contractor shall undertake the following:

- A traffic control and operational plan will be prepared together with the local traffic management authority prior to any construction. The plan shall include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings with an emphasis on ensuring public safety through clear signs, controls and planning in advance.
- As much as possible, schedule delivery of construction materials and equipment during non-peak hours.

248. **Operation.** Adverse impacts to traffic flow are not anticipated during operation phase.

M. Occupational Health and Safety

249. **Construction.** To ensure health and safety of workers and communities, the following measures shall be implemented by the contractor:

Construction site sanitation

- Effectively clean and disinfect the site.
- During site formation, spray with phenolated water for disinfection.
- Disinfect toilets and refuse piles and ensure timely removal of solid waste.
- Exterminate rodents on site at least once every 3 months, and exterminate mosquitoes and flies at least twice each year.
- Provide public toilets in accordance with the requirements of labor management and sanitation departments in the living areas on construction site.
- Appoint designated staff responsible for cleaning and disinfection.

Workers' health and safety

- Appoint Environment, Health and Safety Officer to develop and implement environmental, health and safety management plan, maintain records concerning

health, safety and welfare and regularly report on accidents, incidents and near misses.

- Train all construction workers in general health and safety matters and on emergency preparedness and response procedures.
- Provide personal protective equipment (hard hats, shoes and high visibility vests) to all construction workers and enforce their use.
- Provide goggles and respiratory masks to workers doing asphalt road paving.
- Provide ear plugs to workers working near noisy powered mechanical equipment (PME), especially during piling of bridge foundations.
- Ensure safe handling, transport, storage and application of explosives for tunnel construction.
- Implement special measures to ensure worker safety in confined spaces during tunnel construction.
- Provide a clean and sufficient supply of fresh, potable water for all camps and work sites.
- Provide an adequate number of latrines and other sanitary arrangements at the site and work areas and ensure that they are cleaned and maintained in a hygienic state.
- Provide adequate waste receptacles and ensure regular collection and disposal.
- Ensure that Contractors have adequate worker and third party insurance cover.
- No children (less than 14 years of age) to work on any contract.

Food safety

- Inspect and supervise food hygiene in cafeteria on site regularly.
- Cafeteria workers must have valid health permits.
- Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading.

Disease prevention and safety awareness

- Construction workers must have physical examination before start working on site.
- If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading.
- From the second year onwards, conduct physical examination on 20% of the workers every year.
- Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.
- Specify the person responsible for health and epidemic prevention responsible for the education and propaganda on food hygiene and disease prevention to raise the awareness of workers.
- Regularly inspect works to ensure there are no areas of stagnant water that could provide breeding grounds for malaria, encephalitis and dengue fever mosquitoes.

N. Community Health and Safety

250. The contractor shall implement the following measures to mitigate potential impacts to community health and safety.

- Inform residents and businesses in advance through publicity about the construction activities and provide the dates and duration of expected disruption and alternative routes, as required.
- Place clear signs at construction sites in view of the public, warn people of potential

dangers such as moving vehicles, hazardous materials, excavations and raising awareness on safety issues.
- Secure all construction sites, discourage access by members of the public through fencing or security personnel, as appropriate.
- Assess construction locations in advance for potential disruption to utility services and identify risks before starting construction.
- If temporary disruption is unavoidable, develop a plan to minimize the utility services disruption in collaboration with relevant local authorities such as power company, water supply company and communication company.
- Communicate the dates and duration of such disruption in advance to all affected people.

251. **Poverty impact.** Most of the project roads pass through low-income counties. There is a danger that economic hardships could arise in the event of access road closure as this could result in loss of perishable products, missed market days, or make it difficult for workers to get to their places of employment. These people lack access to alternative modes to reach markets and employment or facilities to store goods in the event of road closure.

252. To help minimize this risk, PMTB/PPMO will hold meetings with local communities along all the roads where access restrictions, road lane restrictions and/or traffic rerouting are anticipated. They will also post advance-warning signs at both ends of the work and also in each settlement area. Signs will define the work, including its boundaries and timetable.

253. The presence of construction camps may cause conflict with the surrounding communities, these will be addressed by:
- Considering the location of construction camps away from communities in order to avoid social conflict in using resources and basic amenities such as water supply.
- Maximizing number of local people employed in construction works.
- Maximizing goods and services sourced from local commercial enterprises.

254. **Operation.** Once the projects are completed there should be no further concern regarding construction labor force. However, safe-driving practices through the enforcement and community safety programs of the Institutional Strengthening component will help alleviate or prevent driving accidents and injury to motorists and pedestrians.

255. The impact on poverty should be positive, since the improved roads will stimulate better public transportation services and reduce travel times.

O. Cultural and Heritage Resources

256. No identified sites of heritage significance or physical cultural resources will require removal or demolition as part of the construction works associated with the Project.

257. There could be as yet undiscovered archaeological relics through the construction of the Menglian-Meng'a Highway and the new re-alignments on the Ning'er-Longfu Road. Contractor must comply with PRC's Cultural Relics Protection Law and Cultural Relics Protection Law Implementation Regulations if such relics are discovered, stop work immediately and notify the relevant authorities, adopt protection measures and notify the local Cultural Bureau to protect the site.

P. Greenhouse Gas Emissions

258. Carbon dioxide emissions were estimated for the project roads based on vehicle numbers, distance (km) travelled and fuel consumption. Vehicle numbers and vehicle types (small, mid-size and large vehicles) were based on estimates in the FSRs, except for the rural roads where vehicles were assumed to consist of 50% small gasoline vehicles and 50% mid-size diesel vehicles since no vehicle type breakdown was provided in the traffic demand estimate. No vehicle fuel type was provided in the FSRs and it was assumed that small vehicles would use gasoline fuel while mid-size and large vehicles would use diesel fuel.

259. For vehicle-km calculation, the weighted average vehicle numbers per day were used for the whole length of the Menglian-Meng'a Road (45 km) and the Ning'er-Longfu Road (257 km). For the rural roads, the lengths of the rural roads in each county were combined and the rural road within each county with the highest vehicle number per day was applied.

260. The following factors were used for estimating carbon dioxide emissions based on available domestic information:

- Fuel consumption per 100 km: 9.2L for small gasoline vehicle, 27.6L for mid-size diesel vehicle, and 31.8L for large diesel vehicle based on Kunming data in Liu *et al*. (2013)[13]
- Fuel density: 740 kg/m^3 for gasoline and 870 kg/m^3 for diesel based on Liu *et al*. (2013)
- Conversion factor to standard coal equivalent: 1.4714 kg standard coal per kg gasoline and 1.4571 kg standard coal per kg diesel based on PRC's *Integrated Energy Consumption Guideline* (GB/T 2589-2008)
- Carbon dioxide emission factor: 2.493 kg CO_2 per kg standard coal based on Liu *et al.* (2013)

261. The results are shown in Table 41, indicating that CO_2 emissions on the project roads individually would not exceed ADB SPS 2009 threshold of 100,000 t/a except for the Ning'er-Longfu Road in 2030. However, the existing CO_2 emissions from all project roads combined would total 138,995 t/a, already exceeding SPS 100,000 t/a threshold. By year 2030, total CO_2 emissions from all project roads would reach 278,375 t/a. Consequently, annual reporting of CO_2 emissions on these project roads will be required.

Table 41: Projected CO2 Emissions for the Project

Project Road	Length (km)	No. of Vehicles per Day		Carbon Dioxide Emission (t/a)	
		Existing	Year 2030	Existing	Year 2030
Menglian-Meng'a	45	3,025	6,404	27,584	43,697
Ning'er-Longfu	257	1,742	4,934	96,188	213,453
Rural roads	600	135-190	294-403	15,223	21,225
			Total:	138,995	278,375

Q. Climate Change Impacts and Mitigation

262. The climate risk and vulnerability analyses made the following key climate change projections:

[13] Liu H. J., H. Wu and Q. H. Yang. 2013. *Research on Improving Urban Traffic Structure based on Low Carbon Conditions*. Yunnan Financial and Economic University. Published in the Chinese Statistics Education Society. www.sescn.org.cn/zyxx/2013dxsjmgs/yxj/A40.pdf.

- Applying the median projection, annual rainfall change in the area will likely be small, with an average increase of 2-3% by 2050 and 4-8% by 2100. However, severe, intense rainfall events are expected to significantly increase. The 1:50 and 1:100 year annual maximum daily rainfall of Lancang (closest observation station to Menglian-Meng'a Road) is projected to increase by 10% by 2050 and 19.5% by 2100. This has implications for flood discharge and height which are the key parameters that determine bridge height. Historic data was available for the Nanlei River at Menglian but not for other river catchments. A 10% increase of 1:100 year flood discharge will be 383.9m^3/s, which corresponds to a flood height of 958.18 metres above sea level (masl) or a 0.15m increment on the current flood height at the Nanlei bridge location. The current design for the bridges crossing the Nanlei River near Menglian is based on the historic 1:100 year flood height with a 0.5 m factor of safety.
- The current 1:50 year event of the annual maximum 1 day rainfall is 152.83 mm for Simao. The median projection for such an event is 168.34 mm by 2050 and 182.23 mm by 2100, with an associated 9.4% and 18.5% increase in rain intensity. In a high emissions scenario, maximum daily rainfall would increase to 183.75 mm and 222.17 mm for 2050 and 2100 respectively, with an associated rain intensity increase of 20.2% by 2050 and 45.4% by 2100. This change in rainfall intensity is much more significant than the change in maximum daily rainfall.
- As heavy rainfall will become much more frequent, landslide/debris flow risk will significantly increase. Projections indicate that the 1 day rainfall risk could increase by 56.4% by 2050 and 117.9% by 2100 and the 6 day rainfall risk will increase by 145.2% by 2010 and 260% by 2100.
- The baseline 1:50 year annual maximum temperature is 42.1 ºC and minimum temperature -3.4ºC. An increase of 1.2ºC by 2050 and 2.3ºC by 2100 is projected for annual average air temperature. There will be little change in the difference between maximum and minimum temperature, both will slightly increase. Heat wave will become more intensified and frequent, as indicated by the 7 day average maximum temperature for the three observation stations in the project area, however, this is generally under 45ºC for most scenarios and still under 50ºC by the end of this century. High temperatures combined with humidity can result in asphalt bleeding and increased incidence of slope failure increasing requirements for maintenance.

263. The study reviewed the key design standards adopted for the project. The projected changes in extreme rainfall and increased flood height imply that standards adopted as the basis of design may not be adequate. The risk of flood, landslide and debris flow will increase in the future which could result in damage to road surface, subgrade and slopes, bridges and culverts, and cause road closure and disruption of service.

264. The study recommends that the detailed design takes account of projected climate change impacts, the following adaptation options are recommended and have been included in the EMP:

- The detailed design for the bridges currently incorporates a factor of safety 0.5 m so is likely to be adequate for low and mid emissions scenarios and up to 2050, however, in the event of a high emissions scenario the 1:100 flood height may exceed the design standard by the end of the century. The detailed design of the river crossings should consider costs associated with increasing the factor of safety

to take account of a potential high emission scenario to determine whether to adopt a higher flood height as the basis of design. This regional road includes 24 large and medium bridges, so detailed design will need to identify which bridges may be at increased flood risk and may need to adopt a higher factor of safety as basis of design. The design team has indicated that the cost of adopting a higher flood height will depend on the bridge type and number of piers. On average, approximately $1632/pier is expected for every meter bridge height increase. More detailed hydrological analyses will be carried out during the detailed design to determine the bridges at most risk and the need for adoption of higher factors of safety.

- The design for stormwater drainage included a minimum 10% factor of safety over and above that inherent in the drainage design code. Projections indicate that this may not be adequate in the event of a high emissions scenario and beyond 2050. For any drainage components that would be difficult to replace or repair it is recommended that a higher factor of safety is adopted as the basis for design.
- More and higher flood discharge may increase risk of damage of road infrastructure. Additional protection of slopes and subgrade may be needed in high risk areas. Detailed design will need to ensure that slope protection design takes account of future increased risk of landslide and debris flow hazards.
- The Government should develop a comprehensive hydro-meteorological prediction system, early warning system and integrated climate and disaster risk management action plan to ensure that loss of life and damage to infrastructure are minimised and continuity of critical transport services are maintained during a severe weather event.
- Watershed and ecosystem management are also key. The Government is implementing an ecosystem restoration program in Pu'er which includes planting of deep rooted vegetation in steep erosion prone areas and prohibiting cultivation on steep slopes. Improved ecosystem protection and management should in the long-term contribute to a reduced landslide risk.

265. These recommendations have been discussed with the Pu'er Municipal Government and the project detailed design team. The Government has agreed to take account of these recommendations in the detailed design and will confirm if/which measures are adopted and if there is an incremental cost of adaptation measures.

R. Other Impacts

1. Indirect Impacts

266. There are no significant negative indirect environmental impacts associated with the Project. Improved roads can lead to increased average vehicle speeds and increased safety risk. Various traffic calming methods, as well as the installation of signs and markings will be installed to encourage reduced traffic speeds near residential areas. This will be combined with a community road safety awareness programme.

2. Cumulative and Induced Impacts

267. Cumulative impacts pertain to impacts from further planned development of the project area, other sources of similar impacts in the geographical area, any existing project or condition,

and other project-related developments that are realistically defined at the time of the assessment.

268. For the purpose of identifying the potential cumulative impacts the area around the rights-of-way of the regional roads has been considered. Cumulative impacts include increase in conversion of land to impermeable surfaces and increased run-off, contributions to increases in noise levels, pollutant and GHG emissions. During operation the forecasted traffic is expected to more than double by 2030. There will be an associated increase in vehicle emissions of pollutants and GHGs. The GHG emission assessment projected the expected yearly level of CO_2 based on projected traffic forecasts for the two regional road projects and the rural roads.

269. Wildlife trafficking, especially illegal trade in protected species, is a major concern at border areas between PRC, Vietnam and Mynmar. The two regional roads will improve access to the border posts of Longfu (border with Vietnam) and Meng'a (border with Myanmar) and may induce increased cross border wildlife trafficking according to the study by the Wildlife Conservation Society. The Wildlife Conservation Society study recommended institutional strengthening of CITES enforcement for border control staff, raising awareness and improved co-ordination between government departments at a prefecture and county level and with neighbouring countries to control wildlife trafficking. These recommendations will be implemented through the institutional development component of this project (see Project Administration Manual, Appendix 2 Consultants' Terms of Reference).. Cross border wildlife trafficking could increase the occurrence of vector borne diseases, strengthening health inspection and disease control at border crossings should also be considered.

270. A positive Project cumulative effect is expected from improved traffic movement along the alignments once construction is completed. Since the Project will be built along existing road corridors, it will not conflict with existing or planned land use. No major construction projects have identified adjacent to the regional roads.

271. Upon completion of construction, the communities along the alignment will benefit from the improved travel time, and less road congestion. This is considered a long-term positive cumulative impact.

272. Based on the foregoing, the Project's adverse cumulative impacts are expected to be low. The 31 rural roads are diversely spread throughout the prefecture and the improvements will be extremely localized and unlikely to generate any cumulative or induced adverse impacts, they are likely to have positive induced impacts as a result of improved accessibility to the road network.

3. Long-term Residual Effects

273. There are no significant long-term residual adverse environmental impacts predicted for the project. Future impact on air quality from motor vehicle emissions would increase but were predicted to comply with applicable air quality standards. With the recommended noise mitigation measures, residual noise impacts would also be acceptable. Increased traffic flow would result in increased levels of GHG emissions and annual reporting of GHG emissions from the project roads will be required. However, the continuing failure and erosion of cut slopes will be an on-going maintenance concern unless remediation measures are adopted that can rectify the issue.

274. The EMP requires the Design Institutes appointed for detailed design to consider recommendations made to adopt higher factors of safety as the basis of design to provide improved adaptive capacity and climate change and disaster resilience..

275. There are positive socio-economic benefits accruing to the local communities, Pu'er Prefecture and Yunnan Province from the project. With anticipated improvements in motor vehicle fuel standards, potential future vehicle and GHG emission impacts could be less than the conservative predictions made in this report.

V. ALTERNATIVES

A. Introduction

276. During project preparation, various alternatives for the project components were proposed, screened, and studied against technical, economic, social, and environmental criteria. The primary objective with respect to environmental criteria was to identify and adopt options with the least adverse environmental impacts and maximum environmental benefits. The following key environmental factors were used in comparing the alternatives: (i) land occupation; (ii) minimization of community disturbance; (iii) resettlement; (iv) drinking water source protection; (v) erosion concerns on cut slopes; and (vi) safety (grades and curvature).

B. No Project Alternative

277. Alternative analyses considered the 'do-nothing' alternative, which would be a continuation of the current situation where the two roads do not provide improved access and travel time to the borders of Pu'er prefecture and the rural roads remain unpaved, limit access and benefits to the minority populations living along those roads. Without implementation of the project, key strategic goals of reducing poverty and supporting regional integration will not occur. The do-nothing option would result in continued poor access and continuing poverty.

C. Alternatives within the Project

1. Highway Alignments

278. The Menglian-Meng'a Highway and the Ning'er-Longfu Roads both explored alternative alignments to improve road geometry and alignment lengths, reducing geotechnical constraints, and avoiding direct impact on communities.

279. **Menglian-Meng'a Highway.** The original Menglian-Meng'a Highway feasibility study evaluated five alternative alignments (A, B, C, D and E) in comparison to the base case. Options A to D involve the Lancang to Menglian section of the road and these are not relevent to the Menglian-Menga section of the road. However, Option E is within the road section of this project. It is proposed as a new road alignment commencing at K78+300 after leaving the old road. It follows the foot of a mountain toward the southeast, then connects back into the existing alignment at K81+855. The new route has a total length of 3.555 km, and is 0.255 km longer than the existing road.

280. The E option has the advantage of little traffic interference during construction but has the disadvantages of occupying more farmland, with more demolition of buildings and requiring a larger investment than the main line. From an environmental perspective, the base option goes through the Mengma town while the E option bypasses the urban area of the town thus resulting in less traffic emissions and noise to urban residents in town than the base option. However, E option was rejected based on more structures required for expropriation, farmland and engineering costs.

281. **Ning'er-Longfu Road.** Along this 232.6 km road there are nine new re-alignments proposed. Table 42 shows the new road sections and the engineering rationale for the re-alignments.

Table 42: Realignment Sections of the Ning'er-Longfu Road

Road Sections	Length (km)	New or Existing	Engineering Rationale
K0+000~K17+300	17.3	**New**	The new alignment reduces the number of housing required for the widened right of way
K17+300~K18+000	0.7	Existing	Only Minor widening required
K18+000~K20+400	2.4	**New**	Will bypass a village reducing re-settlement requirements
K20+400~K20+700	0.3	Existing	Uses the existing National Road
K20+700~K58+100	25.29	**New**	Existing road is longer, cost saving in construction and travel time
K58+100~K72+100	14	Existing	Minor widening required
K72+100~K102+600	30.5	**New**	Existing road has steep grades and substandard curvature
K102+600~K110+600	8	Existing	Minor widening required
K110+600~K117+600	7	**New**	Substandard geometry. Switchbacks and tight curvature
K117+600~K121+600	4	Existing	Minor widening required
K121+600~K130+100	8.5	**New**	Substandard geometry. Switchbacks and tight curvature in addition steep slopes
K130+100~K140+723	10.623	Existing	Minor widening required
K140+732~K156+000	15.277	**New**	New alignment reduces the length by 6.5 km and improves geometry, less soil erosion, earth cut and house demolition
K156+000~K174+500	18.5	Existing	Minor widening required
K174+500~K175+000	0.5	Existing	Minor widening required
K175+000~K200+000	25	Existing	Minor widening required
K200+000~K215+323	15.323	**New**	The new alignment is 14km shorter than the existing road with better geometry, less soil erosion, earth cut and house demolition
K215+323~K223+000	7.677	Existing	Minor widening required
K223+000~K228+000	5	**New**	Avoids steep slopes and switchbacks
K228+000~K244+799.25	16.79925	Existing	Minor widening required

Source: PRC EIR, 2012.

282. For the section between K20+700 to K47+450, two alignments (A- new and B- existing road) were evaluated (Figure 11). The A alignment option is shorter by 4.9 km (total length = 14.6 km) but it will traverse through Protection Zone 1 (from K25+200 to K44+500) and Zone 2 (K44+500 to K45+200) of the planned Wenquan River Reservoir, a centralized drinking water source. The Xishitou to Shanshen Temple Pass B-alignment option is longer (total length = 19.5 km) but will avoid passing through the drinking water source protection zones. The Xishitou to Shanshen Temple Pass alignment option was selected as it will avoid the drinking water source protection zones although the construction cost will be higher and there will be more land take, earthworks, land acquisition and resettlement.

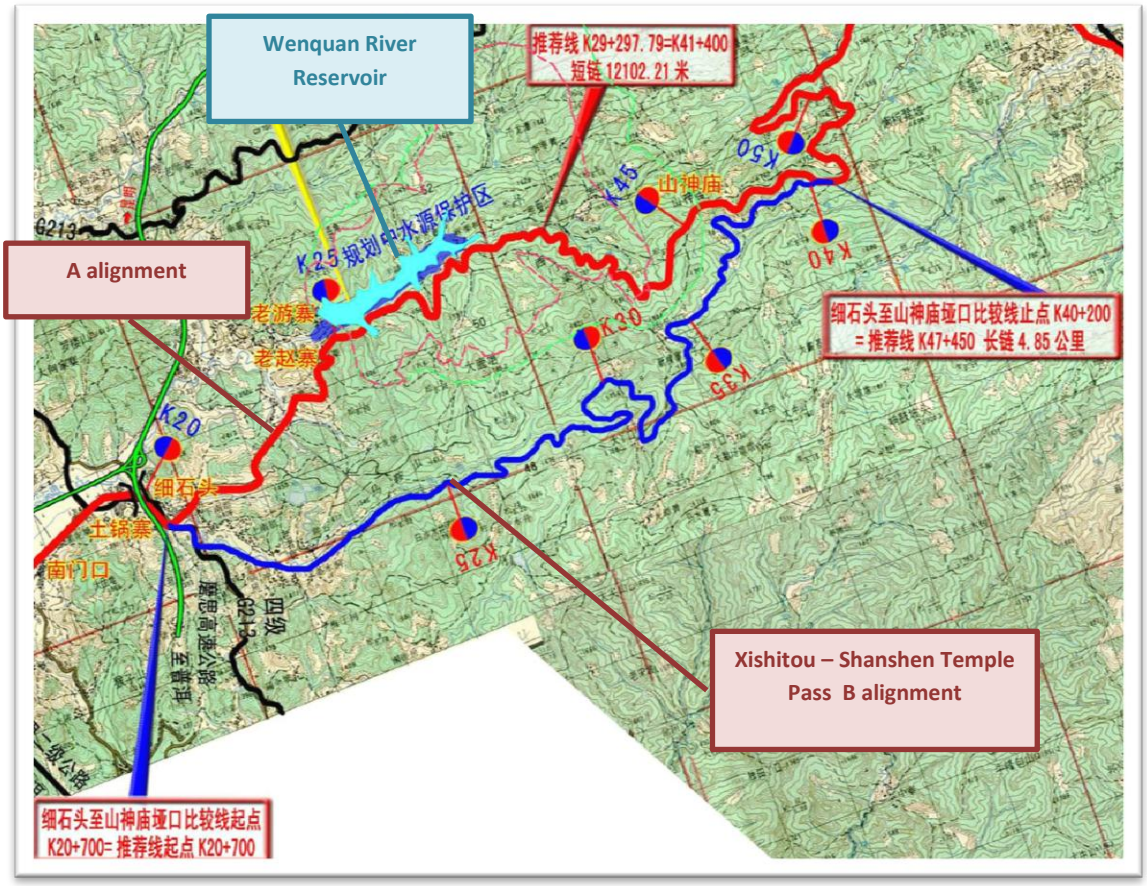


Figure 11: Alignment Options for Ning'er-Longfu Highway: KM20+700-KM47+450

283. Of the total 232.6 km, new construction accounts for 126.6 km or 55% and the existing road is 104.9 km or 45% of the project. New construction was selected for a number of sections to reduce steep grades, reduce slope failure risks and sub-standard curvature (switchbacks). Two of the new re-aligned sections reduce the road length by 6.5 and 14 km, respectively.

2. River Crossings on the Ning'er-Jiangcheng-Longfu Highway

284. There will be 13 large (length 110-250 m) and 39 mid-size (length 50-96 m) bridges on the highway crossing the Dong'er River tributary, Mengxian River, Manxian River, Manbengtian River, Mengye River, Lahu River, Longdong River, Shili River and Qing Channel. Four bridge structural designs were considered: T-beam bridge, hollow slab bridge, pre-stressed T-beam bridge and pre-stressed hollow slab bridge. The T-beam design was selected for the longest large bridge (length = 250 m). The hollow slab design was selected for the remaining 12 large bridges. The pre-stressed T-beam design was selected for the longest mid-size bridge (length = 96 m) and the pre-stressed hollow slab design was selected for the remaining 38 mid-size bridges. There is one river crossing, the Nanma River, on the Menglian-Meng'a Road There is an existing bridge in place.

3. Paving of Rural Roads

285. Two alternatives for paving the rural roads were considered: asphalt concrete and cement concrete. The majority of rural roads will adopt cement concrete pavement. The use of cement-concrete roads is more common for rural roads and cheaper to construct by using local materials. Bridge pier foundation construction methods.

4. Bridge Pier Foundation Construction Methods

286. Different bridge pier foundation construction methods were examined. The selection of construction method will depend on the site conditions at the time of construction, such as pile foundation, extended foundation, in-situ masonry or casting construction. The use of construction platform or earth-filled artificial island is suitable for shallow water; while steel pipe construction platform, double wall steel cofferdam platform, or floating platform is more suitable for deeper water.

VI. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

A. Introduction

287. ADB SPS requires meaningful consultation with affected people early in the project preparation process to ensure that their views and concerns are made known to and understood by decision makers and taken into account. Consultations with stakeholders should continue throughout project implementation as necessary to address issues related to environmental assessment. Every project financed by ADB is required to establish a grievance redress mechanism to receive and facilitate resolution of the affected people's concerns and grievances regarding the project's environmental performance.

288. In addition, in the PRC relevant provisions in the Environmental Protection Law of PRC and the Regulations on the Administration of Construction Project Environmental Protection (Order of the State Council, No. 253) require that "Environmental Impact Report formulated by construction unit shall be in accordance with relevant laws to solicit the opinions of units concerned and inhabitants of project construction site". ADB's SPS (2009) also requires meaningful participation, consultation and information disclosure. The consultation process for this project followed both the PRC and the ADB requirements.

289. This section presents the public consultation carried out for the Project drawing on information from the domestic environmental impact assessments and, the social and household surveys carried out as part of the PPTA study.

B. Public Consultation on the Menglian-Meng'a Highway

290. During preparation of the Menglian-Meng'a Highway EIR a series of information disclosure and public consultation events were undertaken in 2009 and again in 2011 following alignment changes from Km 0+00 to Km 54+00. Local communities were provided with an initial overview of the types of environmental issues identified that would be subject to consideration in the environmental construction specifications and the EMP. Modes of public consultation included: (i) information disclosure on relevant web-sites; (ii) posting of project information in public places of affected communities; and (iii) questionnaire surveys of representatives from government agencies, enterprises and affected communities.

1. Information Disclosure

291. Information disclosure was conducted twice. The first time was from 31 May to 14 June 2011 upon commencement of the EIR for the alignment changes. Information on the project and relevant contacts were disclosed on the web-sites of Lancang County Traffic Bureau (www.gs.yn.gov.cn), Menglian County Traffic Bureau (www.stats.yn.gov.cn), and PRC Environmental Impact Assessment Public Participation (www.ppeia.com). There were 21 hits from the three web-sites but no comments were received. The second time was from 1-14 August 2011 after completion of the draft EIR. Information on the project, impact assessment findings and proposed mitigation measures was disclosed on the PRC Environmental Impact Assessment Public Participation web-site. Two comments related to resettlement compensation were received regarding reasonable compensation and suitable resettlement. No objection to the Project was received from the web postings.

292. Figure 12 shows screen prints of the websites during information disclosure.

First disclosure on Menglian County Transport Bureau website

Second disclosure on PRC Environmental Impact Assessment Public Participation website

Figure 12: Information Disclosure on the Menglian-Meng'a Highway

2. Public Posting

293. Project information was posted in public places in the affected communities along the highway alignment whilst carrying out on-site questionnaire surveys. Figure 13 shows a public posting in Menglian County.

Figure 13: Public Posting in Menglian County

3. Questionnaire Survey

294. **Stakeholders from government agencies, enterprises and community groups.** Table 43 lists the twenty-four government agency representatives and stakeholders were consulted via a questionnaire with the ten questions listed below:

Table 43: Government Agencies, Enterprises and Community Groups Consulted on the Lancang-Menglian-Meng'a Road

SN	Name of Unit	Consultation Location
1	Construction Bureau of Lancang County	Lancang Lahu Autonomous County
2	Meteorological Bureau of Lancang County	Lancang Lahu Autonomous County
3	Tourist Administration of Lancang County	Lancang Lahu Autonomous County
4	Development and Reform Commission of Lancang County	Lancang Lahu Autonomous County
5	Civil Affairs Bureau of Lancang County	Lancang Lahu Autonomous County
6	People's Congress of Lancang County	Lancang Lahu Autonomous County
7	Statistical Bureau of Lancang County	Lancang Lahu Autonomous County
8	People's Political Consultative Conference of Lancang County	Lancang Lahu Autonomous County
9	Forest Bureau of Lancang County	Lancang Lahu Autonomous County
10	Water Supplies Bureau of Lancang County	Lancang Lahu Autonomous County
11	Land Resource Bureau of Lancang County	Lancang Lahu Autonomous County
12	Construction Bureau of Menglian County	Menglian Dai-Lahu-Va Autonomous County
13	Environmental Protection Agency of Menglian County	Menglian Dai-Lahu-Va Autonomous County
14	Land Resource Bureau of Menglian County	Menglian Dai-Lahu-Va Autonomous County
15	County Annals Office of Menglian County	Menglian Dai-Lahu-Va Autonomous County
16	Government Office of Menglian County	Menglian Dai-Lahu-Va Autonomous County
17	Statistical Bureau of Menglian County	Menglian Dai-Lahu-Va Autonomous County
18	Meteorological Bureau of Menglian County	Menglian Dai-Lahu-Va Autonomous County
19	Forest Bureau of Menglian County	Menglian Dai-Lahu-Va Autonomous County
20	Tourist Administration of Menglian County	Menglian Dai-Lahu-Va Autonomous County
21	Civil Affairs Bureau of Menglian County	Menglian Dai-Lahu-Va Autonomous County
22	Water Resources Bureau of Menglian County	Menglian Dai-Lahu-Va Autonomous County
23	Vocational High School of Menglian County	Menglian Dai-Lahu-Va Autonomous County
24	Villager Committee of Langle Village, Jingxin Township, Menglian County	Langle Village, Jingxin Township, Menglian County

Source: PRC Supplemental EIR, 2011.

- Whether or not you agree with the construction of the roads;
- Whether or not building roads can ease traffic in local area;
- Whether or not road construction is conducive to local economic development;
- Whether or not road construction is beneficial to alleviate poverty of local residents;
- Whether or not you have opinions on land acquisition and demolition along the highway;
- Whether or not you have knowledge of the land requisition and demolition compensation policy in the construction of the highway;

- Whether or not you agree with land acquisition, demolition and resettlement;
- What requirements for you propose for resettlement compensation;
- What is the status of local environmental quality; and
- Provide a suggestion on environmental measures to reduce the environmental impact.

295. Table 44 summarises the responses. There was 100% support for the project. Over 95% agreed that the road would improve the local economy. Again, 87.50% saw construction improving local and public utilities, one felt that there would be no effect and two had "no opinion". Twenty-two respondents felt that local people's quality of life would improve with the improved road. Fifteen of the respondents felt there would be a beneficial impact to local and tourist attractions, nine felt there would be no effect.

Table 44: Questionnaire Result from Government Agencies, Enterprises and Community Groups

Survey content	Survey item	Number of Respondents (No.)	Percentage (%)
Views and attitudes on the construction of the highway	Support	24	100.00
	Undecided	0	0
Impact of the road construction on local economic development	Favorable	23	95.83
	Undecided	1	4.17
Impact of construction of the highway on the regional social and public utilities, such as energy, transportation, communications, culture and entertainment, health, education, etc.	Promote development	21	87.50
	No effect	1	4.17
	Undecided	2	8.33
Impact of the road construction on local ecological environment	No effect	16	66.67
	Affect	6	25.00
	Undecided	2	8.33
Impact of the road construction on the living quality of people	Improved	22	91.67
	No effect	2	8.33
	Undecided	0	0
Impact of the road construction on local monuments and tourist attractions	Positive effect	15	62.50
	No effect	9	37.50

Source: PRC Supplemental EIR, 2011.

296. Other comments were:

- Commence the Project as soon as possible, guarantee efficient and high-quality construction of this project and realize an earlier operation of the road; and
- Strive to reduce damage to the ecological environment, protect the native vegetation, occupy as little farmland as possible and control construction dust and noise pollution, and landscape both sides of the road.

297. **Stakeholders from affected communities.** Questionnaire survey of stakeholders from affected communities was conducted twice: the first time was in 2009 when the project was announced and during the EIR preparation, and the second time was in 2011 when there was alignment change and during the supplemental EIR preparation.

298. **2009 questionnaire survey.** The consultant team distributed 120 questionnaires to the villagers and farmers living along the proposed road and 108 responses were returned. Table 45 highlights the respondents' profiles and Table 46 summarises the survey results.

Table 45: Public Ethnicity and Profiles of Those Surveyed along Lancang-Meng'a Road

Location No.	Type	Sampling Population (person)	Ratio (%)	Location No.	Type	Sampling Population (person)	Ratio (%)
Investigation place							
1	Mengbin coal mine	4	3.70	16	Wa nationality of Liangxiang Village	4	3.70
2	Ayong Village	4	3.70	17	Meng'e Village	4	3.70
3	Mengbin Primary School	3	2.78	18	Longhai Village	16	14.81
4	Donggang Village	4	3.70	19	Menghai Village	4	3.70
5	Mengle Village	6	5.56	20	Outer Heling village	4	3.70
6	Jingxin Primary School of Jingxin Township	2	1.85	21	Village Committee of Mengma	3	2.78
7	Mengbai Village	5	4.63	22	1st level power station of Nanmahe	2	1.85
8	Nuoge Village	4	3.70	23	Guoying farmland	2	1.85
9	Zhongle Village	4	3.70	24	Jianghui Village	3	2.78
10	Fenshuiling	3	2.78	25	Manggui Village	4	3.70
11	72 tea plantation of Mengma	4	3.70	26	Manglang	3	2.78
12	Darongshu Village	4	3.70	27			
13	Darongshu(old village)	4	3.70	28			
14	Heyang village	4	3.70	29			
15	Nayanghe Village	4	3.70	30			
Gender							
1	Male	66	61.11	2	Female	42	38.89
Age							
1	Below 20 years old	3	2.78	4	40～49 years old	31	28.70
2	20～29 years old	27	25	5	50～59 years old	8	7.41
3	30～39 years old	36	33.33	6	Over 60 years old	3	2.78
Ethnic Group							

Location No.	Type	Sampling Population (person)	Ratio (%)	Location No.	Type	Sampling Population (person)	Ratio (%)
1	Dai	33	30.56	4	Hui	1	0.92
2	Va	26	24.07	5	Han	23	21.30
3	Lahu	25	23.15				
Education background							
1	Primary school or below	50	46.30	3	Junior high school, secondary normal school secondary technical school	20	18.52
2	Junior middle school	37	34.26	4	Junior college and above	1	0.92
Occupation							
1	Farmer	76	70.37	4	Driver	2	1.85
2	Teacher	6	5.56	5	Worker	17	15.74
3	Cadre	3	2.78	6	Other	4	3.70

Source: PRC EIR, 2009.

299. The largest group of those surveyed was farmers, accounting for 70.37%. Males were in the majority, accounting for 61.11% of the total. Age of the residents ranged between 20 to 49 years old and the Lahu, Dai, Va, Han and Hui ethnic groups were represented. The majority of those surveyed attended elementary and junior high school.

Table 46: Statistical Results of Survey of Stakeholders from Affected Communities

Sr. No.	Main Investigation Content	Suggestions	Ratio (%)
1	Understanding of the Project	Publicity during meeting	64.81
		Seen from media	12.96
		Heard from others	21.32
		Not know	0.92
2	Satisfaction to current traffic condition	Satisfied	47.23
		So-so	49.07
		Not satisfied	3.70
3	Whether approve to construct the Project or not	Approved	100
		Object	0
4	Whether satisfy the route selection, trend of the Project or not	Agree	94.45
		Not agree	1.85
		Don't know	3.70
5	Whether benefit to the local economic development or not	Benefit	97.22
		Not benefit	1.85
		Don't know	0.93
6	Whether beneficial to poverty alleviation of the local residents of the Project or not	Benefit	98.15
		Not benefit	0
		No effects	0.925
		Don't know	0.925
7	Effect on environment of the Project construction	Quite serious	2.75
		So-so	58.36

Sr. No.	Main Investigation Content	Suggestions	Ratio (%)
		No effects	38.89
8	Whether agree with land acquisition/demolition of the Project construction or not	No	65.74
		Yes	34.26
		Don't know	0
9	Whether know about the compensation policy of land acquisition/demolition of the Project construction or not	Yes	21.30
		Yes, a little	51.85
		Don't know	26.85
10	Whether to obey land acquisition/demolition and relocation	Yes	29.63
		Obey with conditions	70.37
		No	0
11	Any requirements to resettlement compensation?	Economic compensation	86.11
		Local relocation	10.19
		Change jobs	3.70
		Others	0
12	Major effects on you during construction period (available for multiple choice)	Construction noise	59.26
		Dust, fugitive dust	55.56
		Sewage water of construction	14.81
		Destruction of landscape	0
		Abandoned soil and dregs	8.33
13	Recommended suggestions to alleviate effects	Highway afforestation	67.59
		Sound barrier	9.26
		Far away from towns and villages	23.15
		Other	0
14	Hope the Project complete as soon as possible?	Yes	100

Source: PRC EIR, 2009.

300. Table 46 shows that on question one most of the surveyed people (64.81%) said they had heard of the project through public meetings. A minority of those surveyed, 21.32% said that they had heard from other people. Twelve percent had read about it in the media and only one person did not know of the project.

301. On the current traffic situation 47.23% and 49.07% felt it was acceptable, only 4 respondents felt the traffic was unacceptable.

302. A large number, 100% of the surveyed people, want the road built as it will improve traffic flow and access.

303. A high number, 94.45% agreed with the new road re-alignments and improved standard and want it opened as soon as possible.

304. 97.22% of respondents believe the construction of the highway would be a benefit to local economic development, but two people did not know believe it would be a benefit to the local environment.

305. There is a 98.15% belief that the road improvements will alleviate poverty.

306. When it comes to the status of the environment, 58.3% believed there will not be any serious concerns and 38.89% believed there will be no concerns. Only 3 (2.75%) people believe that there will be damaging impacts to the environment from road construction.

307. For question 8 in Table 46 those surveyed, 65.74% said they would strongly support construction of the highway and have no objection to land acquisition, demolition and farmland occupation. Some of the respondents (34.26%) have concerns that compensation may not be paid on time to them personally. There was a number of respondents (26.85%) who said they didn't know about the land acquisition and demolition compensation policy.

308. Most of the surveyed people, 70.3% said they could conditionally accept the land acquisition, demolition and resettlement, and only a few surveyed people (129.63%) said they were willing to obey. 86.11% of respondents hoped to get economic compensation, 10.19% hoped to get local settlement, 3.70% hoped to change their occupations or make other changes (such as receiving subsistence allowances by land acquisition).

309. For question 12 the majority of respondents believed that they will be impacted by construction noise (representing 59.26%) and fugitive dust (55.56%) during construction period, respondents also felt they would be affected by construction wastewater (14.81%) and spoil (8.33%). Some respondents (9.26%) recommended the implementation of sound insulation measures, keeping the highway away from the village (23.15%) and landscaping (67.59%) to reduce the environmental impact of highway construction.

310. Other opinions from respondents were as follows:

- A good design of the highway that results in the least occupation of farmland as possible; a one-time payment of land acquisition and demolition costs paid directly to affected households;
- The majority of the public consulted did not understand the land acquisition and resettlement compensation policy. The PMG needs to ensure the relevant departments strengthen information disclosure and consultation in respect of this aspect;
- Completing the highway landscaping at earliest stage possible during the construction to reduce the traffic noise pollution of the highway during operation. If the route is near villages and schools, it was suggested that sound proof windows or sound insulation in the walls should be installed to reduce noise; and
- 100% of the surveyed people agreed to the construction of the highway and hoped it would be completed and open to traffic as soon as possible.

311. **2011 supplemental questionnaire survey.** This involved a questionnaire survey of 75 stakeholders from affected communities, of which 69 were returned. The results are shown below.

Table 47: Results of Supplemental Questionnaire of Stakeholders from Affected Communities

Sr. No.	Main investigation content	Suggestions	Ratio (%)
1	Understanding of the Project	Publicity during meeting	65.22
		Seen from medium	11.59
		Heard from others	21.74
		Don't know	1.45

Sr. No.	Main investigation content	Suggestions	Ratio (%)
2	Satisfaction to current traffic condition	Satisfied	44.93
		So-so	46.68
		Not satisfied	8.70
3	Whether approve to construct the Project or not	Approved	100.00
		Object	0
4	Whether satisfy the route selection, trend of the Project or not	Agree	94.20
		Not agree	1.45
		Don't know	4.35
5	Whether benefit to the local economic development or not	Benefit	95.65
		Not benefit	1.45
		Don't know	2.90
6	Whether beneficial to poverty alleviation of the local residents of the Project or not	Benefit	97.10
		Not benefit	0
		No effects	2.90
		Don't know	0
7	Effect on environment of the Project construction	Quite serious	2.90
		So-so	57.97
		No effects	39.13
8	Whether agree with land acquisition/demolition of the Project construction or not	No	66.67
		Yes	33.33
		Don't know	0
9	Whether know about the compensation policy of land acquisition/demolition of the Project construction or not	Yes	21.74
		Yes, a little	49.28
		Don't know	28.99
10	Whether to obey land acquisition/demolition and relocation	Yes	26.09
		Obey with conditions	73.91
		No	0
11	Any requirements to resettlement compensation?	Economic compensation	88.41
		Local relocation	8.70
		Change jobs	2.90
		Others	0
12	Major effects on you during construction period(available for multiple choice)	Construction noise	60.87
		Dust, fugitive dust	53.62
		Sewage water of construction	14.49
		Destruction of landscape	0
		Abandoned soil and dregs	8.70
13	Recommended suggestions to alleviate effects	Highway afforestation	68.12
		Sound barrier	10.14
		Far away from towns and villages	21.74
		Other	0
14	Hope the Project complete as soon as possible?	Yes	100.00

Source: PRC Supplemental EIR, 2011.

312. Among respondents, 65.22% of them were informed through public meetings; 11.59% through media; and 21.74% heard from other people. Only one person did not know, accounting for 1.45%.

313. For question 2, 44.93% of the people expressed satisfaction with the traffic conditions while 46.38% were non-committal only 6 people (8.7%) disagreed.

314. In the survey, 100% of the residents agreed that the improved road would further improve the traffic situation in the region.

315. In the survey, 94.20% of the respondents agreed with the alignment selection and hoped that the road could be opened to traffic as soon as possible. Only 1 person disagreed (1.45%); another 3 persons did not express an opinion (accounting for 4.35%).

316. 95.65% of respondents believed that construction of this project will benefit the region's economic development, only 2 persons did not know (2.90%); 1 person (representing 1.45%) considered that it is not conducive to economic development in the region.

317. 97.10% of respondents believed that construction is beneficial to the local residents to alleviate poverty and will promote the rapid conversion of agricultural and sideline products into commodities; only two persons considered that it has no effect (representing 2.90%).

318. 57.97% of respondents believed that the degree of influence on the environment was not serious; 39.13% of them believed that it will have no effect and the construction unit of the Project can deal with environmental issues very well. Two people thought construction will damage the environment, (accounting for 2.90%). Their concerns will be addressed (see section C below).

319. 66.67% of respondents expressed strong support for the construction of the highway, and had no objection on the land acquisition and resettlement. 33.33% of respondents had opinions on land acquisition and resettlement. They were mainly worried that the compensation will not be paid on time and issued to them direct according to the standard. 28.99% of respondents did not understand relevant policies of land acquisition and resettlement compensation, 49.28% of respondents understood some but not all of the policies of land acquisition and resettlement compensation. They hoped that the relevant departments will provide further publicity and explanation on the Project land acquisition and resettlement compensation policy.

320. Most of the respondents (73.91%) agreed with the land acquisition and resettlement compensation policy with conditions. Some of the respondents (26.09%) expressed unwillingness to obey the policy. The majority of people (88.41%) hoped to get economic compensation, 8.7% hoped to get local settlement, 2.90% hoped that the compensation would lead to a change in their occupations.

321. The majority of respondents believed that they will be impacted by construction noise (representing 60.87%) and fugitive dust (53.62%) during construction. Also the respondents were concerned about construction wastewater (14.49%), and spoil (8.70%) discharges. Also they recommended the implementation of sound insulation measures (representing 10.14%), keeping the highway away from the village (21.74%) and landscaping of the highway (68.12%).

322. 100% of the respondents hoped that construction of the road would start and be open to traffic as soon as possible.

323. Other opinions offered by respondents were similar to those in the 2009 questionnaire survey.

C. Public Consultation on the Ning'er-Longfu Road

324. The PRC EIR consultants used the following methods to consult project affected persons: (i) information disclosure on government web-site; (ii) posting of project information in public places of affected communities; and (iii) questionnaire surveys of representatives from government agencies, enterprises and affected communities.

1. Information Disclosure

325. Information disclosure was conducted twice during the EIR preparation for the Ning'er-Longfu Road, both times by posting on the Pu'er Traffic and Transport Bureau web site (http://www.pesjtj.gov.cn/). The first time was from 25 June to 5 July 2012 upon commencement of the EIR, providing project and contact information. The second time was from 8 to 23 January 2013 after completion of the draft EIR, to solicit comments and suggestions on the impact assessment findings and proposed mitigation measures. No objection to the project was received during and after both web postings. There were two people who responded suggesting the PMG pay attention to environmental pollution concerns by adopting appropriate measures to suppress noise and dust during construction, and providing vehicle access in the construction zone.

326. Figure 14 shows screen shots from the information disclosure of the EIR on the Pu'er Traffic and Transport Bureau web site.

First web posting | **Second web posting**

Figure 14: Information Disclosure on the Pu'er Traffic and Transport Bureau Website

2. Public Posting

327. Project information was posted on billboards in villages of affected communities along the road alignment in June to July 2012, as shown in Figure 15.

Figure 15: Public Posting in Affected Communities along the Ning'er-Longfu Alignment

3. Questionnaire Survey

328. Government Agencies. Questionnaire surveys were conducted with representatives from the 15 government agencies listed in Table 48. Table 49 summarizes the questionnaire survey results.

Table 48: Government Agencies Participated in the Survey

SN	Administrative Entity	Government Agency
1	Ning'er Hani and Yi Autonomous County	Cultural Relic Management Department
2		Meteorological Bureau
3		Traffic and Transport Bureau
4		Water Affairs Bureau
5		Forestry Bureau
6		Environmental Protection Bureau
7		Housing and Urban-Rural Construction Bureau
8		Tourism Bureau
9		Development and Reform Bureau

SN	Administrative Entity	Government Agency
10		Land Resource Bureau
11	Jiangcheng Hani and Yi Autonomous County	Meteorological Bureau
12		Traffic and Transport Bureau
13		Forestry Bureau
14		Water Affairs Bureau
15		Urban-Rural Planning Bureau

Source: PRC EIR 2012.

Table 49: Statistical Results of Government Agency Questionnaire

Survey content	Survey Item	(Unit)	Proportion (%)
The perceptions and attitudes on the construction of the highway	Support	15	20. 100
	Opposed		
Construction of the highway and its effect on the region's economic development	Favorable	15	21. 100
	Unfavorable		
Construction of the road on social and public utilities in the region, such as energy, transport, communications, culture and entertainment, health, education, etc.	Favorable	15	22. 100
	No effect		
The construction of the road on the ecological environment of the region	No effect		
	Influential	15	100
	Do not know		
The construction of the road on the quality of people's lives The impact of the construction of the road on the heritage of the region, tourist attractions etc	Favorable	15	100
	No effect		
	Favorable		
	No effect	15	100
	Do not know		
Additional comments or concerns appended to the questionnaire	Reasonable line selection, occupy less farmland, good soil and water conservation work.		

Source: PRC EIR, 2012.

329. The 15 government agency representatives had the following comments:

- 100% actively supported or agreed to the construction of the road and requested that construction is completed as soon as possible;
- 100% agreed that the highway will have a positive role in promoting the economic development of the region;
- 100% of the representatives supported that road will benefit social and public utilities in the region, such as energy, transport, communications, culture, entertainment, health, and education;

- All 15 representatives were of the view that the reconstruction of the road will have a negative impact on the ecological environment: resulting in damage to vegetation and landscaping on both sides of the road is needed to minimize the impact on the ecological environment;
- 100% of the 15 representatives believed that the road upgrading will have a significant role in promoting improved quality of life for the local people; and
- Three representatives believed the road will promote the development of tourism in the region and the protection of cultural relics. The other 12 representatives believed that the road will have no effect on regional cultural heritage and tourist attractions.

330. They also urged:

- That the road be built to high standards and quality;
- To commence construction as soon as possible;
- To do a good job on the project and ensure water and soil conservation measures are implemented; and
- Implement the EIR measures to reduce the impact on the ecological environment.

331. **Stakeholders from affected communities.** The PRC environmental consultants conducted a random sample survey of residents in the affected areas of the proposed road reconstruction. One hundred participants were surveyed with a 100% return rate.

332. The survey respondents were mostly male, 20 years to 50 years old, and accounting for 98.3% of the total number of respondents. Ethnic groups surveyed included Han, Hani, and Yi. Farmers accounted for 85% of the total. Most respondents, 83.8%, had primary education (primary and junior high school).

333. The respondents filled out a pre-prepared public opinion survey form which provided information on the project. The survey focused on eliciting from the public their opinions on the following eleven issues. Table 50 summarizes the survey results.

- Are you in favor of the construction of the highway;
- Whether the project can ease the traffic problem;
- Will the road result in economic development of the region;
- Will the project result on improving the poverty level of the local people;
- Construction of the project will result in demolition of housing;
- Awareness of land acquisition and relocation compensation policy;
- The feelings on land acquisition, demolition of housing and resettlement;
- What are the requirements for resettlement compensation;
- Existing quality of the local environmental;
- The main environmental impacts; and
- What environmental protection measures need to be put in place.

Table 50: Results of Questionnaire of Stakeholders from Affected Communities

No.	Survey Questions		Survey Opinion	Statistics	Proportion
1	Are you in favor of the construction of the highway?		Approval	100	100%
			Do not agree	0	0
			Do not know	0	0
2	Will the project alleviate the traffic?		Yes	100	100%
			No	0	0
			Do not know	0	0
3	Will the road provide economic development of the region?		Favorable	100	100%
			Unfavorable	0	0
			No effect	0	0
			Do not know	0	0
4	Will construction of the road help the local people out of poverty?		Favorable	100	100%
			Unfavorable	0	0
			No effect	0	0
			Do not know	0	0
5	The project will require some fields and demolition of some housing. What is your opinion?		No concern	100	100%
			Have a concern	0	0
			Do not know	0	0
6	Are you familiar with land acquisition and relocation compensation policy?		Understand	17	17%
			Understand some	52	52%
			Do not know	29	29%
			Unsure	2	2%
7	Whether to obey land acquisition/ Demolition and resettlement?		Obey	48	48%
			Conditional obedience	52	52%
			Disobedience	0	0
8	What do you require if facing resettlement?		Economic compensation	50	50%
			Local integration	39	39%
			Change career	0	0
			Other	11	11%
9	Status of local environmental quality	Forest status	Good	65	65%
			General	35	35%
			Serious damage	0	0
		Soil erosion status	Mild	81	81%
			Moderate	19	19%
			Severe	0	0
			Pole strength	0	0
		Sources of drinking water	Rivers, lakes	0	0
			Groundwater	17	17%
			Running water	83	83%
			Yan Tang water	0	0
		Drinking water quality	Good	26	26%
			Acceptable	74	74%
			Serious pollution	0	0
		Wild animal	Common	13	13%

No.	Survey Questions		Survey Opinion	Statistics	Proportion
			Rare	87	87%
			Serious hunting	0	0
10	What are the major environmental problems with road construction?		Destruction of vegetation	45	45%
			Soil erosion	52	52%
			Occupation of farmland	12	12%
			Water Pollution	0	0
			Noise pollution	28	28%
			Air Pollution	40	40%
			Landscape damage	14	14%
			Other	0	0
11	Need to adopt environmental protection measures?	Construction period	Reduce construction noise	60	60%
			Dust suppression	77	77%
			Wastewater discharge after treatment	12	12%
			Location of the disposal	2	2%
		Operation period	Highway greening	74	74%
			Implementation of sound attenuation measures	26	26%
			Highway drainage	5	5%
			Increase the channel	1	1%
			Spoil material recovery	4	4%
			Water quality protection	20	20%
			Do not know	1	1%

Source: PRC EIR, 2012.

334. As Table 50 shows the respondents were 100% in support of the first five questions on the survey dealing with support for the project and anticipated economic benefits.

335. Although there was 100% understanding that acquisition of land and resettlement would be required, the respondents were not familiar with the expropriation process. Sixty-nine percent understood or had some understanding of the process; however, thirty-one percent had no knowledge of the process. They said they would respect the expropriation process with the majority wanting financial compensation and to be resettled locally.

336. On the environmental questions, most of the respondents (65%) expressed that the environment was in a good state. Also 81% felt that the forest, vegetation, soil erosion conditions were good. 26% of the respondents believed that drinking water quality was good with 74% indicating it was acceptable. The majority of respondents (87%) considered there was rare wildlife within their local environment.

337. Most of the respondents (45%) believed that loss of vegetation will be the main environmental impact, with 68% of people believing that noise and air pollution will be the most negative effect of construction.

338. The majority of the respondents (77%) believed that dust suppression and noise attenuation (60%), will be minimized during the operation phase by ensuring and maximizing road landscaping measures (74%).

339. In summary, most of the respondents believed that the road construction will create adverse impacts in the form of noise pollution, occupation of farmland, air pollution and damage to vegetation. It was considered that road landscaping measures can mitigate the impact by providing sound attenuation and improve highway drainage.

340. The respondents also had the following comments:

- That the road design should strive to occupy as little arable land, as possible;
- That compensation for land acquisition and resettlement should be timely, and a one-off payment in full. It was also recommended that affected persons should be treated well and more should be done to gain the support of the general public for the project; and
- Specific environmental mitigation measures as recommended in the EIR should be implemented to reduce the adverse environmental effects of construction of the project.

D. Public Consultation on the Rehabilitation of Rural Roads

1. Questionnaire Survey

341. The Guangxi environmental consultants preparing the EIT carried out a consultation exercise along the rural roads. However, only 12 questionnaires (see Appendix 3) were submitted to the PPTA team. A supplementary consultation exercise for the five supplementary rural roads was also carried out.

342. Based on the 12 recorded interviews, only one respondent on each of the 12 rural roads was interviewed and recorded. The survey results are shown in Table 51.

343. This section describes the results of the public consultation carried out along the 12 selected rural roads. The data sheets and results can be found in Appendix 3. In addition, the PPTA Social Development Specialist incorporated five environmental/social questions in the household survey exercise.

Table 51: Results of Questionnaire of Residents along Twelve Rural Roads

Rural Road No.	Questions																								
	1				2			3			4			5			6			7					8		
	How do you know about this project?				Do you think the project will contribute to the local economy?			The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?			Do you know about the compensation policy for land acquisition and resettlement?			Will you obey the land acquisition, building demolition and resettlement policy?			How do you think the project will impact the environment?			Which affects you most during construction?					Do you agree with the construction of these rural roads?		
	At meeting	From media	From others	No idea	Yes	No	No idea	Yes	No	No idea	Yes	A little	No knowledg e	Yes	Possibly	No	Big effect	Small effect	No effect	Noise	Dust	Wastewat er	n of landscap	Other	Agree	Disagree	No idea
1	√				√				√			√		√					√					√	√		
2			√		√				√			√		√					√					√	√		
3	√				√				√		√			√				√						√	√		
4	√				√				√		√			√				√						√	√		
6	√				√				√		√			√				√						√	√		
19	√				√				√			√		√				√		√					√		
20	√				√				√			√		√				√						√	√		
21	√				√				√			√		√				√						√	√		
22	√				√				√			√		√					√					√	√		
23	√				√				√		√			√				√						√	√		
24	√				√				√		√			√				√						√	√		
25	√				√				√		√			√				√			√				√		

Source: PRC EIR, 2012.

344. The results of the consultation show a very consistent response where there is an overwhelming positive response to road construction and the expected economic benefits that will result. Based on discussions with the PMTB and the data provided on the rural roads, where existing right-of way width is adequate to meet the paved cross-section, there is no anticipated land acquisition or resettlement required for the proposed works on these roads. However, it was evident from the survey that respondents had some knowledge of the expropriation process and would comply should it be required. The majority of respondents did not believe that there would be a significant negative effect on the environment. Most responded that they had concerns other than noise, dust and water pollution. The "other" concerns were not elaborated by the respondents.

2. Household Survey

345. A number of environment-related questions were added to the household survey questionnaire conducted along the rural roads. Table 52 presents the responses received to these questions.

Table 52: Environmental Concerns from the Household Survey

Environmental Question			# of respondents (total = 138)	% of respondents
Air Quality	Is dust generated by motor vehicles a concern?	Yes	87	63.0
		No	51	37.0
		Total	**138**	**100.0**
Drainage and water quality	Drains in the road that remove water	Yes	125	90.6
		No	13	9.4
		Total	**138**	**100.0**
	If no, do you experience in the rainy season? (N=13	flooding	6	46.2
		Ponding of water in front of the house	4	30.8
		Access difficulty	3	23.1
		Mobility problems	8	61.5
		Health concerns from standing water	1	7.7
	Do you receive your domestic water from a well?	Yes	15	10.9
		No	123	89.1
		Total	**138**	**100.0**
	Distance of your well from the road?	Longest distance	2,000m	
		Shortest distance	1m	
		Average distance	254.8m	
	If yes do have good water quality	Yes	14	93.3
		No	1	6.7
		Total	**15**	**100.0**
Safety	Is speed of vehicles passing your home a safety concern?	Yes	101	73.2
		No	37	26.8
		Total	**138**	**100.0**
	If yes, would like to see speed controls installed?	Yes	98	97.0
		No	3	3.0
		Total	**101**	**100.0**

346. The concern raised regarding dust levels should be addressed through paving of the roads.

347. Ninety percent of the respondents indicate that they have drains in their villages. Only 9.4% indicate that they have no drainage structures. The respondents in the villages without drainage indicate that during the rainy season they experience: flooding (46%), ponding in front the home (30%), access difficulties (23%), and mobility issues (61%). Only one respondent indicated that there was health concern from standing water. All of these adverse effects can be rectified by installing drainage measures.

348. In paving the roads the contractors have to ensure that they do not block or alter existing drainage. Where villages have no drains the provision of drainage should be provided in the detailed design. In adition, the Village Acess Spot improvement component also provides for drainage measures. Good drainage will also provide a longer life-span of the pavement.

349. Only 15 of 123 respondents receive the domestic water from wells. The average distance for 14 of the wells is 254m from the road. Therefore, most wells are set-back sufficiently to avoid any negative effects from paving. However, one well was one meter from the road. This road, household and well should be identified and protected during construction. Well water quality is considered good for 14 out of the 15 respondents. Again, the one well with poor water quality should be identified and sampled If the water quality is found to be poor, then remediation measures (new well or piped water) should be installed.

350. Road safety is a concern. One hundred and one (73%) out of 138 indicated speed through their villages was a concern and that 97% felt speed controls were necessary. The road safety component of the PPTA is addressing these concerns and the road sfety engineer has confirmed that as part of the works, road safety measures in the form of berms will be installed through all villages.

E. PRC Procedures to Address Public Respondents Concerns

351. The opinions offered by the public have been and will continue to be taken into account by the design consultants, the EA and local government and will be documented. The public opinions on the Project include:

352. **Compensation for land acquisition and demolition.** Land acquisition and demolition of the Project is the responsibility of the government at each level. According to relevant policies and guidelines, the EA will submit the land acquisition and demolition fund to the district (county) government where the re-constructed road is located. Local government will take charge of the compensation payments by conducting control over land acquisition examining and approving applications, based on appraisals of property and assigning valuation. Based on the principles of openness, fairness and transparency, the program for land acquisition compensation and resettlement will be announced in all townships and towns.

353. The EA is to hold a wide range of public hearings before land acquisition and demolition is carried out to ensure the households to be relocated understand the land acquisition and demolition process as well as the policies toward re-settlement and compensation. The standard method for allotting monetary compensation for land acquisition and demolition shall be open and transparent to any organizations and individuals whose land will be expropriated. Notify the affected organizations and individuals before land acquisition is carried out. The EA is to focus on the concerns of the households affected by land acquisition and demolition.

354. The EA, the IA and designers along with the contractor shall further consult with local government and the public during the design and construction of the Project, and properly satisfy the reasonable requests of the public.

355. **Noise.** The residents and schools along the proposed road are concerned about the effect of noise and hope that effective noise reduction measures will be taken. In response, the IA will conduct specific designs of noise reduction measures for villages and schools based on the EIR report. Multiple noise reduction measures such as installing insulation and soundproof windows will be considered. The EA also agrees to adopt these suggestions, and any other special designs for noise attenuation based on the requirements in the EIR report when the subgrade has been basically finished.

356. **Addressing other environmental concerns.** The specific measures and requirements for environmental protection provided in the EIR report shall be implemented during design and construction of the Project so as to reduce the adverse impacts of the Project on water, air and acoustic environments along the line.

F. Future Plans for Public Participation

357. Meaningful consultation will continue throughout construction and operation phases. The IA and the PMTB/PPMO will be responsible for organizing the public consultations, with the support of the Loan Implementation Environmental Consultant (LIEC) to be hired by the PPMO under the loan implementation consulting services. The contractors will be required to communicate and consult with the communities in the project area of influence, especially those near the rural road alignments. Eye-catching public notice boards will be set at each work site to provide information on the purpose of the project activity, the duration of disturbance, the responsible entities on-site (contractors, IA), and details of project level grievance redress mechanism (GRM). Contact information for all GRM entry points and the PPMO will be disclosed on the construction site information boards.

358. Future consultation (see E) will involve informal interviews with affected persons on an ad hoc basis during inspection and monitoring of EMP implementation. The EMP (attached to this EIA - Attachment EMP) provides more details of proposed future public consultation.

359. The project environmental information will be disclosed by ADB as follows: (i) this project EIA will be made available at www.adb.org; (ii) copies of the domestic EIRs (in Chinese) are available on request at the PPMO; and (iii) environment progress will be reported in the quarterly project progress reports and the semi-annual environmental monitoring reports which will be disclosed on ADB's project website (www.adb.org).

VII. GRIEVANCE REDRESS MECHANISM

A. PRC Guidelines on Grievance Redress in the Environmental Field

360. Through establishment of a grievance redress mechanism (GRM), PMG shall promptly address affected people's concerns, complaints, and grievances about the Project's environmental performance at no cost to the complainant and without retribution. The GRM shall make use of the existing procedures of PRC and Yunnan Province. The PEPB has established a hotline (number 12369) for receiving complaints related to environmental issues in the city.

361. The GRM will be fully compliant with the PRC's Public Complaints Decree No. 431(01-2005), and the Ministry of Environmental Protection (MEP) Environmental Complaints Management Regulation (Decree No. 34).

B. GRM to be Applied to the Project

362. Public participation, consultation and information disclosure undertaken as part of the domestic environmental impact assessment process, assessment and development of resettlement plans, and consultations undertaken by the project consultants have discussed and addressed major community concerns. Continued public participation and consultation have been emphasised as a key component of successful project implementation. As a result of this public participation and safeguard assessment during the initial stages of the project, major issues of grievance are not expected. However, unforeseen issues may occur. To settle such issues effectively, a transparent GRM for lodging complaints and grievances has been defined for environment related issues.

363. In addition to serving as a platform to resolve grievances, the GRM has been designed to help achieve the following objectives: (i) open channel for effective communication, including the identification of new environmental issues of concern arising from the project; (ii) prevent and mitigate any adverse environmental impacts on communities caused by project implementation and operations; (iii) improve mutual trust and respect and promote productive relationships with local communities; and (iv) build community acceptance of the Project.

364. The GRM will be accessible to diverse members of the community, including more vulnerable groups such as women and youth. Multiple points of entry and modes of access, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available. Opportunities for confidentiality and privacy for complainants will be honored where this is requested. The details of the GRM are described in the EMP (Attachment EMP), and were also explained during public consultation with the participants. The GRM will be operational prior to commencement of construction works.

365. In addition to the GRM described above, ADB's overall accountability mechanism (2012) applies.[14] The mechanism provides opportunities for people adversely affected by ADB-financed projects to express their grievances; seek solutions; and report alleged violations of ADB's operational policies and procedures, including safeguard policies. ADB's accountability mechanism comprises two separate, but related, functions: (i) consultation, led by ADB's special project facilitator, to assist people adversely affected by ADB-assisted projects in finding

[14] The revised accountability mechanism became effective on 24 May 2012.

solutions to their problems; and (ii) providing a process through which those affected by projects can file requests for compliance review by ADB's Compliance Review Panel.

VIII. ENVIRONMENTAL MANAGEMENT PLAN

A. Objectives

366. The environmental management plan (EMP) for the Project is presented in Attachment A. The EMP defines mitigation measures and describes the involved institutions and mechanisms to monitor and ensure compliance with environmental regulations and implementation of the mitigation measures. Such institutions and mechanisms will seek to ensure continuous improvement of environmental protection activities during preconstruction, construction, and operation of the project in order to prevent, reduce, or mitigate adverse impacts. The EMP draws on the domestic EIR and on the PPTA discussions and agreements with the relevant government agencies. The EMP will be reviewed and updated at the end of the detailed design in order to be consistent with the final detailed design. The updated EMP will be disclosed on ADB's project website.

B. Organizational Structure for Environmental Management

367. As Executing Agency (EA), the Pu'er Municipal Government (PMG) will be responsible for the overall implementation and compliance with loan assurances and the EMP (including Environmental Monitoring Plan). The EA has established a Pu'er Project Management Office (PPMO), who will be responsible, on behalf of the EA, for the day-to-day management of the project. The PPMO will have the overall responsibility delegated by the EA for (amongst others) supervising the implementation of environment mitigation measures, coordinating the project level Grievance Redress Mechanism (GRM) and reporting to ADB. PPMO will engage technical engineering design institutes and project implementation consultants and will manage the procurement process. The PPMO will appoint one environment specialist in charge to supervise the effective implementation of the EMP and to coordinate the Project level GRM. In addition, the PPMO will prepare quarterly project progress reports and semi-annual environmental monitoring reports and submit them to ADB.

368. Pu'er Municipal Transport Bureau. (PMTB) will be the implementing agency (IA) for the project. PMTB will assume the debt servicing responsibility as the end-user of the ADB loan. It will implement project components, administer and monitor contractors and suppliers, and be responsible for construction supervision and quality control. PMTB will ensure that the EMP is implemented, and respond to any adverse impact beyond those foreseen in the EIA. PMTB will also attend to requests from relevant agencies and ADB regarding the mitigation measures and monitoring program. PMTB will nominate dedicated, trained, and qualified environment specialists to (i) supervise contractors and ensure compliance with the EMP; (ii) conduct regular site inspections; (iii) coordinate periodic internal environmental monitoring in accordance with the approved monitoring plan, (iv) act as local entry point for the project grievance redress mechanism (GRM); (vi) submit quarterly monitoring results to the contractors for information, and to the PPMO and PEPB for verification and confirmation.

369. The IA, PMTB, will contract an independent Environmental Supervision Engineer (ESE), who could be a qualified individual or a company, to undertake compliance monitoring for third-party verification of compliance with EMP implementation. They will also engage a Loan Implementation Environmental Consultant (LIEC) as part of the Loan Implementation Project Management Consulting Services.

370. Contractors will be responsible for implementing the mitigation measures during construction under the supervision of the PPMO through the ESE and LIEC. To ensure that

contractors comply with the EMP's provisions, the PPMO and PMTB will prepare and provide the following for incorporation into the bidding procedures: (i) a list of environmental management and monitoring requirements to be budgeted by the bidders in their proposals, (ii) environmental clauses for contractual terms and conditions, and (iii) full EIA and EMP for compliance. In their bids, contactors will be required to respond to the environmental management and monitoring requirements defined in the EMP. Each contractor will be required to develop contract-specific EMPs and will assign a person responsible for environment, health and safety.

371. Environmental training will be essential for the PPMO, PMTB and contractors to implement the EMP. The PPMO, with the support of the loan implementation environmental consultant (LIEC) who will provide the training, will be responsible for organizing training programs for the staff and environmental specialists within PPMO and PMTB, which will cover (i) environmental laws, regulation, and policies; (ii) implementing mitigation measures; (iii) environmental technologies and procurement; (iv) environmental monitoring, and supervision; and (v) documentation and reporting.

372. **Loan Implementation Environmental Consultant (LIEC).** Under the loan implementation consultancy services and within six months after loan signing, a LIEC will be appointed by PMTB to support the project with (i) project preparation, including EMP update; (ii) EMP training, (iii) semi-annual EMP compliance verification; (iv) quarterly project progress and semi-annual environment monitoring reporting; (v) identifying environment-related implementation issues and necessary corrective actions to be reflected in an action plan; and (v) undertaking site visits as required. The LIEC will:

(i) assess the project components' environmental readiness prior to implementation based on the readiness indicators defined in Table 4 in the EMP;
(ii) support PMTB in updating the EMP including monitoring plan as necessary to revise or incorporate additional environmental mitigation and monitoring measures, budget, institutional arrangements, etc, that may be required based on the detailed design; submit to ADB for approval and disclosure; ensure compliance with the PRC's environmental laws and regulations, ADB's Safeguard Policy Statement (2009) and Public Communications Policy (2011), and the World Bank Group's Environmental, Health and Safety Guidelines;
(iii) if required, update the EIA and EMP reports for changes in the project during detailed design (for example if there is a major scope change) that would result in adverse environmental impacts not within the scope of the approved EIA/EMP;
(iv) support the PMG, PPMO, PMTB and tendering companies in preparing tender documents; ensure that the bidding documents and civil works contracts contain provisions requiring contractors to comply with the mitigation measures in the EMP and that relevant sections of the project EMP (or updated EMP, if prepared) are incorporated in the bidding and contract documents;
(v) assist the PMG, PPMO, PMTB to establish a GRM, and provide training for the PPMO and GRM access points;
(vi) conduct regular EMP compliance assessments, undertake site visits as required, identify any environment-related implementation issues, propose necessary corrective actions, reflect these in a corrective action plan;
(vii) assist the PPMO to prepare semi-annual environmental monitoring and progress reports to ADB;

(viii) provide training to PPMO, PMTB and contractors on environmental laws, regulations and policies, SPS 2009, EMP implementation, and GRM in accordance with the training plan defined in the EMP; and
(ix) assist the PPMO and PMTB in conducting consultation meetings with relevant stakeholders as required, informing them of imminent construction works, updating them on the latest project development activities, GRM.

C. Inspection, Monitoring and Reporting

373. Internal environmental monitoring will include monitoring of air quality, noise, water quality and other parameters described in the EMP. Internal environmental monitoring during construction and operation will be conducted by the Pu'er Environmental Monitoring Station, a licensed environmental monitoring station (EMS), contracted by PMTB. The monitoring results will be submitted to the PPMO and PMTB, and will be reported in the quarterly project progress reports and the semi-annual environmental monitoring reports prepared by the PPMO and submitted to ADB.

374. External environmental monitoring will be periodically conducted by the local environmental authorities in the framework of their legal mandate to check compliance with applicable environmental regulations. They will be responsible for undertaking regular and random environmental monitoring and inspection activities before, during, and after construction as well as in the event of emergencies.

375. **Compliance monitoring.** EMP compliance monitoring/ verification will be undertaken by the PPMO, with support of the ESE and LIEC. The PPMO will report to ADB the progress of the EMP, implementation, environmental performance of the contactors, and environmental compliance in the semi-annual environmental monitoring reports. Quarterly project progress reports will include a summary of EMP implementation progress and compliance. The LIEC will support the PPMO in developing the semi-annual environmental monitoring reports. The reports should confirm the project's compliance with the EMP, local legislation such as EIA requirements, and identify any environment related implementation issues and necessary corrective actions, which should be reflected in a corrective action plan. The performance of the contractors will also be reported with respect to environmental protection and impact mitigation. The operation and performance of the project GRM, environmental institutional strengthening and training, and compliance with all covenants under the project will also be included in the report.

376. Moreover, within 3 months after each component completion, or no later than one year with permission of the PEPB, environmental acceptance monitoring and audit reports of each component completion shall be: (i) prepared by a licensed environmental monitoring station in accordance with the PRC Regulation on Project Completion Environmental Audit (MEP, 2001), (ii) reviewed for approval by environmental authorities prior to the official commencement of component operation, and (iii) finally reported to ADB. The environmental acceptance reports for completed components will indicate the timing, extent, effectiveness of completed mitigation and of maintenance, and the needs for additional mitigation measures and monitoring during operation. These environmental acceptance reports will be provided to the LIEC who is responsible for preparing an environmental completion report and inputs for the Project Completion Report for ADB.

377. After project completion, environmental management responsibilities will be handed over to Operation and Maintenance units.

IX. CONCLUSIONS

378. The Project was classified as environment Category A as it was considered that there would be some potentially significant environmental and involuntary resettlement impacts. The project will not directly impact any sensitive, ecological, heritage or cultural sites. Most of the negative impacts will arise from construction activities and their effects on ambient air, surface water and noise conditions, soils (excavation, haulage and disposal), traffic management, and resettlement of project affected persons. During operation, increased traffic volumes are expected to result in increased emissions and noise levels. This assessment has determined that project environmental impacts are largely localized and can be reduced to acceptable levels through appropriate mitigation measures. Estimates showed that existing GHG emissions on the project roads combined already exceeded ADB SPS (2009) threshold of 100,000 t/a. It was estimated that GHG emissions from all the project roads would total approximately 278,000 t/a in year 2030. Annual reporting of GHG emissions will be required.

379. Sensitive receptors have been identified for the two regional roads and 31 rural roads. The Menglian-Menga Road has 16 sensitive receptors including two river crossings. The assessment found that ambient and predicted noise levels exceed standards at Menghai Primary School, a noise barrier is proposed. Insulation and double glazed windows are proposed for a further three sites at Mengma Township, Manglang and Anma. On the Ning'er-Longfu road there are 36 sensitive receptors and 11 river crossing sites. The assessment found predicted noise levels that exceed national standards at six locations, noise barriers will be installed at these locations. Costs are provided in the EMP.

380. The regional road projects will result in improved access to borders with Vietnam and Myanmar. The Wildlife Conservation Society has carried out a specialist wildlife trafficking due diligence study, increased wildlife trafficking could be an induced impact from this project. The study recommended institutional strengthening of CITES enforcement for border control staff, raising awareness and improved co-ordination between government departments at a prefecture and county level and with neighbouring countries to control wildlife trafficking. These recommendations will be implemented through the institutional development component of this project (see Project Administration Manual, Appendix 2 Consultants' Terms of Reference). Cross border wildlife trafficking could also increase the occurrence of vector borne diseases and strengthening health inspection and disease control at border crossings should also be considered.

381. The assessment determined that the preferred alignment for the Ning'er-Longfu road traverses through Protection Zone 1 (from K25+200 to K44+500) and Zone 2 (K44+500 to K45+200) of the planned Wenquan River Reservoir, a centralized drinking water source. Consequently, a new alignment, the Xishitou to Shanshen Temple Pass alignment is now the preferred alignment. The EMP also requires the avoidance of intact woodlands along the Menglian-Meng'a alignment at sections K0+500-K5+500、K55+200-K65+500、K70+100-K72+300、K75+300-K77+200.

382. For the rural roads, proposed paving works is expected to result in generally minor, and temporary localized negative impacts due to all construction activity being confined to ROW. There will be localized increases in noise levels due to PME, temporary material stockpiles and water requirements. Access may be restricted while the pavement cures and temporary detours may be required. Rural Road #11, an existing road, traverses 3.5 km through the experimental

zone of the Ailao Mountain National Nature Reserve. It was confirmed by the Ailao Mountain Jingdong Management Bureau that no special permit would be needed for paving this section of the rural road. The boundary of the nature reserve will be demarcated and no tree felling and concrete batching will be allowed in the road section within the nature reserve. Works will be carried out in close co-ordination with reserve bureau staff to ensure that impacts are restricted to the ROW.

383. Paving of the rural roads will result in a significant reduction of road dust as well as have a number of important benefits. Local residents during the public consultation program, indicated that reduced travel time to markets and improved transport services would be very beneficial. The project proposes road safety improvements in the villages of the rural roads, including traffic calming and a community safety program. The rural road maintenance program proposes developing procedures for local people to maintain their improved roads. The proposed village access road spot improvements will improve drainage structures, retaining walls and other road features Local people with minimal training and supervision, using local materials, will carry out most improvements. Under the Rural Transport Services sub-component improved public transport will be encouraged to service the rural roads.

384. During the detailed design the Design Institute will document how issues, concerns and comments as expressed in the public consultation sessions have been addressed. Results will be included in the update of the EIA that will be carried out following detailed design. The project GRM will deal with affected persons' environmental concerns throughout implementation. The PPMO will publish and disseminate information to the communities along the Project corridors and affected persons.

385. The Environmental Management Plan (EMP) will be included in contracts for regional and rural road works to ensure that Contractors include costs and resources in civil work estimates for implementing environmental mitigation and monitoring measures identified for the project. The EMP includes all estimated mitigation and monitoring costs.

386. In view of the possibility that some rural roads might be replaced by other existing rural roads, an EARF has been prepared to provide guidance to the PPMO for selection, screening, categorisation and environmental assessment of substitute rural roads, as required.

387. This EIA and EMP provides PMTB with a comprehensive assessment of environmental impacts associated with all project components and sets out all necessary environmental management measures for design and implementation. No further surveys or studies will be required as long as there are no major changes in the type and location of construction activities proposed.

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ATTACHMENT TO ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

For the proposed Yunnan Pu'er Regional Integrated Road Network Development Project, People's Republic of China.

Prepared by the Pu'er Municipal Government for the Asian Development Bank.

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A. Introduction

1. This Environmental Management Plan (EMP) has been developed for the Yunnan Pu'er Regional Integrated Road Network Development Project (the Project). This EMP outlines mitigation and monitoring requirements designed to avoid or reduce environmental impacts to acceptable levels, to maximize environmental benefits and achieve compliance with the PRC environmental laws and regulations and ADB's Safeguard Policy Statement (2009). The EMP draws on the findings from the project EIA, the domestic EIRs, PPTA and ADB review mission discussions and agreements with the relevant government agencies. It includes the following components:

(i) Institutional responsibilities for EMP implementation
(ii) Environmental mitigation
(iii) Environmental monitoring program
(iv) Independent compliance monitoring
(v) Institutional capacity building and training
(vi) Public consultation plan
(vii) Estimated budget requirements
(viii) Reporting requirements
(ix) Project specific grievance redress mechanism (GRM)

2. The EMP will be reviewed and updated at the end of the detailed design in order to be consistent with the final technical design. The updated EMP will be disclosed on the ADB project website and included in the Project Administration Manual (PAM). The updated EMP will also be included as a separate annex in all bidding and contract documents. The contractors will be made aware of their obligations to implement the EMP and to budget EMP implementation costs in their proposals.

3. Environmental monitoring results will be used to evaluate (i) the extent and severity of actual environmental impacts against the predicted impacts, (ii) the performance of the environmental protection measures and compliance with regulations, (iii) overall effectiveness of the project EMP, and (iv) need for adjustment of the project EMP.

B. Institutional Responsibilities for EMP Implementation

4. Table 1 shows the institutional responsibilities for EMP implementation covering activities across the project stages from project preparation to operation. Key points are summarized below.

(i) The Pu'er Municipal Government is the Executing Agency (EA) who has overall responsibility for project implementation and compliance with loan assurances and the EIA/EMP. The EA has established the Pu'er Project Management Office (PPMO) for this project, who has been delegated overall responsibility for day-to-day management of the Project, supervising the implementation of the EMP, coordinating the project environmental grievance redress mechanism and reporting to ADB. The PPMO will submit quarterly project progress reports to ADB and semi-annual environmental monitoring reports.
(ii) The Pu'er Municipal Transport Bureau is the Implementing Agency (IA) responsible for implementing project components, administering and monitoring contractors and suppliers, construction supervision, quality control and EMP implementation. The IA will prepare bid documents and ensure that bids are

responsive to environmental requirements and budgets and contracts include environmental clauses covering major items in the EIA, and the full EMP.

(iii) The PPMO and the IA will both be required to assign at least one environmental staff to manage, coordinate, oversee and verify EMP implementation.

(iv) Some mitigation measures (for example, road alignment avoiding sensitive or protected areas) need to be built into the detailed design by the Design Institutes.

(v) The IA, PMTB, will contract the Pu'er Environmental Monitoring Station (PEMS) to conduct an environmental monitoring program as set out in this EMP during the construction and operational stages.

(vi) The IA, PMTB, will also contract an independent Environmental Supervision Engineer (ESE), who could be a qualified individual or a company, to undertake compliance monitoring for third-party verification of compliance with EMP implementation.

(vii) A Loan Implementation Environmental Consultant (LIEC) will be appointed through the Loan Implementation Project Management Consulting Services. They will assist the PPMO and the IA with EMP implementation including environmental training and reporting.

(viii) Contractors will be responsible for implementing the mitigation measures during construction under the supervision of PPMO through the ESE and LIEC. In their bids, contractors will be required to respond to the environmental management and monitoring requirements defined in the EMP. Each contractor will be required to develop site specific EMPs and will assign a person responsible for environment, health and safety. After project completion, environmental management responsibilities will be handed over to Operation and Maintenance (O&M) units.

Table 1: Environmental Responsibility

Responsible Entity	Project Stage and Environmental Responsibility				
	Project Preparation	**Engineering Detailed Design**	**Tendering & Pre-construction**	**Construction**	**Operation**
PMG	The Executing Agency (**EA**) for the Project responsible for overall implementation and compliance with loan assurances and the EMP.				
PPMO	Established by the EA to be responsible for the day-to-day management of the Project. The PPMO has overall responsibility delegated by the EA for supervising the implementation of environment mitigation measures, coordinating the project level GRM and reporting to ADB				
	• Engage design institutes on FSR, EIR, RP and SWCR	• Engage design institutes • Review updated EMP, confirm that mitigation measures have been included in engineering detail design	• Appoint at least one environmental specialist on staff • Incorporate EIA/EMP clauses in tender documents and contracts • Prepare environmental assessments for replacement rural roads according to the EARF and submit to ADB for approval.	• Supervise the effective implementation of the EMP • Establish and operate the project public complaint s center and coordinate the project environment GRM. • Prepare quarterly project progress reports and semi-annual environment monitoring reports and submit them to ADB • Conduct information disclosure and public consultation • Inspect implementation of mitigation measures.	• Instruct the IA (PMTB) and O&M units on environmental management requirements • Prepare quarterly project progress reports and semi-annual environmental monitoring reports until a PCR is issued • Calculate CO_2 emissions from project roads annually and report to ADB until a PCR is issued.
PMTB	The Implementing Agency (**IA**) for the Project to implement project components, administer and monitor contractors and suppliers, and take responsibility for construction supervision and quality control. PMTB will ensure that the EMP is implemented proactively and will respond to any adverse impact beyond those foreseen in the EIA and ensure that if there are any changes in scope the EIA/EMP will be updated, as needed. PMTB will also attend to requests from relevant agencies and ADB regarding the mitigation measures and environmental monitoring program.				
			• Manage the procurement process • Incorporate EIA/EMP clauses in tender documents and contracts • Appoint at least	• Supervise contractors and ensure compliance with the EMP • Approve method statements • Coordinate construction supervision and	• Coordinate environmental monitoring according to the approved EMP until a PCR is issued

Responsible Entity	Project Stage and Environmental Responsibility				
	Project Preparation	**Engineering Detailed Design**	**Tendering & Pre-construction**	**Construction**	**Operation**
			one environmental specialist on staff • Engage LIEC as part of the Loan Implementation Project Management Consulting Services • Engage PEMS for environmental monitoring • Engage ESE for independent compliance monitoring	quality control • Coordinate environmental monitoring according to the environmental monitoring program in the approved EMP • Act as a local entry point for the project GRM • Submit quarterly monitoring results to PPMO, PEPB.	
Design institutes	• Prepare project FSRs, EIRs, RPs, SWCRs • Conduct public consultation	• Incorporate mitigation measures defined in the EMP into engineering detail designs • Update the EMP in cooperation with the LIEC			
YEPD	• Review and approve the project EIRs				
PEPB/PWRB				• Conduct inspections of construction sites and activities to monitor compliance with PRC regulations and standards	
PPTA consultant	• Provide technical assistance • Review EIRs				

Responsible Entity	Project Stage and Environmental Responsibility				
	Project Preparation	**Engineering Detailed Design**	**Tendering & Pre-construction**	**Construction**	**Operation**
	• Prepare EIA report and EMP				
LIEC		• Review updated EMP, confirm that mitigation measures have been included in engineering detailed design	• Review bidding documents to ensure that the EIA/EMP clauses are incorporated • Confirm project's readiness in respect of environmental management.	• Advise on mitigation measures • Provide technical support to PPMO and PMTB for environmental management • Conduct environmental training • Conduct semi-annual EMP compliance review • Support PPMO in preparing quarterly project progress reports and semi-annual environmental monitoring reports. • Review domestic environmental acceptance reports • Prepare environmental completion report.	• Conduct EMP compliance review • Support PPMO in instructing PMTB and O&M units on environmental management requirements • Support PPMO in preparing quarterly project progress reports and semi-annual environmental monitoring report until a PCR is issued • Coordinate environmental monitoring until a PCR is issued
Contractors			• Ensure sufficient funding and human resources for proper and timely implementation of required mitigation and monitoring measures in the EMP throughout the construction phase	• Appoint an environment, health and safety (EHS) officer to oversee EMP implementation related to environmental, occupational health and safety on construction site • Ensure health and safety • Implement mitigation measures • Prepare method statements on the	

Responsible Entity	Project Stage and Environmental Responsibility				
	Project Preparation	**Engineering Detailed Design**	**Tendering & Pre-construction**	**Construction**	**Operation**
				implementation of pollution control and mitigation measures listed in Table 2, and submit to PMTB and ESE for review • Act as a local entry point for the project GRM	
PEMS				• Undertake environmental monitoring according to the environmental monitoring program in the approved EMP (*contracted by PMTB*) • Report monitoring data to ESE and PMTB monthly	• Undertake environmental monitoring until a PCR is issued (*contracted by PMTB*) • Submit monitoring results to PPMO,PMTB and, PEPB
ESE				• Conduct independent verification of project's environment performance and compliance with the EMP (*contracted by PMTB*) • Review monthly monitoring data submitted by PEMS and conduct compliance checking against applicable environmental standards • Provide advice to contractors for resolving on-site environmental problems when monitoring data show non-compliance.	

Responsible Entity	Project Stage and Environmental Responsibility				
	Project Preparation	**Engineering Detailed Design**	**Tendering & Pre-construction**	**Construction**	**Operation**
				• Submit quarterly compliance monitoring results to PPMO, PMTB and PEPB	
O&M units					• Ensure proper operation of component facilities according to design standards • Implement mitigation measures • Conduct post-construction public consultation.
ADB	• Review and approve the EIA and EMP and disclose on ADB website	• Approve updated EMP and disclose on ADB website	• Review bidding documents • Confirm project's readiness • Review, approve and disclose environmental assessment reports for replacement rural roads	• Review quarterly project progress reports, semi-annual environmental monitoring reports and project completion report • Undertake review missions • Advise on compliance issues, as required • Disclose semi-annual environmental monitoring reports on ADB website.	• Review and approve environmental monitoring reports and disclose on ADB website • Undertake project completion review mission and prepare Project Completion Report for approval by Board and disclosure on ADB website.

Notes:
ADB = Asian Development Bank; **EA** = Executing Agency; **EARF** = Environmental Assessment and Review Framework; **EHS** = Environmental, Health & Safety; **EIA** = Environmental Impact Assessment; **EIR** = Environmental Impact Report; **EMP** = Environmental Management Plan; **ESE** = Environmental Supervision Engineer; **FSR** = Feasibility Study Report; **GRM** = Grievance Redress Mechanism; **IA** = Implementing Agency; **LIEC** = Loan Implementation Environmental Consultant; **PCR** = Project Completion Report; **PEPB =** Pu'er Environmental Protection Bureau **PEMS =** Pu'er Environmental Monitoring Station; **PMG =** Pu'er Municipal Government; **PMTB =** Pu'er Municipal Transport Bureau; **PPMO =** Pu'er Project Management Office; **PPTA** = Project Preparation Technical Assistance; **PWRB** – Pu'er Water Resources Bureau; **O&M** = Operation and Maintenance; **RP** = Resettlement Plan; **SWCR** = Soil and Water Conservation Report; **YEPD** = Yunnan Environmental Protection Department

C. Summary of Potential Impacts and Mitigation Measures

5. Potential environmental issues and risks and corresponding mitigation measures designed to minimize the impacts as identified in the EIA during the pre-construction, construction and operation phases are summarized in Table 2.

6. Mitigation and safeguard measures that will permanently become part of the infrastructure such as landscape planting, road signage and markings and road side noise barriers should all be included within the main civil works contract costs and not double-counted as part of the EMP costs.

7. Those that are temporary measures particularly during the construction stage, such as dust suppression by watering and wheel washing, the use of quiet / low noise powered mechanical equipment, flocculants used to facilitate sedimentation of suspended solids in construction site runoff, etc. These will need to be included in the tender documents for the contractor to include as a separate item in the bill of quantities. Guideline costs for implementing these measures are included in the EMP.

8. The mitigation measures defined in the EMP will be (i) checked and where necessary updated by the design institutes; (ii) incorporated into tender documents (where appropriate), construction contracts, construction and operational management plans; and (iii) implemented by contractors, PMTB or PPMO, as relevant. The effectiveness of these measures will be evaluated based on the EMP compliance verification conducted by the ESE and LIEC and the environmental quality monitoring conducted by PEMS.

Table 2: Potential Impacts and Mitigation Measures

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
A. Potential impacts and mitigation measures common to Ning'er-Jiangcheng-Longfu Road, Menglian-Meng'a Road and rural roads					
Detailed Design Stage					
Conservation of soil and land resources	Soil resources	Loss of land and topsoil and increased risk of erosion	• Minimize permanent and temporary land take for both highways, especially cultivated land and basic farmland. • Retain/incorporate landscape features of interest in design. • Optimize balance between cut and fill and avoid deep cuts and high embankments to minimize earthworks. • Maximize reuse of spoil within the construction or adjacent construction works. • Agree borrow and spoil disposal sites, management and rehabilitation plan with PEPB if these sites are different from those specified in the Soil and Water Conservation Report. • Remove and store topsoil (10-30cm) for restoration works prior to main earthworks. • Specify landscape species that serve a specific bioengineering function, are in keeping with natural habitats and landscape and of local provenance. • Design appropriate retention and drainage systems for slopes to reduce soil erosion.	Design Institute	PPMO; PMTB
Design of road alignment, road pavement, subgrade, slopes, drainage and bridges/culverts	Extreme weather events due to climate change	Flooding, landslide and debris flow due to heavy rainfall	• Bridge designs should be reviewed to determine if there is a need to adopt a higher factor of safety as basis of design to increase climate resilience. • For any drainage components that would be difficult to replace or repair it is recommended that a higher factor of safety is adopted as the basis for design to increase climate resilience. • More and higher flood discharge may	Design Institute	PPMO; PMTB

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			increase risk of damage of road infrastructure. Additional protection of slopes and subgrade may be needed in high risk areas. Adopt appropriate slope protection measures such as vegetation cover, geotextiles, settling basins, permeable paving, infiltration ditches, stepped slopes, riprap, crib walls, retaining walls and intercepting ditches to reduce the speed of surface run-off.		
	Water quality	Bridge construction across water bodies	• All construction staging areas, construction camps, fuel and materials storage, re-fuelling and maintenance areas to be located at least 500m from watercourses. • Design of these construction staging areas and construction camps must ensure proper collection and treatment of wastewater and site runoff.	Design Institute	PPMO; PMTB
	Health and safety	Promotion of pedestrian safety, protection of vulnerable road users	• Design must ensure public health and safety. • Design must ensure safety of pedestrians and agricultural traffic. • Adopt universal design principles for where appropriate.	Design Institute	PPMO; PMTB
	Air emissions	Construction transport emissions	Specify local materials from licensed providers that minimize transport distance.	Design Institute	PPMO; PMTB
	GHG emissions	Energy efficiency	Consider energy efficient machinery and operational equipment	Design Institute	PPMO; PMTB
	Wildlife	Collisions with traffic	Consult with expert organisations within Yunnan to identify locations where warning signs and/or other measures are needed in relation to elephant and other wildlife crossing points.	Design Institute	PPMO, PMTB
Pre-construction Stage					
Institutional strengthening	-	Lack of environment management capacity within PPMO	• Appoint qualified environment specialist to PPMO staff. • Include LIEC in loan implementation project management consulting services.	PPMO, LIEC, PEPB	ADB

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			• LIEC to conduct environment management training for PPMO staff and environmental specialist.		
	-	Lack of environment management and monitoring capacity within PMTB	• Appoint qualified environmental specialist to PMTB staff. • Contract PEMS to conduct environment monitoring • Contract qualified ESE to conduct external compliance monitoring and verification of EMP implementation • LIEC to conduct environment management training for PMTB staff and their environmental specialist.	PMTB, LIEC, PEPB	PPMO, ADB
EMP update	-	-	• Review mitigation measures defined in this EMP and update as required to reflect detailed design. • Submit to ADB/PPMO for approval and disclose updated EMP on ADB website. • Prepare a revised environmental compliance monitoring plan as required to meet the environmental requirements in the updated EIA and EMP.	PMTB, LIEC	PPMO, ADB
Environmental assessment reports for replacement rural roads			• Prepare environmental assessment reports for replacement rural roads according to the EARF and submit to ADB for approval.	PPMO	ADB
Tender documents	Air quality	Dust (TSP) impact to sensitive receptors	Put into tender documents dust suppression measures: • Frequent watering of unpaved areas, backfill areas and haul roads to suppress dust; • Erect hoarding around dusty activities to contain emissions; • Manage stockpile areas with frequent watering or covering with tarpaulin; • Minimize the storage time of construction and demolition wastes on site by regularly removing them off site;	Design Institute	PPMO; PMTB

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			• Do not overload trucks when transporting earth materials to avoid spilling dusty materials onto public roads; • Equip trucks for transporting earth materials with covers or tarpaulin to cover up the earthy materials during transport; • Install wheel washing equipment or conduct wheel washing manually at each exit of each works area to prevent trucks from carrying muddy or dusty substance onto public roads; • Immediately cleanup all muddy or dusty materials on public roads outside the exits of the works areas; • Sensibly plan the transport routes and time to avoid busy traffic and heavily populated areas when transporting earthy materials; and • Immediately plant vegetation in all temporary land take areas upon completion of construction to prevent dust and soil erosion.		
		Fumes and particulate matter from asphalt mixing plant and concrete batching plant	Put into tender documents that • These plants must be enclosed and equipped with bag house filter or similar air pollution control equipment. • Locate asphalt mixing plants and concrete batching plants at least 300m downwind from residential areas and other sensitive receptors.	Design Institute	PPMO; PMTB
	Noise	Power mechanical equipment noise impact to sensitive receptors	Put into tender documents the following noise mitigation measures: • Use quiet equipment; • Adopt good O&M of machinery; • Use temporary hoardings or noise barriers to shield off noise sources; • Avoid night time construction between 2200 and 0600 hours;	Design Institute	PPMO; PMTB

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			• If night time construction needed, consult nearby residents beforehand for their consensus; • If night time construction needed, avoid using noisy equipment; and • Maintain continual communication with the schools along the road alignments to avoid noisy activities near the schools during examination periods.		
	Water quality	Construction site wastewater impact on water bodies	Put into tender documents the following measures to treat wastewater and runoff from construction sites and to prevent pollution to nearby water channels:: • All construction camps, fuel and materials storage, re-fuelling and maintenance areas to be located at least 500m from watercourses • Provide portable toilets and small package WWTPs for workers and canteens; and • Install sedimentation tanks on-site to treat process water and muddy runoff.	Design Institute	PPMO; PMTB
	Ecology	Protection of flora and fauna	Put into tender documents: • All project personnel, including construction workers, are prohibited from catching or trading in flora or fauna • Project personnel will immediately report to the PMTB and ESE any fauna found trapped within project sites e.g. in ditches or pits	Design Institute	PPMO; PMTB
	Solid waste	Disposal or storage of excavated spoil	Specify in tender documents the spoil disposal or storage sites and that only these sites could be used.	Design Institute	PPMO; PMTB
	Health & safety	Occupational health & safety of workers	Specify in tender documents the provision of personal safety and protective equipment such as safety hats and shoes, eye goggles, respiratory masks, etc. to all construction workers;	Design Institute	PPMO; PMTB

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
Grievance redress mechanism (GRM)	Social and environmental	Handling and resolving complaints received during project implementation	• PPMO to establish a project Complaint Center with hotline • PPMO to publicize local access points (contractors, PMTB) for the GRM • PPMO to establish grievance redress mechanism procedures for resolving, documenting and reporting complaints according to the EMP	PPMO	ADB
Construction traffic	Traffic	Construction vehicles causing traffic congestion	Plan transport routes for construction vehicles and specify in tender documents to forbid vehicles from using other roads during peak traffic hours.	Design Institute, Local traffic police	PPMO; PMTB
Estimated cost for Design and Pre-construction stage: costs are included in the detailed design fee					
Construction Stage					

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
Construction site good practice	Soil resources	Spoil disposal	• Strip and store topsoil in a stockpile for reuse in restoration. • Use spoil disposal sites approved by PEPB and manage in accordance with approved plan. • Avoid side casting of spoil on slopes. • Co-ordinate with water resources bureau monitoring station on effectiveness of soil erosion prevention measures and any need for remedial action. • Rehabilitate and restore spoil disposal sites in accordance with agreed plan. • Conduct project completion audit to confirm that spoil disposal site rehabilitation meets required standard, contractor liable in case of non-compliance.	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
		Soil erosion	• Implement soil erosion protection measures as defined in the Soil and Water Conservation Report • Confirm location of the borrow pits and spoil storage and disposal sites; if these are different from those specified in the Soil and Water Conservation Report. • Construct intercepting ditches and drains to prevent runoff entering construction sites, and diverting runoff from sites to existing drainage; • Construct hoardings and sedimentation ponds to contain soil loss and runoff from the construction sites • Limit construction and material handling during periods of rains and high winds; • Stabilize all cut slopes, embankments, and other erosion-prone working areas while works are ongoing; • Stockpiles shall be short-term, placed in sheltered and guarded areas near the actual construction sites, covered with clean tarpaulins when not in use, and sprayed with water during dry and windy weather conditions; • All cut areas shall be stabilized with thatch cover within 30 days after earthworks have ceased at the sites; • Immediately restore and landscape temporarily occupied land upon completion of construction works. • Unauthorized extraction or disposal at other sites would be subject to penalties.	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
		Soil contamination	• Properly store petroleum products, hazardous materials and wastes on an impervious surface. • Develop spill response plan. Keep a stock of absorbent materials (e.g. sand, earth or commercial products) on site to deal with spillages and train staff in their use. • If there is a spill take immediate action to prevent entering drains, watercourses, unmade ground or porous surfaces. Do not hose the spillage down or use any detergents. Use oil absorbent materials and dispose at a licensed waste management facility. • Record any spill events and actions taken in environmental monitoring logs and report to LIEC. • Properly store petroleum products, hazardous materials and waste in clearly labeled containers on an impermeable surface in secure and covered areas, preferably with bund and/or containment tray for any leaks. • Remove all construction waste from the site to approved waste disposal sites.	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
	Air quality	Dust (TSP) during construction	• Frequent watering of unpaved areas, backfill areas and haul roads to suppress dust. • Pave frequently used haul roads • Limit the speed of vehicles travelling on unpaved areas and haul roads • Pay particular attention to dust suppression near sensitive receptors such as schools, hospitals, residential areas and natural areas. • Erect hoarding/screens around dusty activities such as demolition. • Manage stockpile areas to avoid mobilization of fine material, cover with tarpaulin and/or spray with water. • Do not overload trucks transporting earth materials. • Equip trucks transporting earth materials with covers or tarpaulin to cover loads during transport. • Install wheel washing equipment or conduct wheel washing manually at each exit of each works area to prevent trucks from carrying muddy or dusty substance onto public roads. • Immediately cleanup all muddy or dusty materials on public roads outside the exits of the works areas. • Plan the transport routes and time to avoid busy traffic and heavily populated areas when transporting earthy materials. • Immediately plant vegetation in all temporary land take areas upon completion of construction to prevent dust and soil erosion.	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
		Fumes and particulate matter from asphalt mixing plant, concrete batching plant and other equipment and machinery	• Locate asphalt mixing plants and concrete batching plants at least 300m downwind from residential areas and other sensitive receptors. • Enclose these plants and equip them with bag house filter or similar air pollution control equipment. • Regularly inspect and certify vehicle and equipment emissions and maintain to a high standard.	Contractor	PMTB; ESE; LIEC
	Noise	Noise from power mechanical equipment and vehicles	• Sensibly schedule construction activities, avoid noisy equipment working concurrently. • Select advanced quiet equipment and construction method, and tightly control the use of self-provided generators. • Comply with local requirements in areas with sensitive receptors very close by, • Avoid construction works, particularly noisy activities such as piling and compaction from 22:00 to 06:00 hr. • If night time construction needed, consult nearby residents beforehand for their consensus. • If night time construction needed, avoid using noisy equipment • If necessary, set up temporary noise barriers. • Control speed of bulldozer, excavator, crusher and other transport vehicles travelling on site. • Specify equipment and machinery that conforms to PRC noise standard GB12523-90 and ensure regular maintenance. • Adopt noise reduction devices and measures for works in proximity to sensitive noise receptors to ensure	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			required standards are maintained. • Locate sites for rock crushing, concrete mixing and other noisy activities at least 1km away from sensitive noise receptors. • Limit the speed of vehicles travelling on site and on haul roads (less than 8 km/hr). • Minimize the use of whistles and horns. • Maintain continual communication with schools along the road alignments to avoid noisy activities near the schools during examination periods and other noise-sensitive activities.		
	Water quality	Management of works in and adjacent to watercourses	• If possible, carry out bridge pier construction during the dry season. • Erect berms or sandbags during bridge foundation works if necessary to contain runoff polluting the rivers. • Maintain adequate flood flow during the rainy season. • All construction camps, fuel and materials storage, refueling and maintenance areas to be located at least 500m from watercourses. • Take all necessary measures to prevent construction materials and waste from entering drains and water bodies.	Contractor	PMTB; ESE; LIEC
	Water quality	Construction site wastewater discharge	• All construction wastewater to be treated to appropriate PRC standard prior to discharge. • Ensure timely cleanup of scattered materials on site, stockpiles must adopt measures to prevent being washed into water bodies by rain water. • Reuse equipment and wheel wash wastewater for dust suppression.	Contractor	PMTB; ESE; LIEC
	Solid waste	Construction site refuse	• Prepare a waste management plan optimising waste minimization, re-use and recycling.	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			• Prepare a spill management plan for hazardous materials on construction sites • Set up centralized domestic waste collection point and transport offsite for disposal at licensed municipal waste facility; • Prohibit burning of waste.		
	Ecology	Protection of vegetation and fauna, and restoration of disturbed areas	• Demarcate the construction working area to prevent encroachment and damage to adjacent areas. • Ensure sufficient aftercare for landscape planting to maximize survival. • Agree compensation planting for any forestry losses in line with PRC forestry laws. • All project personnel, including construction workers, are prohibited from catching or trading in flora or fauna • Project personnel will immediately report to the PMTB and ESE any fauna found trapped within project sites e.g. in ditches or pits	Contractor	PMTB; ESE; LIEC
		Wildlife trafficking	Hire specialist firm to implement wildlife trafficking enforcement capacity development program as described in Project Administration Manual, Consultants' Terms of Reference, Appendix 2.	PMG/PMTB	PMG/PMTB
	Physical cultural resources	Destruction of cultural relics in river bed and soil	Contractor must comply with PRC's Cultural Relics Protection Law and Cultural Relics Protection Law Implementation Regulations if such relics are discovered, stop work immediately and notify the relevant authorities, adopt protection measures and notify the local Cultural Bureau to protect the site.	Contractor	Cultural Relics Bureau; PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
Health and Safety	Occupational health and safety	Construction site sanitation	• Effectively clean and disinfect the site. • During site formation, spray with phenolated water for disinfection. • Disinfect toilets and refuse piles and ensure timely removal of solid waste; • Exterminate rodents on site at least once every 3 months, and exterminate mosquitoes and flies at least twice each year; • Provide public toilets in accordance with the requirements of labor management and sanitation departments in the living areas on construction site, • Appoint designated staff responsible for cleaning and disinfection.	Contractor	PMTB; ESE; LIEC
		Occupational safety	• Appoint Environment, Health and Safety Officer to develop and implement environmental, health and safety management plan, maintain records concerning health, safety and welfare and regularly report on accidents, incidents and near misses. • Train all construction workers in general health and safety matters and on emergency preparedness and response procedures. • Provide personal protective equipment (hard hats, shoes and high visibility vests) to all construction workers and enforce their use. • Provide goggles and respiratory masks to workers doing asphalt road paving. • Provide ear plugs to workers working near noisy powered mechanical equipment (PME), especially during piling of bridge foundations. • Ensure safe handling, transport, storage and application of explosives for tunnel	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			construction. • Implement special measures to ensure worker safety in confined spaces during tunnel construction. • Provide a clean and sufficient supply of fresh, potable water for all camps and work sites. • Provide an adequate number of latrines and other sanitary arrangements at the site and work areas and ensure that they are cleaned and maintained in a hygienic state. • Provide adequate waste receptacles and ensure regular collection and disposal. • Ensure that Contractors have adequate worker and third party insurance cover. • No children (less than 14 years of age) to work on any contract.		
		Food safety	• Inspect and supervise food hygiene in cafeteria on site regularly. • Cafeteria workers must have valid health permits. • Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading	Contractor	PMTB; ESE; LIEC
		Disease prevention and safety awareness	• Construction workers must have physical examination before start working on site. • If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. • From the second year onwards, conduct physical examination on 20% of the workers every year. • Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents. • Specify the person responsible for health	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			and epidemic prevention responsible for the education and propaganda on food hygiene and disease prevention to raise the awareness of workers. • Regularly inspect works to ensure there are no areas of stagnant water that could provide breeding grounds for malaria, encephalitis and dengue fever mosquitoes.		
	Community health and safety	Temporary traffic management	• A traffic control and operation plan will be prepared together with the local traffic management authority prior to any construction. The plan shall include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings with an emphasis on ensuring public safety through clear signs, controls and planning in advance. • As much as possible, schedule delivery of construction materials and equipment during non-peak hours.	Contractor, local traffic police	PMTB; ESE; LIEC
		Information disclosure	Residents and businesses will be informed in advance through publicity about the construction activities and provided with the dates and duration of expected disruption and alternative routes, as required.	Contractor, PMTB	PPMO, LIEC
		Access to construction sites	• Clear signs will be placed at construction sites in view of the public, warning people of potential dangers such as moving vehicles, hazardous materials, excavations and raising awareness on safety issues. • All sites will be made secure, discouraging access by members of the public through fencing or security personnel, as appropriate.	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
		Utility services interruptions	• Assess construction locations in advance for potential disruption to services and identify risks before starting construction. • If temporary disruption is unavoidable, develop a plan to minimize the disruption in collaboration with relevant local authorities such as power company, water supply company and communication company. • Communicate the dates and duration in advance to all affected people.	Contractor, local service providers	PMTB; ESE; LIEC
Grievance redress mechanism	Social & environmental	Handling and resolving complaints	• Appoint a GRM coordinator within PPMO. • Brief and provide training on GRM access points (PMTB, contractors). • Disclose GRM to affected people before construction begins at the main entrance to each construction site. • Maintain and update a Complaints Register to document all complaints and their resolution. Report on GRM in quarterly project progress reports and semi-annual environmental monitoring reports..	PPMO, PMTB, Contractor	ADB
Estimated cost for the Construction Stage: **$256,000** (this amount does not include $9,450,000 for soil erosion mitigation according to the Soil and Water Conservation Reports for the two regional roads)					
Operational Stage					
CO_2 emissions	Traffic	Emissions	Annually monitor traffic volume, assess associated emissions according to approved IPPC methodology and report to ADB.	O&M units	PPMO/PMG
Road condition and safety, wildlife trafficking	Traffic	Road condition	Regularly inspect and maintain the road surface, drains and verges.	O&M units	PPMO
		Road safety and traffic accidents	Strictly enforce traffic law to improve road safety and reduce traffic accidents.	Pu'er Traffic Police	PMG
		Collisions with wildlife	Monitor incidence and type of wildlife fatality and install warning signs or other preventative measures, as required.	O&M units	PPMO/PMG
	Wildlife trafficking and	Lack of capacity for enforcement	Border staff to participate in training to improve capacity to enforce CITES and disease	Pu'er Customs Bureau	PMG

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
	vector-borne diseases		prevention.		
		Illegal wildlife trafficking	Conduct regular inspections and strictly enforce CITES and disease controls.		
				Estimated cost for the Operational Stage: costs are included in the O&M budget	
B. Specific potential impacts and mitigation measures for Ning'er-Jiangcheng-Longfu Road					
Detailed Design Stage					
Design of road alignment and drainage system	Drinking water source – Wenquan Reservoir	Alignment near the reservoir at section K25+200 to K45+200.	• Alignment design of road section K25+200 to K45+200 must not traverse through Protection Zone 1 of the Wenquan Reservoir • Drainage design of road section K25+200 to K45+200 traversing through Protection Zone 2 of the Wenquan Reservoir must have collection, containment and treatment systems for the road runoff.	Design Institute	PPMO; PMTB
	Social, environmental health	Traffic noise impact to sensitive receptors	• Design road side noise barriers at the following 6 locations as indicated in the domestic EIR: ■ Banhai Village – 2.5 m high x 100 m long ■ Manlian Village – 2.5 m high x 90 m long ■ Sanjia Village – 2.5 m high x 50 m long ■ Longtangba – 2.5 m high x 50 m long ■ Xishitou Village – 2.5 m high x 100 m long ■ Baozang Township – 2.5 m high x 250 m long	Design Institute	PPMO; PMTB
Pre-construction Stage					
Ecology	Trees native to Yunnan	Damage to protected tree species native to Yunnan by construction workers and machinery	Trees at the following locations shall be tagged, conspicuously marked and fenced off prior to commencement of construction activities • *Panax zingiberensis* 姜状三七: 20 trees in Liming Township along chainage K80 to K85 • *Phoebe nanmu* 滇楠: 3 trees in Liming Township approximately 200 m to the right of road center line at chainage K85+100	PMTB environmental specialist	PPMO

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			and in Qushui Township approximately 55 m to the right of road center line at chainage K200+800 • *Dalbergia retusa* 黑黄檀: 1 tree in Mengxian Township approximately 100 m to the left of road center line at chainage K48+800. • *Aesculus wangii* 云南七叶树: 5 trees in Qushui Township approximately 50 m to the right of road center line at chainage K215+800.		
Estimated cost for Detailed Design and Pre-construction Stages of the Ning'er-Jiangcheng-Longfu Road: costs are included in the detailed design fee and the PMTB operating budget					
C. Specific potential impacts and mitigation measures for Menglian-Meng'a Road					
Detailed Design Stage					
Design of road alignment	Social, environmental health	Traffic noise impact to sensitive receptors	Design road side barrier at the following one location as indicated in the domestic EIR: Menghai Primary School – 3 m high x 200 m long	Design Institute	PPMO; PMTB
	Landscape	Preservation of trees and woodlands	Permanent and temporary land-take to avoid intact woodlands at sections K0+500-K5+500、K55+200-K65+500、K70+100-K72+300、K75+300-K77+200	Design Institute	PPMO; PMTB
Design of bridges	Climate change	Increased flood risk	The detailed design of the Nanlei River bridge and any other bridges at risk from climate change impacts should consider whether a higher flood height should be adopted as the basis of design to increase climate resilience.	Design Institute	PPMO; PMTB
Estimated cost for Detailed Design Stage of the Menglian-Meng'a Road: costs are included in the detailed design fee					
Operational Stage					
Traffic	Social, environmental health	Traffic noise impact to sensitive receptors	Install 140 m^2 of double-glazed windows on first row of non-commercial buildings facing the road at the following 3 locations as indicated in the domestic EIR (CNY1,000/m^2). Total cost = $23,000 • Mengma Township at K79+800 • Manglang at K95+200	PPMO	PMG, PEPB

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
			• Anma at K97+350		
Estimated cost for the Operational Stage: **$23,000** for provision of double-glazed windows.					
D. Specific potential impacts and mitigation measures for the rural roads					
Pre-construction Stage					
Tender documents	Protected area	Impact on the Experimental Zone of the Ailao Mountain National Nature Reserve during construction of rural road no. 11 from chainage K21 to K24+459	Specify in the tender documents that • The contractor shall demarcate on rural road no. 11 the boundary of the Ailao Mountain National Nature Reserve at chainage K21 in Bangqing Village • There will be no tree felling within chainage K21 to K24+459 on rural road no. 11 • No asphalt mixing plant or concrete batching plant will be allowed within chainage K21 to K24+459 on rural road no. 11 • Opportunities to improve drainage and stabilise slopes should be considered to increase climate resilience.	Design Institute	PPMO; PMTB
Estimated cost for the Detailed Design Stage: costs are included in the detailed design fee					
Construction Stage					
Ecology	Protected area	Impact on the Experimental Zone of the Ailao Mountain National Nature Reserve during construction of rural road no. 11 from chainage K21 to K24+459	• The contractor shall demarcate on rural road no. 11 the boundary of the Ailao Mountain National Nature Reserve at chainage K21 in Bangqing Village • There will be no tree felling within chainage K21 to K24+459 on rural road no. 11 • No asphalt mixing plant or concrete batching plant will be allowed within chainage K21 to K24+459 on rural road no. 11 • The contractor shall maintain close liaison with the Ailao Mountain Jingdong Management Bureau throughout the construction of this section of rural road no. 11	Contractor	PMTB; ESE; LIEC

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity
				Estimated cost for the Construction Stage: **$10,000**	

Notes: ADB = Asian Development Bank; EIR = Environmental Impact Report; ESE = Environmental Supervision Engineer; LIEC = Loan Implementation Environmental Consultant; **O&M** = operation & maintenance; PEPB **=** Pu'er Environmental Protection Bureau PMG **=** Pu'er Municipal Government; **PMTB** = Pu'er Municipal Transport Bureau; PPMO **=** Pu'er Project Management Office.

9. The costs for implementing the construction phase mitigation measures is $289,000. These costs do not include $9,450,000 provided in the Soil and Water Conservation Reports (SWCR) for implementing soil erosion prevention measures. Table 3 shows the breakdown for the implementation of mitigation measures listed in Table 2. The costs were based on information provided in the two EIRs, Ning'er-Jiangcheng-Longfu Highway and the Menglian-Meng'a Highway respectively, with adjustments by the PPTA consultant for the rural roads and where appropriate. For the Menglian-Meng'a Highway, the costs were pro-rata for the section that will be funded by ADB. Permanent works such as road-side barriers and landscaping, road signage for no horn zones were not included as these costs should be included in the civil engineering costs.

Table 3: Cost Breakdown of Environmental Mitigation Measures

Stage	Mitigation Measures	Highway			Project Total
		Ning'er – Jiangcheng – Longfu	Menglian – Meng'a	Rural Roads	
Detailed design	Included in the design contracts	0	0	0	0
Pre-construction	Included in the tender preparation for main works contracts	0	0	0	0
Construction	Noise	$20,000	$18,000	$38,000	$76,000
	Water quality	$15,000	$18,000	$33,000	$66,000
	Dust suppression	$20,000	$15,000	$35,000	$70,000
	Solid waste	$12,000	$10,000	$22,000	$44,000
	Construction Stage subtotal	*$67,000*	*$61,000*	*$128,000*	*$266,000*
Operation	Noise – provision of double glazed windows	0	$23,000	0	$23,000
	Operation stage subtotal	*0*	*$2,3000*	*0*	*$23,000*
	Total:	**$67,000**	**$84,000**	**$128,000**	**$279,000**

Sources: EIRs and SWCRs.

D. Environmental Monitoring and Reporting

10. The project monitoring program focuses on the environment within the project's area of influence. Monitoring will include project readiness monitoring, environmental monitoring and compliance monitoring described below.

11. **Project readiness monitoring.** Before construction, the LIEC will assess the project's readiness in terms of environmental management based on a set of indicators (Table 4) and report it to ADB and the PPMO. This assessment will demonstrate that environmental commitments are being carried out and environmental management systems are in place before construction starts, or suggest corrective actions to ensure that all requirements are met.

Table 4: Project Readiness Monitoring Indicators

Indicator	Criteria	Assessment
EIA approval	• The EIA has been approved by ADB and relevant PRC environmental authority	Yes No
EMP update	• The EMP was updated after technical detailed design and approved by ADB	Yes No
Compliance with loan covenants	• The borrower complies with loan covenants related to project design and environmental management planning	Yes No
Public involvement effectiveness	• Meaningful consultation during project design	Yes No
	• GRM established with entry points	Yes No
Environmental Supervision in place	• LIEC is in place	Yes No
	• Environment specialist appointed by PPMO	Yes No
	• Environment specialists appointed by PMTB	Yes No
	• Environmental supervision engineer appointed by PMTB	Yes No
	• Environment monitoring station contracted by PMTB	Yes No

Indicator	Criteria	Assessment
Bidding documents and contracts with environmental safeguards	• Bidding documents and contracts incorporating the environmental activities and safeguards listed as loan assurances	Yes No
	• Bidding documents and contracts incorporating the impact mitigation and environmental management provisions of the EMP	Yes No
	• Environmental requirements of EMP included in contract documents for construction contracts	Yes No
EMP financial support	• The required funds have been set aside to support the EMP implementation	Yes No

12. **Environmental monitoring.** Table 5 shows the environmental monitoring program specifically designed for this project, defining the requirements, including scope, location, parameter, duration and frequency of monitoring during the construction and operational stages. The Pu'er Environmental Monitoring Station (PEMS), an approved entity to conduct such monitoring, will be contracted by PMTB to carry out monitoring of air and water quality and noise during construction and operation. Since CO_2 emissions from the project roads have been estimated to exceed the ADB threshold of 100,000 t/a, the PPMO is required to conduct traffic counts and calculate CO_2 emissions on the project roads annually during operation until a project completion report (PCR) for the road(s) is issued.

13. The costs for environmental monitoring have been estimated at $444,000, comprising of $136,000 for the Menglian-Meng'a Highway, $228,000 for the Ning'er-Jiangcheng-Longfu Highway, and $80,000 for the 33 rural roads. The SWCR estimated that soil erosion monitoring would cost $261,000, comprising of $51,000 for the Menglian-Meng'a Highway, $210,000 for the Ning'er-Jiangcheng-Longfu Highway.

14. The PPMO, PMTB, the contractor and the LIEC will, at the outset of project implementation, prepare more detailed environmental monitoring programs for construction and operational phases if necessary. The monitoring program and budgets will be included in the project tendering documents and budgets, as well as the construction and operation contracts.

15. Environmental monitoring consists of air and water quality and noise during the construction stage, and air quality and noise during the operational stage. Monitoring locations for air quality and noise were selected based on their proximities to the road alignments (all were within 20 m from the road alignments), the number of units facing the road, and sensitivity to noise nuisance (e.g. schools). Water quality monitoring is applicable to river-crossing bridge construction. The approach is to monitor only when there is bridge construction activity, with a running control station concept. At each bridge construction site, two water quality monitoring stations will be established. One station will be set up at 50 m upstream of the bridge alignment, which will act as the "control station". Another station will be set up 100 m downstream of the bridge alignment, which will act as the "impact station". If water quality data (e.g. suspended solids levels) at the downstream impact station is 130% higher than the upstream control station (for dissolved oxygen, it would be 130% lower than the control station), it is indicative of elevated SS levels caused by the construction activities and mitigation measures such as changing the construction method or slowing down construction activities would need to be considered.

16. For the 33 rural roads, air quality and noise monitoring locations during the construction stage were selected based on the distances from the roads (< 50 m), the potentially affected

population (>800) and the noise sensitive nature of the location (e.g. schools). One water quality monitoring location was selected at the road crossing at Bangqing River in Rural Road No. 11, where it is within the Ailao Mountain Nature Reserve.

17. The environmental monitoring results will be compared with relevant PRC performance standards (Table 6), and non-compliance with these standards will be highlighted in the monitoring reports. Monitoring results will be submitted by the PEMS to the ESE, PPMO and the PMTB on a monthly basis, and will be reported in the quarterly project progress reports and semi-annual environmental monitoring reports by the PPMO (with the support of the LIEC, see reporting plan in Table 7).

Table 5: Environmental Monitoring Program

Item	Monitoring Parameter	Monitoring Location	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
Menglian-Meng'a Highway					***Estimated cost: $136,000***
Construction Stage					
Air quality	TSP; (SO_2 & NO_2 only if there is asphalt mixing within 500 m)	10 locations that are within 20 m of the alignment: 1. Hegelaozhai (K76+460) 2. Hegexinzhai (K77+060) 3. Mengma Primary School (K79+900) 4. Hehaxinzhai (K82+500) 5. Manghai Primary School (K89+060) 6. Nanma Electric Station Dormitory (K89+800) 7. Guangsan (K90+650) 8. Bingsuo (K91+800 9. Manglang (K95+350) 10. Anma (K97+350)	1 day (24-hr) per month (Monitor only when road section has construction activities within 500 m)	PEMS	PMTB, ESE
Noise	L_{Aeq}	10 locations that are within 20 m of the alignment: 1. Hegelaozhai (K76+460) 2. Hegexinzhai (K77+060) 3. Mengma Primary School (K79+900) 4. Hehaxinzhai (K82+500) 5. Manghai Primary School (K89+060) 6. Nanma Electric Station Dormitory (K89+800) 7. Guangsan (K90+650) 8. Bingsuo (K91+800 9. Manglang (K95+350) 10. Anma (K97+350) [*Note: night time monitoring not needed at the school locations*]	2 times per day (day time and night time); 1 day per month (Monitor only when road section has construction activities within 500 m)	PEMS	PMTB, ESE
Water quality	DO, SS, TPH	3 locations in Nanma River during bridge construction at the following road sections: 1. K64+200 2. K77+800	1 time per day; 1 day per month during bridge construction	PEMS	PMTB, ESE

Item	Monitoring Parameter	Monitoring Location	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
		3. K99+200 Set up 2 stations for water quality monitoring at each of the 3 locations as follows: 1. Control station: 50 m upstream of the bridge alignment 2. Impact station 100m downstream of the bridge alignment (Note: if downstream impact station data > 130% of upstream control station data (DO <130%), mitigation measures are needed)			
Operational Stage *(until a PCR is issued)*					
Air quality	PM_{10}, NO_2	4 locations: 1. Mengma Primary School (K79+900) 2. Manghai Primary School (K89+060 3. Manglang (K95+200) 4. Anma (K97+350)	7 consecutive days every 3 months	PEMS	PPMO, ESE
Noise	L_{Aeq}	4 locations: 1. Mengma Primary School (K79+900) 2. Manghai Primary School (K89+060 3. Manglang (K95+200) 4. Anma (K97+350) [Note: no night time needed at school locations]	2 times per day (day time and night time), 2 consecutive days every 3 months	PEMS	PPMO, ESE
GHG	CO_2	Conduct traffic counts and calculate CO_2 emission	Once per year	PPMO	ADB
Ning'er-Jiangcheng-Longfu Highway				***Estimated cost : $228,000***	
Construction Stage					
Air quality	TSP; (SO_2 & NO_2 only if there is asphalt mixing within 500 m)	11 locations that are within 20 m of the alignment 1. Banhai Primary School (K4+100) 2. Manlian Primary School (K7+100) 3. Xishitou Village (K20+200) 4. Mengxian Middle School (K56+900) 5. An'ning Village (K63+800) 6. Xuan'de Village (K69+800) 7. Xianren Village (K106+500) 8. Liming Village (K123+350) 9. Baozang Village (K156+500) 10. Qiyiqiao (K174+600) 11. Niuluohe Village (NK1+200)	1 day (24-hr) per month (Monitor only when road section has construction activities within 500 m)	PEMS	PMTB, ESE
Noise	L_{Aeq}	11 locations that are within 20 m of the alignment	2 times per day (day time and	PEMS	PMTB, ESE

Item	Monitoring Parameter	Monitoring Location	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
		1. Banhai Primary School (K4+100) 2. Manlian Primary School (K7+100) 3. Xishitou Village (K20+200) 4. Mengxian Middle School (K56+900) 5. An'ning Village (K63+800) 6. Xuan'de Village (K69+800) 7. Xianren Village (K106+500) 8. Liming Village (K123+350) 9. Baozang Village (K156+500) 10. Qiyiqiao (K174+600) 11. Niuluohe Village (NK1+200) [*Note: night time monitoring not needed at the school locations*]	night time); 1 day per month (Monitor only when road section has construction activities within 500 m)		
Water quality	DO, SS, TPH	<u>7 rivers during bridge construction at the following road sections:</u> 1. Mengxian River (K68+160) 2. Manxian River (K101+983) 3. Manbangtian River (K126+353) 4. Mengyejiang (K153+643) 5. Lahu River (K207+253) 6. Longtong River (K234+283) 7. Shili River (K238+173) <u>Set up 2 stations for water quality monitoring at each of the 7 rivers as follows:</u>: 1. Control station: 50 m upstream of the bridge alignment 2. Impact station 100m downstream of the bridge alignment (Note: if downstream impact station data > 130% of upstream control station data (DO <130%), mitigation measures are needed)	1 time per day; 1 day per month during bridge construction	PEMS	PMTB, ESE
Operational Stage *(until a PCR is issued)*					
Air quality	PM_{10}, NO_2	<u>11 locations that are within 20 m of the alignment</u> 1. Banhai Primary School (K4+100) 2. Manlian Primary School (K7+100) 3. Xishitou Village (K20+200) 4. Mengxian Middle School (K56+900) 5. An'ning Village (K63+800) 6. Xuan'de Village (K69+800) 7. Xianren Village (K106+500) 8. Liming Village (K123+350) 9. Baozang Village (K156+500) 10. Qiyiqiao (K174+600) 11. Niuluohe Village (NK1+200)	7 consecutive days every 3 months	PEMS	PMTB, ESE

Item	Monitoring Parameter	Monitoring Location	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
Noise	L_{Aeq}	11 locations that are within 20 m of the alignment 1. Banhai Primary School (K4+100) 2. Manlian Primary School (K7+100) 3. Xishitou Village (K20+200) 4. Mengxian Middle School (K56+900) 5. An'ning Village (K63+800) 6. Xuan'de Village (K69+800) 7. Xianren Village (K106+500) 8. Liming Village (K123+350) 9. Baozang Village (K156+500) 10. Qiyiqiao (K174+600) 11. Niuluohe Village (NK1+200) [*Note: night time monitoring not needed at the school locations*]	2 times per day (day time and night time); 2 consecutive days every 3 months	PEMS	PMTB, ESE
GHG	CO_2	Conduct traffic counts and calculate CO_2 emissions	Once per year	PPMO	ADB
Rural Roads					***Estimated cost: $80,000***
Construction Stage					
Air quality	TSP	Locations on the following rural roads (RR): 1. RR2: Tuanshan Village Committee 2. RR8: Huazhuqing 3. RR9: Xingping Jianxing Village 4. RR10: Nan'an Primary School 5. RR11: Bangqing Village Committee 6. RR11: Bangqingyuan Primary School 7. RR13: Xungang 8. RR13: Xungang Primary School 9. RR14: Keli 10. RR15: Tuzaichang 11. RR15: Guihai Village Primary School 12. RR16: Zhetie Village Committee 13. RR16: Zhetie Village Primary School 14. RR17: Banghai Village Committee 15. RR22: Moyang 16. RR22: Manru Primary School 17. RR23: Gongji Primary School 18. RR24: Hui'e Group #1 19. RR25: Manglang 20. RR32: Lianhua Village 21. RR32: Namotian Village 22. RR33: Tuanshan Village 23. RR35: Nadong Village	1 day (24-hr) per month (Monitor only when road section has construction activities within 500 m)	PEMS	PMTB, ESE

Item	Monitoring Parameter	Monitoring Location	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
Noise	L_{Aeq}	Locations on the following rural roads (RR): 1. RR2: Tuanshan Village Committee 2. RR8: Huazhuqing 3. RR9: Xingping Jianxing Village 4. RR10: Nan'an Primary School 5. RR11: Bangqing Village Committee 6. RR11: Bangqingyuan Primary School 7. RR13: Xungang 8. RR13: Xungang Primary School 9. RR14: Keli 10. RR15: Tuzaichang 11. RR15: Guihai Village Primary School 12. RR16: Zhetie Village Committee 13. RR16: Zhetie Village Primary School 14. RR17: Banghai Village Committee 15. RR22: Moyang 16. RR22: Manru Primary School 17. RR23: Gongji Primary School 18. RR24: Hui'e Group #1 19. RR25: Manglang 20. RR32: Lianhua Village 21. RR32: Namotian Village 22. RR33: Tuanshan Village 23. RR35: Nadong Village	2 times per day (day time and night time); 1 day per month (Monitor only when road section has construction activities within 500 m)	PEMS	PMTB, ESE
Water quality	DO, SS, TPH	1 location on the Bangqing River where Rural Road 11 crosses the river 1 location on the Pu'er River where Rural Road 32 crosses the river Set up 2 stations for water quality monitoring at each of the river crossings as follows: 1. Control station: 50 m upstream of the river crossing 2. Impact station 100m downstream of the river crossing (Note: if downstream impact station data > 130% of upstream control station data (DO <130%), mitigation measures are needed)	1 time per day; 1 day per month when road construction activity is within 500 m of the river	PEMS	PMTB, ESE
Operational Stage *(until a PCR is issued)*					
GHG	CO_2	Conduct traffic counts and calculate CO_2 emissions	Once per year	PPMO	ADB

Item	Monitoring Parameter	Monitoring Location	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
					Total estimated cost: $444,000

Notes: **ESE** = Environmental Supervision Engineer; **PCR** = Project Completion Report; **PEMS =** Pu'er Environmental Monitoring Station; **PMTB =** Pu'er Municipal Transport Bureau **; PPMO =** Pu'er Project Management Office.; **TSP** = total suspended particulates; **PM_{10} =** particulate matter with diameter ≥10 micron; **SO_2** = sulfur dioxide; **NO_2** = nitrogen dioxide; **L_{Aeq}** = A-weight equivalent sound pressure level; **DO** = dissolved oxygen, **SS** = suspended solids; **TPH** = total petroleum hydrocarbon; **GHG** = greenhouse gas; **CO_2** = carbon dioxide

Table 6: Monitoring Indicators and Applicable PRC Standards

Period	Indicator	Standard
Construction	TSP	Class II Ambient Air Quality Standard (GB 3095-1996)
	Fume from asphalt mixing plant (SO_2, NO_2)	Air Pollutant Integrated Emission Standard (GB 16297-1996)
	Noise limits of PME at boundary of construction site	Emission Standard of Environmental Noise for Boundary of Construction Site (GB 12523-2011)
	Discharge of wastewater from construction sites	Class I standard of Integrated Wastewater Discharge Standard (GB 8978-1996)
	DO, SS and TPH levels in river during bridge construction works	SS and TPH at downstream impact station <130% of the upstream control station. DO at downstream impact station >70% of the upstream control station and must not be < 2mg/L
Operation	Traffic noise at sensitive receptor within 35 m of road red line	Noise standard for Category 4a Functional Area in Environmental Quality Standard for Noise (GB 3096-2008)
	Traffic noise at sensitive receptor beyond 35 m of road red line	Noise standard for Category 1 and Category 2 Functional Areas in Environmental Quality Standard for Noise (GB 3096-2008)

18. **Compliance monitoring.** External and independent EMP compliance monitoring will be undertaken by the ESE contracted by the PMTB. The ESE could be a qualified individual or a company. The ESE will report to PMTB and PPMO the project's adherence to the EMP, information on project implementation, environmental performance of the contractors, and environmental compliance. PPMO in turn and with support of the LIEC, will report these items to ADB through the quarterly project progress reports and semi-annual environmental monitoring reports (Table 7). The estimated cost for compliance monitoring by the ESE is $485,000, comprising of $370,000 for the Ning'er-Jiangcheng- Longfu Highway, $75,000 for the Menglian-Meng'a Highway and $40,000 for the rural roads, based on information provided in the EIRs with estimate from the PPTA consultant for the rural roads. The SWCR also estimated supervision of soil erosion mitigation and monitoring would total $226,200, comprising of $163,200 for the Ning'er-Jiangcheng- Longfu Highway, $63,000 for the Menglian-Meng'a Highway.

Table 7: Reporting Plan

Reports		From	To	Reporting Frequency
Construction Phase				
Internal environmental progress reports by contractors	Internal environmental progress report by construction contractors	Contractors	PMTB	Monthly
Environmental monitoring	Environmental quality monitoring report	PEMS	PEPB, ESE, PPMO, PMTB	Monthly
Environmental Compliance monitoring	Environmental compliance monitoring report	ESE	PMTB, PPMO	Quarterly
Reports to ADB	Project progress report (including section on EMP implementation and monitoring)	PPMO	ADB	Quarterly
	Environmental monitoring	PPMO	ADB	Semi-annual

Reports		From	To	Reporting Frequency
	reports			
Acceptance report	Environmental acceptance monitoring and audit report	Licensed institute	PEPB	Once, not later than one year after completion of physical works
Completion report	Environmental completion report for ADB	LIEC	ADB	Once, one year after completion of physical works
Operational Phase				
Environmental monitoring	Environmental monitoring report	PEMS	PEPB, PPMO, PMTB	Quarterly
Compliance monitoring	Compliance monitoring report	ESE	PPMO, PMTB	Quarterly
Reports to ADB	Project progress report (including section on EMP implementation and monitoring)	PPMO	ADB	Quarterly
	EMP progress and monitoring report	PPMO	ADB	Once (after first year of operation)

Notes: **ADB** = Asian Development Bank; **ESE** = environmental supervision engineer; **LIEC** = loan implementation environmental consultant; **PEMS =** Pu'er Environment Monitoring Station; **PEPB =** Pu'er Environmental Protection Bureau; **PPMO =** Pu'er Project Management Office; **PMTB** = Pu'er Municipal Transport Bureau.

19. Quarterly progress reports by the PPMO to ADB will include a summary of EMP implementation progress and compliance. The LIEC will support the PPMO in developing the semi-annual environmental monitoring reports. The reports should confirm the project's compliance with the EMP, local legislation such as PRC EIA requirements, and identify any environment related implementation issues and necessary corrective actions, and reflect these in a corrective action plan. The performance of the contractors in respect of environmental compliance will also be reported. The operation and performance of the project GRM, environmental institutional strengthening and training, and compliance with all covenants under the project will also be included in the report.

20. Within three months after completion, or no later than one year with permission of the PEPB, environmental acceptance reports shall be prepared by a licensed institute in accordance with the PRC Regulation on Project Completion Environmental Audit (MEP, 2001) and approved by the relevant environmental authority, and finally reported to ADB (Table 7). The environmental acceptance report will indicate the timing, extent, effectiveness of completed mitigation and of maintenance, and the need for additional mitigation measures and agreed monitoring during operation. These environmental acceptance reports will be provided to the LIEC who is responsible for preparing an environmental completion report and inputs for the Project Completion Report for ADB.

21. **Monitoring by ADB.** Besides reviewing the quarterly project progress reports and the semi-annual environment monitoring reports from the PPMO and the verification reports from the LIEC, ADB missions will inspect the project progress and implementation on site at least once a year. For environmental issues, inspections will focus mainly on (i) monitoring data; (ii) the implementation status of project performance indicators specified in the loan documents for the environment, environmental compliance, implementation of the EMP, and environmental institutional strengthening and training; (iii) the environmental performance of contractors, LIEC, PMTB and PPMO; and (iv) operation and performance of the project GRM. The performance of

the contractors in respect of environmental compliance will be recorded and will be considered in the next bid evaluations.

22. **Project design and monitoring framework.** At the outset of project implementation, the PPMO and PMTB will finalize: (i) comprehensive project design and monitoring framework (DMF) procedures to systematically generate data on inputs and outputs of the project components; and (ii) detailed environmental and related social economic indicators to measure project impacts. The DMF indicators for the project include (i) percentage of population in counties with access to paved rural roads; (ii) average vehicle operating costs per vehicle-kilometer on trunk roads; and (iii) increase or decrease in road accident fatalities. Under the DMF, baseline and progress data will be reported at the requisite time intervals by PMTB. PMTB and Traffic Police will be responsible for analyzing and consolidating the data through their management information system. The DMF will be designed to permit adequate flexibility to adopt remedial actions in relation to project design, schedules, activities, and development impacts. The PPMO and PMTB will refine the DMF, confirm achievable goals, firm up monitoring and recording arrangements, and establish systems and procedures no later than six months after loan effectiveness.

E. Institutional Capacity Building and Training

23. The capacity of the PPMO, PMTB and contractors' staff responsible for EMP implementation and supervision will be strengthened. All parties involved in implementing and supervising the EMP must have an understanding of the goals, methods, and practices of project environmental management. The project will address the lack of capacities and expertise in environmental management through (i) institutional capacity building, and (ii) training.

24. **Institutional strengthening.** The capacities of the PPMO and PMTB to coordinate environmental management will be strengthened through a set of measures:

(i) The appointment of at least one qualified environment specialist within the PPMO in charge of EMP coordination, including GRM;
(ii) The appointment of at least one qualified environmental specialist within PMTB to conduct regular site inspections and coordinate environmental monitoring
(iii) The appointment of a LIEC under the loan implementation project management consulting services to guide PPMO and PMTB in implementing the EMP and ensure compliance with ADB's SPS 2009.

25. **Training.** The PPMO, PMTB, contractors and O&M units will receive training in EMP implementation, supervision, and reporting, and on the Grievance Redress Mechanism (Table 8). Training will be facilitated by the LIEC with support of other experts (e.g. the ESE) under the loan implementation project management consulting services. The estimated budget is $12,000.

26. The institutional strengthening component of the project will involve training by loan implementation project management consultant in operation and maintenance of the completed facilities. Part of this training will focus on teaching staff how to use a set of indicators to monitor performance of the completed facilities. These indicators will be designed by the loan implementation project management consultant prior to operation start-up.

Table 8: Training Program

Training	Attendees	Contents	No. of Times	Period (days)	No. of persons	Cost ($/person /day)	Total Cost
EMP adjustment and implementation	PPMO, PMTB, contractors	Development and adjustment of the EMP, roles and responsibilities, monitoring, supervision and reporting procedures, review of experience (after 12 months)	Twice - Once prior to, and once after one year of project implementation	2	15	100	$6,000
Grievance Redress Mechanism	PPMO, PMTB, contractors, PEPB	Roles and responsibilities, procedures, review of experience (after 12 months)	Twice - Once prior to, and once after one year of project implementation	1	10	100	$1,000
Environmental technologies and processes	PPMO, PMTB, contractors, O&M units	Engineering and pollution control technologies, equipment selection and procurements,	Once (during project implementation)	2	10	100	$2,000
Environmental quality monitoring	PPMO, PMTB, contractors, O&M units	Monitoring methods, data collection and processing, reporting systems	Once (at beginning of project construction)	1	10	100	$1,000
Roads and traffic	PMTB, O&M units	Traffic management and traffic safety	Once (during project implementation)	1	10	100	$1,000
	Customs Bureau	Wildlife trafficking	Once (during project implementation)	1	10	100	$1,000
						Total estimated cost:	**$12,000**

Notes: **PEPB =** Pu'er Environmental Protection Bureau; **PPMO =** Pu'er Project Management Office; **PMTB** = Pu'er Municipal Transport Bureau; **O&M** = operation and maintenance

F. Consultation, Participation and Information Disclosure

27. **Consultation during project preparation.** Section VII of the report has described the public participation and consultation implemented during project preparation.

28. **Future public consultation plan.** Plans for public involvement during construction and operation stages have been developed during project preparation. These plans include public participation in (i) monitoring impacts and mitigation measures during the construction and operation stages; (ii) evaluating environmental and economic benefits and social impacts; and (iii) interviewing the public after the project is completed. These plans will include several types of public involvement, including site visits, workshops, investigation of specific issues,

interviews, and public hearings, as indicated in Table 9. The budget for public consultation is estimated at approximately $10,000.

Table 9: Public Consultation Plan

Organizer	Format	No. of Times	Subject	Attendees	Budget
Construction Stage					
PPMO	Public consultation & site visit	4 times: 1 time before construction commences and 1 time each year during construction	Adjusting of mitigation measures, if necessary; construction impact; comments and suggestions	Residents adjacent to project sites, representatives of social sectors	$5,000
PPMO, PMTB	Expert workshop or press conference	As needed based on public consultation	Comments and suggestions on mitigation measures, public opinions	Experts of various sectors, media	$2,000
Operational Stage					
PMTB, O&M units	Public consultation and site visits	Once in the first year	Effectiveness of mitigation measures, impacts of operation, comments and suggestions	Residents adjacent to project sites, representatives of residents and representatives of social sectors	$1,500
PMTB, O&M units	Expert workshop or press conference	As needed based on public consultation	Comments and suggestions on operational impacts, public opinions	Experts of various sectors, media	$1,500
				Total budget:	**$10,000**

Notes: **PPMO** = Pu'er Project Management Office; **PMTB** = Pu'er Municipal Transport Bureau; **O&M** = operation and maintenance

G. Grievance Redress Mechanism

29. Public participation, consultation and information disclosure undertaken as part of the local environmental impact assessment process have discussed and addressed major community environmental concerns relating to dust, noise, wastewater and traffic congestion during construction, and traffic noise and vehicle emissions during operation. Continued public participation and consultation has been emphasized as a key component of successful project implementation. As a result of public participation and safeguard assessment carried out during the initial stages of the project, major issues of grievance are not expected. However, unforeseen issues may occur. To address potential issues, a project-specific Grievance Redress Mechanism (GRM) providing effective and transparent channels for lodging and addressing complaints has been defined. The GRM will be established prior to construction of the project components. The GRM is responsive to ADB's SPS (2009) and PRC legislation.

30. **The proposed project GRM.** In consultation with the PPMO, PMTB, PEPB and potentially affected people, it was agreed that the PPMO will establish a complaints center and coordinate the GRM for both environmental and resettlement safeguards. The complaint center will direct all environmental complaints as appropriate to: (i) the contractors; (ii) PMTB; (iii) O&M units. There are multiple entry points to whom the affected people could directly register their complaints. Contact details for the complaints center and the entry points will be publicly disseminated on information boards at construction sites and nearby communities. Multiple

means of using this mechanism, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available. In the construction and the operational periods until ADB's project completion report (PCR), the PPMO will report progress to the ADB, this will include reporting complaints and their resolution.

31. Basic steps for resolving complaints are as follows and illustrated in Figure 1:

- Step 1: For environmental problems during the construction stage, the affected person (AP) can register his/her complaint directly with the contractors, or through GRM access points (PPMO complaint center hotline, PMTB, local EPB hotline). Contractors are required to set up a complaint hotline and designate a person in charge of handling complaints, and advertise the hotline number at the main entrance to each construction site, together with the hotline number of the PPMO complaint center. The contractors are required to maintain and update a Complaint Register to document all complaints. The contractors are also required to respond to the complainant in writing within 7 calendar days on their proposed solution and how it will be implemented. If the problem is resolved and the complainant is satisfied with the solution, the GRM ends here. The contractors are required to report complaints received, handled, resolved and unresolved to the PPMO complaint center immediately, and to PMTB and PPMO monthly (through progress reporting).
- Step 2: For environmental issues that cannot be resolved by the contractors, the affected person can take the grievance to PMTB and/or PEPB. On receiving complaints by PMTB or PEPB, the party receiving the complaints must notify the other relevant parties and document the complaint in writing in a Complaint Register. PMTB and PEPB must reply to each complainant in writing within 14 calendar days with the proposed solution and method of implementation. If the issue is resolved and the complainant is satisfied with the solution, PMTB should document the complaint and resolution process in its Complaint Register, with monthly reporting to PPMO.
- Step 3: If the complainant is not satisfied with the proposed solutions in Step 2, he/she can, upon receiving the reply, take the grievance to the PPMO complaints center. Upon receiving the complaint, the center must deal with it within 14 calendar days. Once a complaint is documented and put on file, the PPMO complaints center will immediately notify ADB. After discussing the complaint and potential solutions amongst ADB, PPMO, the LIEC, the complainant and the contractor, PPMO must propose a resolution strategy within 14 calendar days from when the complaint is registered.

32. The tracking and documenting of grievance resolution by the PPMO (through its complaints center) will include the following elements: (i) tracking forms and procedures for gathering information from project personnel and complainant(s); (ii) dedicated staff to update the database routinely; (iii) systems with the capacity to analyze information so as to recognize grievance patterns, that can identify systemic causes of grievances, promote transparency, publicize how complaints are being handled, and periodically evaluate the overall functioning of the mechanism; (iv) processes for informing stakeholders about the status of a case; and (v) procedures to retrieve data for reporting purposes, including the periodic reports to the ADB.

33. The PPMO will record the complaint, investigation, and subsequent actions and report results in the monthly internal Environmental Management Plan reports. In the construction period and the initial operational period covered by loan covenants the PPMO will periodically

report complaints and their resolution to ADB in the quarterly project progress reports and the semi-annual environmental monitoring reports.

H. Cost Estimates

34. Cost estimates for EMP implementation, including mitigation measures, environmental monitoring, compliance monitoring, training and public consultation are summarized in Table 10. Excluded from the costs estimates are infrastructure costs which relate to environment and public health but which are already included in the main civil works contract (e.g. road-side noise barriers). Excluded are also the remuneration costs for environment specialists within PPMO and PMTB, loan implementation environmental consultant, and technical experts on equipment operation and maintenance, which are covered elsewhere in the project budget.

Table 10: EMP Implementation Budget Estimate

EMP Item	Estimated Cost
Mitigation measures	
Construction	$256,000
Operation	$23,000
Mitigation measures sub-total:	*$279,000*
Environmental monitoring	
Ning'er-Jiangcheng-Longfu Highway	$228,000
Menglian- Meng'a Highway	$136,000
Rural roads	$80,000
Environmental monitoring sub-total:	*$444,000*
Compliance monitoring of EMP implementation by ESE	$485,000
Training	$12,000
Public consultation	$10,000
Total	**$1, 230,000**

35. PMTB will bear all environmental and compliance monitoring costs during construction and the first year of operation and will ensure the necessary budgets are available for the PEMS and the ESE. Contractors will bear the costs for all mitigation measures during construction, including those specified in the tender and contract documents as well as those to mitigate unforeseen impacts due to their construction activities. The O&M units will bear the costs related to mitigation measures during operation, except the indirect mitigation measures of resettlement and provision of double-glazed windows, which will be borne by PMTB. The project as a whole (through PPMO) will bear the costs for training, for coordinating the Grievance Redress Mechanism (GRM), and the LIEC under contract to PPMO through the loan implementation project management consulting services.

I. Mechanisms for Feedback and Adjustment

36. The EMP is a live document. The need to update and adjust the EMP will be reviewed when there are design changes, changes in construction methods and program, unfavorable environmental monitoring results, inappropriate monitoring locations and ineffective or inadequate mitigation measures. Based on environmental monitoring and reporting systems in place, the PPMO (with the support of the LIEC) shall assess whether further mitigation and monitoring measures are required. PPMO will inform ADB promptly of any changes to the project and needed adjustments to the EMP. The updated EMP will be submitted to ADB for review and approval, and will be disclosed on the project website.

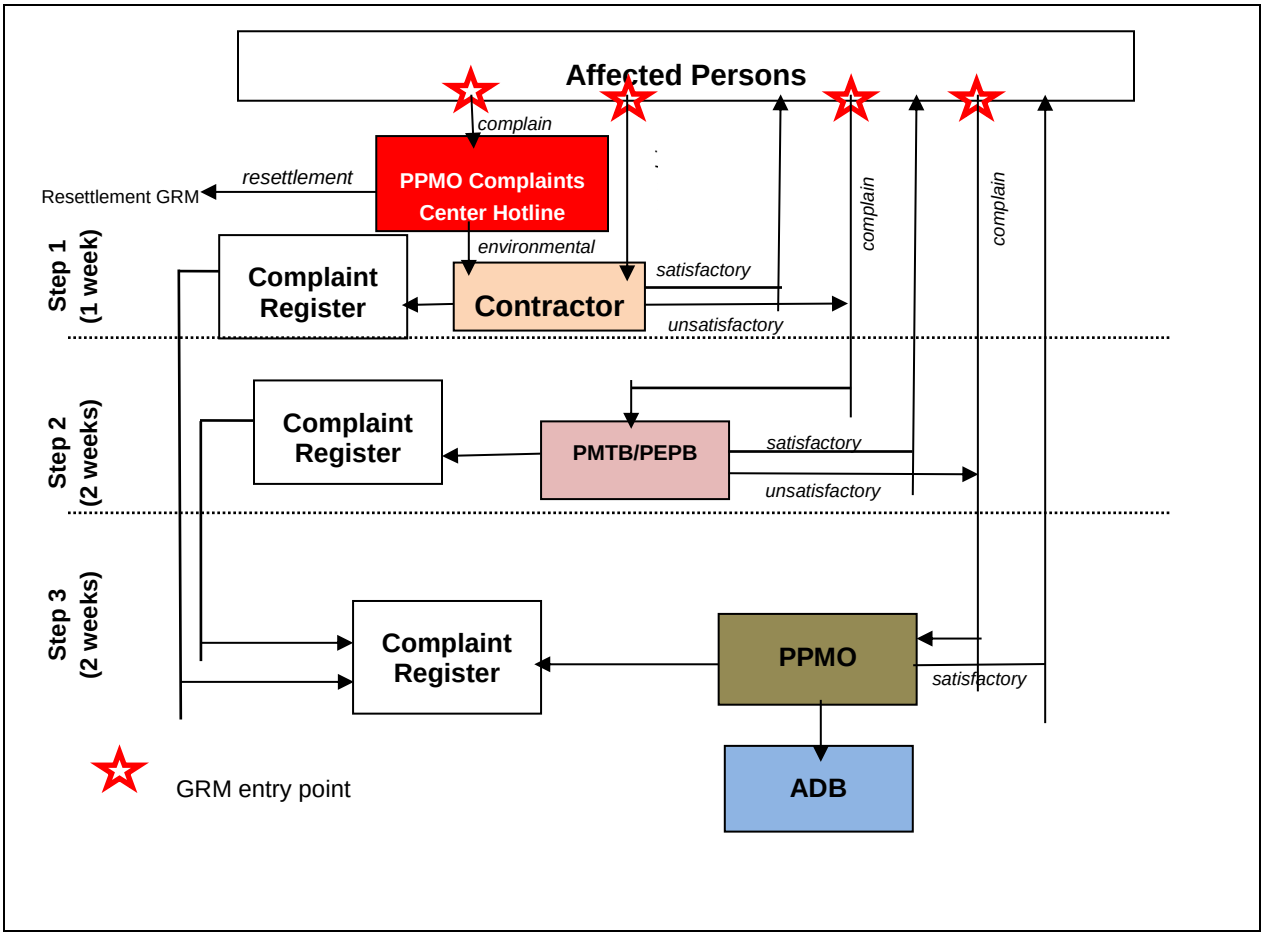

Figure 1: Proposed Grievance Redress Mechanism

Environmental Assessment and Review Framework

June 2014

PRC: Yunnan Pu'er Regional Integrated Road Network Development Project

Prepared by the Pu’er Municipal Government for the Asian Development Bank.

CURRENCY EQUIVALENTS
(as of 30 November 2013)

Currency Unit	–	yuan (CNY)
CNY1.00	=	$0.16078
$1.00	=	CNY6.078

ABBREVIATIONS

ADB	–	Asian Development Bank
CNY	–	Chinese Yuan
CO_2	–	carbon dioxide
EA	–	Executing Agency
EARF	–	Environmental Assessment and Review Framework
EIA	–	Environmental Impact Assessment
EIR	–	Environmental Impact Report
EIT	–	Environmental Impact Table
EMP	–	Environmental Management Plan
EPB	–	Environmental Protection Bureau
FS	–	feasibility study
FSR	–	feasibility study report
GHG	–	greenhouse gas
GRM	–	grievance redress mechanism
IA	–	Implementing Agency
LDI	–	local design institute
MSW	–	municipal solid waste
NO_x	–	nitrogen oxides
PM_{10}	–	particulate matter with diameter ≥10 μ
PEPB	–	Pu'er Environmental Protection Bureau
PMO	–	Project Management Office
PPMO	–	Pu'er Project Management Office
TSP	–	total suspended particulates

WEIGHTS AND MEASURES

μ	–	micron
^oC	–	degree Centigrade
cm	–	centimeter
dB[A]	–	decibel based on A-weighted measurements
d/a	–	day per annum
h	–	hour
h/d	–	hour per day
ha	–	hectare
kg	–	kilogram
kg/m3	–	kilogram per cubic meter
km	–	kilometer
km^2	–	square kilometer

KWh	–	kilowatt hour
KWh/a	–	kilowatt hour per annum
Leq	–	equivalent continuous sound pressure level [dB]
m	–	meter
m^2	–	square meter
m^3	–	cubic meter
m^3/d	–	cubic meter per day
m/s	–	meter per second
m^3/s	–	cubic meter per second
mg/l	–	milligram per liter
mg/m^3	–	milligram per cubic meter
mm	–	millimeter
mm/a	–	millimeter per annum
t/a	–	ton per annum
t/d	–	ton per day
tCO_2e	–	ton of carbon dioxide equivalent

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I. INTRODUCTION

1. The Project, Yunnan Pu'er Regional Integrated Road Network Development Project, includes a rural road component that proposes paving and drainage improvements to 33 rural road sections, a total of 600 km in length. The project is classified by ADB as environment category A. A Project environmental impact assessment (EIA) report including an environmental management plan (EMP) has been prepared that covers all project components including the 33 rural roads. There is the possibility that the final list of rural roads funded by ADB may need to be updated after project approval.

2. As there is some degree of uncertainty over the 33 rural road sections that will be funded, this Environmental Assessment and Review Framework (EARF) has been prepared to present the agreed processes for updating the EIA and EMP in the event of change as required by ADB operational procedures for Safeguard Policy Statement (SPS, 2009).

II. RESPONSIBILITIES AND AUTHORITIES

3. The Pu'er Project Management Office (PPMO) is responsible for (i) the selection of rural roads to be added to the list, (ii) the appointment of a domestic environmental design institute to prepare the EIT for these rural roads for submission to and approval by the PEPB, and (iii) the preparation of new environmental assessment reports for replacement rural roads for submission to and approval by the ADB.

4. The new environmental assessment reports shall be submitted to ADB for review, approval and disclosure according to operational procedures as described in SPS (2009).

III. CRITERIA FOR RURAL ROAD SELECTION

5. The Project criteria for selecting rural roads are:

(i) that the road should connect multiple village groups and administrative villages,
(ii) that the road should connect to a national or provincial highway or an important county road,
(iii) that there should be a balance between the 9 counties and 1 district, and
(iv) that there should be no dead-end roads (roads should not end in the middle of nowhere, but should connect to higher level roads on both sides or end at an administrative village).

6. Rural road selection should avoid significant environmental impacts where possible. For the rural roads that have been appraised works are restricted to paving and drainage improvement and it has been agreed that replacement roads will only be considered if works are restricted to these activities. Rural roads selected should avoid sensitive habitats such as wetland and drinking water sources and protected areas, where possible.

IV. PROCEDURES FOR ENVIRONMENTAL IMPACT ASSESSMENT FOR NEWLY SELECTED RURAL ROADS

A. Key Environmental Impacts and Risks

7. If there is a need to assess new subprojects for the rural road component it will be necessary to assess proposed replacement roads to determine key environmental risks and impacts that need to be addressed in the environmental assessment reports, these may include the following:

(i) Traffic forecast: although traffic forecast is not environmental, yet it forms the basis for predicting future traffic emissions and traffic noise. Therefore, traffic forecast up to a design horizon of 15 to 20 years must be provided by the feasibility study, so that the environmental assessment team can use the figures to predict future traffic emissions and noise, and propose appropriate mitigation measures if needed.
(ii) Environmental protection targets: sensitive receptors that could potentially be affected by the construction and operation of the project roads. Such targets could include residential households, schools and medical establishments that are sensitive to air quality and noise pollution; protected flora and fauna, and protected areas such as nature reserves and other conservation areas; water bodies; and physical cultural resources.
(iii) Construction phase air quality: asphalt or concrete batching plants are the main air pollution sources during road construction. Provide information or design requirements on their air pollution control requirements, such as equipped with dust removal bags, etc. Also provide specifications on where they can or cannot be sited, based on information on the locations of air sensitive targets such as schools, hospitals, temples and residential areas.
(iv) Traffic noise during the operation phase: based on the traffic forecast, calculate the traffic noise levels at the identified noise sensitive targets such as schools, hospitals, temples and residential areas for the:
    (a) condition at road opening,
    (b) intermediate condition (mid-way between now and the design horizon), and
    (c) long term condition (at the design horizon).
    Mitigation measures, such as double-glazed windows or air-conditioning, should be provided for sensitive targets impacted by traffic noise exceedance.
(v) Greenhouse gas (GHG) emission during the operation phase: based on the types of vehicles travelling on the project roads, distances travelled and types of fuel consumed, calculate the total amount of carbon dioxide emitted from traffic travelling on all project roads each year at the design horizon.
(vi) Climate change impacts: Opportunities to improve drainage and stabilise slopes should be considered to increase climate resilience.

B. Country Environmental Assessment and Review Procedures

8. Similar to ADB, the PRC has procedures to categorize the environmental assessment requirements for different types of projects based on their potential environmental impacts. For projects having substantial impacts on the environment (which is similar to ADB's category A projects), the PRC requires the preparation, submission and approval of a project Environmental Impact Report (EIR). For projects with less substantial environmental impacts on the environment (which is similar to ADB's category B projects), the PRC requires the preparation, submission and approval of a project Environmental Impact Table (EIT). For projects with minimal environmental impacts on the environment (which is similar to ADB's category C projects), the PRC requires the preparation, submission and approval of a project Environmental Impact Registration Form.

9. An EIT for the 33 proposed rural roads was prepared, which was approved by the Pu'er Environmental Protection Bureau (PEPB) in March 2014. Should new rural roads be added to the list, an EIT will need to be prepared and submitted to the PEPB for domestic approval.

C. Inception of the Environmental Impact Assessment Study for ADB

10. Selection of an appropriately qualified domestic design institute to conduct the environmental assessment study and prepare the report is of utmost importance. The degree of details required by ADB in environmental assessment reports is much more than that required locally. An environmental design institute with international funded investment project experience is preferred. If not available, the design institute should at least have adequate experience, staffing and capability to produce all the information mentioned in this report.

11. The selection of the Feasibility Study (FS) design institute is also important, because it will have a direct bearing on the quality of the environmental assessment report. Again, ADB requires much more details in the FS than what is required locally. In fact, ADB's 'FS' requirement is approximately equivalent to the completion of preliminary design in the PRC. Therefore, the FS design institute for the rural roads must have the experience, staffing, capability and willingness to complete the preliminary design of the rural road improvement in order to meet ADB requirements. An institute with general consulting experience will not be able to meet ADB requirements.

12. Upon start of the environmental assessment study, the environmental assessment team should complete the following tasks as soon as possible:

(i) Site visit: The environmental assessment team should visit the proposed rural roads as soon as possible to get an understanding of the environmental conditions in the vicinity. During the site visit, all targets sensitive to air, noise and water pollution from the project must be identified and documented. Sensitive targets include residential areas, hospitals, schools, temples, cultural heritage sites, protected areas on conservation and ecology, national parks and nature reserves, water gathering grounds, and water bodies such as rivers and streams. These should be photographed and with their relative distances to the project sites measured and documented.

(ii) Baseline monitoring: Based on the site visit, the environmental assessment team should determine whether there is a need to conduct baseline monitoring. Such determination should be based on the existing traffic conditions on the proposed rural roads, the number and locations of environmental protection targets especially schools and medical clinics, the presence of ecologically sensitive or protected areas, and the presence of surface or ground drinking water sources within the project area of influence. Baseline monitoring should be conducted if needed.

(iii) Public consultation: ADB requires two rounds of public consultation. The first round should be conducted at environmental assessment inception. The purpose of the first round is to describe the project to the stakeholders and to solicit their views, concerns and suggestions so that these could be adequately considered in the environmental assessment study. It should be conducted as soon as the environmental assessment study is started and should be in form of a public forum. More details on public consultation are provided in later sections.

D. Procedures for Preparing the Environmental Assessment Report

13. The structure of the addendum environmental assessment report and information required under each chapter is described below.

Chapter 1 – Executive Summary

14. This chapter describes concisely the critical facts, significant findings, and recommended actions. The following information should be included in this Chapter. Where appropriate, the environmental assessment report for the substitute rural roads could make reference to information already presented in the EIA and EMP for the whole project (the Project EIA report).

(i) Summarize the rationale for selecting these rural roads and their locations;
(ii) Summarize the potential environmental benefits and impacts during construction and operation phases;
(iii) Summarize information disclosure and public consultation activities undertaken during environmental assessment preparation; and
(iv) Summarize the recommended actions in mitigating potential impacts and EMP implementation.

Chapter 2 – Policy, Legal, and Administrative Framework

15. This chapter discusses the national and local legal and institutional framework within which the environmental assessment is carried out, including applicable environmental standards. It also identifies project-relevant international environmental agreements to which the country is a party. This chapter can make reference to the same chapter in the Project EIA report.

Chapter 3 – Description of the Project

16. This chapter describes the proposed rural roads. The following information should be provided in this chapter:

(i) Description of rationale in selecting these rural roads;
(ii) Locations, lengths and engineering design features for the proposed rural roads;
(iii) Existing traffic volume and projected traffic demand forecast;
(iv) Permanent and temporary land take areas;
(v) Earth cut and earth fill balance;
(vi) Construction methods and duration, e.g. road paving, road drainage, etc.; and
(vii) Drawings and maps showing the rural road locations and their project area of influence (assessment area).

Chapter 4 – Description of the Environment

17. Chapter 3 describes relevant physical, biological, and socioeconomic conditions within the project's area of influence (assessment area). The following information should be provided in this chapter where appropriate:

(i) Description of the project sites (existing land use on permanent and temporary land take areas);

(ii) Description of air quality and noise sensitive receptors (locations, distances to the road red line, number of households, types (e.g. school, residential, etc.);
(iii) Description of water bodies in the assessment area, their planned function and water quality;
(iv) Description of ecological resources that are under international, national or provincial protection; presence or absence of protected areas within the assessment area;
(v) Description of presence or absence of physical cultural resources; and
(vi) Information on the socio-economic profiles of the counties where these rural roads are located.

Chapter 5 – Anticipated Environmental Impacts and Mitigation Measures

18. Chapter 5 starts with describing the positive impacts and environmental benefits of the project, followed by information on environmental impacts during construction and operation, mitigation measures needed to reduce such impacts, and resettlement. The following information should be provided in this chapter:

(i) Positive impacts and environmental benefits: Describe positive impacts and environmental benefits of the rural roads. The description should be both qualitative and quantitative.
(ii) Impact and mitigation measures during the construction phase: Provide information on the assessment results on air quality, noise, water (surface and ground) quality, waste, ecology and cultural heritage during the construction phase. Information to address the key environmental issues during construction of the rural roads must be included here, and the information should be quantitative as far as possible. The following should be noted:
    (a) the assessment results should be quantitative,
    (b) compare these results with the environmental standards in Chapter 2 to see if they comply with or exceed the relevant standards,
    (c) if there is exceedance, propose mitigation measures that will reduce the environmental impact to acceptable levels, and
    (d) also list these mitigation measures in the environmental management plan (EMP).
(iii) Resettlement: Provide information on
    (a) area of land to be permanently acquired by the project,
    (b) area of land to be temporarily occupied by the project,
    (c) how much of the land to be permanently acquired is cultivated land,
    (d) area of buildings to be demolished, and
    (e) number of persons to be resettled due to the project.
    The land to be permanently acquired represents resources that will be permanently lost and that cannot be replaced.
(iv) Impact and mitigation measures during the operation phase: Provide information on the assessment results on air quality, noise, water (surface and ground) quality, waste, ecology and cultural heritage during the operation phase. Information to address the key environmental issues during operation of the rural roads must be included here, and the information should be quantitative as far as possible. The following should be noted:
    (a) the assessment results should be quantitative,
    (b) compare these results with the environmental standards to see if they comply with or exceed the relevant standards,

(c) if there is exceedance, propose mitigation measures that will reduce the environmental impact to acceptable levels,
(d) also list these mitigation measures in the environmental management plan (EMP),
(e) assess impact from demand on resources as well, e.g. the quantity of ground water extracted by the water supply project and assess such impact due to increased demand on this resource, and
(f) also describe pollutant reductions during the operation phase, e.g., the amount of BOD_5 and COD_{Cr} reduced from discharging into the river due to the provision of WWTP by the project, the number of small boiler rooms demolished which will result in the reduction of how many tons of SO_2 emission per year due to the provision of district heating, etc.

(v) Calculate the total annual carbon dioxide emission from traffic traveling on all the proposed rural roads in the long term design year, to assess whether the ADB threshold of 100,000 t/a carbon dioxide is exceeded.

Chapter 6 – Analysis of Alternatives

19. Chapter 6 various options considered for the rural roads, including the “no project” (no improvement) option. Examples of options that could be evaluated could include road paving, road drainage design, slope stabilization design, etc.

Chapter 7 – Information Disclosure, Consultation, and Participation

20. Chapter 7 describes the public consultations conducted during the environmental assessment study. ADB requires that the consultation must be meaningful and prefers it to be conducted in form of a discussion forum. Information to be provided in this chapter includes:

(i) the dates and locations of the public consultation,
(ii) the number and make up (e.g. government representatives, village leaders, private citizens, etc) of participants questions, concerns, ideas,
(iii) suggestions raised by the participants,
(iv) how are the questions, concerns, ideas and suggestions raised by the participants addressed in the environmental assessment study and report, and
(v) the planned information disclosure measures (including the type of information to be disseminated and the method of dissemination) and the process for carrying out consultation with affected people and facilitating their participation during project implementation.

Chapter 8 – Grievance Redress Mechanism

21. This chapter describes the grievance redress framework (both informal and formal channels), setting out the time frame and mechanisms for resolving complaints about environmental performance. This report could make reference to the grievance redress mechanism (GRM) described in the Project EIA and EMP.

Chapter 9 – Environmental Management Plan

22. An Environmental Management Plan (EMP) has to be prepared as an Appendix to the environmental assessment report. The requirements of the EMP are described in later sections.

Chapter 9 in the environmental assessment report summarizes the key components of the EMP, which include:

(i) a summary of environmental impacts and their respective mitigation measures,
(ii) a summary of the environmental monitoring plan,
(iii) public consultation needs during the construction and operation phases,
(v) responsibilities of various parties during the implementation of the EMP,
(vi) a project specific GRM, and
(v) cost estimates for implementing the EMP.

Chapter 10 – Conclusions

23. Chapter 10 summarizes the findings of the environmental assessment study. It should include information on:

(i) project benefits including both socio-economic and environmental benefits,
(ii) summary of significant environmental impacts during the construction and operation phases, and their respective mitigation measures,
(iii) the use of irreplaceable resources such as the area of land and associated habitats and resources that will be permanently lost due to permanent land acquisition, and
(iv) highlights of the environmental management plan including environmental monitoring requirements.

E. Procedures for Preparing the Environmental Management Plan

24. The EMP should include 5 main items. These are (i) environmental mitigation measures, (ii) environmental monitoring, (iii) public consultation, (iv) institutional strengthening and training, and (v) project GRM. These items are described below.

25. The EMP should include a table listing the implementation of the mitigation measures (see Table 2 of the project EMP). All mitigation measures for the rural roads mentioned in the environmental assessment report should be listed in this table, covering the detail design, construction and operation phases. It is important to include the detail design phase because some mitigation measures such as drainage and slope stability will become part of the road infrastructure and will have to be designed and included in the specifications for tendering. It is important to clearly state the responsibilities, on who is responsible for implementation and who for supervision. Cost estimates also need to be provided. To avoid double counting of costs, costs for items that will become a permanent part of the facility (such as road side landscaping, road drainage etc) and for items that are already included in the daily operational costs of the project should not be included in this table, since these should already have been included in the overall project cost. Costs to be included in the table should be mostly temporary measures during the construction stage. Examples are the watering of construction site and haul roads to reduce dust, temporary noise barriers around noisy machines, sedimentation basins and perimeter drainage ditch to control muddy site runoff, temporary chemical toilets for construction workers etc.

26. Based on results of the environmental impact assessment and the locations of sensitive targets such as residential areas, hospitals, schools, temples, rivers, etc, an environmental monitoring plan should be compiled for the construction and operation phases (see Table 5 of the project EMP). The plan should be impact and location specific. For example, construction dust and noise monitoring at environmental protection target locations might only be needed

when construction activities are within 500 m of the targets. The plan should also be very specific on the parameters to be monitored, the total number of monitoring locations, the exact locations (=location and name of each sensitive target) where monitoring is to be carried out, and the frequency and duration of monitoring. The table should also list clearly who is responsible for doing the monitoring and who is responsible for supervision. Cost estimates should be provided for undertaking such monitoring. For the operation phase, cost estimates should be provided for the first year, and the need to continue monitoring after the first year should be reviewed at the end of the first year.

27. The need for public consultation should be addressed in the EMP, with the numbers and types of public consultation during the construction and operation phases listed (see Table 9 of the project EMP). This is an important public relations means to get the stakeholders involved and informed in the project. Cost estimates for conducting such consultation should also be provided.

28. Institutional strengthening and training of the local PMO, EA, IA and other parties involved in the project is important in ensuring that they have the capacity to implement the EMP (see Table 8 of the project EMP). The environmental assessment report should review and determine if further training will be needed, such as for the new O&M units for the substitute rural roads.

29. A GRM for the project should be included in the EMP. This report could make reference to the GRM already established for the project as described in the approved Project EIA and EMP.

F. Report Review and Submission

30. The PPMO should first review the environmental assessment report. Their review criteria will be based on adequacy of information requirements described in this report. If the environmental assessment reports are deemed to fulfil the information requirements described in this EARF, the PPMO will submit to ADB for review, approval and disclosure.

31. ADB will update the approved Project EIA/EMP with the information from the new environmental assessment report. This will be done by including an addendum cover sheet explaining the changes and their implications for implementation and the new environmental assessment report for the replacement road sections will be included as a new appendix in the updated version of the Project EIA/EMP. The updated Project EIA/EMP will be disclosed on the ADB website for a period of 120 days prior to approval of the change in scope.

G. Staffing Requirements and Budget

32. The EAs will bear the costs for preparing the new environmental assessment studies and reports. The EMP will itemize the staffing requirements, institutional strengthening and training needs, implementation of the environmental mitigation measures and environmental monitoring. The EAs will bear all these costs.

CONSULTATION RECORD FOR THE RURAL ROADS

Public Opinion Poll of Residents about Environmental Impact Assessment to Tuanshan #2 Highway on Simao District

Name	Gender	Age	Nationality	Degree of Education	Profession	Politics Appearance
Hu Jiahong	Male	46	the Yi Nationality	Junior High School	Farmer	Public People
Unit or Address		Shangdatian Group Tuanshan Village				
Project Survey	Tuanshan Highway in Simao District is located on the village road in Yunxian County of Simao District with 27.7km long, leading from Siyun Highway K37+200 kilometers to Tuanshan Village Committee. Major Controlling Points are Dahebian, Nanen, Nae, Xinzhai, Tea Factory, Tuanshan Village Committee.					

Survey Questions

1. How much do you know about Tuanshan Highway in Simao District?
   Propaganda in Meetings☐ Have seen/read via media☐ Heard from others☑ No Idea☐

2. Do you think the project will contribute to the local economy development?
   Yes☑ No ☐No Idea☐

3. The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?
   No☑ Yes☐ No Idea☐

4. Do you know the compensation policy of land procurement and relocation of highway construction?
   Yes☐Yes, but a little☑ No☐

5. Do you obey the land procurement/demolition and relocation?
   Yes☑ Obey under some condition☐ No☐

6. How do you think the project impacts the environment?
   Big Effect☐ Nothing Big☐ No Effect☑

7. Which of below affects you most?
   Construction Noise☐ Dust☐ Construction Waste Water☐ Deconstruction of Landscape☐
   Dregs☐ Others☑

8. Do you agree the construction of Tuanshan Highway in Simao District?
   Agree☑ Not Agree☐ No Idea☐

   Why are you not in favor of the construction?

9. Do you have any other comments and suggestions to the project?
   No

Your comments and suggestions are important to the project. Thank you for your participation.

Public Opinion Poll of Residents about Environmental Impact Assessment to Chahe #4 Highway in Liming Village Ninger County

Name	Gender	Age	Nationality	Degree of Education	Profession	Politics Appearance
Li Feng	Male	42	the Hani Nationality	Junior High School	Branch Secretary	Party Member
Unit or Address		Daqiao Group in Chahe, Liming Village				
Project Survey	Chahe Highway in Liming Village Ninger County is 14.851km long, leading from the bealock of Pu-niu Line Tangliushu Village to the bealock of Lingfang. Major controlling points are the bealock of Tangliushu, Chahe Village, BumaoStockaded Village, Nanbenhe and the bealock of Lingfang.					

Survey Questions

1. How much do you know about Chahe Highway in Liming Village Ninger County
   Propaganda in Meetings☑ Have seen/read via media☐ Heard from others☐ No Idea☐

2. Do you think the project will contribute to the local economy development?
   Yes☑ No☐No Idea☐

3. The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?
   No☑ Yes☐ No Idea☐

4. Do you know the compensation policy of land procurement and relocation of highway construction
   Yes ☑Yes, but a little☐ No☐

5. Do you obey the land procurement/demolition and relocation?
   Yes☑ Obey under some condition☐ No☐

6. How do you think the project impacts the environment?
   Big Effect☐ Nothing Big☑ No Effect☐

7. Which of below affects you most?
   Construction Noise☐ Dust☐ Construction Waste Water☐ Deconstruction of Landscape☐ Dregs ☐ Others ☑

8. Do you agree the construction of Chahe Highway in Liming Village Ninger County?
   Agree☑ Not Agree☐ No Idea☐

   Why are you not in favor of the construction?

9. Do you have any other comments and suggestions to the project?
   No

Your comments and suggestions are important to the project. Thank you for your participation.

Public Opinion Poll of Residents about Environmental Impact Assessment to Habo Village #19 Highway in Guoqing Town Jiangcheng County

Name	Gender	Age	Nationality	Degree of Education	Profession	Politics Appearance
Li Chunwen	Male	50	the Hani Nationality	Junior High School	Director	Public People
Unit or Address		Habo Village Committee				
Project Survey	Habo Village Highway in Guoqing Town Jiangcheng County is 14.302km long, leading from Ferrosilicon Factory to Habo Village Association. Major controlling points are ferrosilicon Factory, the bealock of Baimu Mountain, Big Mountain Stockaded Village, Laogong Stockaded Village, Chikeng, Habo Village Association.					

Survey Questions

1. How much do you know about Habo Village Highway in Guoqing Town Jiangcheng County?
   Propaganda in Meetings☑ Have seen/read via media☐ Heard from others☐ No Idea☐

2. Do you think the project will contribute to the local economy development?
   Yes☑ No☐No Idea☐

3. The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?
   No☑ Yes☐ No Idea☐

4. Do you know the compensation policy of land procurement and relocation of highway construction
   Yes☐ Yes, but a little☑ No☐

5. Do you obey the land procurement/demolition and relocation?
   Yes☑ Obey under some condition☐ No☐

6. How do you think the project impacts the environment?
   Big Effect☐ Nothing Big☑ No Effect☐

7. Which of below affects you most?
   Construction Noise ☑ Dust☐ Construction Waste Water☐ Deconstruction of Landscape☐ Dregs ☐ Others ☐

8. Do you agree the construction of Habo Village Highway in Guoqing Town Jiangcheng County?
   Agree☑ Not Agree☐ No Idea☐

   Why are you not in favor of the construction?

9. Do you have any other comments and suggestions to the project?
   No

Your comments and suggestions are important to the project. Thank you for your participation.

Public Opinion Poll of Residents about Environmental Impact Assessment to Two-tree Village Liangkeshu #20 Highway in Jiangcheng County

Name	Gender	Age	Nationality	Degree of Education	Profession	Politics Appearance
Ma Jichao	Male	46	the Han Nationality	Primary School	Farmer	Public People
Unit or Address		Two-tree Village				
Project Survey	Two-tree Village Highway in Jiangcheng County is 24.769km long, leading from Two-tree Village to the bealock of Yaojia Mountain. Major controlling points are Two-tree Village, Dabei, Two-tee Stockaded Village, Xiangjiao Mountain, the bealock of Yaojia Mountain					

Survey Questions

1. How much do you know about Two-tree Village Highway in Jiangcheng County?
   Propaganda in Meetings☑ Have seen/read via media☐ Heard from others☐ No Idea☐

2. Do you think the project will contribute to the local economy development?
   Yes☑ No☐No Idea☐

3. The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?
   No☑ Yes☐ No Idea☐

4. Do you know the compensation policy of land procurement and relocation of highway construction?
   Yes ☐Yes, but a little☑ No☐

5. Do you obey the land procurement/demolition and relocation?
   Yes☑ Obey under some condition☐ No☐

6. How do you think the project impacts the environment?
   Big Effect☐ Nothing Big☑ No Effect☐

7. Which of below affects you most?
   Construction Noise☐ Dust☐ Construction Waste Water ☐ Deconstruction of Landscape☐ Dregs ☐ Others ☑

8. Do you agree the construction of Two-tree Village Highway in Jiangcheng County?
   Agree☑ Not Agree☐ No Idea☐

   Why are you not in favor of the construction?

9. Do you have any other comments and suggestions to the project?
   No

   Your comments and suggestions are important to the project. Thank you for your participation

Public Opinion Poll of Residents about Environmental Impact Assessment to Longtang Village #21 Highway in Qushui Town Jiangcheng County

Name	Gender	Age	Nationality	Degree of Education	Profession	Politics Appearance
Tao Jiangrong	Male	35	the Hani Nationality	Junior High School	Farmer	Public People
Unit or Address		Longtang Village				
Project Survey	Longtang Village Highway in Qushui Town Jiangcheng County is 20.189 km long, leading from Tianxin Road switch to Longtang Village. Major controlling points are the Fock of Tianxin Road, Luoshitang, the Fork of Old High Mountain Village, Longtang Village.					

Survey Questions

1. How much do you know about Longtang Village Highway in Qushui Town Jiangcheng County?
   Propaganda in Meetings☑ Have seen/read via media☐ Heard from others☐ No Idea☐

2. Do you think the project will contribute to the local economy development?
   Yes☑ No ☐No Idea☐

3. The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?
   No☑ Yes☐ No Idea☐

4. Do you know the compensation policy of land procurement and relocation of highway construction?
   Yes☐ Yes, but a little☑ No☐

5. Do you obey the land procurement/demolition and relocation?
   Yes☑ Obey under some condition☐ No☐

6. How do you think the project impacts the environment?
   Big Effect☐ Nothing Big☑ No Effect☐

7. Which of below affects you most?
   Construction Noise☐ Dust☐ Construction Waste Water☐ Deconstruction of Landscape☐ Dregs ☐ Others☑

8. Do you agree the construction of Longtang Village Highway in Qushui Town Jiangcheng County?
   Agree☑ Not Agree☐ No Idea☐
   Why are you not in favor of the construction?

9.

10. Do you have any other comments and suggestions to the project?

    No

Your comments and suggestions are important to the project. Thank you for your participation.

Public Opinion Poll of Residents about Environmental Impact Assessment to Damannuo Village #22 Highway in Menglian County

Name	Gender	Age	Nationality	Degree of Education	Profession	Politics Appearance
Yanniu	Male	36	the Va Nationality	Senior High School Party School	Farmer	Clerk
Unit or Address		Bangao Group Fuyan Village Menglian County Yuannan Province				
Project Survey	Damannuo Village Highway in Menglian County is 17km long, lasting from Fu-mo Line K8+900 to Gelangyang River. Major controlling points are Tujingyinglang, Yingbaile, Yingming, Banmiao, Yingwai, Damannuo, Yinglong, Yingkou, Nuodao, Yingbalatuan, Moyang.					

Survey Questions

1. How much do you know about Damannuo Village Highway in Menglian County?
   Propaganda in Meetings☑ Have seen/read via media☐ Heard from others☐ No Idea☐

2. Do you think the project will contribute to the local economy development?
   Yes☑ No ☐No Idea☐

3. The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?
   No☑ Yes☐ No Idea☐

4. Do you know the compensation policy of land procurement and relocation of highway construction
   Yes☐ Yes, but a little☑ No☐

5. Do you obey the land procurement/demolition and relocation?
   Yes☑ Obey under some condition☐ No☐

6. How do you think the project impacts the environment?
   Big Effect☐ Nothing Big☐ No Effect☑

7. Which of below affects you most?
   Construction Noise☐ Dust☐ Construction Waste Water☐ Deconstruction of Landscape☐ Dregs☐ Others ☑

8. Do you agree the construction of Damannuo Village Highway in Menglian County?
   Agree☑ Not Agree☐ No Idea☐

   Why are you not in favor of the construction?

9. Do you have any other comments and suggestions to the project?
   Try to handle as soon as possible!

   Your comments and suggestions are important to the project. Thank you for your participation

Public Opinion Poll of Residents about Environmental Impact Assessment to Gongliang Village # 23 Highway in Mengliang County

Name	Gender	Age	Nationality	Degree of Education	Profession	Politics Appearance
Yan Dong	Male	38	the Dai Nationality	Junior High School	Farmer	Public People
Unit or Address		Banlaba in Muliang Village				
Project Survey	Gongliang Village Highway in Mengliang County is 14.3km long, leading from Xiangjiao Six Group to Fengwo. Major controlling points are Nanhong, Bansong, the Cock, Banwei, Banke, Mande, Laba, Fengwo.					

Survey Questions

1. How much do you know about Gongliang Village Highway in Mengliang County?
   Propaganda in Meetings☑ Have seen/read via media☐ Heard from others☐ No Idea☐

2. Do you think the project will contribute to the local economy development?
   Yes☑ No ☐No Idea☐

3. The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?
   No☑ Yes☐ No Idea☐

4. Do you know the compensation policy of land procurement and relocation of highway construction
   Yes ☑Yes, but a little☐ No☐

5. Do you obey the land procurement/demolition and relocation?
   Yes☑ Obey under some condition☐ No☐

6. How do you think the project impacts the environment?
   Big Effect☐ Nothing Big☑ No Effect☐

7. Which of below affects you most?
   Construction Noise☐ Dust☐ Construction Waste Water☐ Deconstruction of Landscape☐ Dregs☐ Others ☑

8. Do you agree the construction of Gongliang Village Highway in Mengliang County?
   Agree☑ Not Agree☐ No Idea☐
   Why are you not in favor of the construction?

9. Do you have any other comments and suggestions to the project?
   No

Your comments and suggestions are important to the project. Thank you for your participation.

Public Opinion Poll of Residents about Environmental Impact Assessment to Huie Village Highway #24 in Menglian County

Name	Gender	Age	Nationality	Degree of Education	Profession	Politics Appearance
Li Zhang	Male	43	the Dai Nationality	Junior High School	Farmer	Public People
Unit or Address		Huie First Group of Huie Village in Menglian County				
Project Survey	Huie Village Highway in Menglian County is 11.8km long, leading from Jingning Village Government to Mengbai Village Committee. Major controlling points are He'en Shangzhai and He'en Xiazhai.					

Survey Questions

1. How much do you know about Huie Village Highway in Menglian County?
   Propaganda in Meetings☑ Have seen/read via media☐ Heard from others☐ No Idea☐

2. Do you think the project will contribute to the local economy development?
   Yes☑ No ☐No Idea☐

3. The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?
   No☑ Yes☐ No Idea☐

4. Do you know the compensation policy of land procurement and relocation of highway construction
   Yes ☑Yes, but a little☐ No☐

5. Do you obey the land procurement/demolition and relocation?
   Yes☑ Obey under some condition☐ No☐

6. How do you think the project impacts the environment?
   Big Effect☐ Nothing Big☑ No Effect☐

7. Which of below affects you most?
   Construction Noise☐ Dust☐ Construction Waste Water☐ Deconstruction of Landscape☐ Dregs☐ Others ☑

8. Do you agree the construction of Huie Village Highway in Menglian County
   Agree☑ Not Agree☐ No Idea☐
   Why are you not in favor of the construction?

9. Do you have any other comments and suggestions to the project?
   No

Your comments and suggestions are important to the project. Thank you for your participation.

Public Opinion Poll of Residents about Environmental Impact Assessment to Dongnai Village Highway #25 in Menglian County

Name	Gender	Age	Nationality	Degree of Education	Profession	Politics Appearance
Napai	Female	33	the Lahu Nationality	Junior High School	Farmer	Public People
Unit or Address		Dongnai Village in Mengma Town				
Project Survey	Dongnai Village Highway in Menglian County is 11.9km long, leading from Meng-meng Line K47+050 kilometers to Nankang Village. Major controlling points are Manglang, the Forth Group of the Farm, Mafeng Stockaded Village, Gelie, Nankang.					

Survey Questions

1. How much do you know about Dongnai Village Highway in Menglian County?
   Propaganda in Meetings☑ Have seen/read via media☐ Heard from others☐ No Idea☐

2. Do you think the project will contribute to the local economy development?
   Yes☑ No ☐No Idea☐

3. The construction of highway needs to occupy a part of farmland and demolish some houses, do you have any objections?
   No☑ Yes☐ No Idea☐

4. Do you know the compensation policy of land procurement and relocation of highway construction?
   Yes ☑Yes, but a little ☐ No☐

5. Do you obey the land procurement/demolition and relocation?、
   Yes☑ Obey under some condition☐ No☐

6. How do you think the project impacts the environment?
   Big Effect☐ Nothing Big☑ No Effect☐

7. Which of below affects you most?
   Construction Noise☐ Dust☑ Construction Waste Water☐ Deconstruction of Landscape☐ Dregs ☐ Others ☐

8. Do you agree the construction of Dongnai Village Highway in Menglian County?
   Agree☑ Not Agree☐ No Idea☐

   Why are you not in favor of the construction?

9. Do you have any other comments and suggestions to the project?
   No

Your comments and suggestions are important to the project. Thank you for your participation.

RURAL ROAD INVENTORY

1. The previous Rural Road Inventory has been deleted owing to changes in proposed road sections, a new inventory will be compiled once all substitute rural roads have been identified and detailed design information is available.

SENSITIVE RECEPTORS FOR AIR, NOISE AND WATER QUALITY FOR ALL COMPONENTS

A. Menglian-Meng'a Road

Table 1: Existing Air Quality and Noise Sensitive Receptors along the Menglian-Meng'a Highway

No.	Location of Sensitive Receptor	Features of Sensitive Receptor	Distance from the center line (m)	Air Quality Standard	Time	Background value	Implementation standard	Year 2012		Year 2018		Year 2026	
								Leq	Superscalar	Leq	Superscalar	Leq	Superscalar
1	Manghuai K52＋200	More than 30 households, 120 persons, which is close to urban roads.	Right 10	II	Daytime	48.8	4a	63.0		65.8		68.0	
					Nighttime	37.3		56.4	1.4	59.2	4.2	61.3	6.3
2	Hegelao K76＋460	More than 40 households, about 120 persons, the households are relatively centralized, the houses are close to S309	Right 20	II	Daytime	48.1	4a	57.3	—	60.0	—	62.1	—
					Nighttime	36.7		50.5	—	53.3	—	55.4	0.4
3	Hege new village K77＋060	About110 households, about 480 persons, the households are relatively centralized, the village is close to current S309	Left 10	II	Daytime	48.1	4a	62.9	—	65.8	—	67.9	—
					Nighttime	36.7		56.3	1.3	59.2	4.2	61.3	6.3
4	Mangle K78＋050	More than 50 households, 210 persons, the households are relatively centralized	Right 120	II	Daytime	52.1	2	52.4	—	52.8	—	53.1	—
					Nighttime	36.4		38.6	—	40.1	—	41.4	—
5	Mengma Town K79＋800	More than 140 households of 600 persons, which are close to S309. the frontage is mainly shops and stores	Left, right 8	II	Daytime	52.1	4a	65.0	—	67.8	—	69.9	—
					Nighttime	36.4		58.3	3.3	61.1	6.1	63.3	8.3
6	Mengma Primary School K79+900	23 classes, 60 teachers, 860 students, 3 storeys' classroom face to S309	Right 40	II	Daytime	50.2	2	53.5	—	55.3	—	56.9	—
					Nighttime	38.4		45.3	—	47.7	—	49.6	—
7	Heha new village K82＋550	About 8 scattered households, 35 persons, by the existing S309.	Left 10	II	Daytime	50.2	4a	63.0	—	65.8	—	68.0	—
					Nighttime	38.4		56.4	1.4	59.2	4.2	61.3	6.3
8	Mnaghai Primary School K89＋060	6 classes, 11 teachers, 115 students, 3 stories' classroom vertically face to S309	Right 8	II	Daytime	52.1	2	61.3	1.3	64.0	4.0	66.0	6.0
					Nighttime	36.4		54.4	4.4	57.1	7.1	59.3	9.3
9	Dormitory of Nanma Power Station k89＋800	About 20 households, 60 persons, the households are relatively centralized, which are close to S309	Left 20	II	Daytime	52.1	4a	58.1	—	60.4	—	62.3	—
					Nighttime	36.4		50.5	—	53.3	—	55.4	0.4
10	Guangsan K90+650	About 30 households, 120 persons, the houses face to S309	Left 20	II	Daytime	53.0	4a	58.3	—	60.5	—	62.4	—
					Nighttime	37.8		50.5	—	53.3	—	55.4	0.4
11	Bingsuo	More than 10	Right 10	II	Daytime	53.0	4a	63.2	—	65.9	—	68.0	—

No.	Location of Sensitive Receptor	Features of Sensitive Receptor	Distance from the center line (m)	Air Quality Standard	Time	Background value	Implementation standard	Year 2012		Year 2018		Year 2026	
								Leq	Superscalar	Leq	Superscalar	Leq	Superscalar
	K91+800	households, 40 persons, the households are relatively centralized, houses face to S309.			Nighttime	37.8		56.4	1.4	59.2	4.2	61.3	6.3
12	Manglang K95＋200	More than 80 households, 350 persons, the households are relatively centralized, the village is close to existing highway.	Left, right 8	II	Daytime	53.0	4a	65.1	—	67.8	—	69.9	—
					Nighttime	37.8		58.3	3.3	61.1	6.1	63.3	8.3
13	Anma K97＋350	More than 10 households, 40 persons, the households are relatively centralized, the village is close to current highway.	Right 8	II	Daytime	52.0	4a	65.0	—	67.8	—	69.9	—
					Nighttime	37.0		58.3	3.3	61.1	6.1	63.3	8.3
14	Jianghui K100+000	More than 70 households, 230 persons,	Right 120	II	Daytime	44.0	1	45.9	—	47.1	—	48.3	—
					Nighttime	36.7		38.8	—	40.2	—	41.5	—
15	Nayang K101+850	More than 10 households, 50 persons, the households are relatively centralized.	Right 50	II	Daytime	44.0	2	50.1	—	52.5	—	54.3	—
					Nighttime	36.7		43.4	—	45.8	—	47.8	—
16	Longhai K102＋300	More than 60 households, 210 persons, the households are relatively centralized.	Right 8	II	Daytime	44.0	4a	65.0	—	67.8	—	69.9	—
					Nighttime	36.7		58.3	3.3	61.1	6.1	63.3	8.3

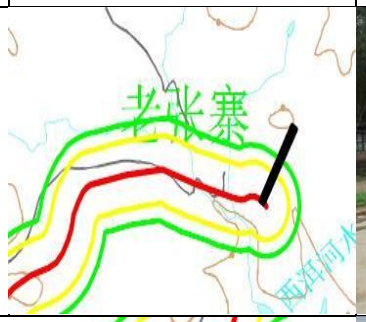
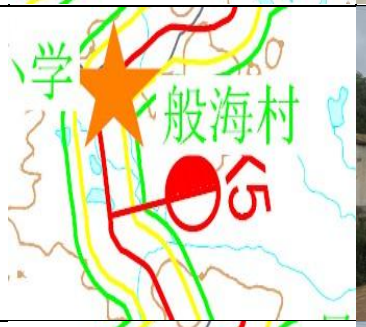
Source: PRC EIR. 2009.

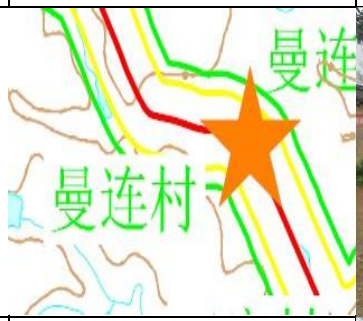
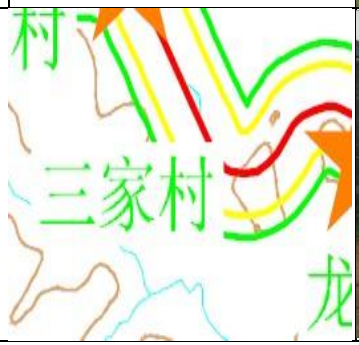
Table 2: Surface Water Quality Sensitive Receptors along the Menglian-Meng'a Highway

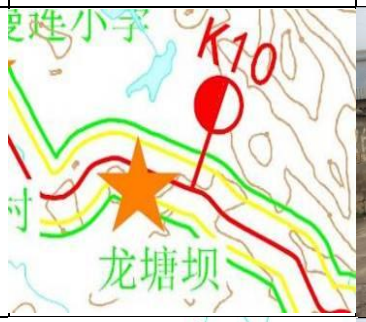
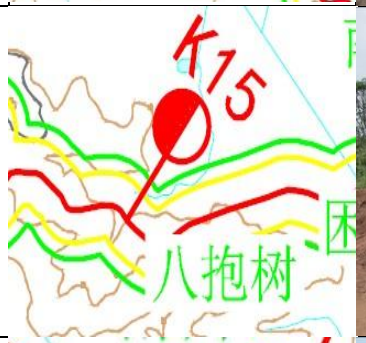
No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category	Remark
1	Nanma River	K77+800	Crossing	Class III	
2	Nanma River	K99+200	Crossing	Class III	

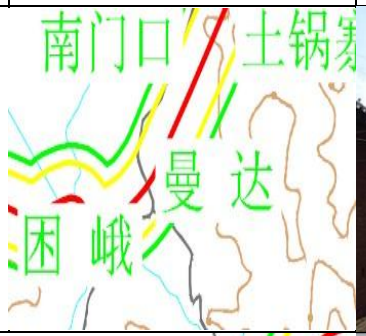
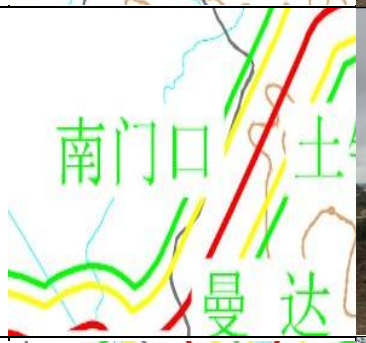
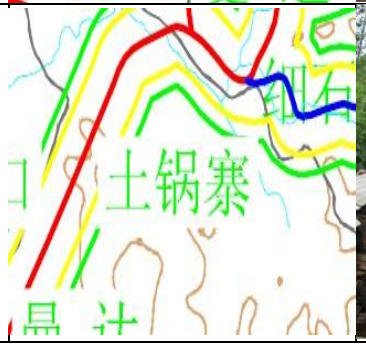
Source: PRC EIR. 2009.

Table 3: Existing Air Quality and Noise Sensitive Receptors along the Ning'er-Jiangcheng-Longfu Road

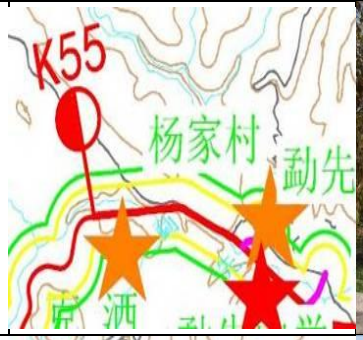
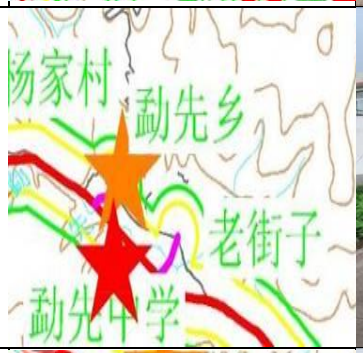
NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
1	Laozhan Village	K1+300	50m (right)	Residential	13 households	II	4a		
2	Banhai Village	K4+150	5m (across village)	Residential	65 households	II	4a		
3	***Banhai school***	K4+100	25m (right)	Students and teacher	180 students and teachers	II	I		

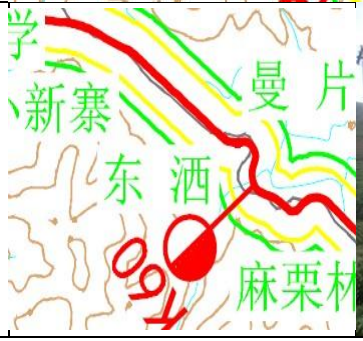
NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
4	Manliang Village	K7+300	5m (across village)	Residential	42 households	II	4a		
5	***Manliang School*** Village	K7+100	10m (left)	Students and teachers	15 students and teachers	II	I		
6	Sanjia Village	K8+000	5m(across village)	Residential	13 households	II	4a		

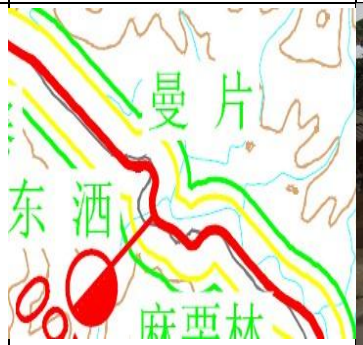
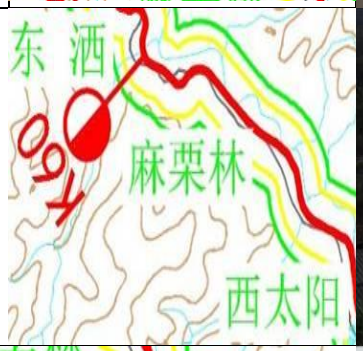
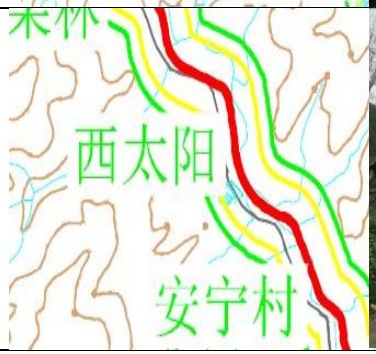
NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
7	Longtanba Village	K9+500	5m (right)	Residential	23 households	II	4a		
8	Babao Village	K16+500	20m (across village)	Residential	16 households	II	4a		
9	Kunwo Village	K16+850	10m (across village)	Residential	18 households	II	4a		

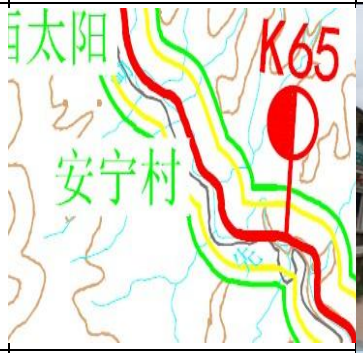
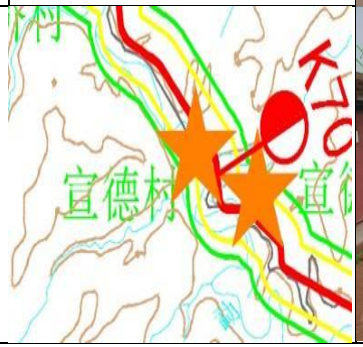
NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
10	Manda Village	K16+800 to 950	15m (across village)	Residential	26 households	II	I		
11	Nanmengkou Village	K18+300	35m (left)	Residential	35 households	II	4a		
12	Tugou Village	K19+600	20m (right)	Residential	11 households	II	4a		

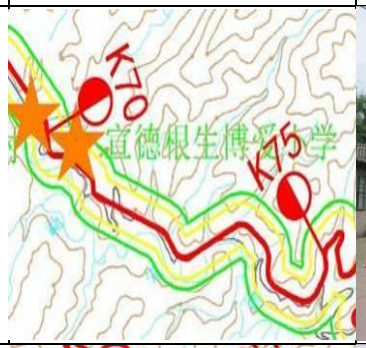
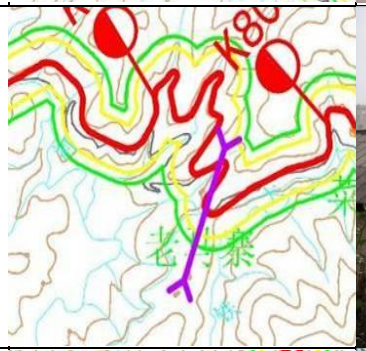
NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
13	Xishitou Village	K20+200	5m (across village)	Residential	34 households	II	4a		
14	Xiananla Village	K21+000	50m (left)	Residential	54 households and 220 persons	II	I		
15	Kesha Village	K55+200	120m (right)	Residential	24 households	II	I		

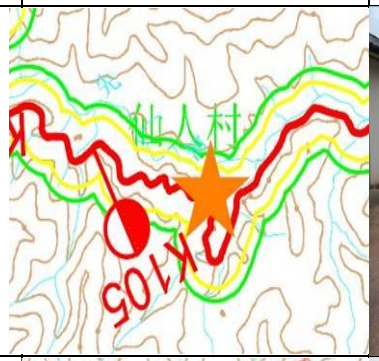
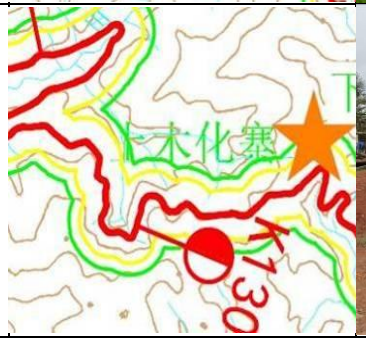
NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
16	Yangjia Village	K56+200	15m (left)	Residential	22 households	II	4a		
17	Memgxian Town	K56+800	110m (left)	Residential	150 households	II	I		
18	***Memgxian school***	K56+900	25m (right)	Students and teachers	400 Students and teachers	II	I		

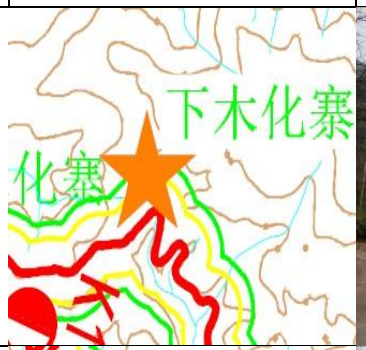
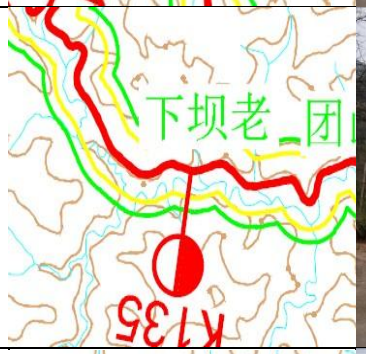
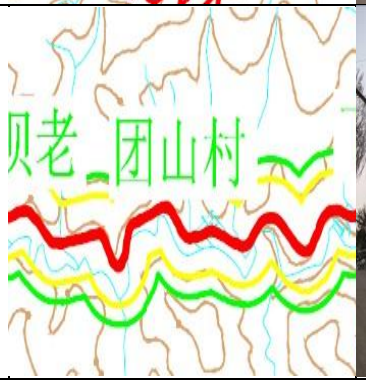
NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
19	Laojiezi Village	K57+800	40m (left)	Residential	31 households	II	4a		
20	Xiaoxing Village	K58+400	110m (right)	Residential	24 households	II	I		
21	Tongsha Village	K58+750	130m (right)	Residential	16 households	II	I		

NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
22	Manpian Village	K59+600	100m (left)	Residential	13 households	II	I		
23	Maliling Village	K61+200	40m (right)	Residential	21 households	II	4a		
24	Xitaiyang Village	K62+800	150m (right)	Residential	19 households	II	I		

NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
25	Anning Village	K63+800	5m (across village)	Residential	59 households	II	I		
26	Sandaoqiao Village	K67+800	10m (across village)	Residential	33 households	II	I		
27	Xuande Village	K69+800	5m (across village)	Residential	67 households	II	4a		

NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
28	Yidegengsheng school	K70+000	120m (left)	Students and teachers	350 Students and teachers	II	I		
29	Laoma Village	K12+600 to K13+100	10m (right)	Residential	23 households	II	4a		
30	Caiziditiechang Village	K80+900	12m (across village)	Residential	23 households	II	4a		

NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
31	Xianren Village	K106+500	5m (left)	Residential	39 households	II	4a		
32	Liming Town	K123+350	5m (across town)	Residential	172 households	II	4a		
33	Shangmuhua village	K131+900	15m (left)	Residential	11 households	II	4a		

NO.	Location	Chainage	Distance (m) from Road Center Line	Receptor Type	No. of Households and Persons	Air Quality Category	Noise Classification	Location of the Sensitive Receptor to the Road	Field Site Photos
34	Xiamuhua village	K132+000	20m (left)	Residential	29 households	II	4a		
35	Xiabalao village	K135+450	60m (left)	Residential	13 households	II	4a		
36	Tuanshan village	K136+100	10m (left)	Residential	65 households	II	4a		

Source: Draft EIR.

Table 4: Surface Water Quality Sensitive Receptors along the Ning'er-Jiangcheng-Longfu Road

No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category	Remark
1	Mengye River	K153+643	Over Mengye river	III	No centralized drinking water intake within the assessment areas
2	Mengxian River	K68+160	Over Mengxian river	III	
3	Tiechang River	K78+300	Over Tiechang river	III	
4	Manxian River	K101+983	Over Manxian river	III	
5	Manpengtian River	K126+353	Over Manpengtian rive	III	
6	Nanken River	K140+723	Over Nanken river	III	
7	Lahhu River	K207+253	Over Lahhu river	III	
8	Longtong River	K234+283	Over Longtong river	III	
9	Shili River	K238+173	Shili river	III	
10	Wunqianhe Reservoir		2km, Out of reservoir basin	III	
11	Xiaoheqing Reservoir	K25+800~K27+300	100m	III	

Source: Draft EIR.

B. Sensitive Receptors along the Rural Roads

Table 5: Existing Air Quality and Noise Sensitive Receptors along Rural Road #2

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Timber mill	Siyun road K37+200	right	residential		II	4a
2	Dahebian		right	residential	3 households and 40 households 5m (right)	II	I
3	Naneng		10m (right)	residential	30 households and 180 persons	II	4a
4	Nae		20m (right)	residential	30 households and 180 persons	II	4a
5	Xin Village		2000m (left and right)	residential	40 households and 200 persons	II	I
6	Tea mill		2000m (left and right)	residential	40 households and 200 persons	II	I
7	Tuanshan committee	terminal	30m (left) 4m (right)	residential	500 households and 2000 persons and a primary school 600 persons	II	4a

Source: Draft EIR.

Table 6: Existing Air Quality and Noise Sensitive Receptors along Rural Road #4

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Yangyutang	Start	5m (right)	residential	1 household	II	4a
2	Chahe Village Dashupo		5m (right) 5m (left)	residential	19 households and 74 persons	II	4a
3	Bumao Village		5m (right) 5m (left)	residential	13 households and 42 persons	II	4a
4	Nanben river			residential	18 households and 75 persons	II	4a
5	Lingfangyakou	terminal					

Source: Draft EIR.

Table 7: Surface Water Quality Sensitive Receptors along Rural Road #4

No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category
1	Muhuazhai river		Over river	III
2	Shunlu river		Over river	III
3	Dajiu river		Over river	III
4	Maobuzhai river		Over river	III
5	Toudao river		Over river	III

Table 8: Existing Air Quality and Noise Sensitive Receptors along Rural Road #5

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Meizi village	Start	5m (right)	residential	1 household	II	4a
2	Xin Village		3m (right) 3m (left)	residential	40 households and 160 persons	II	I
3	Zhong Village		2m (right) 2m (left)	residential	30 households and 120 persons	II	4a
4	Shengming committee	Terminal	2m (right) 2m (left)	residential	70 households and 300 persons	II	4a

Source: Draft EIR.

Table 9: Surface Water Quality Sensitive Receptors along Rural Road #5

No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category
1	Wengao river		Over river	III
2	Manbie river		Over river	III
3	Wuga river		Over river	III

Table 10: Existing Air Quality and Noise Sensitive Receptors along Rural Road #7

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Lushuilin chang	Start	3m (across village)	residential			
2	Lushuilin chang	1 – 3 km	3m (left) 5m (right)	residential	30 households and 120 persons	II	4a
3	Shangbaka	8km	3m (left) 3m (right)	residential	40 households and 150 persons	II	4a
4	Xiabaka		1m (left)	residential	30 households and 120 persons	II	4a
5	Wafang Village	K10+000	3m (left) 3m (right)	residential	80 households and 300 persons	II	4a

Source: Draft EIR.

Table 11: Rural Road #8

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Huazhuqing Village	K0+000	3m (across village)	residential	350 households and 1600 persons	II	4a
2	Chenjiapo Village	K1+000	50m (left)	residential	20 households and 100 persons	II	4a
3	Dawafang Village	K2+200	3m (across village)	residential	20 households and 100 persons	II	4a
4	Gongguan Village	K7+000	3m (across village)	residential	60 households and 270 persons	II	4a
5	Zhatie Village	K10+000	5m (left)	residential	17 households and 80 persons	II	4a
6	Heinitan	K11+000	3m (across	residential	23 households	II	4a

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
	Village		village)		and 100 persons		
7	Shibanqing Village	K14+200	5m (across village)	residential	32 households and 120 persons	II	4a
8	Shangnagui Village	K17+200	5m (across village)	residential	13 households and 50 persons	II	4a
9	Xianagui Village	K20+100	10m (left)	residential	19 households and 80 persons	II	4a
10	Baha Village	K23+400	10m (across village)	residential	18 households and 80 persons	II	4a

Source: Draft EIR.

Table 12: Surface Water Quality Sensitive Receptors along Rural Road #8

No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category	Remark
1	Huida river	K7+200	Over Mengye river	III	No centralized drinking water intake within the assessment areas
2	Yaqi river	K18+600	Over Yaqi river	III	

Source: Draft EIR.

Table 13: Existing Air Quality and Noise Sensitive Receptors along Rural Road #9

NO.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Xinsheng Village	K38+580	3m (left) 5m (right)	residential	60 households and 250 persons	II	4a
2	Xiabanhong		3m (left) 3m (right)	residential	50 households and 200 persons	II	4a
3	Shangbanhong		5m (right)	residential	50 households and 200 persons	II	4a
4	Wazi		3m (left) 3m (right)	residential	25 households and 100 persons	II	4a
5	Manjiu		10m (left)	residential	80 households and 300 persons	II	4a
6	Manlang		3m (left) 3m (right)	residential	44 households and 200 persons	II	4a
7	Mandian		3m (left) 3m (right)	residential	24 households and 100 persons	II	4a
8	Beiqi		2m (left) 2m (right)	residential	22 households and 80 persons	II	4a
9	Lisheng		3m (left) 3m (right)	residential	48 households and 200	II	4a

NO.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
					persons		
10	XingpingJianxing Village		3m (left) 3m (right)	residential	300 households and 1200 persons	II	4a
11	Mali Village		3m (right) 3m (left)	residential	20 households and 80 persons	II	4a
12	Shimen Village		3m (right) 3m (left)	residential	20 households and 80 persons	II	4a
13	Shiyanjiao		5m (left)	residential	20 households and 80 persons	II	4a
14	Xiaoshuijing		100m (left)	residential	30 households and 120 persons	II	I
15	Alou Village		10m (right) 10m (left)	residential	70 households and 300 persons	II	4a
16	Ganlongtan		3m (right) 3m (left)	residential	30 households and 120 persons	II	4a
17	Hongyan Village		20m (right) 5m (left)	residential	30 households and 120 persons	II	4a
18	Shilong Village		5m (right) 5m (left)	residential	90households and 400 persons	II	4a
19	Panpo Village		3m (right) 3m (left)	residential	100 households and 450 persons	II	4a
20	Menglong Village		5m (right) 3m (left)	residential	60 households and 250 persons	II	4a

Source: Draft EIR.

Table 14: Existing Air Quality and Noise Sensitive Receptors along Rural Road #10

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Longjie Village	start					
2	Cha River		10m (right)	residential		II	4a
3	Liangtian		3m (right)	residential	50 households and 200 persons	II	4a
4	Dalubian		5m (right)	residential	20 households and 80 persons	II	4a
5	Nanan Village committee		3m (left) 3m (right)	residential	80 households and 300 persons	II	4a
	Nanan primary school		***20m right)***		***172 students and 8 teachers***		
6	Shanbeihouzu		100m (left)	residential	37 households	II	4a

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
					and 160 persons		
7	Dayangtian		5m (right)	residential	20 households and 80 persons	II	4a
8	Nananyucun		5m (right) 5m (left)	residential	42 households and 296 persons	II	4a
9	Heshao Village comittee		5m (right) 5m (left)	residential	100 households and 400 persons	II	4a
10	Heshaocun Huang jiazu		5m (right) 3m (left)	residential	70 households and 300 persons	II	4a
11	Heshaocun Wuangjiazu		3m (right) 3m (left)	residential	100 households and 400 persons	II	4a
12	Wen long long tan kou		3m (right) 3m (left)	residential	50 households and 200 persons	II	4a

Source: Draft EIR.

Table 15: Surface Water Quality Sensitive Receptors along Rural Road #10

No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category
1	Nanan river		Over river	III
2	Heshao river		Over river	III
3	Leidashi		Over river	III

Table 16: Existing Air Quality and Noise Sensitive Receptors along Rural Road #11

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Yiqizuo team		3m (right) 3m (left)	residential	50 households and 200 persons	II	4a
2	Majiezi		50m (right)	residential	60 households and 240 persons	II	4a
3	Xinpin		50m (left)	residential	17 households and 70 persons	II	4a
4	Bangqing Village Xia cun		10m (left) 10m (right)	residential	19 households and 128 persons	II	4a
	Bangqing primary school		***30m (left)***		***137 students and 8 teachers***		
5	Huanglilin		2m (left) 2m (right)	residential	51 households and 202 persons	II	4a
6	Yanzitou		2m (left) 2m (right)	residential	41 households and 168 persons	II	4a
7	Bnagqing		3m (left)	residential	442 households	II	4a

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
	Village committee		3m (right)		and 1795 persons		
8	Shanbeihouzu			residential	39 households and 168 persons	II	
9	Ai laoshan Natural protection area		3 km long			I	I

Source: Draft EIR.

Table 17: Surface Water Quality Sensitive Receptors along Rural Road #11

No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category
1	Bangqing river		Over river	III

Table 18: Existing Air Quality and Noise Sensitive Receptors along Rural Road #12

No.	Location	Chainage	Distance from Road Center Line	Type	No. of Households and persons	Air Quality Category	Noise Functional Region
1	Manbian Village	K1+500	5m (left)	residential	70 households and 300 persons	II	4a
2	Yonganbanpo Village	K13+800	10m (left)	residential	80 households and 350 persons	II	4a

Source: Draft EIR

Table 19: Existing Air Quality and Noise Sensitive Receptors along Rural Road #13

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Wenhui road	K12+80					
2	Xungang		3m (right) 3m (left)	residential	180 households and 800 persons	II	4a
	Xungang primary school		***20m (left)***		***230 students and 13 teachers***		
3	Zhongtian fang		30m (right) 30m (left)	residential	30 households and 120 persons	II	4a

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
4	Qianjia village mengma		50m (left)	residential	17 households and 70 persons	II	4a
5	Qianjia village qingtou		5m (right)	residential	24 households and 100 persons	II	4a
6	Lulaqingzhai	Terminal	50m (right)	residential	30 households and 120 persons	II	4a

Source: Draft EIR.

Table 20: Surface Water Quality Sensitive Receptors along Rural Road #13

No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category
1	Xungang river		Over river	III

Table 21: Existing Air Quality and Noise Sensitive Receptors along Rural Road #14

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Start	G323 K2361+800					
2	Keli		20m (right)	residential	300 households and 1200 persons	II	4a
3	Wenzha		50m (right)	residential	70 households and 300 persons	II	4a
4	Long tang		10m (left) 5m (right)	residential	50 households and 200 persons	II	4a
5	Lazhuang		50m (right)	residential	50 households and 200 persons	II	4a
6	Manggui		3m (right)	residential	90 households and 360 persons	II	4a
7	Wennai		50m (right)	residential	43 households and 220 persons	II	4a
8	Xiaopingzhang. Qingzhong Yejiazhai		2m (right) 2m (left)	residential	70 households and 300 persons	II	4a
9	Wenhui village comittee		2m (right) 2m (left)	residential	39 households and 200 persons	II	4a
10	Xingfu di		3m (left)	residential	15 households	II	4a

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
					and 70 persons		

Source: Draft EIR.

Table 22: Surface Water Quality Sensitive Receptors along Rural Road #14

No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category
1	Longtang river		Over river	III
2	Xungang river		Over river	III

Table 23: Existing Air Quality and Noise Sensitive Receptors along Rural Road #15

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Manhai river	Start	10m (right)				
2	TuzaiChang		10m (right)	residential	300 households and 1200 persons	II	4a
3	Dalubianzhai		5m (right) 3m (left)	residential	10 households	II	4a
4	Difangzhai		30m (right)	residential	10 households and 50 persons	II	I
5	Guihai Village Daaozizhai		50m (right)	residential	20 households and 80 persons	II	4a
	Guihai village primary school		***20m (left)***		***50 students and 6 teachers***		
6	BazuoheGuishu Village team		200m (right)	residential	40 households and 160 persons	II	I
7	Guihai village		10m (right) 10m (left)	residential	40 households and 160 persons	II	4a

Source: Draft EIR.

Table 24: Existing Air Quality and Noise Sensitive Receptors along Rural Road #16

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Xinwen village sanzhangtian group	Start	3m (right) 3m (left)	residential	27 households and 106 persons	II	4a
2	Xinwen village Dapingtian Group		3m (right) 3m (left)	residential	34 households and 125 persons	II	4a
3	Jiujiazheng Liangzi Group		3m (right) 3m (left)	residential	61 households and 250 persons	II	4a
4	Songlingjiao group		10m (left)	residential	19 households and 77	II	4a

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
					persons		
5	Zhetie village Banglu group		5m (right)	residential	24 households and 80 persons	II	4a
6	Xin Village Dafatian group		10m (right) 10m (left)	residential	24 households and 80 persons	II	4a
7	Zhetie Village Baihushan group		10m (left)	residential	44 households and 155 persons	II	4a
8	Yangjia group		5m (left)	residential	51 households and 182 persons	II	4a
9	Zhetie Village Committee		5m (right) 5m (left)	residential	457households and 1647persons	II	4a
	Zhetie village primary school		***30m (left)***		***98 students and 6 teachers***		

Source: Draft EIR.

Table 25: Existing Air Quality and Noise Sensitive Receptors along Rural Road #17

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Nazhuangtian	Start	3m (right) 3m (left)	residential	68 households and 234 persons	II	4a
2	Dahunan		20m (right)	residential	12 households and 50 persons	II	4a
3	Bnaghai village committee		2m (right) 2m (left)	residential	328 households and 1200 persons	II	4a

Source: Draft EIR.

Table 26: Surface Water Quality Sensitive Receptors along Rural Road Alignment #17

No.	Location	Chainage	Shortest Distance to Road Alignment	Environment feature
1	Manmo river		Over river	3m width

Table 27: Existing Air Quality and Noise Sensitive Receptors along Rural Road #18

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Laoyouku		100m	residential	60 households	II	I

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
			(left)		and 250 persons		
2	Xingcheng village Erdao river		100m (right)	residential	30households and 120 persons	II	I
4	Moqing village Songxiangchang		20m (right)	residential	400 -500 persons	II	4a
5	Xiaguan yin		3m (right) 3m (left)	residential	90 households and 400 persons	II	4a
6	Moqing Village Shan bridge		5m (right) 3m (left)	residential	40 households and 160 persons	II	4a
7	Nanhong Village		3m (left) 3m (right)	residential	90 households and 400 persons	II	4a
8	Xingchengnamian		5m (right)	residential	40 households and 160 persons	II	4a
9	LianmengLiujia Group		10m (left)	residential	100 households and 400 persons	II	4a
10	LianmengWangjia Group		30m (left)	residential	40 households and 160 persons	II	4a
11	Lianmeng Village committee			residential	30 households and 120 persons	II	4a

Source: Draft EIR

Table 28: Surface Water Quality Sensitive Receptors along Rural Road #18

No.	Location	Chainage	Shortest Distance to Road Alignment	Environment Feature
1	Erdao river		Over river	
2	Shanqiao reservoir		Over river	
3	Nanhong river		Over river	
4	Namian river		Over river	

Table 29: Existing Air Quality and Noise Sensitive Receptors along Rural Road #19

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Guijiao factory	Start	3m (left) 3m (right)	residential	100 households and 400-500 persons	II	4a
2	Biandianzhan		10m (left)	residential	100	II	4a

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
					households and 400-500 persons		
3	Bomushanyakou		50m (left)	residential	6 households and 30 persons	II	4a
4	Dashan zhai		100m (left)	residential	27 households and 120 persons	II	I
5	Laogongzhai		5m (right) 5m (left)	residential	45 households and 200 persons	II	4a
6	Hangchikangxinzhai and jiuzhai		5m (right) 5(left)	residential	40 households and 160 persons	II	4a
7	Habo village Gongsuo	terminal	10m (right)	residential		II	4a

Source: Draft EIR.

Table 30: Surface Water Quality Sensitive Receptors along Rural Road #19

No.	Location	Chainage	Shortest Distance to road alignment	Environment feature
1	Habo river		Over river	
2	Chiken river		Over river	

Table 31: Existing Air Quality and Noise Sensitive Receptors along Rural Road #20

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Lianggeshu Village	K2+600	10m (across village)	Residential	31 households and 130 persons	II	4a
2	***Lianggeshu school***	***K2+600***	***300m (left)***	***Students and teachers***	***443 Students and teachers***	II	I
3	Dabei Village	K7+500	5m (across village)	Residential	40 households and 200 persons	II	4a
4	Liangke Village	K12+300	5m (left)	Residential	25 households and 100 persons	II	4a
5	Zhongxianjiao Village	K13+600	5m (across village)	Residential	20 households and 100 persons	II	4a
6	Xianjiaoshan Village	K22+400	5m (right)	Residential	30 households and 120 persons	II	4a

Source: Draft EIA.

Table 32: Existing Air Quality and Noise Sensitive Receptors along Rural Road #21

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Tianxin road chakou	Start					
2	Luoshitang		5m (left)	residential	3 households and 10 persons	II	4a
3	Longtang Village	terminal	3m (right) 3m (left)	residential	144 households and 557 persons	II	4a

Source: Draft EIR.

Table 33: Existing Air Quality and Noise Sensitive Receptors along Rural Road #22

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Tianxin road chakou	Start (sanchalukou)					
2	Yinlang		10m (right)	residential	60 households and 260 persons	II	4a
3	Yinbaile		5m (left)	residential	26 households and 72 persons	II	4a
4	Banmi		10m (right)	residential	31 households and 101 persons	II	4a
5	Yinwai		20m (right)	residential	80 households and 270 persons	II	4a
6	Damanru village committee		left	residential		II	4a
	Manru primary school		***30m (right)***		***130 students and 6 teachers***		
7	Yinlongyinting		50m (right)	residential	75 households and 350 persons	II	4a
8	Rudao			residential	95 households and 367 persons	II	4a
9	Caoyang	terminal		Right and left	300 households and 1500	II	4a

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
					persons		

Source: Draft EIR.

Table 34: Existing Air Quality and Noise Sensitive Receptors along Rural Road #23

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Gongxin village Group 6	Start	5m (right) 5m (left)	residential	38 households and 158 persons	II	4a
	Gongji primary school		***10m (left)***	***primary school***	***200 students and 7 teachers***		
2	Nanhong group		5m (right) 10m (left)	residential	24 households and 128 persons	II	4a
3	Gongliang village committee		30m (right)	residential	10 groups	II	4a
4	Mande		2m (left)	residential	44 households and 277 persons	II	4a
5	Banke		5m (left)	residential	47 households and 210 persons	II	4a
6	Banla		200m (left)	residential	38 households and 140 persons	II	I
7	Longla		8m (right)	residential	14 households and 80 persons	II	4a
8	Wengo		Right and left	residential	70 households and 287 persons	II	4a

Source: Draft EIR

Table 35: Surface Water Quality Sensitive Receptors along Rural Road #23

No.	Location	Chainage	Shortest Distance to Road Alignment	Environment Feature
1	Nanghong river		Over river	III

Table 36: Existing Air Quality and Noise Sensitive Receptors along Rural Road #24

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Huie Group1		10m (right)	residential	61 households and 2258 persons	II	4a
2	Huie Group2		5m (left)	residential	56 households and 227	II	4a

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
					persons		
3	Heenshangzhai group		10m (right)	residential	49 households and 245 persons	II	4a
4	Heenxiazhai group		20m (right)	residential	36 households and 167 persons	II	I
5	Heenlagu group		10m (left)	residential	34 households and 163 persons	II	4a
6	Mengbo village committee	terminal	3m (left) 3m (right)	residential	20 households and 80 persons	II	4a

Source: Draft EIR.

Table 37: Existing Air Quality and Noise Sensitive Receptors along Rural Road #25

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Kalie Village	K4+700	10m (right)	Residential	52 households and 250 persons	II	4a
2	Nongchangsidui Village	K8+300	3m (across village)	Residential	56 households and 250 persons	II	4a
3	Nankan Village	K11+700	5m (across village)	Residential	98 households and 500 persons	II	4a

Source: Draft EIR.

Table 38: Surface Water Quality Sensitive Receptors along Rural Road #25

No.	Location	Chainage	Shortest Distance to Road Alignment	GB 3838-2002 Category	Remark
1	Nanzhhu River	K7+200	5m (left)		No centralized drinking water intake within the assessment areas

Source: Draft EIR.

Table 39: Existing Air Quality and Noise Sensitive Receptors along Rural Road #26

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Mangnong Village	K0+000	10m (right)	residential	40 households and 130 persons	II	4a
2	Ashudi	K7+500	35m (left)	residential	16 households and 65 persons	II	4a
3	Tuanjie village	K9+300	100m (right)	residential	20 households and 75 persons	II	I
4	Bisuoluo	K17+500	10m (right)	residential	28 households and 100 persons	II	4a
5	Saihan village	K18+600	20m (right)	residential	52 households and 160 persons	II	4a
6	Kemei	K20+800	110m (left)	residential	40 households and 140 persons	II	I

Source: Draft EIR.

Table 40: Existing Air Quality and Noise Sensitive Receptors along Rural Road #27

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Xiananxian	K0+0	2m (right) 2(m left)	residential	25 households and 110 persons	II	4a
2	Aozizhai	K8+700	5m (right)	residential	52 households and 200 persons	II	4a
3	Xianandi river	K18+600	30m (right)	residential	30 households and 130 persons	II	4a
4	Lidihexinzhai	K23+400	5m (left)	residential	20 households and 100 persons	II	4a
5	Lixi river	K30+800	10m (right)	residential	18 households and 70 persons	II	4a
6	Dacheshu	K36+900	110m (left)	residential	16 households and 50 persons	II	I
7	Mangnong village	K39	10m (right)	residential	40 households and 130 persons	II	4a

Source: Draft EIR.

Table 41: Surface Water Quality Sensitive Receptors along Rural Road #27

No.	Location	Chainage	Shortest Distance to Road Alignment	Environment feature
1	Lincangxiannanlingxiangmangnong village (Hei river influent)	K33+400	Over Mangnong river	

Table 42: Existing Air Quality and Noise Sensitive Receptors along Rural Road #28

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Laishimiao	K3+800	5m (right) 5m (left)	residential	23 households and 80 persons	II	4a
2	Galou village	K9+600	3m (right) 3m (left)	residential	60 households and 230 persons	II	4a
3	Laierlie	K12+100	5m (right) 5m (left)	residential	50 households and 180 persons	II	4a

Source: Draft EIR.

Table 43: Existing Air Quality and Noise Sensitive Receptors along Rural Road #29

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Zhongke village	K0+0	1m (right) 1m (left)	residential	30 households and 130 persons	II	4a
2	Zhongke village weishengyuan	K0+80	3m (left)	residential	11 persons	II	4a
3	Yonglong	K11+500	5m (right) 5m (left)	residential	60 households and 250 persons	II	4a
4	Yonggeng	K12+600	70m (left)	residential	40 households and 150 persons	II	4a
5	Kanaxinzhai	K13+800	190m (right)	residential	10 households and 30 persons	II	I
6	Dadie	K14+200	120(left)	residential	23 households and 75 persons	II	I
7	Yongbuluo	K15+0	50m (left)	residential	30 households and 110 persons	II	4a

Source: Draft EIR.

Table 44: Surface Water Quality Sensitive Receptors along Rural Road #29

No.	Location	Chainage	Shortest Distance to Road Alignment	Environment feature
1	XimengxianYongbuluo village Kuxing river	K1+150	Over Kuxing river	

Table 45: Existing Air Quality and Noise Sensitive Receptors along Rural Road #30

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Yongban Village	K5+300	12m (right)	Residential	40 households and 200 persons	II	4a
2	Amou Village	K13+700	5m (across village)	Residential	52 households and 210 persons	II	4a

3	Nankan village	K11+700	5m (across village)	Residential	98 households and 500 persons	II	4a

Source: Draft EIR.

Table 46: Existing Air Quality and Noise Sensitive Receptors along Rural Road #31

No.	Location	Chainage	Distance from Road Edge (m)	Type	No. of Households and Persons	Air Quality Category	Noise Functional Region
1	Yongye village	K0+250	80m (right)	residential	20 households and 70 persons	II	4a
2	Yongle	K1+400	40m (right)	residential	40 households and 150 persons	II	4a
3	Pengyong	K9+300	50m (right)	residential	120 households and 420 persons	II	4a
4	Momei	K10+100	30m (left)	residential	40 households and 150 persons	II	4a
5	Yonglai	K11+500	5m (right)	residential	53 households and 185 persons	II	4a

Source: Draft EIR.

Table 47: Existing Air Quality and Noise Sensitive Receptors along Rural Road #32

No.	Location	Chainage	Distance from Road edge (m)	Type	No. of Households and persons	Air Quality Category	Noise Functional Region
1	Lianhua Village		5m (left & right)	residential	200 households and 1000 persons	II	4a
2	Namotian Village		10m (left) and 5m (right)	residential	180 households and 900 persons	II	4a

Table 48: Existing Air Quality and Noise Sensitive Receptors along Rural Road #33

No.	Location	Chainage	Distance from Road edge (m)	Type	No. of Households and persons	Air Quality Category	Noise Functional Region
1	Jiangxi Village		22m (left)	residential	50 households and 250 persons	II	4a
2	Tuanshan Village		5m (left & right)	residential	300 households and 1500 persons	II	4a

Table 49: Existing Air Quality and Noise Sensitive Receptors along Rural Road #34

No.	Location	Chainage	Distance from Road edge (m)	Type	No. of Households and persons	Air Quality Category	Noise Functional Region
1	Longjie		3m (left & right)	residential	50 households and 250 persons	II	4a
2	Longjie Village		3m (left & right)	residential	40 households and 200 persons	II	4a
3	Bangwan Village		3m (left & right)	residential	40 households and 200 persons	II	4a
4	Bangwai Village		3m (left & right)	residential	80 households and 400 persons	II	4a

Table 50: Existing Air Quality and Noise Sensitive Receptors along Rural Road #35

No.	Location	Chainage	Distance from Road edge (m)	Type	No. of Households and persons	Air Quality Category	Noise Functional Region
1	Nadong Village		4m (left & right)	residential	180 households and 900 persons	II	4a

Table 51: Existing Air Quality and Noise Sensitive Receptors along Rural Road #36

No.	Location	Chainage	Distance from Road edge (m)	Type	No. of Households and persons	Air Quality Category	Noise Functional Region
1	Bonongzhai		3m (left & right)	residential	50 households and 250 persons	II	4a
2	Tuanjiezhai		3m (left & right)	residential	40 households and 200 persons	II	4a
3	Nanlie Village		3m (left & right)	residential	100 households and 500 persons	II	4a

Technical Assistance Consultant's Report

Contract No. 115420-S82962

TA-8149 PRC: Yunnan Pu'er Regional Integrated Road Network Development Project

Climate Change Impact Assessment on Yunnan Pu'er Regional Integrated Road Network Development Projects in People's Republic of China

October 2014

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Asian Development Bank

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Abbreviations

ADB	Asian Development Bank
AR5	The Fifth Assessment Report of Intergovernmental Panel on Climate Change
FSR	Feasibility Study Report of Yunnan Pu'er Regional Integrated Road Network Development Projects
GCM	General Circulation Model
GEV	General Extreme Value function
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
PRIRNP	The Yunnan Pu'er Regional Integrated Road Network Development Project
PMG	Pu'er Municipal Government
PMO	Project Management Office of PRIRNP
PPTA	Project Preparatory Technical Assistance of PRIRNP
PRC	The People's Republic of China
RCP	Representative Concentration Pathways of future GHG
V&A	Vulnerability and Adaptation of climate change impact
YTPDI	Yunan Transport Planning and Design Institute
masl	meters above sea level

Executive Summary

Climate change may pose various threats to transport system. The objective of this study is to assess the vulnerability of the Pu'er Regional Integrated Road Network Development Project (PRIRNP) to the impact of projected climate change and to identify adaptive measures to reduce the vulnerability. Pu'er is located in the south western part of the Yunnan Province of the People's Republic of China (PRC). It borders with Viet Nam, Lao People's Democratic Republic and Myanmar; hence the PRIRNP has strategic importance by connecting isolated rural communities to the regional road network and provide infrastructure to support trade and regional cooperation between countries.

Geographically, more than 98% of Pu'er consists of mountains. Geologically, sedimentary and alluvial formations are common in Pu'er, with laterite soils in the north and sedimentary and alluvial formations in the south and east. About 25% of Pu'er's area is erosion prone. Meteorologically, Pu'er is among the areas in China that have the highest precipitation. Characterised by its mountainous topography and abundant precipitation during the rainy season, Pu'er has been under consistent threat of flood and landslide risk. The floods and landslide are caused by torrential or heavy rainfall, which is normally high in intensity but short in duration, and in most times is much localized phenomenon within Pu'er. It has been found that torrential rain and consequently induced river flood and landslide were the highest climate risks to the PRIRNP.

Based on the IPCC AR5 GCM outputs and historical observation from the PRIRNP area, quantitative climate projections and their associated uncertainty for the key climate variables that affect the PRIRNP were generated. From such quantitative and other relevant information, it is then possible to identify adaptation options that could enhance the sustainability (e.g. lifetime) of the project to climate change impact by "climate proofing" the risk sensitive components at the design and construction stages.

Climate scenario analysis has revealed that, by 2050 and towards the end of this century, climate change may have little impact on the total rainfall amount of the dry season, but may lead to noticeable rainfall increases in the rainy season. In contrast to small changes in long-term average rainfall; climate change will manifest largely as changes in the frequency and consequences of extreme rainfall, hence has significant impact on floods and landslide or debris flow disasters. If these adverse impact consequences are not taken into consideration in design, the delivery of the project objective may be impeded.

Several adaptation options are discussed based on the impact assessment and other relevant information. A more comprehensive vulnerability and adaptation (V&A) assessment may be accomplished with more relevant observation data, when/if this become available.

1. Introduction

A transport project is normally designed for providing long term service. Climate poses various threats to a transport system. The long term climatic averages and extreme weather events are important factors which need to be considered in the planning, design, operations, maintenance and management of transport systems. Climate change will likely alter both long term climatic averages and the frequency and severity of extreme weather events. For sustainable transport development, it is thus important to make climate adaptation adjustments to engineering specifications, alignments, and master planning; incorporating associated environmental measures; and adjusting maintenance and contract scheduling (ADB 2010). An effective climate-proofing of a transport system requires project specific climate change impact vulnerability assessment and identifying, evaluating and implementing feasible adaptation measures to strengthen project resilience to future climate change impact. The objective of this study is to conduct climate change impact vulnerability and adaptation (V&A) assessment for the Yunan Pu'er Regional Integrated Road Network Project (PRIRNP) in China.

1.1 Background of the project area

Yunnan is one of the least developed provinces of the People's Republic of China (PRC), and Pu'er is one of the most impoverished cities at prefecture-level of Yunnan. Pu'er is located in the south-western Yunnan province with latitude between 22°02′ to 24°50'N and longitude between 99°09′ to 102°19′E. It has an area of 45385 Km^2, of which more than 98% consists of mountains with altitude ranging between 376 meters above sea level (masl) in the south and 3,306 masl in the north. There are three mountain chains across the city area: Ailao, Wuliang and Nu; which are bisected by three major river systems, the Lancang River, Red River and Nu River. The Lancang River catchment accounts for the largest portion of the city's area at 61.2% or 27776 Km^2, and the Red River and the Nu River account for 33.8% and 5% of city's area respectively. Pu'er is situated in the subtropical humid monsoon climate zone, with mild climate but distinct seasons. Generally, temperatures decline from south to north, but can also have dramatic changes vertically along with altitude change. The annual average temperature is between 15.0ºC in the north to 20.3ºC to the south. Pu'er is one of the areas that have the highest precipitation in China. The average annual precipitation is between 1100 mm to 2780 mm. Geologically, sedimentary and alluvial formations are common in Pu'er, with laterite soils in the north and sedimentary and alluvial formations in the south and east. About 25%, or 10486 Km^2, of the city area is erosion prone. Along with the socio-economic development, the ecosystems in Pu'er have been degraded due to intensified human activities. A large part of the Nanlei River catchment inside Menglian County has been cultivated for agricultural development. The clearance of the natural forest for sugarcane, tea and coffee plantation has significantly changed the landcover and seriously damaged the ecosystems, and subsequently exacerbated the flood, soil erosion and landslide disasters (Menglian Political Consultation Committee, 2013).

Characterised by its unique geographic, geologic and meteorological conditions, Pu'er has been under consistent threat of flood and landslide/debris flow risks (Li et al. 2007; Yang, 2008; Chen, 2014). The floods and landslide/debris flow in Pu'er are triggered by torrential or heavy rainfall, which is normally high in intensity but short in duration, and sometimes is a

much localized phenomenon. Long term or large area heavy rainfall is generally rare (Chen, 2014).

However, due to historical reasons, the flood protection measures in Pu'er are relatively poor. About 80% of the rivers of Pu'er either have no flood protection or have flood protection measures which are lacking maintenance. A common observation is that river channels have many twist ad turns, making it difficult for flood water to pass (Li et al. 2007). It is also common to find river channels silted up due to soil erosion. Hence the heavy rainfall and its aftermath have resulted in tremendous economic loss. The 1996 Nanlei River flood in Menglian County caused severe landslides and 50 Km long state road damages (Li et al. 2007). The 1984 flood in Simao and Jiangcheng caused 34 Km long road subgrade damages and affected 10 road bridges (Li et al. 2007). During 2000 to 2005, Pu'er had direct economic losses of CNY 850 million due to flooding, with a death toll of more than 70 (Pu'er Government, 2008).

Pu'er is strategically located at the border of PRC with other three developing countries in the region: Viet Nam, Lao PDR and Myanmar. The PRIRNP will connect isolated rural communities to the regional road network and provide infrastructure to support trade and regional cooperation between countries. The PRIRNP comprises three road components (Figure 1):

- rural road upgrading, with total 33 road across Pu'er city;
- rehabilitation of the Ning'er-Jiangcheng-Longfu road in the southeast; and
- rehabilitation of the Menglian-Meng'a road in the southwest.

For a sustainable transport system development, all three components require careful consideration of the local climate conditions in the design phase to prevent any disastrous damage to the system by climate hazard. Climate change has the potential to alter the climate condition; hence this study is focused on the climate change impact on the sensitive project components to the climate and the consequent implication in the design process.

1.2 Potential risks of climate change to the proposed project

Transport is vulnerable to climate variability and change. Although most climate factors can influence transport system; for the inland region, the major road damages are derived from temperature and precipitation factors. The influence of the two factors on a transport system is to a large degree manifested by their extremes and aftermath.

In terms of temperature, extreme heat places stress on road infrastructure, softens the asphalt causing traffic rutting and potentially resulting in pavement cracking. Extreme heat can also stress the steel in bridges through thermal expansion and movement of bridge joints. Extremely low temperature can cause fatigue and thermal cracking of the pavement. A wide range of temperatures (the difference between the high and low temperature) will make asphalt binders difficult to span accordingly. Flood triggered by torrential or heavy rainfall can cause severe water damage to roads, including collapse of the slope bed; damage to the subgrade, surface, and key infrastructure components (such as bridges and culverts); damage from landslide and debris flow etc.

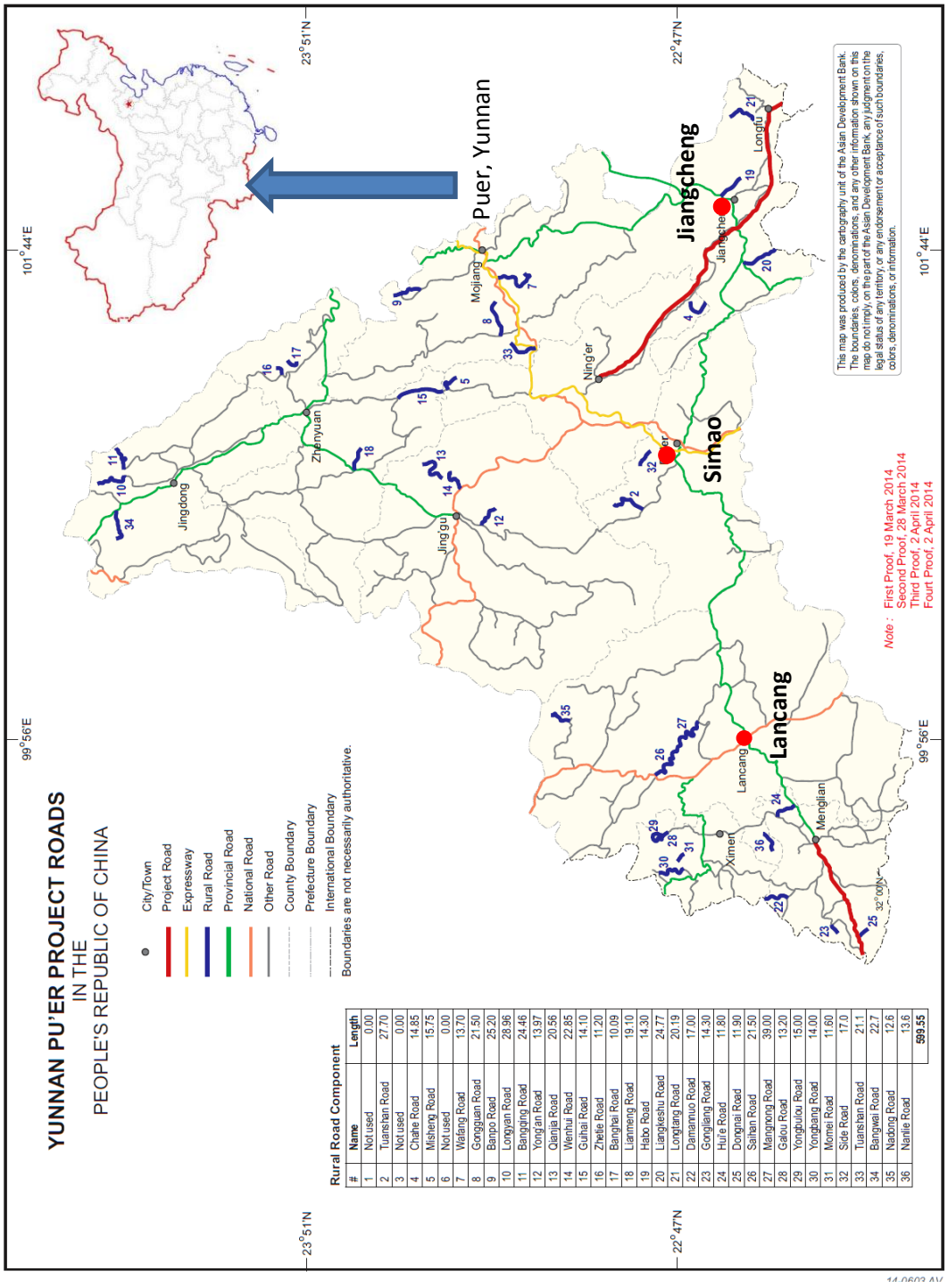

Figure 1: Project area (Source: ADB)

The PRIRNP will be built in a mountainous area characterised by steep slope and erosion prone soil. The heavy rainfall triggered flood and landslide/debris flow have already caused significant damages to the road networks. The damages are common in Pu'er, especially in the rural area. During the rainy season, many rural roads become impassable due to landslides and poor road surfaces. Almost all susceptible damages are closely related with torrential rainfall.

The latest climate science projects that the climate will change at an increasingly rapid pace over the coming decades. Such change will likely alter the long term climatic averages and, in particular, the frequency and severity of extreme weather events; and subsequently the risk profiles that were adopted for the transport system design. Therefore, it is critical to assess and manage possible changing risks of road infrastructure during the design and construction stage to ensure the viability of the PRIRNP in the future changing climate. The regional road sections have 33 bridges: including 3 major bridges (Class II) and 3 middle (Class III) bridges for the Menglian-Meng'a section; 3 major bridges (Class II) and 24 middle (Class III) bridges for Ning'er-Longfu section. The flood protection design criteria for large bridges (Class II) is above 1:100 year flood levels; and 1:50 year flood levels for middle and small bridges and culverts. It is likely that the flood intensity will not be status-quo in the future due to the climate change impact on rainfall and its extremes. How the flood intensity will change may have impacts for the design of the transport system and affect its serviceability and lifespan.

1.3 Purpose and scope of this study

This study aims to provide an assessment of potential risks posed by climate change to the design of the climate sensitive components of the PRIRNP, and identify options to manage such risks by proposing and analysing a range of adaptive measures. Two future timeslices, i.e. 2050 and 2100 were chosen to demonstrate the V&A assessment processes.

Climate risk assessment will consider changes in temperature and rainfall based on outputs from the latest climate modelling experiments. Consideration of climate risk management options will include both "hard" measures entailing possible adjustments in design specifications, as well as "soft" options of ecological, governance or an institutional learning approach.

The overall objective of the climate change V&A assessment is to minimize road damage and disruptions in road use due to climate change impact. A scoping exercise was carried out to identify the vulnerability of the project to climate change impact. For the PRIRNP, the temperature and rainfall sensitive project components include road subgrade, pavement, bridge structures, slope protection and drainage system. The current design criteria are based on historical data and do not take account of changes in key hydro-met parameters under a changing climate.

Because the focus of this study is on the project vulnerability to changes in temperature and rainfall and its extremes; the required information to support this climate change impact assessment is historical observed temperature and rainfall at the appropriate spatial and temporal scale, in addition to the future climate change projections based on the latest scientific findings. Section 2 below will describe the methodology underlying the climate risk assessments. Details on the baseline and scenario datasets used for climate impacts

assessment are provided in Section 3 as well as the impacts of climate change on the various components of the proposed project and implications for the design, construction and operation of the project. Possible options to manage climate risks within the context of the project, as well as a preliminary assessment of such risks, are discussed in Section 4. The report concludes with a set of recommendations on the design, construction and operation of the proposed project.

2. Methodology

A risk is the product of the interactions between hazards, exposure and vulnerability. In this study; hazard is used to denote the threat from climate factors of temperature and rainfall, their extremes and aftermath. Exposure refers to the presence of infrastructure and other assets related to a transport system that could be adversely affected when hazards occur and which, thereby, are subject to potential future harm, loss, or damage. Vulnerability is defined generally as the susceptibility to be adversely affected by climate hazards. Vulnerability can be either physical or socio-economic. The vulnerability of the PRIRNP project is mainly due to the geo-physically flood prone and erosion prone areas of the project. The vulnerability also derives from the serious ecosystem degradation due to human activities in the area. The vulnerability may also come from the inadequate design standard, or the possible economic constraints of constructing and maintaining the road system for the changing climate. Without adequate protection measures, such vulnerability lead to high risk of the road networks across the area to climate-related damage. This section describes the methodology of identifying climate variables that may become hazardous to the project and their future change projections. The climate change projection focuses on the relative changes between historical and future periods by applying an ensemble based pattern scaling approach.

2.1 Overall approach

The first step in climate change impact assessment is the construction of the future climate change scenarios. The construction of climate change scenarios involves the development of the baseline climate condition and the future climate change projections. Depending on the assessment requirements, spatial and/or site specific climate change scenarios are needed for impact studies. In this study, the baseline spatial climatology for the project areas was obtained from the WorldCLIM database (http://www.worldclim.org). The station based observed data collected was used for developing the site specific baseline climate condition.

The future climate change is subject to considerable uncertainty. One important aspect in climate change V&A assessment is to comprehend such an uncertainty range in decision making and policy planning processes. Within this context, any climate change scenario constructed on single Greenhouse Gas (GHG) emission rate and/or individual GCM output is generally considered inappropriate for V&A assessment purposes, because it cannot provide information of the uncertainty range associated with its projection. In this study, to reflect the uncertainties in future GHG emission rates and in climate sensitivity, a combination of different GHG Representative Concentration Pathways (RCPs) and climate sensitivities are used to characterise the future climate change scenario with the associated uncertainty range. RCP6.0 with mid-climate sensitivity represents a middle range future global change scenario, which was used as an indicator of the median projection of the future global change, while RCP4.5 with low-climate sensitivity and RCP8.5 with high-climate sensitivity was used as an indicator of the corresponding low and high bound of the uncertainty range (Table 1). Another important uncertainty in climate change scenario generation is the difference in different GCM simulations. To account for such an uncertainty in V&A assessment, a pattern scaling method was adopted and applied to a wide range of GCMs to build a model ensemble. The average of models' simulation of changes for a climate variable is normally used to capture the middle conditions, as that average often matches better with

observed climate than any individual model estimates (Reichler and Kim, 2008). However, in this study the 50 percentile of the GCM model ensemble was used in order to prevent the influence of huge outliers in some GCM simulation on the final change values.

The method was thus termed 'ensemble based pattern scaling'. Details of the method, as well as the steps of constructing the future climate change scenario, can be found in Appendix 1; while Appendix 2 lists the 40 IPCC AR5 GCMs used for model ensemble.

Table 1: Three climate projections and their input conditions represent the uncertainty ranges

Climate projection	Representative Concentration Pathways	Climate sensitivity
Median scenario	RCP6.0	Mid
Low scenario	RCP4.5	Low
High scenario	RCP8.5	High

2.2 Spatial climate change scenario

Monthly and seasonal climate change impact was assessed spatially over the project areas. The baseline climatology for the project areas was obtained from the WorldCLIM database with a spatial resolution of about 1 Km (http://www.worldclim.org). In generating the climate change scenario for the project areas, the simulation results from 40 GCMs that were assessed in the IPCC AR5 were used (Appendix 2). All 40 models have their monthly simulation results available.

2.3 Site specific climate change scenario

Besides the spatial monthly change projections, site specific climate change scenarios with more detailed temporal scale are usually required for impact assessment. The site specific climate change scenario was constructed by perturbing the station observed daily data using the normalised GCM pattern value from the GCM grid where the climate station is located. In this report, all observation data from a station was used to represent the baseline climate condition for the site.

For site specific extreme value analysis, we first chose an intensity value (such as 1:20 year annual maximum daily precipitation) and then selected its normalised pattern value from the GCM gird where the site is located. The value is then applied to the same precipitation intensity that derived from the observed historical data to generate the future change scenarios.

In the following two sections, the method described above is adopted to generate the change projections for climate variables that may become hazardous to the proposed project. Rainfall and temperature data were collected for 8 stations around the project area and 3 stations were analysed in detail for climate change impact on the project. Table 2 lists the information for the three stations. The locations of the stations can be found in Figure 1. Of the three stations, Simao has the longest observation period and is located in the centre of the project area, Jiangcheng is located in the middle of the regional road of Ning'er-Jiangcheng-Longfu, and Lancang is close to the regional road of Menglian-Meng'a. Simao is

also used to represent the upper stream catchment rainfall conditions for the areas of both regional road projects.

Table 2: Location information of the three stations

Station Name	Longitude (°)	Latitude (°)	Altitude (m)	Observation Period
Simao	100.98	22.77	1302.1	1951-2013
Jiangcheng	101.82	22.62	1119.5	1954-2013
Lancang	99.93	22.57	1502.4	1973-2013

3. Climate observation and change projections

3.1 Observational temperature data and their future projections

The temperature related climate variables that have impacts on transport systems include the mean, minimum and maximum temperature; the extreme maximum temperature and related heat waves; and the temperature change range (the difference between minimum and maximum temperature). Appendix 3 lists the baseline temperature related climate variables and their projected future changes in 2050 and 2100 for Pu'er. The median scenario change projection is an increase of 1.2°C and 2.3°C for the annual mean temperature across Pu'er by 2050 and 2100 respectively. The high mountainous area in the north has a slightly higher increase rate than the low altitude area in the south. In terms of extremes, the maximum and minimum temperatures have a similar increase rate as the mean temperature changes. The baseline 1:50 year annual daily maximum and minimum temperatures are 42.1°C and -3.4°C and these values changes to 43.1°C and -2.4°C by 2050 projected by the median scenario, approximately a 1°C increase with an uncertainty range between 0.9°C to 2.6°C. There are little changes in the difference between the maximum and minimum temperature, as both temperatures are projected to increase. Heat wave will likely become more intensified and frequent, as indicated by the 7 day average maximum temperature for the 3 stations, but is generally under 45°C in most change projections and still under 50°C for the high scenario by the end of this century.

3.2 Observational rainfall data and their future projections

The rainfall related climate variables and their aftermath which could become hazardous for the project include torrential rain, flood, landslide and debris flow. Details of the observed rainfall data and their future change projections for the project area are demonstrated in Appendix 4. The key findings are discussed below:

Baseline:

1) The rainfall is characterized by strong variability in terms of both time and space. Spatially, rainfall increase from north to south and is the highest in the southeast area (where the regional road of Ning'er-Jiangchang-Longfu located). The annual average rainfall is around 2000 mm in southeast; more than double in the north where it is around 800 mm. The southeast area, where the regional road of Menglian-Meng'a is located, has an annual rainfall of around1500 mm. In addition, there is a high inter-annual variability in rainfall. The annual average precipitation of Simao is 1486 mm with a coefficient of variation (C_v) of 0.14. Jiangcheng has an annual average of 2213 mm and C_v of 0.16. Lancang has an annual average of 1600 mm and C_v of 0.12. For Simao station, the maximum annual rainfall of 1924 mm was recorded in 2001, while the minimum of 941 mm, which is less than half of the maximum value, was recorded in 1951.

2) Other than large inter-annual variability in annual rainfall, the distinctive feature of the rainfall is the seasonality. For Simao, the average rainfall of the rainy season from May to October is 1293 mm, which accounts for 87% of the annual total. The average rainfall in the dry season of November to April is less than 200 mm, which accounts for only 13% of

annual rainfall. Similar conditions were also found for the other 2 stations. In general, July is the wettest month in a year, and accounts for more than 20% of annual rainfall.

Future projection

3) Applying the method described in the previous section to the area, the median scenario change projection indicates the annual rainfall change in the area will likely be small, with an average increase across the area between 2 to 3% by 2050 and 4 to 8% by 2100.

4) For each station, the monthly rainfall change from the median scenario projection is also small, particularly for the dry season, but becomes noticeable for the rainy season. However, rainfall projection is associated with varied uncertainty ranges. The months in the rainy season generally have large uncertainty range than the months in dry season, and the uncertainty range is skewed to a large rainfall increase from the median climate change projection.

Extreme rainfall and its projection

According to the extreme value theorem, for normalized maxima (minima) of a sequence of independent and identically distributed random variables such as annual daily maximum rainfall, the generalized extreme value (GEV) distribution is the only possible limit distribution, and it is often used as an approximation to model the maxima (minima) of long (finite) sequences of random variables. In this study the GEV distribution was applied to the daily observation to investigate extreme rainfall and their future changes. A detailed method description and analysis process can be found in Ye and Li (2011). The torrential rain in Pu'er is characterised by high intensity and short duration. It is common in the area for 6 hour torrential rain to account for 70-80% of the 24 hour rain total (Yang, 2008). Therefore it was expected that 1 day of torrential rain would have a reasonable correlation with a triggered river flood. More explanation can be found in Appendix 5. For this reason, the annual maximum 1 day rain was analysed in detail for the three stations. Figures A4-4 and A4-5 of Appendix 4 show the result for Simao. The right-shifting of the projected GEV function indicates an increment of torrential rain in terms of both intensity and frequency under climate change impact. The 2050 change is noticeable, with a relative small uncertainty range. The 2100 change is significant, but accompanied with a high uncertainty range. Table 3 lists the baseline and future change projections with uncertainty range of annual daily maximum rainfall for the three stations.

As shown in Table 3, the current 1:50 year event of the annual maximum daily rainfall is 152.83 mm for Simao. The median scenario projection for such an event is 168.34 mm by 2050 and182.23 mm by 2100, which represent 9.4% and 18.5% increase in rain intensity respectively. The high projected change, shown by the high scenario, could reach 183.75 mm and 222.17 mm for 2050 and 2100 respectively, or a rain intensity increase of 20.2% at 2050 and 45.4% at 2100.

In summary, the rainfall change in the project area will noticeable under climate change. The annual rainfall may increase slightly in the future, but the change in extreme rainfall is much more significant than the change in normal rainfall, which implies an increased flood risk in the future.

Table 3: The GEV results of annual maximum 1 day rainfall and its future projections

Stn Name	Return period (years)	Annual maximum daily rainfall changes (%)						
		Baseline	2050 scenario			2100 scenario		
			Low	Median	High	Low	Median	High
Siamo	20	132.06	6.7	9.2	18.9	9.1	18.0	43.1
	50	**153.83**	6.9	9.4	19.5	9.4	18.5	44.4
	100	170.99	7.1	9.8	20.2	9.7	19.1	46.1
Jiang-cheng	20	227.85	6.4	8.7	17.9	8.6	17.0	40.8
	50	**325.15**	6.5	8.9	18.3	8.88	17.4	41.7
	100	429.62	6.7	9.1	18.9	9.1	18.0	43.2
Lancang	20	122.96	7.0	9.6	19.8	9.5	18.8	45.1
	50	**140.81**	7.2	10.0	20.6	9.9	19.5	47.1
	100	154.59	7.6	10.4	21.5	10.3	20.4	49.3

3.3 Climate change impact on the PRIRNP and the implication to the project design

The climate change information needs to be related to the project components that are sensitive to the climate, to support the vulnerability assessment and adaptation options identified. In the context of this project, the target sensitive project components include:

- Change in maximum temperature of the pavement;
- Change in minimum temperature of the pavement;
- Change in the range of temperature of the pavement;
- Change in the heavy rainfall intensity which will affect the drainage design; and
- The change of 1:100 year flood water level; which is the criterion for big bridge design and 1:50 year flood height which is the criterion for middle size bridge design

The pavement temperature has a linear relationship with the air temperature, so the increase in air temperature will lead to increase of pavement temperature. The baseline annual average air temperature of Pu'er is relatively mild. An increase of 1.2°C by 2050 or 2.3°C by 2100 will not cause significant impact to the transport system. Heat wave may become more severe and longer lasting. Nevertheless, the 7 day average maximum temperature of 2050 for all 3 stations will still be around 40°C, even from high scenario projection. Thus the temperature change may not have significant effects on the project. Special modification of the asphalt binders may be required if the difference between high and low temperature is more than 90°C. In Pu'er, the difference between high and low temperature is much less than 90°C currently and in the future. Thereby, no special impact concern is expected from the temperature changes in the future.

In contrast to temperature, the heavy rainfall and its consequent induced flood, landslide or debris flow pose a much greater risk to road systems. For the purpose of assessing climate change impact on flood, landslide or debris flow, it is essential to have insightful understanding of their relationship with rainfall. Normally hydrological or hydraulic models, either physically or statistically based, are used to simulate the rainfall – flood and rainfall – landslide processes. Long term observed meteorological and hydrological data are required for model calibration/validation in such model development. However, the hydrologic observations for the PRIRNP area are largely unavailable.

For the project area, the only available data is the 54 years observed annual maximum river discharge of the Nanlei River at Menglian hydrometric station, which is 40 Km at the downstream of the Lancang Metrological station. No significant statistical relationship could be found between the Menglian annual maximum flow data and the rainfalls at Lancang, either from individual daily rainfall and or combination of multiple day rainfalls. The reasons are twofold: firstly it is because of the complexity of the local geo-hydrological conditions; second and more importantly, because of the extensive human intervention to the Nanlei River systems, such as man-made changes to the river channels and the landcover in the river catchment. Such conditions are by and large common to most areas in Pu'er, so in the absence of reliable hydrological observations for a more sophisticated model development, the one day maximum rainfall may be used as a surrogate in investigating the climate change impact on river flood, as it was expected that the flood discharge and the one day heavy rainfall would have a reasonable linear relationship. For the landslide/debris flow, a statistical relationship of 6 day rainfall was used to simulate its risk changes as well as 1 day rainfall. Appendix 5 described the details of reasoning and development of these methods.

With regard to climate change impact on flood assessment, the 1:50 and 1:100 year annual maximum daily rainfall of Lancang will likely have a 10% and 19.5% increment by 2050 and 2100 respectively, based on the median scenario projection (Table 3). This implies a corresponding increment of flood discharge of 10% by 2050 and 19.5% by 2100. During the bridge design, it would be desirable to examine if the design still meets the increased flood risk in 2050 and in 2100. Field surveying may be required to obtain the information about the river channel, such as the shape and area of the cross section, at the bridge site, in order to calculate the flood height. Hu (2009) rectified the flood discharge and flood height relations for the Nanlei River at Menglian, as shown in Table 4. A regression model can be obtained from Table 4, as shown in Figure 2:

$$y = 0.0041x + 956.61 \quad (1)$$

where: y is the flood height (masl); x is the flood discharge (m^3/s).

A 10% increase of 1:100 year flood discharge will be 383.9 m^3/s, and it corresponds to a flood height of 958.18 masl, or a 0.15 metre increment of current flood height. Similarly, a 20.6% increase of flood discharge by 2050 projected by the high scenario will lead to a 0.31 metre increment of the current flood height. For Menglian-Meng'a Road, the current design for the bridges crossing the Nanlei River near Menglian is based on the historical flood survey of 1:100 year flood height with a 0.5 metre safety factor. Thus the safety factor of the current design may offset of the climate change induced height increase by 2050. It may become inadequate toward the end of this century, when more than 0.68 metre will add to the current 1:100 flood height under the high scenario projection.

For the landslide and debris flow risks, the 6 day total rainfall of 140, 180 and 230 mm, as well as daily rainfall of 70, 90 and 100 mm were used as an indicator for the risk profile changes.

Table 4: The relationship between flood discharge and flood height at Menglian (source: Hu, 2009)

	Flood frequency				
	20%	10%	5%	2%	1%
Q (m^3/s)	200	237	274	316	349
h (masl)	957.42	957.58	957.75	957.90	958.03

Q: flood river discharge
h: flood height.

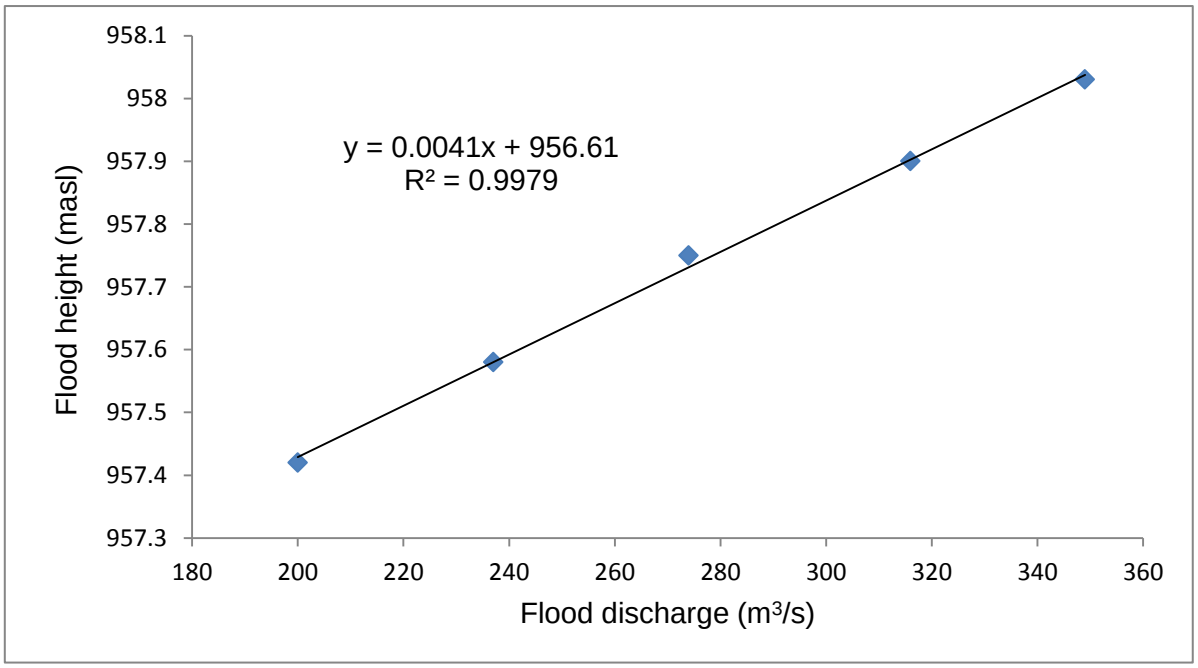

Figure 2: the regression model of flood discharge and flood height at Menglian.

The GEV function was applied to analyse the annual maximum rainfall of 6 consecutive days for the three stations. Again, future climate change scenario was generated for such a climate variables and the result is shown in Table 5. According to Table 5, it is most likely that the heavy/torrential rain will become much more frequent in the future, and so do the landslide/debris flow risks, especially for the for 6 day triggered landslide or debris flow. As shown in Table 6, the baseline frequency of 1 day rainfall corresponding to high risk landslide for Lancang is 1:6.1 years, and its median scenario change projections are 1:3.9 and 1:2.8 years by2050 and 2100 respectively, which implies a 56.4% and 117.9% frequency increase. In comparison, the 6 day rainfall risk increase will even larger, as the frequency increase 145.2% and 260.0% by 2050 and 2100 respectively. Great attention should be paid at design stage to ensure the slope protection is sufficient of future climate change impact on landslide and debris flow hazards.

Table 5: The rainfall frequencies corresponding to low, medium, high landslide risk and their future projections under climate change impact.

Rainfall (mm)	Station name	Frequency as return period (years)				
		Baseline	2050 median scenario	Change	2100 median scenario	Change
Daily						
70	Simao	1.6	1.3	23.1	1.1	45.5
	Jiangcheng	1.1	<1	N/A	<1	N/A
	Lancang	1.6	1.3	23.1	1.1	45.5
90	Simao	3.3	2.3	43.5	1.8	83.3
	Jiangcheng	1.6	1.3	23.1	<1	N/A
	Lancang	3.7	2.5	48.0	1.9	94.7
100	Simao	5.0	3.4	47.1	2.5	100.0
	Jiangcheng	2.1	1.6	31.3	1.3	61.5
	Lancang	6.1	3.9	56.4	2.8	117.9
6 day total						
140	Simao	1.4	1.2	17.9	1.1	30.2
	Jiangcheng	<1	<1	N/A	<1	N/A
	Lancang	1.3	1.1	13.6	1.0	23.8
180	Simao	2.6	1.9	37.2	1.5	74.7
	Jiangcheng	1.2	1.0	12.5	<1	N/A
	Lancang	3.0	1.9	61.6	1.4	113.5
230	Simao	8.0	5.0	59.9	3.4	132.8
	Jiangcheng	2.1	1.5	33.8	1.2	66.1
	Lancang	16.4	6.7	145.2	4.6	260.0

4. The adaptation options

Given the likely changing climate in the future, managing climate risks in road transport sector will require effective adaptation of infrastructure, operations and maintenance, in order to avoid costly repair and/or replacement in the future. Proper adaptation measures can effectively alleviate vulnerability and reduce the potential damage from the climate change impact. As discussed in the previous sections, the flood and landslide/debris flow are the two major climate induced risk to the PRIRNP. In this section, the adaptations that are identified based on literature review and/or from the discussion with the staff from the Project Management Office (PMO) and the Yunnan Transport Planning and Design Institute (YTPDI) are provided as options with brief discussion:

4.1 "Hard" options: adjustments to design of relevant project component(s)

- Enhanced flood drain system to reduce the water flood risk on the road surface. Staff from YTPDI have indicated that high standard was used in the water drain system design, such as the side ditch, culvert size etc. A safety coefficient of 1.1 (10% higher than required design standard) was adopted, and it is even higher in some places. The 10% capacity increment may be adequate by 2050 under median scenario projection, but could become insufficient for 2050 high scenario projection or beyond 2050. A 20% capacity increment may be more appropriate based on the extreme rainfall projections.
- For road section along the rivers, the design process should take the future increased flood discharge into account. More flood discharge not only means an increased flood height, but also an increase in flood speed, so that increase damage risk of the flood water flushing away the subgrade materials. Engineering techniques should be designed or planned, either to enhance the stability of the road subgrade or to reduce the flood speed.
- Climate change will manifest most impact effects on rural road. However, the current rural road development is based on existing road structure, which limits the "Hard" adaptation choices. It would be desirable to examine all the aspects involved in rural road design and adopt as much as possible the design standard for climate sensitive components, such as slope protection, and drainage systems. Almost all the rural roads are located in the mountainous area. Flood in this area are generally characterised by fast happening but short in duration. For sections that are susceptible to flood but are also difficult to raise the subgrade, it may be economical to adopt design standard using special materials to ensure the robustness of the road when it is submerged by flood water.
- Bridge design is based on the observed historical highest flood level as the design standard with an extra of 0.5 to 1.0 meter as safety factor. The climate change will likely produce 10% and 20% more flood discharge by 2050 and 2100. An examination of the current design standard is needed to ensure the safety factor is adequate for the extra flood discharge. As shown in this study, the 0.5 metre safety factor may be adequate to offset the median scenario change induced flood height increase at Menglian, but may become inadequate at the end of this century or for high climate change scenario. Further increase the bridge height may be necessary, which will introduce additional construction cost. The total cost will depend on the

bridge type and the number of piers. On average, approximate CNY10000/pier (US$1632/pier) is expected for every metre bridge height increase (per comm. YTPDI).

- Heavy rainfall triggered landslide risk will likely become more frequent. Special design consideration should be given to the road sections that have steep slope on the side of the road. Proper slope stabilization techniques, including engineering methods, should be adopted or planned for future implementation.

4.2 "Soft" measures: ecological solutions, institutional and technical capacity building to enhance risk awareness and ability for ongoing risk assessment & management, knowledge management to improve risk assessment as new information emerges

- Human activities have an important role to play in terms of ensuring the road network is maintained in good working order. The PRIRNP is located in an area that are characterised by high soil erosion. The river channel siltation is rather common in this region; hence regular dredging and/or clearing of the river channels can significantly reduce the risk of flood and landslide risks.
- Heavy rainfall is weighted at only 20% in total landslide risk. Landcover accounting for 30% in total landslide risk, is an even larger weighting factor. Prohibiting cultivation along the steep slope land and planting deep rooted vegetation in the erosion prone area will effectively prevent landslide from occurring. The government has made great effort in ecological restoration in Pu'er and, as indicated by the staff from both PMO and YTPDI, there has been steady improvement in ecosystem restoration and protection in Pu'er. However in the short term the landslide will still present a considerable threat to the road network in Pu'er, particularly to the rural road.
- The Pu'er government has placed flood protection as one of its priorities for future development. It is expected that most of the work under government hydraulic plan will significantly benefit the PRIRNP.

As discovered by the PPTA team, the current operation of the road network still has much space for improvement, in terms of both 'hard' engineering options and 'soft' measures. Good climate resilience can also be achieved through institutional and technical capacity building to enhance risk awareness and ability for ongoing risk assessment & management. It is also worthwhile to note that not all adaptation needs to be implemented immediately. In fact, by taking economic into consideration, as long as good plan has been in place, some adaptation can be implemented in the future as climate change is also a gradual process. The above adaptations are mostly discussed against their targeted vulnerable components. However, one adaptation will not only strength the resilience of target component, but will likely also benefit all components across the project.

5. Conclusion

The objective of the PRIRNP development is to facilitate growth and regional integration by connecting isolated rural communities to the regional road network and providing infrastructure to support trade and regional cooperation between the PRC, Viet Nam, Lao PDR, and Myanmar. Climate change may have a significant impact on the serviceability and usable life of the project. Actions should be taken to include effective and efficient adaptations as an integral part of project design and construction to alleviate any negative climate change impact consequences. Incorporating effective adaptation measures in project design and construction will prevent costly infrastructure remedy and/or re-construction and also expedite the long term economic benefits for which the project is designed.

This study produces quantitative climate change information relevant to the project by making use of the pattern scaling based GCM ensemble method. The advantage of this method is that it not only takes the key uncertainties in climate change science into future projection into consideration, but also treats these key uncertainties independently. Therefore climate change projections and their associated uncertainty range can be produced consistently through a combination of the different scenarios. A quantitative impact assessment can then be conducted by linking the relevant climate factors to the key vulnerable components of the project, and targeted adaptation options can subsequently be identified and evaluated.

As revealed by the study, the biggest climate related risk to the project is river flood and landslide/debris flow caused by heavy rainfall event. The climate change scenario analysis indicated enhanced risks for both hazards. Several adaptation options were identified and discussed. Despite the importance of taking necessary ‘hard’ adaptation measures in project design and construction, it is worthwhile to emphasise that the ‘soft’ options could be much cost effective and equally efficient. The deforestation in the mountainous area and the blocking of the waterway system have both contributed to the increased vulnerability of the project to flood. Therefore ecosystem restoration should be considered as a long term adaptation option to enhance the resilience of the project to climate change impact.
This study was constrained by a number of limitations:

- The impact assessment was conducted on the basis of available data. Though we considered this data adequate for this study, a properly developed impact model would reveal the detailed relationship between torrential rain and the flood or landslide. For example, a time series river flow data would assist in developing proper hydrologic and hydraulic models so that the impact on flood due to changing in rainfall could be explored; a rainfall - landslide model built on detailed topography, soil information and vegetation cover information would provide valuable adaptation management options.
- No flood height data or analysis can be found for the Ning’er-Jiangchen-Longfu regions road section. The design of bridges in this section may take the recommendation of Menglian-Meng’a in this study as a reference.
- The adaptation options discussed were presented as initial recommendation. No economic data was available to investigate the cost-benefit of implementing such adaptation options. However, we recommend selection of appropriate adaptations and/or their combination to be considered in projects design wherever feasible.

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Appendix 1: Climate change scenario generation

The uncertainties in climate change scenario generation

The future climate change projection includes uncertainties, particularly at the regional and local level. The major sources of uncertainties come from: 1) the difference of spatial change projections modelled by different GCMs; 2) the future Greenhouse Gas (GHG) emission rates; and 3) different GCM model parameterisation due to the unknown or not fully understood mechanism and feedbacks in the climate systems. A thoroughly studied uncertainty by the scientific community is the difference in GCM model parameterisation, or the climate sensitivity. The climate sensitivity is conventionally defined as the equilibrium change in global mean surface temperature following a doubling of the atmospheric (equivalent) CO_2 concentration simulated by a GCM. It has been found that the uncertainty range is between 2.0°C to 4.5°C (Solomon et al., 2007).

To reflect the uncertainty of future GHG emission rates, a new process has been used for future global climate change projection since IPCC AR5. In this process, GHG emissions and socioeconomic scenarios are developed in parallel, building on different trajectories of radiative forcing over time to construct ***pathways*** (trajectories over time) of radiative forcing levels (or CO_2-equivalent concentrations) that are both ***representative*** of the emissions scenario literature and span a wide space of resulting GHG ***concentrations*** that lead to clearly distinguishable climate futures. These radiative forcing trajectories were thus termed "Representative Concentration Pathways" (RCPs). A RCP was simulated in an Integrated Assessment model to provide one internally consistent plausible pathway of GHG emissions and land use change that leads to the specific radiative forcing target. The full set of RCPs spans the complete range of integrated assessment literature on emissions pathways and the radiative forcing targets are distinct enough to result in clearly different climate signals.

In this study, three RCPs: RCP4.5, RCP6.0 and RCP8.5, are used to characterise the possible climate change scenario for the project area and uncertainty range. RCP6.0 with mid-climate sensitivity represents a GHG concentration reaching 850 ppm and stabilized after 2100, it is a middle range future change scenario. Similarly, RCP4.5 (650 ppm GHG and stabilized at 2100) with low-climate sensitivity and RCP8.5 (concentration larger than 1370 ppm at 2100 and still rising) with high-climate sensitivity represents the low and high bound of the uncertainty range of future global change scenarios as shown in Table 1. The three RCPs represent rising radiative forcing to 4.5, 6 and 8.5 W/m^2 by 2100 respectively.

The General Circulation Model (GCM) is the most reliable tool in generating the future climate change scenarios at large to global scale. However, given the current state of scientific understanding and limitations of GCMs in simulating the complex climate system, for any given region in the world, it is still not possible to single out a GCM that outperforms all other GCMs in future climate change projection. Future climate change projection based on the analysis of a large ensemble of GCM outputs is more appropriate than using any individual GCM outputs (Wilby et al. 2009). This is particularly important if such a projection is used for impact assessments; a large ensemble of GCM simulations can provide a reliable specification of the spread of possible regional changes by including samples covering the widest possible range modelling uncertainties (Murphy et al. 2004, Sortberg and Kvamsto 2006, Murphy et al. 2007, Räisänen 2007). A single GCM projection of future climate made

with even the most sophisticated GCM can be of limited use for impact assessment as it lacks the ability to provide information on the range of uncertainties. Within an ensemble approach; provided the members of the ensemble are independent, a larger ensemble size could lead to a more reliable statistical result (Sterl et al. 2007). In this study, the 50 percentile value from the model ensemble sample was used in generating future climate change projections.

The pattern scaling method

The pattern-scaling method (Santer *et al*., 1990) is based on the theory that firstly, a simple climate model can accurately represent the global responses of a GCM, even when the response is non-linear (Raper et al. 2001), and secondly, a wide range of climatic variables represented by a GCM are a linear function of the global annual mean temperature change represented by the same GCM at different spatial and/or temporal scales (Mitchell, 2003, Whetton et al. 2005). Constructing climate change scenarios using the pattern-scaling method requires the following information:

a) regional patterns of changes in climate (e.g. for precipitation) by specified timeframe (e.g. month) from GCM results, which are normalized to give a spatial pattern of change per degree of global-mean temperature change;
b) time-dependent projections of global-mean temperature change projected by a selected RCP under a selected “climate sensitivities”
c) baseline climate variables derived from observational records.

In generating a “time-slice” scenario for a future year, the normalised pattern (a) is scaled by a time dependent projection of global-mean temperature change (b). The resultant scenario of climate change is then used to perturb the underlying observed spatial climatology (c) to give a “new” climate for the year in question. In this way, the three key uncertainties – the GCM spatial patterns of change, the future GHG emission rates and the climate sensitivity – can be treated independently and combined flexibly and quickly to produce future climate scenarios (as per Wigley, 2003).

The pattern scaling method is also extended to analyse the climate change impact on climate variability, such as the extreme precipitation event. A general extreme value (GEV) function was applied to the daily precipitation data from historical observations and GCM outputs to derive precipitation intensity values. Similar to a normalised pattern for monthly precipitation, normalised patterns of a series of precipitation intensities, such as 1:20 year maximum daily precipitation, are calculated for a GCM following the steps discussed previously. In generating the normalised patterns, the GCM simulated period of 1975 to 2005 was used as GCM baseline.

Out of the 40 GCMs 22 have their daily simulation outputs publically available (see Appendix 2). For the GCM with available daily data, a linear regression method was used to process them in order to derive the normalised pattern for the precipitation intensity series. A more detail discussion of the extreme precipitation change scenario generation can be found from Ye and Li (2011).

Appendix 2: IPCC AR5 GCMs used in this scenario generation and their horizontal and vertical resolutions. Models with daily data available are used for extreme rainfall event scenario generation

Model label	Resolution (longitude°× latitude°)	Daily	Institution
ACCESS1.0	1.875×1.25	No	Commonwealth Scientific and Industrial Research Organisation/Bureau of Meteorology (CSIRO-BOM) Australia
ACCESS1.3	1.875×1.25	Yes	Commonwealth Scientific and Industrial Research Organisation/Bureau of Meteorology (CSIRO-BOM) Australia
BCC-CSM1.1	2.8125×2.8125	No	Beijing Climate Center (BCC) China
BCC-CSM1.1(m)	2.8125×2.8125	No	Beijing Climate Center (BCC) China
BNU-ESM	2.8125×2.8125	No	Beijing Normal University (BNU) China
CanESM2	2.8125×2.8125	Yes	Canadian Centre for Climate Modelling and Analysis (CCCma) Canada
CCSM4	1.25×0.9375	Yes	National Center for Atmospheric Research (NCAR) USA
CESM1(BGC)	1.25×0.9375	Yes	National Center for Atmospheric Research (NCAR) USA
CESM1(CAM5)	1.25×0.9375	No	National Center for Atmospheric Research (NCAR) USA
CMCC-CM	0.75×0.75	Yes	Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC) Italy
CMCC-CMS	1.875×1.875	Yes	Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC) Italy
CNRM-CM5	1.4×1.4	Yes	Centre National de Recherches Météorologiques (CNRM-CERFACS) France
CSIRO-Mk3.6.0	1.875×1.875	Yes	Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australia
EC-EARTH	1.125×1.125	No	EC-EARTH consortium published at Irish Centre for High-End Computing (ICHEC) Netherlands/Ireland
FGOALS-g2	2.81x1.66	No	Institute of Atmospheric Physics, Chinese Academy of Sciences(LSAG-CESS) China
FGOALS-s2	2.81x1.66	No	Institute of Atmospheric Physics, Chinese Academy of Sciences(LSAG-IAP) China
GFDL-CM3	2.5 × 2.0	No	Geophysical Fluid Dynamics Laboratory (GFDL) USA
GFDL-ESM2G	2.5x2.0	Yes	Geophysical Fluid Dynamics Laboratory (GFDL) USA
GFDL-ESM2M	2.5x2.0	Yes	Geophysical Fluid Dynamics Laboratory (GFDL) USA
GISS-E2-H	2.5×2×L40	No	NASA Goddard Institute for Space Studies (NASA-GISS) USA
GISS-E2-H-CC	2.5×2×L40	No	NASA Goddard Institute for Space Studies (NASA-GISS) USA
GISS-E2-R	2.5×2×L40	No	NASA Goddard Institute for Space Studies (NASA-GISS) USA
GISS-E2-R-CC	2.5x2×L40	No	NASA Goddard Institute for Space Studies (NASA-GISS) USA
HadCM3	3.75x2.5	No	Met Office Hadley Centre (MOHC) UK

HadGEM2-AO	1.875 × 1.2413	No	National Institute of Meteorological Research, Korea Meteorological Administration (NIMR-KMA) South Korea
HadGEM2-CC	1.875 × 1.2413	No	Met Office Hadley Centre (MOHC) UK
HadGEM2-AO	1.875 × 1.2413	No	National Institute of Meteorological Research, Korea Meteorological Administration (NIMR-KMA) South Korea
HadGEM2-CC	1.875 × 1.2413	No	Met Office Hadley Centre (MOHC) UK
HadGEM2-ES	1.875 × 1.2413	Yes	Met Office Hadley Centre (MOHC) UK
INM-CM4	2x1.5	Yes	Russian Academy of Sciences, Institute of Numerical Mathematics (INM) Russia
IPSL-CM5A-LR	3.75x1.875	Yes	Institut Pierre Simon Laplace (IPSL) France
IPSL-CM5A-MR	2.5x1.25874	Yes	Institut Pierre Simon Laplace (IPSL) France
IPSL-CM5B-LR	3.75x1.875	Yes	Institut Pierre Simon Laplace (IPSL) France
MIROC-ESM	2.8125x2.8125	Yes	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology (MIROC) Japan
MIROC-ESM-CHEM	2.8125x2.8125	Yes	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology (MIROC) Japan
MIROC4h	0.5625x0.5625	No	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology (MIROC) Japan
MIROC5	1.40625 × 1.40625	Yes	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology (MIROC) Japan
MPI-ESM-LR	1.875x1.875	Yes	Max Planck Institute for Meteorology (MPI-M) Germany
MPI-ESM-MR	1.875 × 1.875	Yes	Max Planck Institute for Meteorology (MPI-M) Germany
MRI-CGCM3	1.125x1.125	Yes	Meteorological Research Institute (MRI) Japan
NorESM1-M	2.5x1.875	Yes	Bjerknes Centre for Climate Research, Norwegian Meteorological Institute (NCC) Norway
NorESM1-ME	2x2	No	Bjerknes Centre for Climate Research, Norwegian Meteorological Institute (NCC) Norway

Appendix 3: Temperature related observed climate variables and their future projections

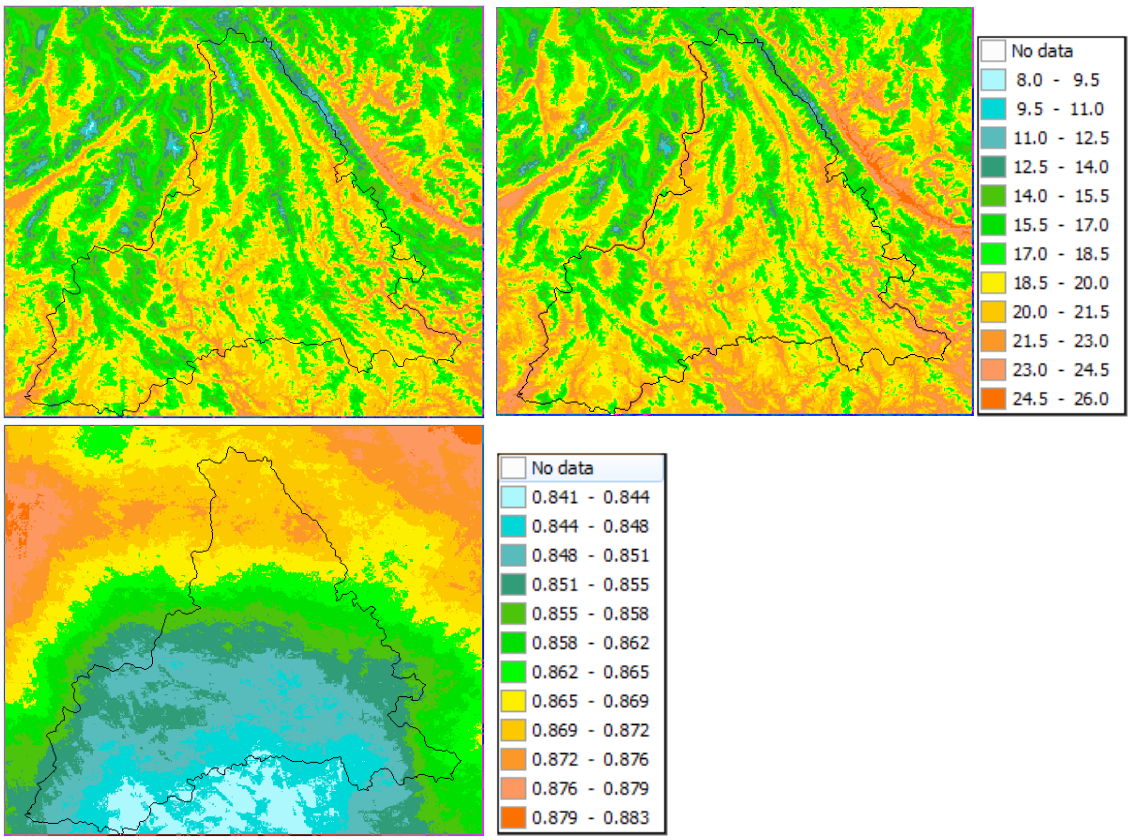

Figure A3-1: Baseline annual mean temperature (°C) and its 2050 change based on the median scenario projection.

Table A3-1: Observed extreme temperatures and their future change projections for Jiangcheng and Lanchang.

	Return period (year)	Baseline	2050			2100		
			Low scenario	Median scenario	High scenario	Low scenario	Median scenario	High scenario
Jiangcheng	Annual daily maximum temperature (°C)							
	20	39.248	40.091	40.402	41.624	40.392	41.503	44.651
	50	42.077	42.846	43.129	44.277	43.120	44.164	47.113
	100	44.578	45.263	45.513	46.585	45.505	46.480	49.224
	Annual daily minimum temperature (°C)							
	20	-2.062	-1.301	-1.025	0.038	-1.034	-0.064	2.572
	50	-3.366	-2.644	-2.389	-1.424	-2.397	-1.513	0.711
	100	-4.229	-3.540	-3.300	-2.418	-3.308	-2.496	-0.632
Lancang	Annual daily maximum temperature (°C)							
	20	36.928	37.760	38.068	39.284	38.058	39.164	42.332
	50	37.369	38.178	38.478	39.662	38.468	39.545	42.636
	100	37.637	38.429	38.722	39.885	38.713	39.770	42.807
	Annual daily minimum temperature (°C)							
	20	-0.304	0.489	0.779	1.906	0.770	1.795	4.692
	50	-1.202	-0.483	-0.223	0.783	-0.231	0.684	3.280
	100	-1.841	-1.190	-0.958	-0.065	-0.965	-0.152	2.152
Jiangcheng	Annual 7 day maximum temperature (°C)							
	20	33.21	34.18	34.52	35.84	34.51	35.71	39.13
	50	33.57	34.57	34.90	36.22	34.89	36.09	39.49
	100	33.78	34.79	35.13	36.44	35.12	36.32	39.70
	Annual 7 day minimum temperature (°C)							
	20	1.03	1.78	2.06	3.12	2.05	3.02	5.73
	50	-0.92	-0.23	0.02	0.97	0.01	0.88	3.26
	100	-2.55	-1.92	-1.69	-0.86	-1.70	-0.93	1.12
Lancang	Annual 7 day maximum temperature (°C)							
	20	35.16	36.00	36.32	37.57	36.31	37.50	41.53
	50	35.38	36.20	36.51	37.74	36.50	37.68	41.92
	100	35.49	36.29	36.60	37.83	36.59	37.77	42.15
	Annual 7 day maximum temperature (°C)							
	20	1.32	2.21	2.53	3.81	2.52	3.68	6.97
	50	0.40	1.29	1.62	2.91	1.61	2.78	6.14
	100	-0.28	0.63	0.96	2.26	0.95	2.13	5.55

Appendix 4: Precipitation related observed climate variables and their future projections

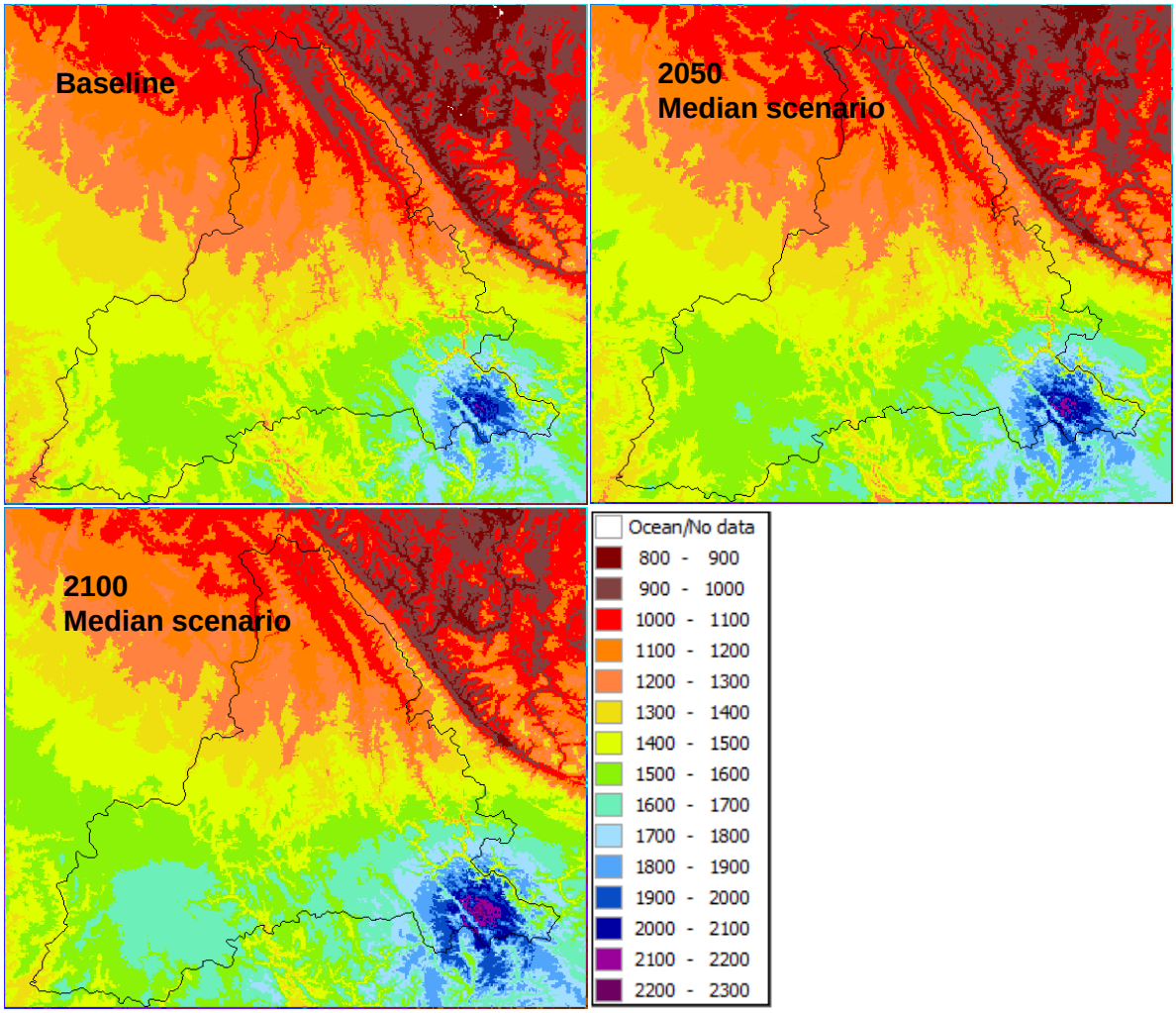

Figure A4-1: Pu'er annual rainfall distribution (mm): baseline and 2050, 2100 median scenario projection

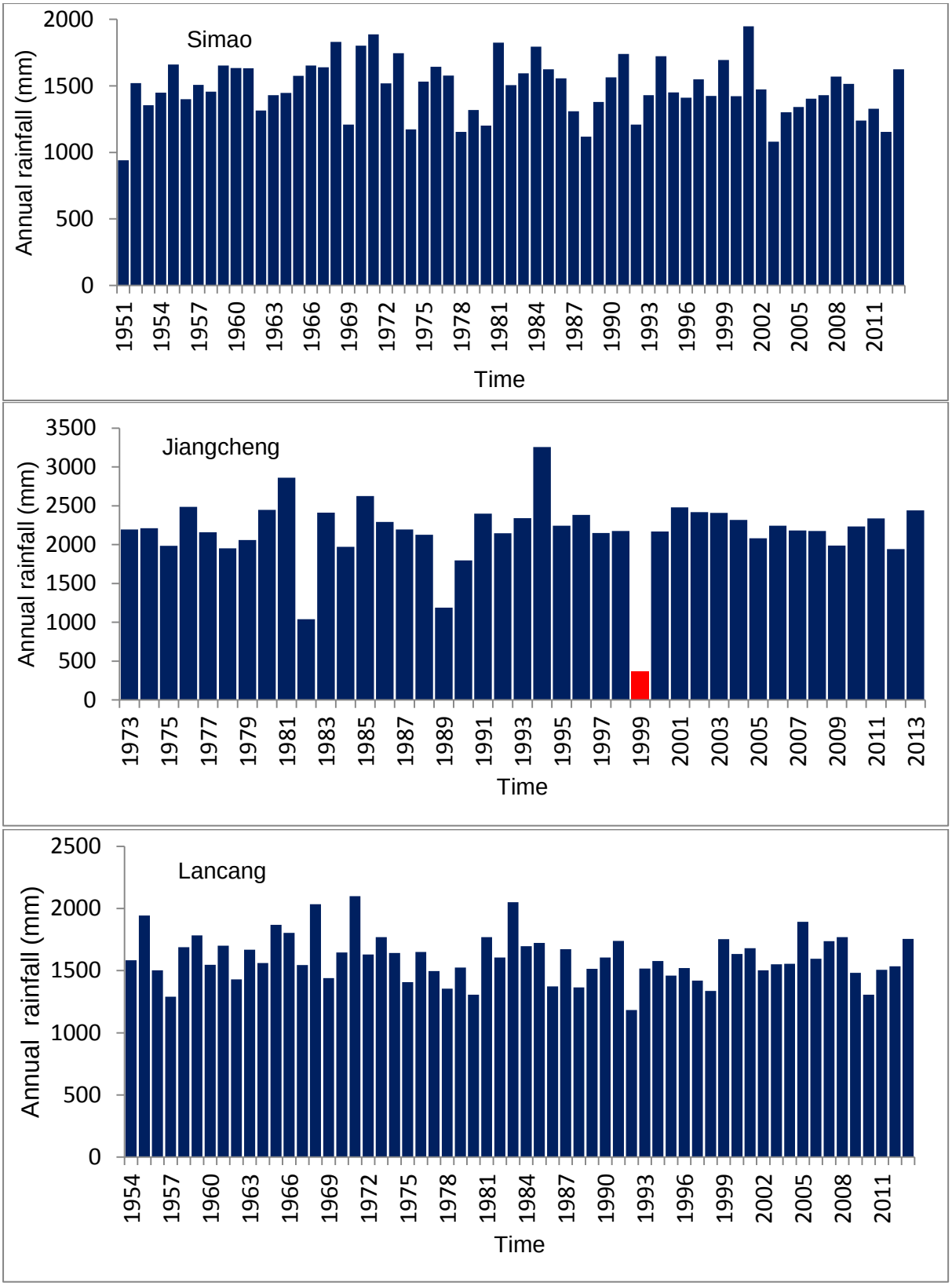

Figure A4-2: Observed annual rainfall of Simao, Jiangcheng and Lancang (Jiangcheng has missing data for 1999)

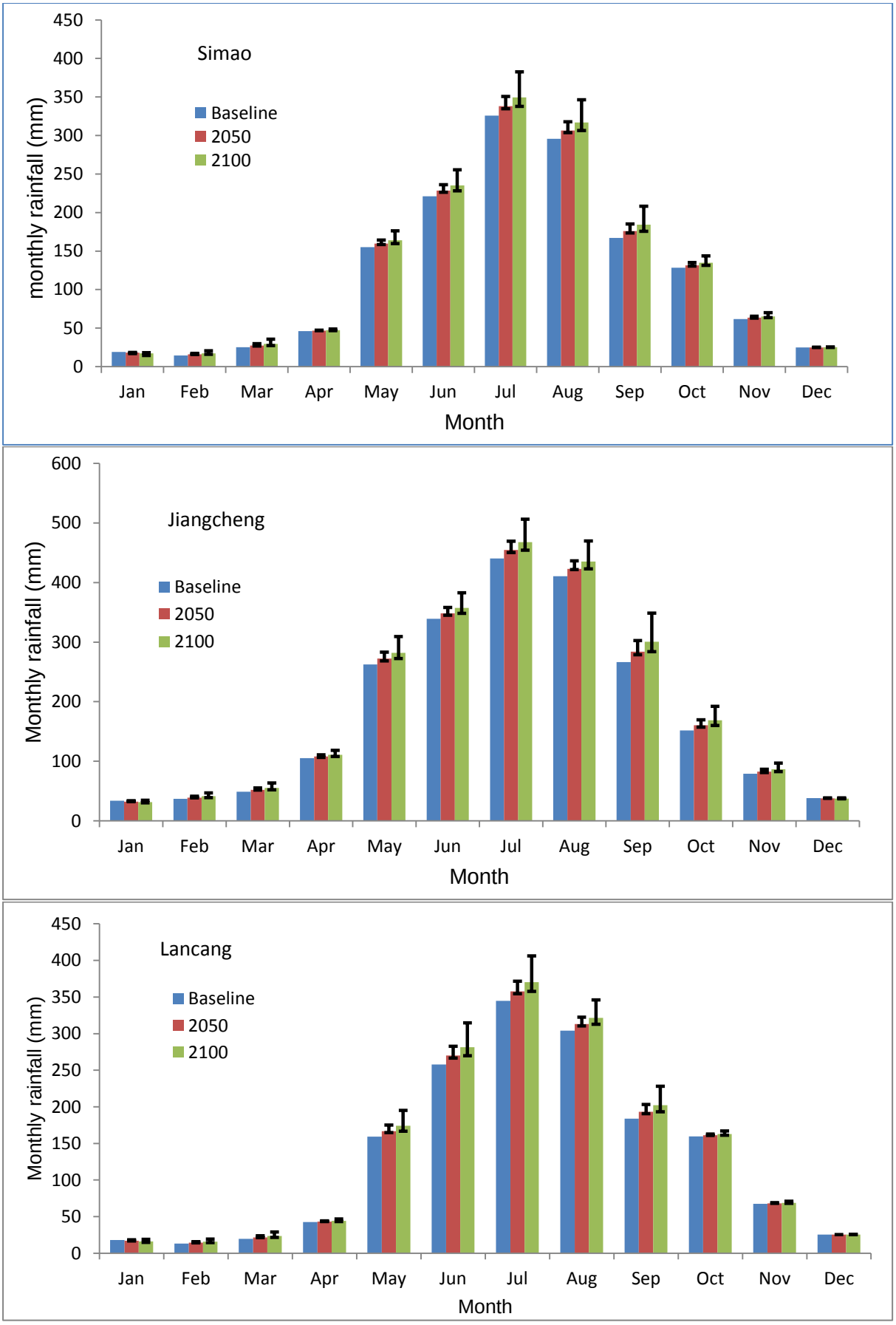

Figure A4-3: Station monthly normal rainfall and future projection. The bar indicates the uncertainty range of the climate change projection as defined in Table 2

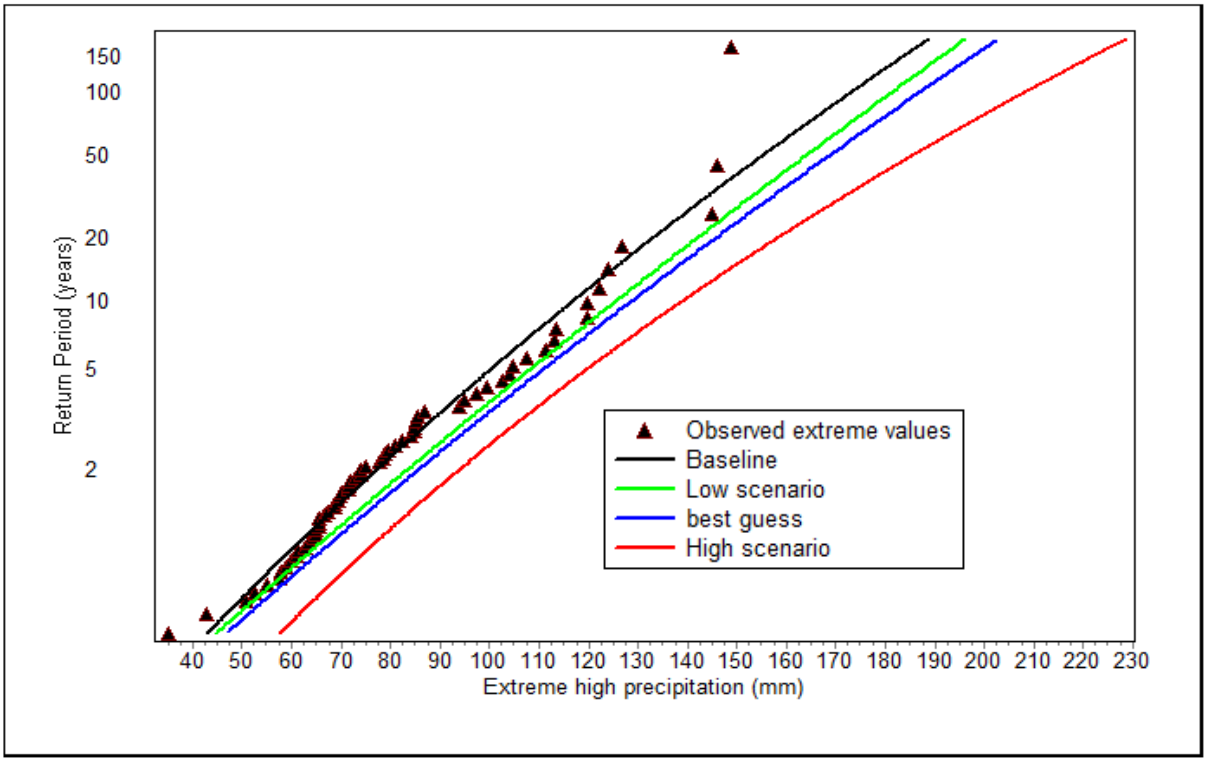

Figure A4-4: Simao annual maximum 1 day rainfall GEV distribution and 2050 projection. Black line is the baseline from historical data; blue and red lines represent the uncertainty range as defined in Table 2; green line is low projection; red line is high projection. The horizontal difference between green and red lines indicates the uncertain range of rainfall intensity for a given rainfall frequency; the vertical difference between green and red lines indicates the uncertain range of rainfall frequency for a given rainfall intensity

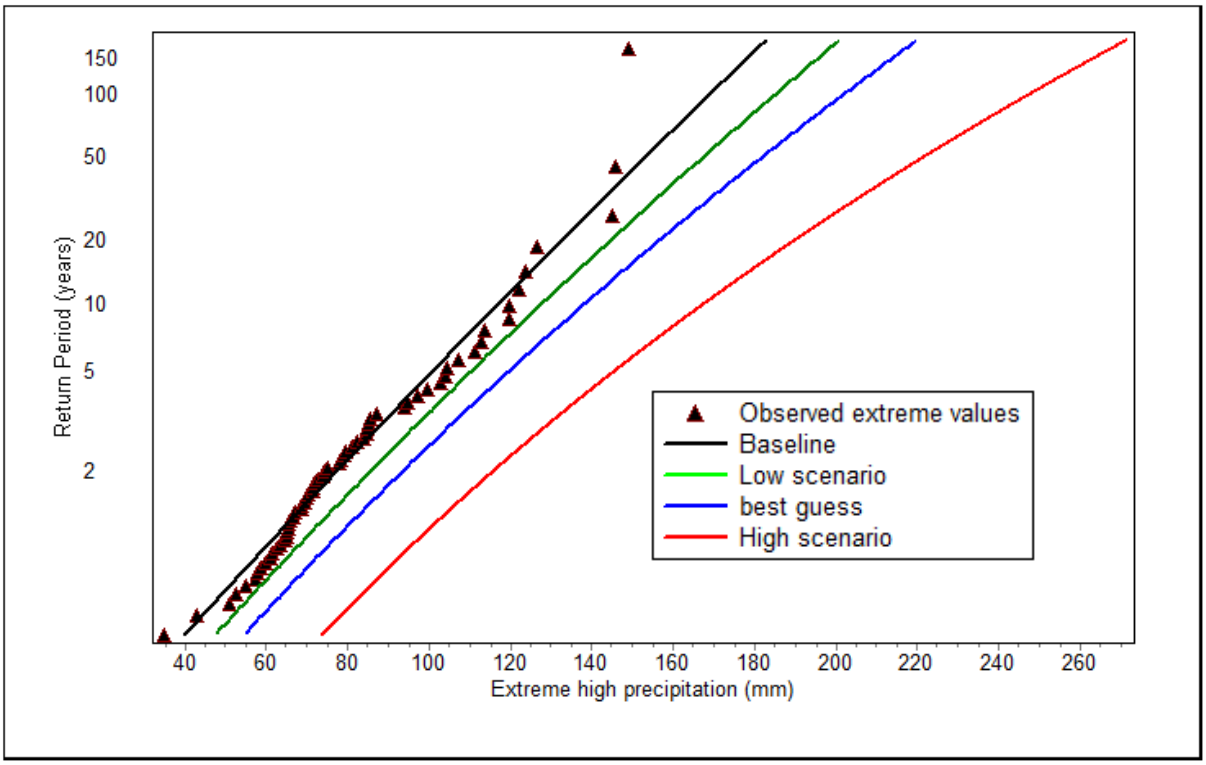

Figure A4-5: Same as Figure 4 but for 2100 projection

Appendix 5: Discussion of the relations of rainfall - flood, rainfall - landslide for Pu'er project climate change impact assessment

There is a lack of hydrologic data in the PRIRNP area for proper hydrologic or hydraulic model development. Only a 54 years annual maximum peak flow data of 1959 to 2013 was collected for the Menglian hydrometric station for the Nanlei River, which is a major tributary to the Lancang River. The Menglian station is about 40 Km west of the Lancang meteorological station. The Lancang Station is in the direction of upper stream of the Nanlei River, but outside of the catchment area. A statistical approach was adopted to explore the relationship between the Menglian peak flow and the Lancang rainfall of various durations from 1 day to up to 10 day rainfall prior to the peak flow. No significant statistical relationship could be found between the peak flow and the rainfalls, either from any individual rainfall duration or from the combination of various durations.

The reason are twofold: firstly it is because of the complexity of the local geo-hydrological conditions; second but also more importantly is because of the extensive human intervention to the river systems, such as man-made changes to the river channels and the extensive cultivation at the river catchment. Such conditions are by and large common to most area in Pu'er. This is evident from the Nanlei River at Mengliang, which is the start point of the Menglian-Meng'a Regional Road for this project. The river channels at Menglian have undergone a number of rehabilitations, which has greatly altered the hydrology of the river flow. The 2006 flood is a typical example: during October 8-10, Menglian had a total three day rainfall of 276.6 mm, the largest in history for Pu'er. The peak flow data observed at Menglian station was 958.11 masl, which was even 0.17 metres below the flood warning height (958.28 masl) . However, the torrential rain had triggered a 1:50 year flood at downstream of Nanlei River downstream and caused CNY 40 million damages and 1 death (Hu, 2011). Thus it has been a great challenge to develop proper hydrological or hydraulic models to simulate the rainfall and flood for Pu'er. In the past, most rainfall – flood research has been focused on either single event analysis or on the qualitative bases. Zhang et al. (2011) thus used directly the rainfall to study the water damage to the road system of Yunnan.

On the other hand, however, the heavy and, in particular, the torrential rainfall of Pu'er is characterised by high intensity and short duration. The steep mountainous topography makes the triggered flood responding quickly to the rainfall and also characterised in short duration in general. Almost all rainfall becomes runoff and goes to river channels (Luo and Jing, 2009). Li et al. (2007) pointed out that there was good spatial and temporal agreement between torrential rain and flood in Pu'er, with a flood event normally last 20 to 30 hours. Hence it is expected that the flood discharge and the 1 day heavy rainfall would have a reasonable good linear relationship. In the absence of reliable hydrological observations for the project area, the 1 day torrential rain may be used as a surrogate in investigating the climate change impact on river flood, i.e., it was assumed that the flood discharge will vary linearly with the 1 day rainfall change. The assumption is hold particularly well for high intensity flood event.

Another biggest climate risk is the heavy rainfall induced landslide. The PRIRNP is located in a high soil erosion prone area. Human activities have also caused serious land degradation. The landslide and debris flow disaster is severe in both frequency and intensity. While slope is the dominated factor contributed to landslide risk, a study on the project area revealed that it only accounts for 50% of the total landslide risk (Yan et al. 2001). The heavy rainfall contributes 20%, and landcover accounts for the rest 30% of the total landslide risk in the PRIRNP area. Tang and Zhu (1999) conducted a survey study in the Lancang catchment, and provided a quantitative relationship between rainfall amount and landslide risk in the area, as shown in Table A5-1.

Table A5-1: Landslide risk area classification for the middle and downstream area of Lancang River (Tang and Zhu. 1999)

	Landslide risk level		
	Low	Medium	High
Rain amount in 1 day (mm)	60-80	80-100	≥100
Total rain in previous 5 day + rain of current day (mm)	100-120 +40	120-150 +60	≥150+80

Based on their results, for the project area it was expected that the 1 day rainfall of 70, 90 and 100, or 6 day total rainfall of 140, 180 and 230 mm would have reasonable good relationship with landslide risk of low, medium and high. Thus these values were used as indicators for future landslide/debris flow risk changes under climate change impact.