Technical Assistance Consultant's Report

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India: Supporting Sustainable Urban Transport I Aizawl City

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Vol. 1 – Main Report

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For Public Work Department, Government of Mizoram
Urban Development Poverty Alleviation Department, Government of Mizoram
Aizawl Municipal Council, Government of Mizoram

Asian Development Bank

Asian Development Bank,
Public works Department, Government of Mizoram

TA 8765 IND: Supporting Sustainable Urban Transport in Aizawl City

Final Report

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List of Abbreviations

ADB TA	Asian Development Bank Technical Assistance
AMC	Aizawl Municipal Corporation
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
ATC	Area Traffic Control
AUA	Aizawl Urban Area
BRT	Bus Rapid Transit
BUA	Build Up Area
CCTV	Closed Circuit Television
CDM	Camp Dresser & McGhee
CDP	City Development Plan
CMO	Chief Minister's Office
CMP	Comprehensive Mobility Plan
CNG	Compressed Natural Gas
CTTP	Comprehensive Traffic and Transportation Plan
DME	Dimethyl Ether
DONER	Ministry of Development for North East Region
DPR	Detailed Project report
EIRR	Economic Internal Rate of Return
ENPV	Economic Net present value
ENVIS	Environmental Information System
EOCC	Economic Opportunity Cost of Capital

E-W, EW	East West
FC	Finance Commission
FCEV	Fuel cell electric vehicles
FRBM	Fiscal Responsibility and Budget management Act, 2003
FY	Financial Year
GoI	Government of India
GoM	Government of Mizoram
GSDP	Gross State Domestic Product
HC	Hydrocarbons
HEV	Hybrid Electric Vehicle
HIRIDAY	Heritage City Development and Augmentation Yojana
HPCL	Hindusthan Petroleum Corporation Limited
IDC	Interest during construction
INR	Indian Rupees
IOCL	Indian Oil Corporation Limited
IRR	Internal Rate of Return
ITI	Industrial Training Institute
JNNURM	Jawaharlal Nehru Urban Renewal Mission
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LRT	Light Rail Transit
MAT	Minimum Alternate Tax
NE	North East
NEDFi	North Eastern Development Finance Corporation Ltd.
NOx	Nitrogen oxides
N-S, NS	North South
NSDP	Net State Domestic Product
O&M	Operation & Maintenance
OTR	Own Tax Revenue
PCB	Pollution Control Board
PCU	Passenger Car Unit
PIU	Project Implementation Unit
PM	Particulate matter
PMU	Project Monitoring Unit
Pphpd	Passengers per hour per direction
PPP	Public Private Participation
PWD	Public Works Department
SCM	Smart City Mission
SP	Superintendent of Police
SUV	Sports Utility Vehicle
TA	Technical Assistance
TCPO	Town & Country Planning Organisation
UD & PA	Urban Development & Poverty Alleviation Department
ULR	Ultra-Light Rail
UMTA	Unified Metropolitan Transport Authority
VAT	Value Added Tax
VOC	Vehicle operating cost
WACC	Weighted Average Cost of Capital
YMA	Young Mizo Association
ZEDA	Zoram Energy Development Authority

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PROJECT, SHORT SUMMARY

The Asian Development Bank (ADB) has assisted the Government of Mizoram through technical assistance TA8765 in developing sustainable urban transport proposals for Aizawl City. Consultants CDM-Smith conducted the pre-feasibility study between July 2015 and March 2016, with PWD as the focal organisation. The main aims were to identify short-term low-cost traffic improvement projects and to develop proposals for improving public transport in the medium to long term, including eco-friendly vehicles and institutional strengthening.

Aizawl's urban population is around 3.5 lakh and expected to grow to over 6.5 lakh by 2035. Many of the main roads are at or close to capacity at peak periods, and traffic speeds and passenger flows have levelled off or even decreased on some roads at peak periods. Overall bus numbers in Aizawl have decreased, and the bus operators consider that congestion is one of the main reasons.

Short-Term Traffic Improvements

Aizawl has a relatively well-developed approach to traffic management. However, key areas for potential improvement are:

- Increased provision for pedestrians – improving footways and side stairs; better management of on-street parking; and safer crossings for pedestrians.
- Improved road junction and corridor design – by introducing road markings, traffic islands, mini-roundabouts, and improved road geometry.
- Encouragement for higher-capacity public transport – particularly bus lanes, bus priorities and enhanced public transport infrastructure (shelters, interchanges, information, etc).

The consultants prepared low-cost junction improvement designs (within the existing public right of way) for over 20 important junctions in Aizawl, and identified a package of short-term measures costing approximately Rs. 1.8 crore, for potential implementation by state and local government organisations in Aizawl using own funds.

Medium-to-Long Term Public Transport Improvements

The consultants assessed five different modes for Aizawl's future public transport: (1) light monorail, (2) cable liner, (3) ultra-light tram, (4) aerial ropeway, and (5) high quality bus system. The monorail and cable liner were ruled out on the grounds of high cost; insufficient passenger demand; difficulty in obtaining a suitable alignment; concentrating investment in Aizawl's crowded central areas; not assisting east-west movements; and limited scope for future network expansion. The ultra-light rail (tram) was not recommended primarily because of competition with existing road traffic.

The consultants' recommendations for Aizawl's future public transport system are: (1) a high quality bus system, and (2) development of an aerial ropeway. Several alternative alignments were examined, and the recommended alignments are:

- Developing the North-south bus corridor between Zemabawk and Kulikawn (10km), and also other bus routes in Aizawl, with new buses, bus priorities and bus lanes, high quality bus shelters, improved road junctions, footways and access, and a unified bus management organisation;
- An east-west aerial ropeway (with capacity for around 3,000 passengers per direction per hour) extending for 5.5km between Thuampui and Chawlhhmun (Solomon's Temple).

In the longer term, the ropeway network could be expanded to include a north-south alignment on Aizawl's central corridor.

Investment proposals totalling Rs.237 crore ($35.6m) were developed for the bus package, and Rs.668 crore ($100m) for the ropeway package. Economic analysis showed that both were economically

viable, with benefit/cost ratios (BCR's) of 1.2 and 2.2 respectively. (This assessment did not include the benefits of decentralization, cleaner air, lower energy consumption, improved urban environment, and tourism development, so the overall benefits would be significantly higher). However, the financial analysis suggested that neither the bus package nor the aerial ropeway package would be commercially attractive, though the bus package might be financially viable if run by a state department (net of tax and accepting a lower return of 8% per annum). All three ropeway alignments investigated were predicted to recover their O+M costs over time, though not in the initial few years. The financial analysis was very sensitive to the number of passengers carried.

Overall, the consultants recommend that both the bus and the east-west ropeway packages should go forward to detailed feasibility study. This view was supported in discussions with both senior government officers and transport sector stakeholder organisations.

Improved Air Quality and Emissions

Three main approaches were recommended for improving air quality and reducing greenhouse gas emissions from Aizawl's urban transport sector: (1) introduce the higher Bharat Stage IV emission standards as soon as possible in Aizawl; (2) strengthen the capacity and activities of the enforcement agencies; (3) encourage traffic and travel demand management measures and invest more in public transport.

Institutional Strengthening for Urban Transport

For institutional strengthening, UD&PA is proposed to take up the strategic urban transport planning function with a dedicated team of transport planners. For the implementation, operation, maintenance and improvement of the proposed bus and ropeway systems, an Aizawl Mass Transport Company or Authority is proposed, to be under UD&PA. For local transport planning, traffic engineering and management, the strengthening of AMC with an expanded team of engineers and planners is recommended.

EXECUTIVE SUMMARY, in MIZO

1. Project in a tum te

Sorkar laipui in Asian development Bank (ADB) chu Aizawl khawpui a lirthei tlan vel dan tih hmasawn leh siam that kawnga hmalak pui turin a sawm a. He ngenna hi bawhzui in ADB chuan sum rawn tum in,Techical Assistant Project, thla 9 chhung awh tur, 'Supporting Sustainable Urban Transport in Aizawl City' (TA 8765) tia vuah chu chhawpchhuah ani. He project hi June 2015 ah tan ani a, hemi hnuaiah hian consultants CDM-Smith chuan Mizoram sorkar thawhpui in, a laimu ah PWD chu hman ani. Project in a tum thil pahnih te chu-

(i) Hun rei vaklo chhung tal (Kum 2-3) a hautak lo zawnga khawpui traffic enkawl dan tur haichhuah (leilung leh thildang dinhmun tiamin)

(ii) Aizawl khawpui lirthei tlan dan kawngah, daih rei tur leh leilung hausakna tiral lo chi ngaihtuah, a bikin kawngpuia tlanlo public transport te, bus leh taxi thianghlim zawk te leh pawl anga intihchak te. Hengah hian hmasawnna daih rei tur leh daih rei vaklo tur thlenga hmuh theih dan kawng a awm em tih zir chian

2. Traffic leh lirthei lama Aizawl dinhmun ni mek

Aizawl khawpui mihring zat hi a pung chak hle a, tun atanga kum sawmhnih ah chuan a let thawk, nuaih 3.5 atanga 6.5 a pung tura ngaih ani. Traffic pawh a tawt chak hle a, tun kum 15 liam ta chhung khan motor register punna zat chu a let 5 thawk niin, traffic tawt lutuk hi harsatna lian tak ani mek ani.

Aizawl kawngpui tam tak chu khawpui lun vanglai chuan khar ani thin a, mahse motor zat a pun chak viau lai in, kawng thenkhat ah chuan motor chuang leh speed kal dan a tlem hle lawi a. Traffic chhiarna in a tarlan dan chuan chhim leh hmar kawng dung lam chu khawpui lun vanglai pawhin, tun kum 8 liamta (2007-2015) chhung khan motor chuang an pung lemlo tih hmuhchhuah ani: two-wheeler a pun viau lai in, car, taxi leh jeep zat tlemin a kiam a, bus service a kiam nasa hle (2007 let thawk ang velin). A tlangpui in, Aizawl ah bus a kiam nasa hle a, hei hi a enkawltute lam chuan khawpui tawt lutuk vangah an ngai.

3. Hun rei vaklo chhunga traffic tihhmasawn na tur

He project hian tun dinhmun tih hmasawn nan rei vaklo chhung (kum 2-3) awh tur inkaihhruai dan project hautaklo zawn chhuah a tum a. A consultants te hian Aizawl khawpui traffic inenkawl dan leh a riruang zir chiangin, helam kawngah chuan a changkang viau ani tih an hmu a, a tlangpui in, one way kawng te, motor thenkhat luh phal lohna kawng siam te, thenkhat chauh park theihna hmun siam te, taxi stand leh fee charge leh a dangte. Heng hmalakna te hian a huam zau in mipuite zawm a hlawh bakah, driver te inthununna pawh a tha hle.

Traffic enkawl dan nawlpui, Asia chhim lam khawpui tana recommend theih awm ho chu hlawhtling takin Aizawl ah hian anlo hmang diam tawh a. Chutih rualin, thenkhatah hmasawn theihna a awm nual a, a tlangpui in:

- Ke a kal te tana zalenna zau zawk pek- kawng zim tak te leh motor parkna siam ten kawngpui tam takah ke a kalte tan hmun a pe tlem hle. Consultant-te hian he harsatna sutkian theih dan kawng a hmu nual a, a bik takin kawngpui tawt zualna veng Zarkawt, bawngkawn, khatla leh vaivakawn ah. Hemi tur hian (i) kawng nek lutuk a step siamte siam that; (ii) kawngpui a motor hun dan leh kawngpui hman dan mumal zawk siam; (iii) ke a kalna tur siamna kawngah dawr leh building neitute inpawh taka thawhpui; (iv) ke a kalte tan kawng corss dan him zawk siam
- Kawng peng thuam riruang siam that- consultant te hian kawng peng thuam pawimawh 20 a motor kal dan that theih zawk dan leh ke a kalte tana him zawk dan tur design a

chhawpchhuak a. Kawng peng tamna hmun engemawzatah motor helkual tur island te chi siam rawt ani. Heng design tehian tuna kaldan phung leh traffic control a tibuai lo ang.

- Vantlang hman lirthei mipui dawng hnem chi hmang tam tura infuihna- Thil chhawpchhuah te hian himna, remchanna leh inkhuahkhirhna lamah hmasawnna thlen mahse, vantlang motor hman tamna lam a awn tawklo deuh a. Mipui tam zawkin vantlang motor an hman tam theihna tur chuan mipui phur tam thei vantlang motor, a bikin bus te, tun aia tih tam a ngai a. Bus tlan na bik siam theihna remchang a awm nual bakah, bus dah pawimawhna kawnga hmalak hi bus tlan chak tir nan a pawimawh bakah vantlang lirthei hmang an kiam zel loh nan a ngai bawk ani. Chuvangin medium term atan bus hmasawnna atana ruahmanna hi dah tel ani a, hei bakah hian zau zawk a traffic thununna a awm theih nan traffic signal dah nise tih ani bawk.
- Zinna lama mamawh enfiahna- pawh hi motor dawng hlawklo chi tih tlem nan a pawimawh a, hei bakah hian thildang remchang ni a hriat te chu volume 2 ah chhawpchhuah ani.

Reilote chhung kawng peng thuam tih thatna tura rawtna hi Cheng Nuaih Rs. 0.45 crore mamawh anga chhut ani a, khawpui dung siam that nan Cheng Nuaih Rs. 1.3 crore chhut ani bawk. Heng rawtna thenkhat hi medium term ang thlenga daih rei tura beisei an ni.

4. Medium leh Long-Term atan Public Transport

Consultant te hi medium leh long term daih tura Aizawl a kan public transport te kan hman theih dan tur zawngchhuak tura tih an ni a. Hemi tur hian thil 5 an buk chhin a: monorail, cable liner, ultra-light tram, aerial ropeway leh bus system changtlung zawk.

Monorail leh cable liner tehi theihloh anga ngaih an ni a, a chhan chu: (i) a to lutuk; (ii) passenger an tam tawklo (a phurh tam theih dan ngaihtuahin); (iii) a nghahna turah harsatna a awm (kawngpui a nghah chu theihloh anga ngaih ani); (iv) Aizawl khawpui lun leh laili laiah in sawrbing lutuk a awm thei;(v) public transport tlemna Aizawl east atanga west kal danah danglamna a awm dawnlo; (vi) hun kal zelah tih hmasawn dan tur a awm meuhlo.

Ultra-light rail (tram) pawh recommend loh anih chhan bulpui ber chu tuna traffic awmdan hi a dal dawn a. Chutih rualin, long term hmasawnna turin ngaihtuah nawn theih ala ni.

Rawtchhuak tak te chu bus system quality sang leh aerial ropeway te an ni.

Heng nghahna tur hian hmun hrang2 ngaihtuah ani a, tha bera hriat te chu:

- Bus service changtlung zawk, aizawl north-south dungah, Zemabawk leh Kulikawn inkar (10km). Hemi mamawhte chu bus thar te, bus tih pawimawh leh tlanna bik siam te, bus dinna thra zawk siam te, kawng peng thuam him zawk siam te, ke a kalna tur siam leh bus enkawltu tur pawl felfai tak an ni.
- East-west lama kal ropeway, 5.5km a thui, Thuampui leh Chawlhhmun (Solomon's Temple) inkar ami tur.

Heng rawtna tehi siam anih chhan te:

i. A man- a zuam awm ber;

ii. Nghawng awmzenei- aizawl khawpui hmawr lamah hmasawnna thlenin, heihi Master Plan in a tum ber ani a, hma nasa takin a sial thei dawn ani;

iii. Hun kal zelah tih hmasawn zel theih ani;

iv. Hlawkna lian tham zawk- bus system hmasawnna hian kawng leh ke a kalna lama hmasawn nan nasa takin kawngro a su tel;

v. Bus leh ropeway rawtna tehi intikim tawn tak an ni;

vi. Ropeway hi lei hlutna manchhuahna kawngah leh inkal pawhna kawnga hmasawn nan hlutna nei sang tak ani.

A long term ah chuan, a senso tlin dan leh a hlawkna hmuh dan azirin, ropeway hi Aizawl khawpui dung north-south kal tlang tura siam belh theih ani.

Man leh sum mamawh zat chhutna

Investment package chihnih ah ruahman ani a: Bus tih hmasawn nan leh east-west ropeway te. A tirah chuan bus ruahmanna hian Aizawl a hmar-chhim kawng dung leh chhak-tlak lam kawng tlem a huam ang a. Sorkar lmite nena sawihona neih anih hnuah leh draft final report chungchangah ngaihdan lak anih hnuah bus package hi huam zauh belh niin khawpuia tanga tlanna hmun thum ah, Lengpui pawhna kawng te, Sairang a rail terminal thar leh Falkawn a referral hospital thar te kalpawhnan. He bus package ennawn thar hi Rs.237 crore ($35.6 m) ngai tura hisap ani. Kum 4 chhunga buatsaih tur niin, bus thar 440 vel lei a ngai ang a, a senso hmun thuma then a hmun khat (1/3rd) hi kawng pengthuam leh ke a kalna hmun siam nan hman tur ani. Hmun thum a bus chawlhna tur leh workshop siam leh, city bus enkawltu pawl siam that te hi a package ah hian a tel bawk ani.

East-west ropeway package atan Rs.668 crore ($100m) mamawh anga ngaih ani a. 5.5 km a thui niin, stations hmun 9 ah a nei anga, Thuampui leh Chawlhhmun (Solomon's temple) inkarah, a lai takah Power House (Bara Bazar) a kal khum ang. Ruahman china leh hman theih anih hun tur thlenga chhutin kum 5 chhunga peih theih tura ngaih ani. Aizawl east lamah chuan Thuampui atanga khawpui lai tak hi minute 10 chhungin (taxi leh bus chuan minute 20-40) direct takin a thlen theih ang. West lamah chuan inkalpawhna puitham tak (darkar khat a mi 3000 kal thelhna) Aizawl Master Plan a designated area lamah long term in duan theih ani ang. Hmun zau zawk kalpawhna kawng pawimawh tak tak rem takin a pawh thei ani.

He package duan chhuah pahnih zirchianna chuan senso lamah pawh a awm ai hle tih a hmu a: bus package laimu hi a Economic Internal Rate of Return (EIRR) 19.1 niin, E-W ropeway (5.5km) hi a EIRR chu 24.9% ani. Ropeway dang pahnih ruahhman (E-W ropeway (2.4km)), leh N-S ropeway (7.5km)) te pawh khan EIRR hniam hret mahse tha tak si 17.6% leh 15.7% v eve an nei ani.

Heng figure te hian a hlawkna a chhut dan hi a hniam thei ang berin ala ni zawk a, hun a duh rei zawng tur leh lirthei hautak lo chi a chhut tel a, mahse heng bakah hian hmasawnna lian tham zawk, Aizawl khawpui hmasawnna lama a hnathawh tur, pollution leh energy humhalh kawnga a rah chhuah, tourism a tih hlawk dan tur, etc. te chhut tel an nilo.

A senso lam zir chian na ah hian bus package hi a Equity Internal Rate of Return chu 8.7% niin, heihi private investor te tana hlawkna tur hisapna ah chuan 15% in a hniam lam daih ani.Amaherawhchu, bus package hi a hlawkna tihpum theih dan awm chu state department net of tax enkawlna hnuaiah, lower return kum khatah 8% vel bawr pawm ni ta se.

Ropeway option pathum tehi mimal sumdawngte tan leh state tan chuan a hlawkna tehin mi hiplo tak ani a, an project IRR leh equity IRR te hi a hniam hle mai a. Mahse, a senso zawng zawng (O+M cost) tehi hmuh let theih vek ni a ngaih ani, a tir lamah hmuh nghal theih phei chu nilo mahse. Senso chhutna ah hian passenger zat tura rin chhut fimkhur hle ani a, passenger tam zawk in an hman chuan a hlawkna hi tuna kan chhut aia sang fe thei ani.

A hmawr bawk naah chuan, consultants te hian bus package leh east-west ropeway package tehi a theihdan ngun taka zirchian tura hmaak nise a ti a. He ngaihdan hi, project sawihona workshop neih anih tum a sorkar officer senior te leh lirthei lama mawhphurhna nei pawl hrang hrang aiawhtute, ngun taka sawipui an nih hnua an rilrem ang thlap a siam ani.

5. Aizawl tana Eco-Friendly Public Transport

Consultant te hi eco-friendly bus leh taxi Aizawl atan ngaihtuah tura tih an ni a. Motor leh fuel khawl changkang chi hrang sawm chuang an endik a, heng zingah hian electric, bio-fuel leh hydrogen fuel cell vehicles leh a chi dangte a tel. Heng zingah hian, pathum thlan bik an nei leh a: LPG; hybrid electric-diesel, leh low-emission diesel.

Amerawhchu, Aizawl a hman atan an tha viau angin lang mahse, LPG leh hybrid electric vehicles chu recommend an nilo, a chhan hrang zingah (i) a man; (ii) technology thar hman lakah risk a sang (hybrid-electric bus te); (iii) fuel sem kual senso leh harsatna tam tak (entirnan, hybrid electric vehicle charge nan current mumal tawklo, LPG man hautak).

Boruak tih thianghlim nan leh greenhouse gas chhuak Aizawla tih tlem na tura thil pathum ruahhman te chu:

i. Low emission diesel (Bharat Stage IV standard) leh national emission standard Bharat Stage IV Aizawla chhawpchhuah;
ii. Boruak quality tih san leh motor khu chhuak test tu pawl leh traffic police tih chak;
iii. Public transport daih rei zawk leh traffic enkawl dan changtlung (entirnan parking fee khawn) leh public transport dawng hlawk tur ngaihtuah

Tun dinhmun a Aizawl boruak chu ala tha angreng hle a hmuh ani a, particulates (PM_{10}), a bikin diesel engine atanga chhuak khu dum erawh a tam hle. Hei hian taksa harsatna ta tak, thawk harsatna, lung natna leh cancer te a thlen thei. Khawpui dung laili ah boruak quality hi a hniam hle a, heihi motor veivak tam tak zinga tlemte (bus, truck leh diesel Sumo an ni tlangpui) vang chauh ani. Heng motor te hi a endik tu pawl ten an edik reng tur ani.

6. Pawl anga hmalak dan tur

Khawpui lirthei kaldan mumal taka siam: Heihi siam that ngai tak ani a, AMRUT leh Smart Cities initiatives hnuaia funding support pek nan phut tlat ani.

A kenkawh hna hi Urban Development and Poverty Alleviation Department (UD&PA) hnuai a dah ni se, tuna Aizawl master planning kalpui mek tu leh a hma in khawpui transport plan kawnga hmalatu an nih vangin. Hemi function bik atan hian UD&PA ah hian team siam ni se.

Aizawl a public transport siam rem: Bus leh ropeway system chhawpchhuah tehi, a thawh nan te, hmanrua atan te, a enkawl nan leh hmasawn nan, Mass Transport Company or Authority hi propose ani a, heihi UD&PA hnuaiah awm se.

He Company/Authority hian 'Governing Body for policy and decision-making' a nei anga, a Board ah a kaihhnawih sorkar department a hnathawk te awm se. Full-time Managing Body awm in, managing director in enkawl se, staff atan professional engineer, planner leh manager te rawih nise. A pawimawh hmasaber tur chu bus leh ropeway project hlawhtlin nan a planning, design leh implementation lam enzui nghal ni se, hemi hnuah hma a sawn chhoh dan tur leh enkawl zel dan tur ngaihtuah nise. Hemi hna hi private operator te hnenah sub-contract anga pek chhawn theih ani ang.

Aizawl a Local Transport Planning, Traffic Engineering leh Management Functions tih chak: Lirthei veivah dan ruahhman leh enkawl lamah Aizawl Municipal Corporation hi thuneihna sang zawk pek nise. Hei hian khawpui a lirthei lama hmasawnna kawngah mipui te tan chanvo a pe ve ang a, service pek leh chawi kawngah inpawhna tha zawk a siam ang. Hei bakah hian, AMRUT leh Smart Cities hmalakna nen a in zul mai nilo in, ram changkang a anlo tih tawh dan ani. Hemi kawnga AMC tih chak theih dan zingah hengte hi a tel:

- AMC engineering department tih changtlun nan 'transport planning and traffic engineering cell' siam;
- PWD a Aizawl Road Division (North leh South) a engineer staff te leh an function AMC hnena transfer;
- Local planning leh kenkawh dan thenkhat zonal level a then hran;
- Zonal Consultative Committees of local stakeholders set up nise, plan ruahmanna leh hnathawh kawnga pui turin.

EXECUTIVE SUMMARY, in ENGLISH

1. Project Aims and Objectives

The Government of India (GOI) requested the Asian Development Bank (ADB) to assist in developing sustainable urban transport proposals for Aizawl City, and ADB responded with a grant for a nine month Technical Assistance project entitled 'Supporting Sustainable Urban Transport in Aizawl City' (TA 8765). The project commenced in June 2015 and consultants CDM-Smith are working with the Government of Mizoram, with PWD as the focal point. The project has two main aims:

(i) To identify low-cost traffic management projects (both physical and non-physical) to improve the situation in Aizawl City in the short term (2-3 years);

(ii) To assess the potential for medium-to-long-term improvements (5-10 years) in Aizawl's urban transport through investments in sustainable and eco-friendly transport systems, particularly non-road public transport, cleaner buses and taxis, and institutional strengthening.

2. Existing Traffic and Transport Situation in Aizawl

Aizawl's urban population is growing rapidly and is expected to nearly double within the next twenty years, from around 3.5 lakh to over 6.5 lakh by 2035. The city's traffic is also growing fast: registered vehicles have increased five-fold within the past 15 years, and traffic congestion is a growing problem.

Many of Aizawl's main roads are at or close to capacity at peak periods, but while vehicle numbers are increasing, speeds and passenger flows are actually declining or static on some roads. Traffic counts showed that on the north-south corridor, peak hour passenger numbers had hardly increased during the past eight years (2007-2015): there was a big increase in two-wheelers, a slight decrease in car, taxi and jeep flows at peak periods, and a big decrease in bus services (roughly half the throughput of 2007). Overall bus numbers in Aizawl have decreased, and the bus operators consider that congestion is one of the main reasons.

3. Short-Term Measures for Traffic Improvement

The project aims at developing low-cost traffic management projects to improve the situation in the short-term (2-3 years) and improve road safety. The consultants investigated Aizawl's traffic management and traffic engineering measures and found that the city is already quite advanced in the range of measures it has adopted: for example, one-way streets, restricted entry for certain vehicles, designated on-street parking and taxi stands with charges, and others. The measures are extensive and well-observed by the local population, and driver discipline is generally high.

Many of the standard traffic management techniques that might normally be recommended in other South Asian cities are already being successfully implemented in Aizawl. However, there are areas where substantial improvements can be made – in particular:

- Increased provision for pedestrians – the narrow streets and vehicle parking leave insufficient width for pedestrians on many roads. The consultants identified potential for introducing or improving footways, especially at heavily congested locations such as Zarwkawt, Bawngkawn, Khatla and Vaivakawn. This will require (i) re-organising side stairs that intrude into the right of way; (ii) better management of on-street parking and roadside use; (iii) working closely with shop and building owners / occupiers to introduce the footways; (iv) safer crossings for pedestrians.
- Improved road junction design – the consultants have developed designs for over 20 important road junctions to improve vehicle movements and provide safer pedestrian crossings. Mini-roundabouts are proposed at several locations. All of the designs are within the existing right of way and the existing traffic police control will continue.

- Encouragement for higher-capacity public transport – The proposals will increase safety, convenience and road discipline but not significantly increase capacity. To achieve higher passenger flows, it will be necessary to promote higher capacity public transport, particularly buses. There are opportunities to introduce bus lanes and bus priorities which will improve bus speeds or at least avoid further reductions. These are recommended for the medium term as part of a bus improvement package, together with the introduction of traffic signals in some places as part of overall traffic control.
- Travel demand management will also be important for reducing the growth in low capacity private transport, and a list of potential measures is presented in Volume 2.

The short-term measures for junction improvements is estimated at Rs. 0.45 crore, whereas the corridor improvements are estimated at Rs. 1.3 crore. Some of these may be implemented in the medium term.

4. Medium to Long-Term Measures for Public Transport

The consultants were instructed to look at alternative public transport options for the medium-to-long term in Aizawl. Five main modes were considered: monorail, cable liner, ultra-light tram, aerial ropeway and high quality bus system.

The monorail and cable liner were ruled out on the grounds of: (i) high cost; (ii) insufficient passenger demand (not justifying such a high capacity mode); (iii) difficulty in obtaining a suitable alignment (a road-based alignment was not considered suitable); (iv) concentrating investment in Aizawl's crowded central areas; (v) not assisting east-west movements, which are more constrained for public transport; (vi) limited scope for future network expansion.

The ultra-light rail (tram) was not recommended primarily because of the competition with existing road traffic. However, it remains a possible long-term option.

The recommended options are a high quality bus system and an aerial ropeway. Several alternative alignments were considered, and the recommended alignment is:

- Improved bus services on the north-south corridor between Zemabawk and Kulikawn (10km), with new buses, bus priorities and bus lanes, high quality bus shelters, improved road junctions, footways and access, and a unified bus management organisation;
- An east-west ropeway extending for 5.5km between Thuampui and Chawlhhmun (Solomon's Temple).

These options are recommended on the grounds of:

i. Cost – most affordable options;
ii. Strategic impact – encouraging development on the outskirts of Aizawl and supporting the Master Plan objectives;
iii. Potential for the network to be expanded over time;
iv. Wider benefits – such as improvements to roads and footways through the bus package;
v. The proposed bus and ropeway packages complement each other;
vi. Potential for land-value capture and transit-oriented development with the ropeway option.

In the longer term, depending on affordability and profitability, the ropeway network could be expanded to include a north-south alignment on Aizawl's central corridor.

Costs and Economic / Financial Assessment

Two investment packages were prepared: a bus improvement package and the east-west ropeway. Initially, the bus package covered the north-south corridor in Aizawl, plus some east-west routes. After discussions with the Government and receiving feedback on the draft final report, the bus

package was widened to include three strategic city routes connecting with the airport at Lengpui, new rail terminus at Sairang, and new referral hospital at Falkawn. The revised bus package cost was estimated at Rs.237 crore ($35.6m). It would be implemented over four years, would include purchase of about 440 new buses, and about one-third of the cost would be for road junction and footway improvements. The package would include three bus depots and workshops and also institutional restructuring of the city's bus services.

The east-west ropeway package was estimated to cost Rs.668 crore ($100m). Extending for 5.5km with nine stations between Thuampui and Chawlhhmun (Solomon's Temple), and crossing the city centre at Power House (Bara Bazar), it could be implemented in five years, from feasibility to operation. On the east side it would provide a direct link between Thuampui and the city centre, taking about 10 minutes compared with 20-40 minutes by taxi and bus. On the west side it would provide a mass transit link (capacity 3,000 persons per hour per direction) towards the area designated in the Aizawl Master Plan for long term expansion. It also integrated well with important strategic roads leading into Aizawl.

An economic analysis of the core bus package[1] and ropeway package found that both were economically viable. The core bus package gave an Economic Internal Rate of Return (EIRR) of 19.1%, and the E-W ropeway (5.5km) an EIRR of 24.9%. The other two ropeway options (short E-W ropeway (2.4km), and N-S ropeway (7.5km)) also had positive though lower EIRR's of 17.6% and 15.7% respectively. These values actually understate the project benefits as they included travel time and vehicle operating cost savings, but not wider benefits such as decentralizing Aizawl's urban development, tourism benefits, energy savings, reductions in pollution, and so on.

The financial analysis predicted an Equity Internal Rate of Return for the bus package at 8.7%, which is below the threshold of 15% to be commercially attractive to private investors. However, the bus package might be financially viable if run by a state department net of tax and accepting a lower return of around 8% per annum.

All three ropeway options did not appear to be financially attractive for private operators or state undertakings as their project IRRs and equity IRRs were below the minimum thresholds. However, it was predicted that they would recover their O+M costs, though not in the first few years. The long ropeway option (Thuampui to Solomon's Temple, 5.5km) performed best in this regard. The financial analysis was very sensitive to the number of passengers carried, so higher passenger numbers could significantly strengthen the financial results.

In conclusion, the consultants recommend that both the bus and the east-west ropeway packages should be taken forward to detailed feasibility study. This view was supported in discussions with both senior government officers and stakeholders representing the transport sector at the consultation workshops.

5. Eco-Friendly Public Transport Options for Aizawl

The consultants were instructed to consider the introduction of eco-friendly buses and taxis in Aizawl. More than ten different vehicle and fuel technologies were reviewed, including electric, bio-fuel and hydrogen fuel cell vehicles, and so on. Of these, three were taken forward to a 'short list': LPG (liquid petroleum gas); hybrid electric-diesel, and low-emission diesel.

Despite being initially attractive for Aizawl, neither LPG nor hybrid electric vehicles are recommended, for several reasons including (i) costs; (ii) risks associated with new technology (hybrid-electric buses); and (iii) fuel distribution costs and problems (e.g. power supply constraints for recharging hybrid-electric vehicles, and high distribution costs for LPG).

[1] The core bus package is the proposals in the draft final report of January 2016 for the north-south corridor and minor improvements on east-west routes (costed at Rs.179 crore or $26.9m). A supplementary package of Rs.58 crore ($8.7m) for the three strategic city routes, plus supporting bus infrastructure, was added following discussions and feedback from the Government of Mizoram

The three main approaches that are recommended for improving air quality and reducing greenhouse gas emissions in Aizawl are:

iv. To bring forward the introduction of low emission diesel (Bharat Stage IV standard) and national emission standard Bharat Stage IV in Aizawl;

v. To strengthen the capacity of the air quality and vehicle testing agencies, and also the traffic police for enforcement;

vi. To encourage more sustainable public transport through traffic management measures (e.g. parking charges) and investment in high capacity public transport.

Regarding Aizawl's present air quality, it is generally good except for the level of particulates (PM_{10}) which occur especially in black smoke emitted from diesel engines and which are responsible for many health problems including breathing difficulties, heart disease and cancer. The air quality is worst on the main corridors, and a small proportion of the total traffic (mainly buses, trucks and diesel Sumo jeeps) is responsible for most of the pollution. These should be targeted by the monitoring and enforcement agencies, and the agencies assisted through a package of support measures (training, equipment, awareness-raising and more staff).

6. Institutional Measures

Strategic urban transport planning: This needs to be strengthened, and is also a requirement for funding support under the recent AMRUT and Smart Cities initiatives. It is recommended that this function should be located within the Urban Development and Poverty Alleviation Department (UD&PA), which is currently responsible for master planning in Aizawl and which has recently been given responsibility for urban transport planning as well. A team should be formed within UD&PA specifically for this function.

Co-ordination of Public Transport in Aizawl: For the implementation, operation, maintenance and improvement of the proposed bus and ropeway systems, an Aizawl Mass Transport Company or Authority is proposed, to be under UD&PA as the latter is the main urban transport planning body for Aizawl.

The Company/Authority would have a Governing Body for policy and decision-making, with its Board comprised of officials from the relevant government agencies. It would have a full-time Managing Body headed by a managing director and staffed by professional engineers, planners and managers. It would be responsible firstly for overseeing the planning, design and implementation of the bus and ropeway projects, and then subsequently for the future oversight and co-ordination of bus and ropeway operations in Aizawl which could be sub-contracted to private operators.

Strengthening the Local Transport Planning, Traffic Engineering and Management Functions in Aizawl: Priority should be given to strengthening Aizawl Municipal Corporation's role in local transport planning, engineering and management. This allows greater accountability and local participation in traffic and transport improvements, and strengthens the link between providing the services and paying for them. It is also in line with the AMRUT and Smart Cities initiatives, and is the approach commonly adopted in developed countries. Measures to strengthen AMC's capacity in these areas include:

- Strengthening AMC's engineering department with a transport planning and traffic engineering cell;
- Transferring engineering staff and functions from PWD's Aizawl Road Division (North and South) to AMC;
- Decentralising some local planning and implementation to the zonal level;
- AMC to prepared detailed land use and transport plans for the city's 10 planning zones;
- Zonal Consultative Committees of local stakeholders to be set up, to help steer the plan preparation and subsequent implementation.

1. INTRODUCTION

A. Project Objectives

1. Aizawl is the capital of Mizoram State. With over 400,000 people in the wider urban area, its population is expected to double by 2030. (Master Plan, 2011, Table 2.4). The urban growth is bringing significant traffic problems, and to address these the Government of India requested assistance from the Asian Development Bank (ADB). Accordingly, an ADB grant was approved for a technical assistance project which began in June 2015. The 9-month study was called 'Supporting Sustainable Urban Transport in Aizawl City' (TA 8765) and carried out by CDM-Smith.

2. The project's overall objective is to improve the urban development planning for urban transport in Aizawl City[2] and the main components were:

   i. To identify low-cost traffic management measures (physical and non-physical) to improve the situation in Aizawl City in the short term (2-3 years) – for example, pedestrian facilities, minor changes to junctions, road markings, traffic signs, parking controls and other traffic management measures;

   ii. To assess the potential for improving Aizawl's urban transport in the medium to long-term (5-10 years) through investments in sustainable transport systems, particularly:
      - Non-road public transport (such as cable cars or light rail transit or monorail, etc.),
      - Introducing eco-friendly buses and taxis, powered by more environmentally-friendly sources (such as electric vehicles, hybrid electric-diesel, LPG, and so on);

   iii. Capacity-building measures for government organisations concerned with urban transport.

   iv. Economic and financial assessment.

   v. Two public consultation workshops.

B. Project Organisation

3. The project's core team consisted of six urban transport specialists of CDM Smith, who worked with the Chief Engineer (Buildings), Public Works Department as the focal point for the Government of Mizoram

4. The project involved close consultation and co-operation with the relevant government organisations responsible for urban transport, including the Aizawl Municipal Council, the Urban Development and Poverty Alleviation Department, the Traffic Police, the Department of Transport and other relevant organisations.

5. The project team also consulted various stakeholder organisations in Aizawl, especially the transport operators (bus, truck, and taxi owners and drivers), and the transport users represented by various civil society organisations and associations. To obtain their views, two consultation workshops were held with stakeholder representatives and government officers in September 2015 and January 2016 respectively, to consider the project's findings and proposals.

C. Approach to the Study

6. The study's main tasks included the following:

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[2] See ADB website, http://adb.org/projects/details?page=overview&proj_id=48356-001

i. **Review of previous transport and planning studies for Aizawl** – the main documents reviewed included the 2007 City Development Plan, the 2010 Aizawl Master Plan and the 2011 Comprehensive Traffic & Transportation Plan (Mobility Plan).

ii. **Data collection from secondary and primary sources:** Data was obtained mainly through secondary sources with limited primary surveys, including traffic counts, parking surveys, topographic surveys, bus and taxi operations, government policies, traffic management methods, institutional set-up, financial situation, etc. Further details of data collected and the results are given in Appendix 1.1 of the Report.

iii. **Site visits and site surveys**: Numerous site visits were carried out within Aizawl's municipal area to observe traffic conditions and take physical measurements. A topographic survey was commissioned to prepare base maps for the main north-south corridor and important junctions, and further physical measurements were taken by the consultants where necessary.

iv. **Meetings** were held with government officers in different organisations concerned with traffic, transport, planning and regulation in Aizawl, and also representatives of non-government transport organisations such as the bus and taxi operator associations. The full list of organisations consulted is given in Appendix 1.2.

v. **Development of proposals:** The information collected by the consultants was analysed and proposals were developed for both short-term traffic improvements and medium to long-term public transport improvements.

vi. **Consultations with Government and Stakeholders:** The consultant's proposals were documented in the Initial Assessment Report (September 2015) and the Draft Final Report (January 2016), and formal presentations were given to senior government officers as follows:

- 2nd July 2015: Inception presentation to the Principal Secretary, Government of Mizoram and senior officers.
- 22nd September 2015: Presentation on Initial Assessment Report to Principal Secretary, Government of Mizoram and senior officers.
- 3rd November 2015: Review meeting with officers from PWD, AMC and UD&PA, to further consider proposals from Initial Assessment Report.
- 19th January 2016: Presentation on the Draft Final Report to the Chief Secretary, Government of Mizoram
- 9th March 2016: Review meeting of Draft Final Report with Secretary, UD&PA and senior officers of UD&PA.

Numerous other meetings were also held with individual senior officers from PWD, AMC, UD&PA, Traffic Police, Dept. of Transport, Pollution Control Board and others.

vii. **Stakeholder workshops:** The first stakeholder workshop was conducted on 21st September 2015 to discuss the Initial Assessment Report. The second workshop was conducted on 18th January 2016 to discuss the draft final report. The participants and feedback from the workshops are presented in Appendix 8 (Volume 3).

D. Structure of this Report

7. This report sets out the consultant's main findings and proposals for developing sustainable urban transport in Aizawl city. The report is divided into three volumes:

Volume 1: The main report, containing both short and medium/long term proposals;
Volume 2: Details and drawings of the short-term traffic and road safety improvements;
Volume 3: Appendices, containing all the relevant technical and background information compiled for the study.

2. EXISTING TRAFFIC AND TRANSPORT IN AIZAWL

A. Population, Land Use and Growth Trends

8. Aizawl is the capital of Mizoram and contains nearly 40% of the State's population. Within the Aizawl Municipal Corporation (AMC) area (129 sq.km.) the population was about 3 lakh in 2011, having doubled in the previous twenty years (159,000 in 1991). The wider Aizawl Urban Area (152.8 sq.km.) is expected to grow to 820,000 by 2031 (source: 2010 Master Plan). A map showing densities across AMC is shown in Appendix 2.1.

9. Urban growth is taking place through densification and along corridors. The settlements start on the higher ridges and spurs, and then spread down the hillsides towards the valley bottoms. Densification is taking place as vacant sites are developed and existing buildings enlarged. Meanwhile, new development is spreading out along the main highways and feeder roads radiating out from Aizawl. The proposed future developments envisaged in Aizawl as per Master Plan are detailed in Appendix 2.2.

B. Transport: Demand and Supply

10. Aizawl's road network is shown in Map 2-1. The major corridor is north-south from Bawngkawn to Kulikawn, with a distance of approximately 7.5km. Much of this corridor is served by two parallel roads, though where they converge – for example at Bawngkawn, Chanmari and Zodin – major bottlenecks occur.

11. The east-west connections are limited. The western side is connected by roads through Vaivakawn, Khatla and Mission Veng. The main connections on the east side are through Sikulpuikawn, Republic, Bazaar Bungkawn, Main Market, Zarkawt and Bawngkawn junctions.

12. The roads are narrow with many steep gradients and acute bends and curves. The junctions have poor geometrics in terms of horizontal angles and vertical gradients. These characteristics reduce capacity and speeds.

13. Roads from the east and west converge on the central areas, which is one of the reasons for congestion during peak periods. There are few alternative routes, so most traffic has to pass through the central areas.

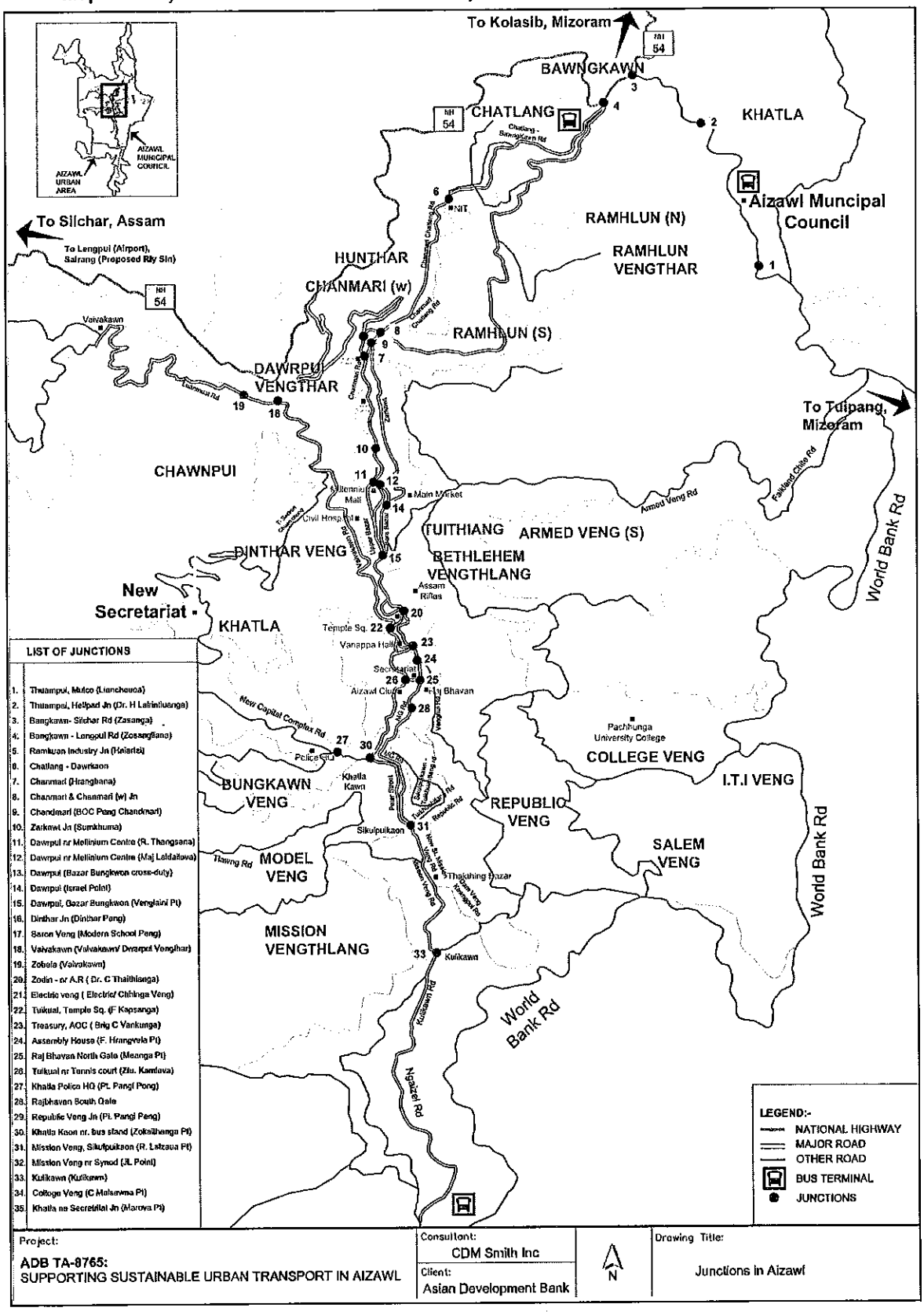
14. **Vehicles and Traffic:** The number of vehicles in Aizawl has increased nearly five-fold in the past fifteen years (19,000 vehicles registered in 1999 and 106,000 in June 2015). Two-wheelers have shown the fastest growth, almost doubling within the past four years. Currently they now account for roughly two-thirds of all vehicles in Aizawl and about 67,000 in number. Cars and jeeps showed the second-fastest growth, approximately 68% over four years (around 30,000 vehicles today). Bus numbers, on the other hand, are growing slowly (Table 2.1).

Table 2-1: Private Vehicles Registered in Aizawl District, 2011-2015

Type of vehicle	Mar-11	Mar-12	Mar-13	June-15
2-wheeler	34,408	44,732	51,698	66,987
Car, Jeep, Maxi, Gypsy	17,616	19,333	21,150	29,519
Bus	647	676	701	n.a.

Source: Transport Department, Govt. of Mizoram

Map 2-1: Major roads and Junctions in Aizawl city



15. The growth in cars, jeeps and 2-wheelers represents a major investment in private transport – at least $80 million invested in Aizawl during the past four years (not including their operating costs). The investment in buses, on the other hand, has lagged behind: probably less than $1.5 million invested in Aizawl during the same period.[3]

Traffic Flows and Congestion

16. Traffic surveys undertaken by this project indicate that Aizawl's traffic pattern has changed significantly during the past eight years. In particular, there has been a big increase in 2-wheeler traffic, a moderate increase in 4-wheeler traffic (cars and taxis), but a decrease in buses operating on the city streets. Evidence for this comes from registration figures, traffic counts and information from the bus operators.

17. **Bus registrations** in Aizawl and Mizoram generally have grown very slowly in recent years. According to the Aizawl Mobility Plan there were 1,007 buses registered in Aizawl in 2007, of which three-quarters were private buses and one-quarter government-owned. But six years later (2013) there were slightly fewer buses registered in Aizawl (987), according to Department of Transport figures. This was mainly due to a decrease in private buses. (Key facts and figures from CTTP/ Mobility Plan – 2011 are presented in Appendix 2.3).

18. Secondly, **traffic counts** also indicate a decline in bus numbers in Aizawl. 16-hour traffic counts were undertaken by this project at three mid-block locations (Hotel Ritz, Zarkawt and Bawngkawn), and compared with traffic counts taken in 2007 for the Aizawl Mobility Plan.

19. While care needs to be taken in drawing conclusions (as the sample size is small), nonetheless the traffic data indicates a substantial drop in bus numbers operating on the north-south corridor – a decrease of nearly half – while 2-wheeler traffic has grown substantially and cars and taxis have remained more or less at the same volume.

20. While total traffic volumes have increased on the north-south corridor, mainly due to the increase in motor-cycles, the decrease in buses means that total passenger numbers have hardly increased (Figure 2.1). [4]

21. In other words, at peak periods the north-south corridor is operating close to its maximum capacity with the current mix of traffic, and the only way to increase its carrying capacity is either (i) to create new road space (as was proposed in the 2010 Master Plan); or (ii) to introduce higher capacity public transport of some type.

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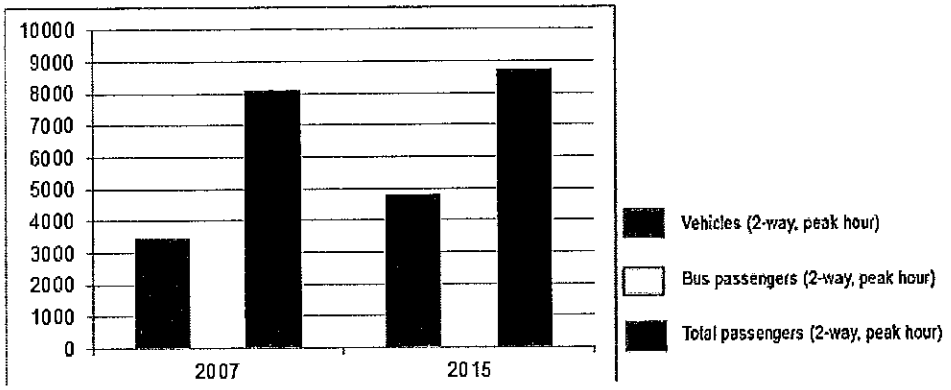
[3] Total capital investment in Aizawl's road vehicles 2011-15 estimated as follows:

Cars & jeeps: 12,000 vehicles (2011-15) @ Rs. 3 lakh = Rs. 360 crore ($55 million)
2-wheelers: 33,000 vehicles (2011-15) @ Rs. 0.5 lakh = Rs. 165 crore ($25 million)
Buses: 54 buses (2011-13) @ Rs. 12 lakh = Rs. 6.4 crore ($1 million, scaled up to $1.5 million)

[4] Two peak hour counts were taken at Hotel Ritz in 2015 for this project. The first recorded 6,971 persons per hour (both directions, assuming average vehicle occupancies); the second recorded 8,722 people per hour (both directions). Traffic was more congested for the first of the two counts.

Figure 2-1: Comparison of Vehicle and Passenger Flows at Hotel Ritz, 2007 and 2015

(Peak hour, both directions – the data is summarized in Tables 2.2 and 2.3 below)



Source: (2007 data): Comprehensive Traffic and Transportation Plan for Aizawl, 2011, Table 3-19
(2015 data): Traffic counts carried out by CDM Smith – see Appendix 2.6.

Table 2-2: Comparison of peak hour VEHICLES at Ritz Hotel, Aizawl (two-way)

Year	2-wheeler	Car	Taxi	Sumo	City Bus	Other Bus	LCV	HGV	Other	Cycle	TOTAL
2007	1087	838	1337	NA	125	4	28	22	0	0	**3,441**
2015	2925	580	1028	154	49	14	60	2	0	0	**4,812**

Table 2-3: Comparison of peak hour PASSENGERS carried at Ritz Hotel, Aizawl (two-way)

Year	2-wheeler	Car	Taxi	Sumo	City Bus	Other Bus	LCV	HGV	Other	Cycle	TOTAL
Average Occupancy	1.4	2.1	1.3	NA	24	24	-	-	-	1.0	-
2007	1522	1761	1738	NA	3010	94	-	-	-	0	**8,124**
2015	4108	1006	1344	757	1300	208	-	-	-	0	**8,722**

Sources: (1) 2011 Comprehensive Traffic and Transport Plan (CCTP), Table 3.19 (assuming peak hour as 10% of 24-hour total);
(2) Peak hour count carried out for this project on Tuesday 15th September 2015, 9.15am – 10.15am

22. The main roads in many places in Aizawl have reached their maximum capacity at peak periods, both on the north-south corridor and also on important east-west routes such as through Vaivakawn and Katla. The result is long delays at critical bottlenecks. The 2011 Aizawl Mobility Plan found that average vehicle speeds had fallen to 3.5 kph on the highly congested sections. Buses were moving at an average speed of 11 kph in 2007, though this fell to 10kph on the north-south corridor (2011 Mobility Plan, Table 3-15).

23. Journey speed surveys undertaken for this project in October 2015 found that the average bus operating speed on the north-south corridor was around 9.7 kmph, slightly lower than the 2007 figure. By comparison, a taxi travelling the same route between Zemabawk and Kulikawn (10km) averaged 12.4 kph, while a 2-wheeler averaged 17.5 kmph. The attraction of using a 2-wheeler in Aizawl becomes clear when comparing these journey time figures (Appendix 3.1).

Figure 2-2: Traffic Congestion on the North-South Corridor

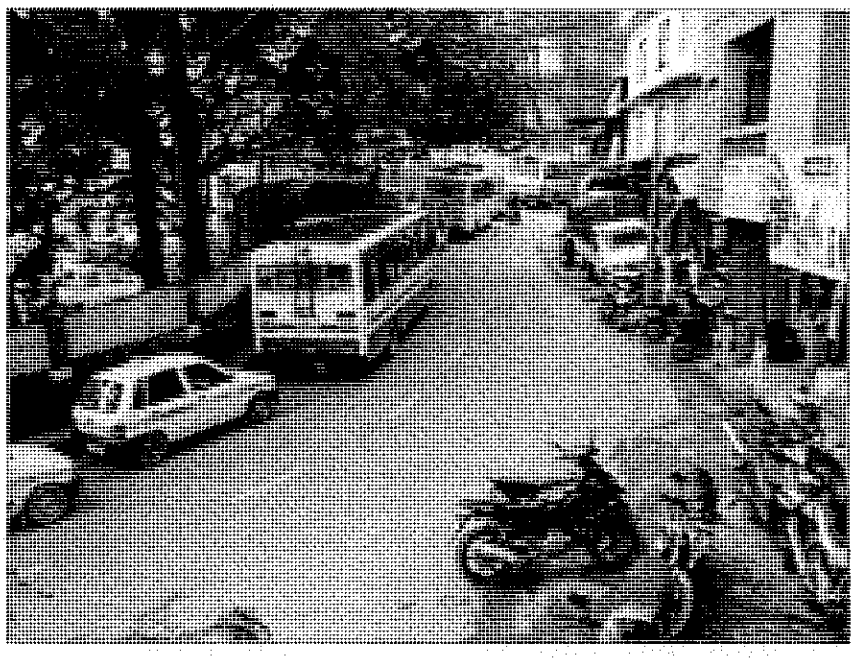


Photo shows almost-stationary traffic north-bound towards Temple Square

24. **Feedback from the bus operators:** Discussions with the bus operators confirmed that they are running fewer buses on the city routes due to congestion. The 2011 Mobility Plan reported that in 2007 there were about 500 buses operating on primary routes in Aizawl, of which about 300-400 were operational at any time (2011 Mobility Plan, Section 3.3.3). Interviews with the bus industry for this project in 2015 found that there were now about 300 buses operating on primary routes in Aizawl, of which about 160 were operational at any time (typically 130 on City Bus routes and 30 on Line Bus routes – see Chapter 4 for further details).

25. The bus operators also stated that their buses are doing fewer trips per day compared with a few years ago. The Mobility Plan reported an average of 7 trips per day in 2007 on the north-south corridor between Zemabawk and Ngaizel, which accounts for about 80% of bus services in Aizawl – 4 northbound and 3 southbound daily (Mobility Plan, Table 3-15). Recent interviews with the bus operators reported only 4 trips per day (2 in each direction) in 2015. Schematic map of bus routes in Aizawl is presented in Appendix 2.5.

26. In conclusion:

- Main roads in Aizawl are close to or at-capacity during peak periods which last for several hours;
- Traffic volumes are still increasing, due to more 2-wheelers and also cars, taxis and jeeps;
- Passenger volumes, on the other hand, are hardly increasing, due to congestion and lower carrying capacity of the private modes;
- Bus services have actually decreased in Aizawl during the past eight years, due largely to the increasing congestion;
- With passenger demand increasing year on year, the options for government are either to increase road capacity, or promote higher capacity public transport, or both.

C. Outline of Government Plans and Policy for Transport in Aizawl

27. Three of the main documents setting out Government policy for transport and urban development in Aizawl are:

- 2007 City Development Plan (prepared for JNNURM)
- 2010 Master Plan for Aizawl, Vision 2030
- 2011 Comprehensive Traffic and Transportation Plan for Aizawl (the Mobility Plan).

28. The City Development Plan proposed a huge package of road network improvements, including bypasses, a 10km elevated road for the central area, junction improvements, off-street multi-storey parking, new roads linking upper and lower roads, underground pedestrian subways, and so on. The Plan also proposed four aerial ropeways:

    i. Chatlang to Hangi Lunglen tlang in the north near ATC
    ii. Maubawk to High Court at Luangmual in the west
    iii. Zemabawk to Ramhlun Vengthar in the east
    iv. Maubawk to Reiek Tourist Centre

29. The Master Plan for Aizawl, Vision 2030 proposed satellite townships located 5-6km from Aizawl on the west side, to decentralize new development. The proposals are illustrated in Appendix 2.2.

30. To improve regional connectivity, the Master Plan proposed alternative road alignments such as by-passes, and also the development of numerous main roads within Aizawl. Management of parking, freight movement, and re-structuring of traffic management was also prescribed.

31. The 2011 Mobility Plan's medium term component included a package of transport infrastructure improvements such as bus and truck terminals and depots, road network expansion, grade separation, pedestrian facilities and geometric improvement of road junctions. Its long term component (2027) suggested development policy and parking policy. The main recommendations included regulation of building density; decentralization of government and commercial activities; stronger parking regulations and extensive off-street parking.

32. However, budgetary resources have not matched the ambitious schemes proposed in the various plans. In the past few years three major road projects costing Rs. 111 crore were taken up by PWD using JNNURM funds (of which 90% was a central contribution). These projects are:

    - Widening & Improvement of Vaivakawn to Mizoram University (Rs. 19 cr)
    - Improving Sihhmui to Mizoram University as spur to Aizawl City Road (Rs. 53 cr)
    - Improvement & Widening of City Roads Ph-I (Rs. 39 cr)

    These projects are still in progress.

3. SHORT TERM MEASURES FOR TRAFFIC IMPROVEMENT

A. Introduction: Study Approach

33. The terms of reference instructed the consultants to identify low-cost traffic management projects which could improve safety for pedestrians and motorists, and also traffic movement, in the short-term (2-3 years). The consultants were also to look at the possible need for traffic signals.

34. The short-term measures considered in this project are located in the Aizawl Municipal Corporation area, particularly the central area. Both main corridors and important road junctions are considered. The consultants focused on:

- The main north-south corridor in Aizawl (Thuampui to Kulikawn);
- Important east-west feeder routes (e.g. roads running through Vaivakawn and Khatla);
- Area-wide traffic management proposals.

35. **Methodology:** Data was collected from various government departments and also through interviews with transport operators. Site visits were made to inspect road and traffic conditions. Road measurements were taken with assistance from PWD staff, and a topographic survey was commissioned for the section between Raj Bhavan and Chanmari and several other road junctions. The consultants also carried out:

- 16-hour link traffic counts at two locations;
- 3-hour (peak period) turning counts at seven junctions;
- Pedestrian counts on the north-south corridor during peak period;
- Journey time surveys on the north-south corridor (Thuampui to Kulikawn);
- Parking accumulation survey, Raj Bhavan to Chanmari.

36. Further details and results of the data collection and survey results are given in Appendix 3.1.

B. Review of Existing Road Infrastructure and Traffic Management Measures

37. **Main Corridors:** Major corridors in Aizawl are shown in Map 2-1. Due to existing urban development there is very little scope to create new north-south roads or widen existing roads. Extensive traffic management measures have been introduced to maximize the available capacity – for example, one-way sections for all vehicles; one-way for buses and other large vehicles; truck restrictions (e.g. no access for large vehicles during the daytime); on-street parking restrictions; and so on. Further details are given in Appendix 3.2.

38. The east-west corridors are also limited in terms of: (i) number; (ii) width (narrow stretches even with less than 6m between buildings); (iii) steep gradients, often 10% to 14%, which result in zig-zagging and steep, tight bends that are unsuitable for large vehicles and sometimes small vehicles too.

39. **Main Junctions:** There are 35 important junctions in Aizawl city (see Map 2-1 and Appendix 3.3). Most are 3-arm or 4-arm, though 5-arm and even 7-arm junctions are not uncommon. Most have very limited scope for widening, though reorganization of traffic lanes and parking allow for additional lanes at some places. There are currently no traffic signals. These junctions are manually controlled by the Traffic Police (of which 6 are at peak hours only). Most of them have police islands, which also act as small traffic circles (mini-roundabouts). The Traffic Police recently (2015) introduced CCTV cameras at 10 important junctions in the central area – these are primarily for security purposes, but they also give the Traffic Police a potential tool for better traffic management. The cameras are coordinated by a control room at the SP's office.[5]

40. **Facilities for Buses and Taxis:** There are no bus lanes in Aizawl at present. A few bus shelters are provided along the main north-south corridor; elsewhere, passengers wait at the kerb-side, usually at or close to junctions. Buses pull over and stop where there is space, but mostly there are no designated bus bays. Taxi parking is very well regulated, with designated taxi stands throughout the

[5] SP – Superintendent, Police (Traffic)

city (indicated by road markings and signs). Taxi drivers normally pay a daily parking fee of Rs. 30 for waiting at these stands. Sumo jeeps also provide an inter-district public transport service, carrying up to 10 passengers and goods. Sumo stands have been designated in various places around Aizawl, but on the north-south corridor are restricted to off-peak hours to reduce congestion.

41. **Pedestrian Facilities:** Pedestrians account for more than 50% of total trips in Aizawl (2011 Mobility Plan, Table 3-7). There is an extensive network of steps and stairways throughout the city, which are maintained by the Municipal Corporation or local neighborhood councils (of which there are 83 in the Aizawl area). Some are also sponsored by local benefactors. Seating areas are also provided at few locations where pedestrians can rest after climbing the steps.

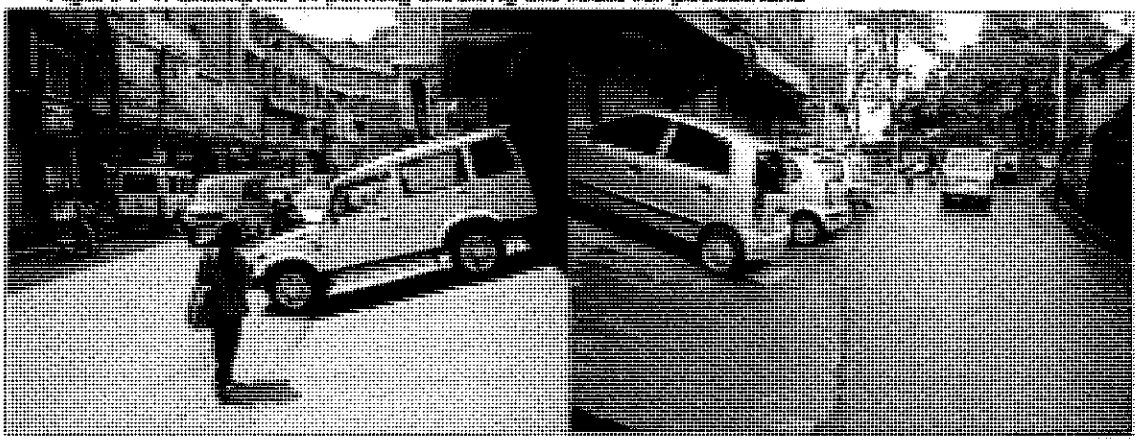
42. **Footways and Crossings:** The provision of road-side footways is variable and depends on the available road width. On most east-west feeder roads, the facility is absent due to narrowness. Even some main roads have no footways (e.g. N-S corridor at Zarkawt area), and on-street parking makes walking very difficult and unsafe. Where the road is next to a steep drop, 'walkways' have been constructed on concrete beams extending out from the road side. There are only a handful of formal 'zebra' pedestrian crossings in the city, but vehicle drivers generally don't observe them. On the other hand, there is a tolerant driving culture in Aizawl and drivers frequently slow down and allow pedestrians to cross. Horn-use are also low compared with elsewhere on the sub-continent, and driver discipline is high.

43. **Footbridges:** There are a few pedestrian footbridges in Aizawl, such as at Zodin junction and Khatla junction. The Aizawl Municipal Council is currently constructing three more on the N-S corridor, at the junctions of Israel Point, Bazar Bungkawn and Assam Rifles Gate.

44. **On-Street Parking:** Aizawl is well-advanced in parking management compared with other cities on the sub-continent. No-Parking restrictions are in force on many of the city's roads, indicated by traffic signs and road markings and backed up by street wardens. There are also 'Dropping Zones' and 'Turning Points' at junctions (with no parking permitted). Parking charges are levied on many central roads: the rates are currently Rs.20 for the first hour for cars / SUV's and Rs.10 for 2-wheelers; thereafter, the rate increases hourly up to Rs.210 for all-day SUV parking (10 hours) or Rs.150 for light motor vehicles and Rs.100 for 2-wheelers. In 2014-15 the Aizawl Municipal Corporation collected nearly Rs.30 lakh ($43,000) in parking charges, with collection out-sourced to private contractors. Nonetheless, on-street parking is a growing problem and many central streets have too much parking, which hampers traffic flows and pedestrian movement.

45. **Off-Street Parking:** There are very few commercial off-street vehicle parks in Aizawl. Many government offices have their own private compounds for parking, and paid customer parking is provided at the Millennium Centre's basement car park. In 2010 the State Government introduced a regulation making it compulsory for citizens buying a car to have an off-street parking space. Generally, car and motorcycle owners try to keep their vehicles off the road. But nonetheless, there is extensive on-street parking outside both residences and commercial premises, and the roads are filling up with parked vehicles. The on-street parking often creates problems for pedestrians, with vehicles blocking the walking route and ramps extending into the street (Refer Figure 3.1).

Figure 3-1: Examples of parking blocking the route for pedestrians



Parked vehicle blocking the path at Zarkawt

Sloping ramps on the footway (near Assam Rifles)

46. **Off-Street Car Parks:** There are been many suggestions for the construction of off-street vehicle parks – for example, in the 2010 Master Plan (Section 6.2.5), in the 2011 Mobility Plan (Section 5.5.2.2), and in a recent briefing for the Traffic Management Co-ordination Committee (which also recommended ground floor parking at all government buildings). The Aizawl Municipal Council is currently implementing a scheme for 'cavern parking' at Chanmari, utilizing the space under the adjoining side road by the YMA Hall, with space for 50 motorcycles and scooters, and is considering others.

47. **Road Accidents and Speed Management:** In the past four years (2012-2015), according to Traffic Police records 61 persons were killed and 45 persons seriously injured in road accidents in Aizawl. Motor cycles were involved in more than half of these accidents, though the data obtained does not give a breakdown of the mode of persons killed or injured.

48. Heavy vehicles (trucks and buses) were involved in only 5 (10%) of the fatal collisions recorded, which is a much lower proportion than is typically found in large cities. This partly reflects the daytime ban on truck movements. The great majority of incidents therefore involved motor-cycles and light motor vehicles (cars and taxis). There appears to be a rising trend: 9 fatalities in 2012, 18 in 2013 and 22 in 2014. (The data for 2015 is not yet complete, but by June 2015 there had already been 12 fatalities).

49. The causes of the accidents were not shown in the data obtained, nor were specific black spots indicated. Speed is one factor, but there can be many other causes such as poor road geometry, weather conditions (slippery roads), road user error, alcohol-related, and so on. In Aizawl generally there are very few speed limits in force, and no traffic-calming measures. On the other hand, driver discipline is generally quite good, and the difficult road geometry encourage slower and more careful driving.

50. There is scope for wider use of traffic calming measures, especially at sensitive locations such as schools and commercial areas. The measures should focus on 'enforcement by design' (e.g. islands, tighter corner radii, use of road markings to visually guide road users), together with speed limits and police enforcement.

C. Road Network Utilisation: Opportunities and Constraints

51. There is generally very little scope to expand the road network in Aizawl's central areas, due to the high density of existing development and proposals in previous city plans for an elevated north-south road or grade separation at junctions represent very high-cost approaches that may not be feasible for Aizawl, given budgetary and physical constraints. Experience from other cities also suggests that building flyovers or elevated roads may simply shift the traffic congestion to other locations, rather than

removing the problem.

52. Regarding utilization of the existing road network, a great deal has already been done by the city and government authorities in terms of traffic management. As described above, extensive one-way systems (Refer Appendix 3.5) and vehicle restrictions are already in place which are largely observed by road users. In this sense, Aizawl is one of the most advanced cities in India. Possible one-way system between Raj Bhavan and Assam Rifles is shown in Appendix 3.4.

53. However, there is potential to achieve a higher utilization of the road network's capacity by giving greater priority to high capacity modes (such as buses) compared with less space-efficient private vehicles (cars and 2-wheelers).

54. Site inspections show that in many places the road capacity is not fully utilized, mainly due to widespread on-street parking. There is also a lack of provision for pedestrians in terms of footways and safe crossing places, and this will grow worse over time as traffic volumes and parking increase.

55. The remainder of this chapter focuses on short-term measures to improve utilisation of the existing road network and also road safety, particularly for pedestrians. Chapter 4 then considers medium to long-term options for higher capacity public transport for Aizawl.

D. Proposals for Short-Term Measures for Traffic Improvement

56. In developing proposals for the short-term improvements in traffic engineering and management, the following guiding principles have been adopted:

1. To improve pedestrian safety and comfort;
2. To facilitate and maximize the movement of PEOPLE (as opposed to vehicles);
3. To support the improvement and expansion of Aizawl's bus services.

57. The proposals are presented below under the following headings:

Short-Term Measures

- Junction designs
- Link designs (especially footway improvements)
- Feeder road improvements

Medium-Longer Term Measures

- Bus priorities and traffic signal control
- Longer-term demand management

Short-Term Measures *(See also Volume 2 of this report for further details of the proposals)*

D1. Junction Improvements

58. Road junctions are the critical points in the road network and determine the overall capacity of the network. As stated above, there is very limited scope to increase junction capacity in Aizawl due to the limited right of way and constraint of existing buildings.

59. Improved junction layouts have been prepared for over 20 junctions along the main north-south corridor and also important east-west feeder roads at Vaivakawn and Khatla, and are shown in Volume 2. Similar improvements are suggested at all other major intersections in the city.

60. The main elements in the proposed junction designs include:

i. **Large vehicles:** The designs will accommodate large vehicles as far as possible (subject to available road widths). Turning movements have been tested using a track testing plugin for Auto-cad 2014.

ii. **Police control:** Where junctions already have traffic police control, this will continue (no electronic traffic signals are proposed at this stage).

iii. **Footways widened:** Footway and pedestrian crossing improvements are proposed at most of the junctions studied. Footways will be widened to the extent possible (while keeping sufficient carriageway width for running traffic).

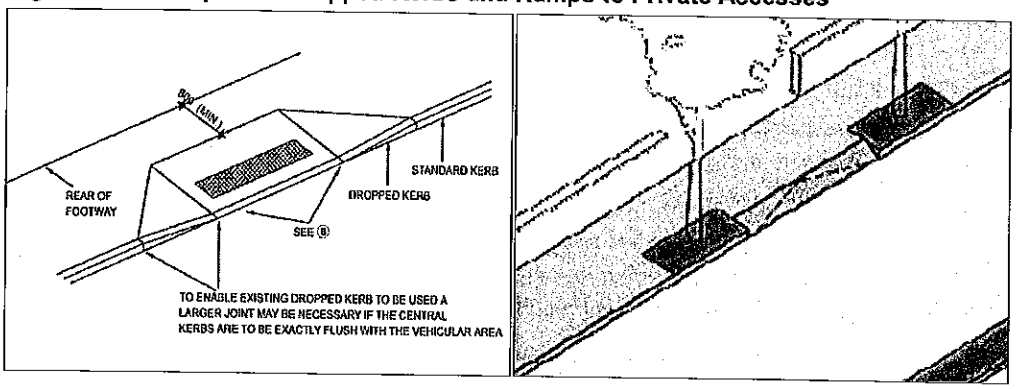
iv. **Footway build-outs** are proposed at crossing points, to shorten the crossing distance, discourage parking at the junctions, and improve sight-lines for both pedestrians and drivers.

v. **Dropped kerbs** are recommended at pedestrian crossing points and private accesses, where width permits (see Figure 3.2).

vi. **Pedestrian islands** (central refuges) have been provided where road width permits, to assist pedestrians crossing and also help channelize traffic. A minimum width of 1.2m for pedestrian islands is recommended.

vii. **Road markings** and traffic signs are designed to IRC (Indian Road Congress) standards. Generally, IRC 35 'Code of Practice for Road Markings' (2nd Revision, 2015) has been used. Reflectorized white paint is recommended as long-lasting and durable.

Figure 3-2: Examples of Dropped Kerbs and Ramps to Private Accesses



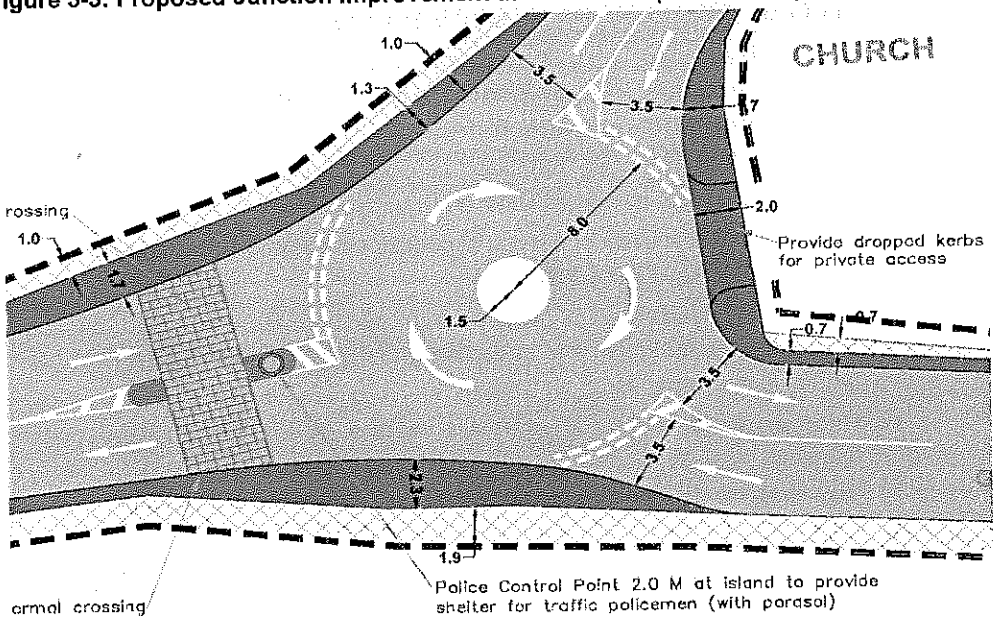
viii. **Mini-roundabouts** are proposed at a number of junctions (e.g. Sikulpuikawn, Vaivakawn, Khatla – see Figure 3.3 below). Traffic police control will continue as before, though the control point will be re-positioned. The ICD (inscribed circle diameter) for the mini-roundabouts is recommended as not less than 16m, with an over-runnable white circle in reflectorized white paint of not more than 4m diameter.[6]

ix. **Re-grading of road junctions** is recommended at numerous junctions throughout Aizawl. This is necessary because of the sharp corners and steep slopes which affect turning movements (causing turning vehicles to obstruct on-coming traffic) and which also create a safety hazard especially for 2-wheelers.

x. **Bus lanes:** There is potential for bus lanes and bus priorities in many places along the north-south corridor. However, these are recommended for implementation in the medium / long term as part of an overall bus improvement package, as they will require detailed planning and design, and possibly traffic signals in some places.

[6] UK guidance on mini-roundabouts advises that a domed white circle can be used at the centre of the mini-roundabout, if it is not likely to be regularly over-run by large vehicles. Maximum dome height should be 25mm per metre-width of the central white circle, and not more than 6mm height at the circle perimeter. (Ref. UK Design Manual for Roads and Bridges, Vol. 6, Section 2, TD 54/07, 2007). For Aizawl, it is recommended that domed white circles are NOT used at this stage, but kept in reserve and considered only after mini-roundabouts have been introduced and tested in practice.

Figure 3-3: Proposed Junction Improvement at Vaivakawn (Junction 18)



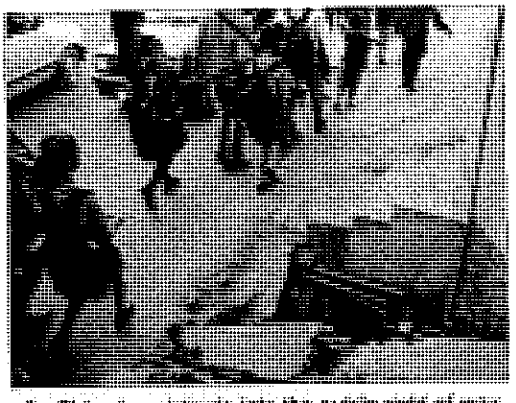
D2. Footway and Link Improvements

61. Aizawl already has an extensive footway and stairway network which is generally well-maintained. However, many roads lack footways, usually because of limited road width, and there are also very few pedestrian crossings.

62. The three main obstacles to providing footways are: (i) limited road width; (ii) side steps intruding into the right of way; (iii) on-street parking. However, there are opportunities to reclaim space within the existing public right of way (see Figure 3.4 below).

Figure 3-4: Public space between buildings and carriageway for creating footways (Vaivakawn)

1. Space between building and carriageway is public right of way, but occupied by shop goods, parked vehicles and side steps, forcing pedestrians to walk on the road



2. Side steps intrude into the public right of way and make it difficult to provide continuous footways

Defining and Reclaiming the 'Public Right of Way'

63. The public right of way normally extends from 'the last column of the building' to the same on the opposite side (i.e. building-to-building). However, this is often not clearly defined, for the following reasons:

i. Building overhang – buildings are constructed with significant overhang, which makes it less

clear where the private property line starts.

ii. Lack of detailed public records – the Public Works Department is responsible for main road upkeep in Aizawl, but does not maintain detailed records regarding rights of way.

iii. Side elevations – the roadside buildings are usually at either higher or lower elevation than the carriageway and have to be accessed by steps. Hence the space between the building and the carriageway, is often occupied by steps running along the entire building frontage.

iv. Parking and private encroachment – the space in front of buildings tends to be used as private commercial space, or for vehicle parking and loading. Goods are often kept in this space, and physical encroachment also takes place, for example constructing underground storerooms in the (public) space beneath the footway in front of the shop.

64. In the early stages of Aizawl's development the roadside encroachment was not a major problem as traffic and pedestrian volumes were low. But now that the roads are heavily trafficked, this has become a serious issue that needs to be addressed, especially on main roads such as the north-south corridor, Bawngkawn (national highway), Vaivakawn, Katla and many other locations.

65. Fortunately, in many places there is sufficient width to provide a footway, provided the space is reclaimed by the authorities with the co-operation of the local community.

66. An illustration of how this can be done is given on the next page, using Khatla main-street as an example. Important elements of the approach are listed below:

i. **Side steps:** Widening the footways will require changes to both public and private side steps. There are at least six options for re-configuring the side steps to improve safety and enable provision of continuous footways (see Figure 3.8). An example at Khatla is shown in Figure 3.5. Proposals for footway widening at Khatla is presented in Figures 3.6 and 3.7.

ii. **On-street parking:** Much of the roadside space is already occupied by parked vehicles. For example, on the north-south corridor between Chanmari and Raj Bhavan a parking accumulation survey by the consultants recorded 1,674 vehicles parked on-street, of which 74% (1,229 vehicles) were two-wheelers, and the remainder were cars and jeeps (439), plus a few buses.[7] The options for dealing with this parking are as follows:

a. On-street parking on the corridor may be allowed to continue, depending on available road space (after footways and bus lanes are implemented), but parking charges should be increased to reflect premium locations and reduce demand. Off-peak parking or short-stay parking or drop-off only may be considered, and vehicles should be parked parallelly instead of perpendicular parking to utilize less road width.

b. Shift parking to other roads further away from the main corridors.

c. Utilize private off-street parking spaces, possibly paid parking. For example, on the north-south corridor at Zemabawk there are several under-utilised private car parks, including the Millennium Centre car park[8] and several basement car parks in commercial buildings. A private rental market in off-street parking has already started in Aizawl, and this can be encouraged. *(Continued on subsequent pages).....*

[7] The parking accumulation survey was carried out on Monday 16th November and Monday 30th November 2015 around mid-day. The survey covered both sides of the north-south corridor, and both arms where the road is one-way. Detailed results are shown in Appendix 3.1.

[8] Site inspections found that over half the parking space at the Millennium Centre basement car park is occupied by very long-stay parking, and therefore unavailable for short-stay parking for shoppers.

Figure 3-5: Footway improvements – Khatla

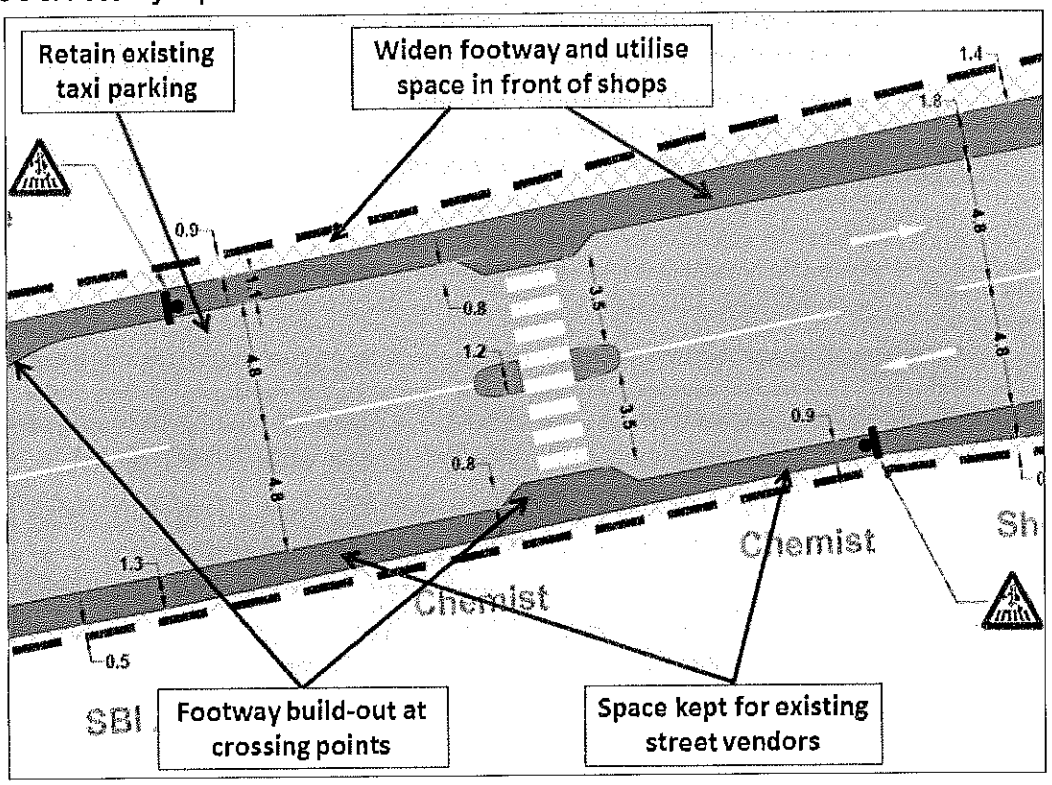


Figure 3-6: Details of proposed footway widening at Khatla

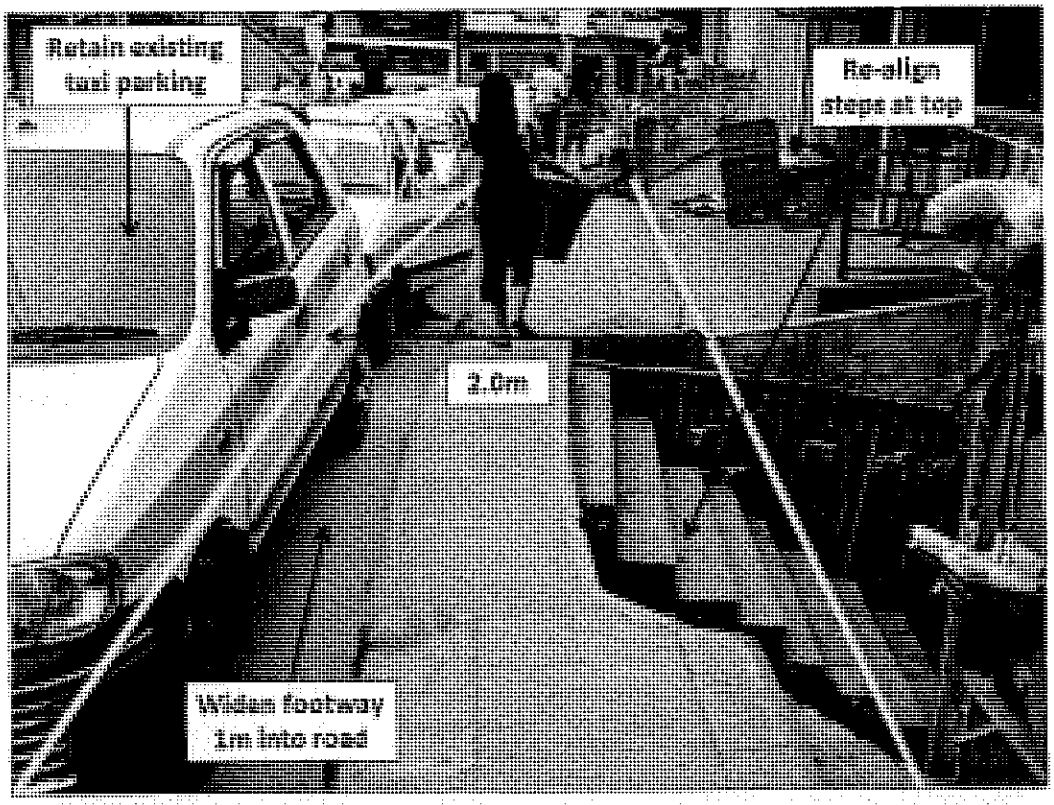
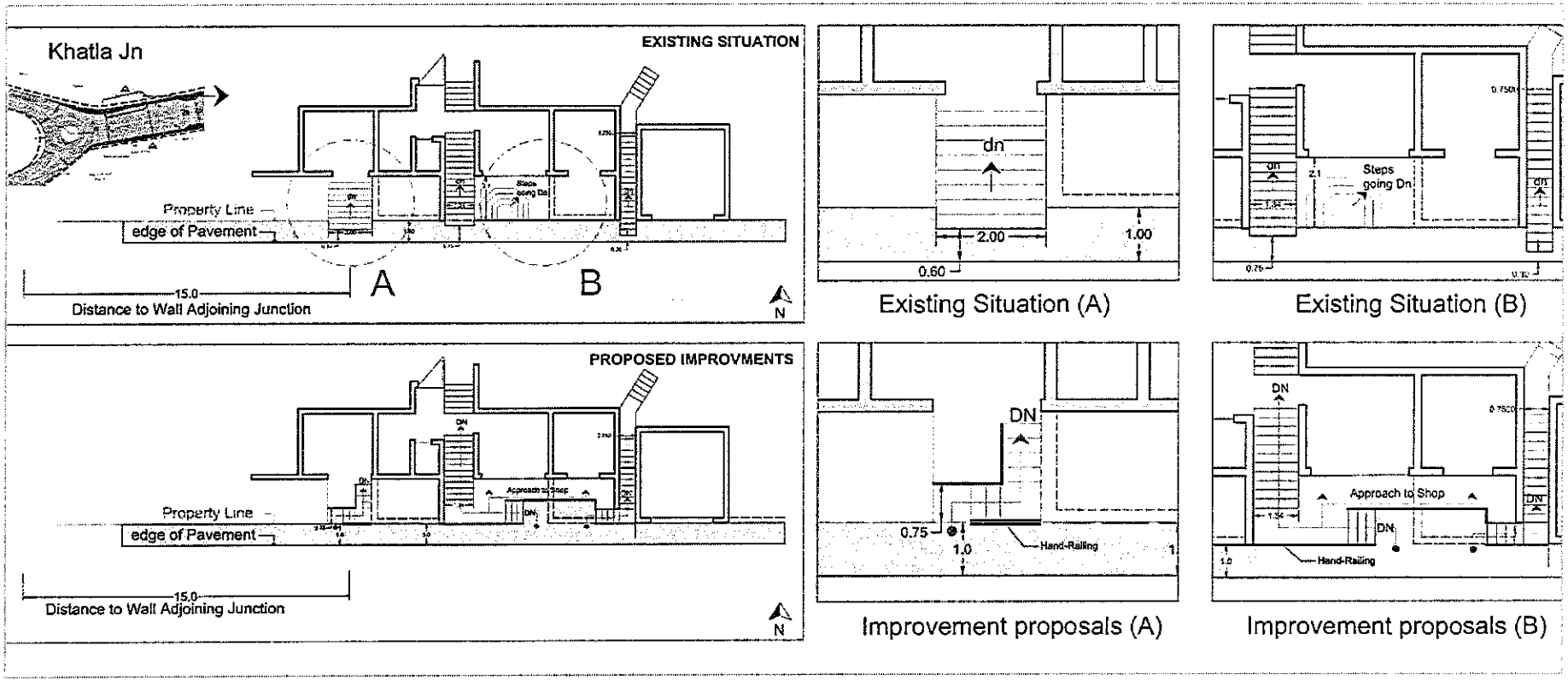


Figure 3-7: Proposals for Footway widening at Khatla



(ii) **On-street parking** *(continued from previous pages)*:

d. Some users will change their travel behavior in response to reduced parking availability – for example, shifting to bus, walk and taxi, or sharing private vehicles, or travelling off-peak, or avoiding the trip altogether.

e. Development of off-street parking by the city authorities. AMC already has plans for a 50-space two-wheeler 'cavern' park at Chanmari underneath the side road, and two others have been considered near Assam Rifles ground and at State Bank area. Generally, however, a big increase in government-sponsored vehicle parks is NOT recommended, as this can be costly and a drain on public resources, and also encourages continued access by less space-efficient private transport with heavy demands on road-space.

It is worth noting that a traffic management plan prepared by the Traffic Police Department for the Aizawl Traffic Management coordinating committee proposed removal of ALL on-street parking on the main north-south corridor between Chanmari and Raj Bhavan, with alternative off-street parking provided at numerous locations along the corridor.

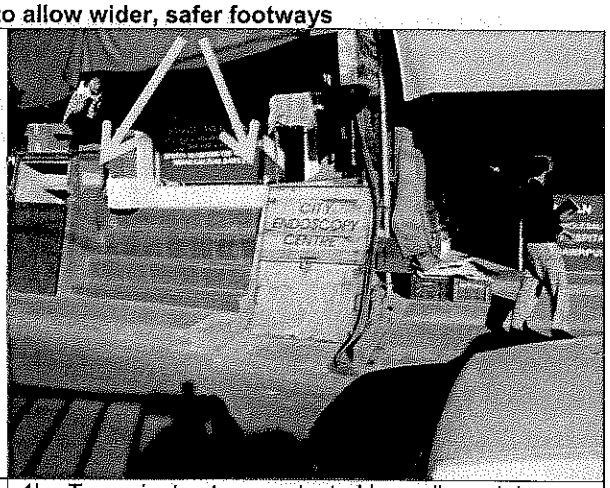
iii. **Community involvement in footway improvements:** To introduce footways on main roads where space permits will require substantial funds and also co-operation from the land-owners and building occupants. It will be an intensive task, requiring detailed planning and negotiations with the local community. For example, the task will include: (i) re-configuring side steps; (ii) re-locating some services such as electric poles and water pipes; (iii) constructing footways and drains; (iv) designating parking spaces, where practicable; (v) designing bus stops and bus shelters; (vi) repairing road surfaces in some places; (vii) incorporating private front steps to buildings in the new footway design; (viii) removing obstructions such as private walls and signs and other barriers; (ix) keeping footways clear of goods and parked vehicles.

The funds for these improvements can come both from the government and also from private donations from property owners and building occupants who will benefit from the improvements.

The task of co-ordinating this work will fall to the relevant government agencies (particularly AMC and PWD), and the involvement and support of the local area council (of which there are 83 in Aizawl) will be crucial. Options for re-configuring side steps to allow wider, safer footways are given in Figure 3.8.

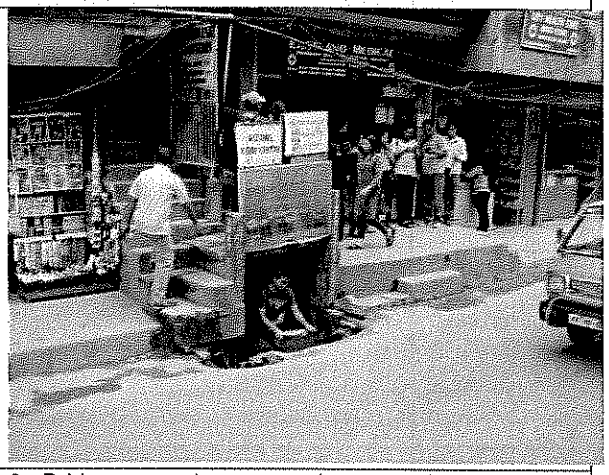
Figure 3-8: Six options for re-configuring side steps to allow wider, safer footways

1a. Private steps protected by walls and door (opposite City Hospital)

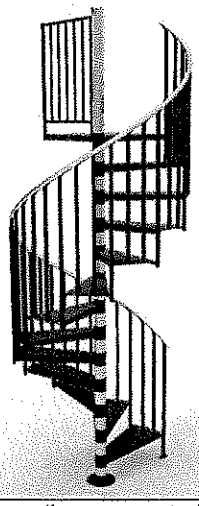


1b. Two private steps protected by walls and door (same location as Photo 1)

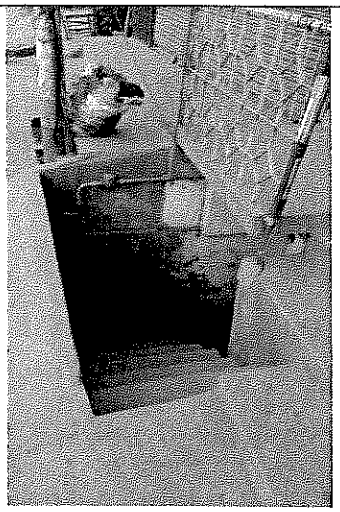
2. Plastic bollards at entrance to public stairs (near City Hospital)



3. Bridge over private steps (opposite City Hospital)



4. Spiral staircase – allows steps to be re-aligned and footway widened



5. Steps with right angle (note bridge and safety rail)

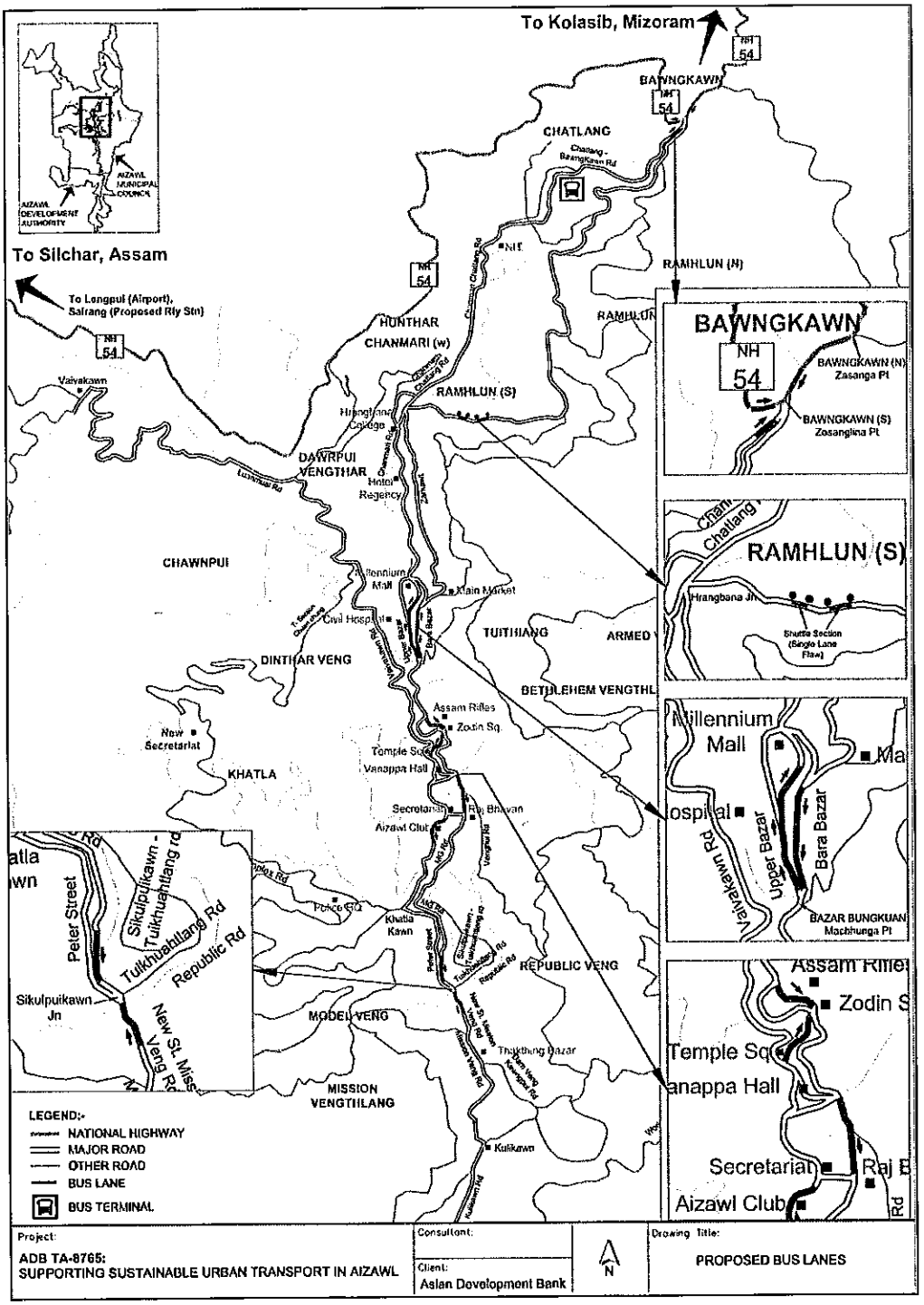
6. (No photo) – Re-align steps to achieve greater set-back, either by steeper gradient or removing intermediate platform

Medium-Term Traffic Improvement Measures *(See also Volume 2)*

D3. Bus Lanes and Bus Priorities

67. There is scope to speed up bus services in Aizawl through the introduction of bus lanes and bus priorities. This is possible because the existing road capacity is not being fully utilized in many places. An overview of possible locations for bus lanes and priorities is shown in Figure 3.9, and detailed examples are given in Volume 2, .Short-Term Traffic Improvements.

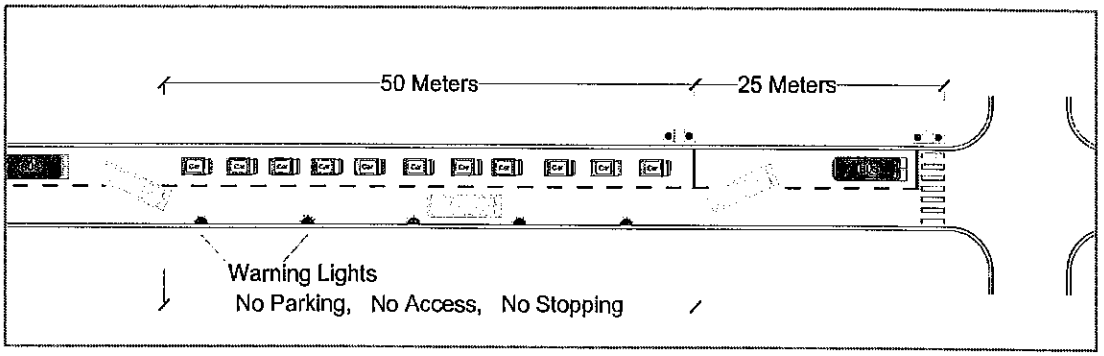
Figure 3-9: Examples of possible locations for bus lanes & bus priorities



68. **Bus 'Queue-Jump' Arrangements:** Although bus lanes can be introduced in some places, the main congestion points occur at junctions, and the benefits of bus lanes will be greatly reduced if buses are stuck in long traffic queues. This applies to many of the main junctions. After observing traffic behavior in Aizawl at difficult junctions, the consultants have identified an innovative arrangement that could allow buses to 'jump' the traffic queue and therefore speed-up bus operations.

69. The queue-jump arrangement (Figure 3.10) would require traffic signals and very careful management. A space at the front of the queue would be reserved for buses. At a certain time movement on all junction arms would be stopped, allowing pedestrians to cross and also buses to use the on-coming lane to overtake the queue. For safety reasons, this would need to be restricted to short distances (say 50m) with good forward visibility and no side road accesses. Safety would be increased by warning lights at the road side, activated when the buses move forward. Buses could operate in platoons of two, for increased safety and also capacity.

Figure 3-10: Illustration of a potential bus queue-jump arrangement for Aizawl



70. To the consultants' knowledge this queue-jump arrangement has not been tried elsewhere, but there are precedents that could make it feasible. Elsewhere in India emergency vehicles are able to pre-empt the traffic signals, using electronic devices to hold the signals at green so the queue continues to move forward. Some very innovative traffic behavior is already taking place at junctions in Aizawl that is not practiced elsewhere – for example, vehicles pulling over to the right side to make a sharp left turn: this happens without any official signage or supervision. Finally, driver discipline in Aizawl is generally very good, which makes it possible to consider a queue-jump arrangement that will depend greatly on driver observance.

71. Introduction of bus lanes and bus priorities would have to take place as part of a wider bus improvement package involving new buses, shelters, equipment, traffic signals, CCTV traffic control, junction geometric improvements (e.g. reducing steep gradients at corners), and so on. Such improvements would also require re-defining some main routes as 'priority bus corridors' – in London, for example, the main bus corridors are labelled as 'Red Routes', with greater restrictions on parking and loading than elsewhere.

72. There is currently a window of opportunity for the introduction of priority bus corridors in Aizawl, due to the existing under-utilisation of road space. But within a few years' time this opportunity will be gone, as traffic continues to grow and the spare capacity is used up. Later on, it will be much harder to introduce bus priorities, as the impact on other traffic may make it difficult to implement.

D4. Potential for Traffic Signals at Intersections in Aizawl

73. **Background:** There are many different types of intersection in Aizawl (e.g. cross roads, Y-type, T-type), with varying methods of traffic control – some are manned by traffic police, some are controlled by traffic circle, and some as yield junctions. The following section gives an initial assessment of the suitability of traffic signal control for Aizawl.

74. **Benefits of Traffic Signals:** Traffic signals can improve road safety, reduce congestion and enable traffic management strategies which regulate the use of city roads. There are established criteria for

when traffic signals might be appropriate (e.g. traffic speeds, traffic flows, pedestrian flows, peak hour proportions, accidents, etc.). If there is Area Traffic Control and intersections are close to each other, traffic signals are more justified. They may also support measures such as bus priorities and Q-jump schemes.

75. **Advantages:** Traffic signals can be installed within a short time. They are also relatively lower cost traffic control options. They are useful where geometry is constrained. They can automate giving right of way to certain category or users on specific directions. Emergency pre-empt is commonly used in developed countries (and also India) to give priority to emergency vehicles. They can be used to interconnect closely spaced signals to influence traffic platooning or traffic progression. Demand responsive signals can effectively respond to variations in traffic flows. They are highly beneficial in giving specific right of way to vulnerable road users such as pedestrians.

76. **Disadvantages:** If signals are not vehicle-actuated or demand-responsive they can lead to increased delay, particularly at off-peak times. In Indian cities most signals are not demand-responsive and lead to unnecessary delays to vehicles which further lead to traffic violations or indiscipline. Also due to the dilemma zone and/or amber time there is increased risk of rear-end collisions. Traffic signals also have significant operating and maintenance costs. Additionally, agencies must constantly monitor traffic flows to update signal settings for non-demand responsive or fixed-time control signals. Under super-saturated traffic conditions, sometimes they do not operate as effectively as manual control.

77. In Aizawl there are several junctions with large vehicular and pedestrian volumes which would meet traffic warrants (i.e. standard criteria for introduction of signals). Currently the critical junctions in Aizawl are manned by police who give right of way mostly to vehicles based on subjective judgement. Pedestrian are not given any right of way but have to wade through the traffic. Several junctions in Zarkawt and Bazar Bungkawn are closely spaced which would benefit from traffic signals for progression. Any bus lane or Q jump projects would probably need traffic signals. Since most intersections in Aizawl have two lane approaches, police manning is convenient and cost effective. But as traffic and pedestrian volumes increase, with increased turning movements and increased collisions involving pedestrians, the need for traffic signals will increase, particularly if bus lane or area traffic control strategies are implemented.

78. **Costs:** Typical signal installation costs in Aizawl will be in the range of Rs.130-150,000 per junction, depending on junction size and complexity. Therefore installing (say) 70 sets of traffic signals at junctions and bus priorities could cost in the order of Rs.1 crore (approximately $150,000), not including operational and maintenance costs.

79. **Institutional Requirements:** Currently across cities in India traffic signals are installed by civic agencies and operated and maintained by police departments through police personnel. However, as described above, this arrangement has not worked well in practice.

80. Internationally, local government organizations (such as municipal councils) are normally responsible for traffic signals operation and maintenance. For Aizawl, a dedicated team staffed by specially-trained traffic management and signal control specialists would be required for installation of signals and traffic police may manage the signal operations.

E. Summary of Costs for Proposed Short-Term Traffic Improvement Measures

81. The cost estimates for short term improvements is given in Appendix 3.6. Based on the consultant's estimate, the total costs that could be incurred for short term improvements for 20 Junctions is around Rs. 0.45 crore. Summary of cost estimates for each junction is given below in Table 3-1.

Table 3-1: Block cost estimates for Junction improvements

Jn. No.	Jn. Name	Cost (INR)
3	Bawngkawn (N-E)	153,650
4	Bawngkawn (S-W)	127,350
7, 8, 9	Chanmari gyratory	850,000
10	Sumkhuma Point	280,000
11, 12	Millennium	209,800
14	Israel Pt	158,450
15	Bazar Bungkawn	367,100
20	Zodin	87,000
22	Temple Sq.	339,650
25	Raj Bhavan	228,250
26	Tennis club	210,800
31	Sikulpuikawn	304,600
18	Vaivakawn (W)	445,050
19	Vaivakawn (E)	477,300
27	Khatla (W)	211,400
30	Khatla (E)	140,800
Sub-total		4,591,200

Certain improvements are proposed along the following corridors, at an estimated cost of Rs. 1.3 crore. Details are provided below in Table 3.2.

Table 3-2: Block cost estimates for improvements proposed along the important corridors

	Unit	Chanmari to Kulikawn	Khatla to Vaivakawn	Bawngkawn (N)-Bawngkawn (S)
Length	KM	6.85	2.7	0.24
Stairway-FP meeting point improvement	each	1,740,000	1,000,000	200,000
Ex. Access reconstruction/Steps re-modification	metre	2,340,000	200,000	960,000
Retro reflective signs	each	685,000	270,000	24,000
Retro Reflective Pavement markings-lane	metre	1,370,000	540,000	48,000
Retro Reflective Pavement markings 0.5m thick and 2m wide -zebra Xing	metre	13,700	5,400	480
Ex .Junction re-gradation	LS	1,500,000	1500,000	750,000
sub-total	INR	7,648,700	3,515,400	1,982,480
Total Cost (in INR)				13,146,580

4. MEDIUM TO LONG-TERM PUBLIC TRANSPORT OPTIONS

A. Introduction

82. The project's terms of reference required the consultants to develop medium to long-term investment plans for public transport improvements in Aizawl: specifically, 'To propose any applicable non-road based transport system in Aizawl to be implemented in the medium to long term (5-10 years), such as cable liners, ropeways, monorail systems. Describe timelines for preparation and implementation of these projects with possible source of funds. Explore the possibility to attract private investors.'

83. This chapter presents the consultants' proposals for medium-to-long term public transport improvements in Aizawl. Firstly, the existing public transport system in Aizawl is reviewed, with projections of future passenger demand. Secondly, alternative public transport options are identified and assessed. Finally, the most promising options are worked up into detailed proposals.

B. Existing Public Transport System

84. Public transport in Aizawl is provided by city buses (about 200 operating on any one day); also small taxis (about 4,600 registered) and Maxi cabs (8-10 seater Sumo jeeps). There are about 1,310 Maxi cabs registered in Aizawl district, but they mostly operate on inter-district services. In addition, there are about 300 government-owned buses serving government and educational institutions.

Bus Services

85. Aizawl's public bus services are run by private operators grouped in two associations: Aizawl City Bus Owners' Association and the Line Bus Association. The former operates five routes in and around Aizawl, including the main north-south corridor, and has about 260 buses (of which 130 are in service on any day). The Line Bus Association is smaller with about 30 buses on peripheral routes on the east and west sides of Aizawl. (Tables 4.1 and 4.2). The main city bus routes are shown in Appendix 2.4.

Table 4-1: Bus Routes operated by the Aizawl City Bus Owners' Association

Route Number	Origin and Destination	No. of Buses Regularly Running on the Route	Distance (km)
1	Ngaizel to Zemabawk	130	10
2	Bawngkawn to Sihphir	8	8
3	Kulikawn to South Hlimen	2	5.3
4	Temple Square to Govt. Complex	2	4.3
5	Temple Square to Sakawrtuichhun	12	10

Table 4-2: Bus Routes operated by the Aizawl Line Bus Association

Route Number	Origin and Destination	Number of Buses Regularly Running on the Route
1	Ramhlun Vengthar – New Market	10
2	Armed veng - New Market	5
3	Bethlehem Vengthlang - New Market	4
4	ITI Mualpui - New Market	7
5	Salem - New Market	1
6	Lawipu - New Market	1
7	Dinthar - New Market	2

86. The buses are all individually owned and the associations co-ordinate their operations. Route permits

and fare structure are controlled by the Strategic Transport Authority. Each vehicle has to obtain fitness and pollution certificates from the Directorate of Transport. There are no depot or workshop facilities, and maintenance is done by individual owners. Buses are parked overnight at private locations or at the roadside, and AMC allows overnight roadside parking for a payment of Rs. 600 per month. A roadside bus terminus facility is available at the southern end at Kulikawn, and a covered bus terminal at the northern end at the Municipal Corporation building at Thuampui.

87. The buses operated by the City Bus Owners' Association are mostly 25 seaters (with a few 30 seaters) – Tata 407, 709, Marco Polo and Starbus – and all run on diesel. Those operated by the Line Bus Association are smaller – mostly Tata 407's (16 seaters) and 3 Starbuses (23 seaters) – as the peripheral roads are not suitable for larger buses. The oldest bus in service is about 11 years old.

88. The bus operators highlighted two key issues affecting their operations: (i) traffic congestion reducing the fleet's effectiveness; and (ii) difficulty of obtaining permits from the government to replace buses.

89. A third issue is the reduction in bus services in recent years, as described in Chapter 2.

Express Bus Service

90. In 2015 the City Bus Owners' Association launched an initiative for an express bus service on the main north-south corridor between Ngaizel and Zemabawk. Called 'Green Line', two limited stop services were planned, stopping at 5 and 7 alternate stops (compared with the existing 29 stops). However, the service could not be started because of some issues in the Directorate of Transport. Summary of current city bus services is presented in Table 4.3.

Table 4-3: Summary of Aizawl's city bus services

Governing body	Private Owner's Association
Operating times	4:30 –19:30 hrs, Sunday 10:00-19:00 hrs
Fleet size	290
Fleet utilization	50% (estimated)
No. of routes	12
Total route length	76 km
Total no. of stops	203
Average distance between stop	400m
Total daily ridership (pass/day)	31,580 (estimated)
Trips in peak period	60% of total ridership
Capacity (seating/vehicle)	16-24-30
Availability of PT per lakh population	45
Average age of vehicle	8 years (oldest is 11 years)

Note: 160 buses available daily for 3.5 lakh people

Taxi Services

91. There are approximately 3,500 taxis plying on Aizawl's roads each day (out of 4,600 registered). They are mostly small, petrol-driven vehicles such as Maruti 800, Alto 800, Alto L, Omni van, Eon, Santro, Spark and Indica. They are all privately owned and often driven by the owners. Fares are set by the Strategic Road Authority and largely observed by drivers. A meter system was introduced a few years earlier, but the drivers did not find it suitable because of the terrain.

92. Despite official discouragement, taxis have proved very popular in Aizawl and numbers have steadily increased. The government has tried to limit their numbers by putting a ceiling on the number of licenses issued. Taxis were also restricted to one of three zones, though this proved unworkable in practice. This measure is now likely to be re-introduced soon.

93. The official restrictions on new taxi licenses are still in place, and this has pushed up the unofficial cost of entry to the taxi sector. For example, one taxi driver who recently acquired a new taxi paid Rs. 2.4

lakh for his vehicle and Rs. 1.1 lakh for the registration, number plate, etc.

94. Although taxi fare is significantly higher than bus fare (typically Rs. 45 per km compared with Rs. 5-10 per km), taxis are frequently shared by several passengers, reducing their unit cost closer to buses while providing a quicker and more comfortable service.

95. Discussions with the taxi operators highlighted three key issues: (i) non-issuance of new taxi permits; (ii) parking restrictions, as they are allowed to park at stands where they are registered; (iii) traffic congestion. The parking restrictions contribute to traffic congestion to some extent, as taxis often circle the central areas while returning to their official parking stand, and much of the traffic on the north-south corridor consists of empty taxis.

Conclusion: Overall service levels for urban transport in Aizawl

96. The overall service levels for urban transport in Aizawl were analysed following Ministry of Urban Development guidance on "Service Level Benchmarks in Urban Transport". Data was obtained from the 2011 Mobility Plan and supplemented with data collected by the consultants.

97. The overall Service Level Benchmarks are shown in Appendix 4.6. They show that improvements are needed particularly for bus transport, pedestrians, reducing traffic congestion, parking facilities and integration of land use and transport.

C. Projection of Future Passenger Demand on Main Corridors

98. According to the 2011 Mobility Plan, Aizawl's urban population is expected to nearly double over the next twenty years (Table 4.4). Growth is taking place in all directions, especially along the main corridors and also through densification within existing built-up areas.

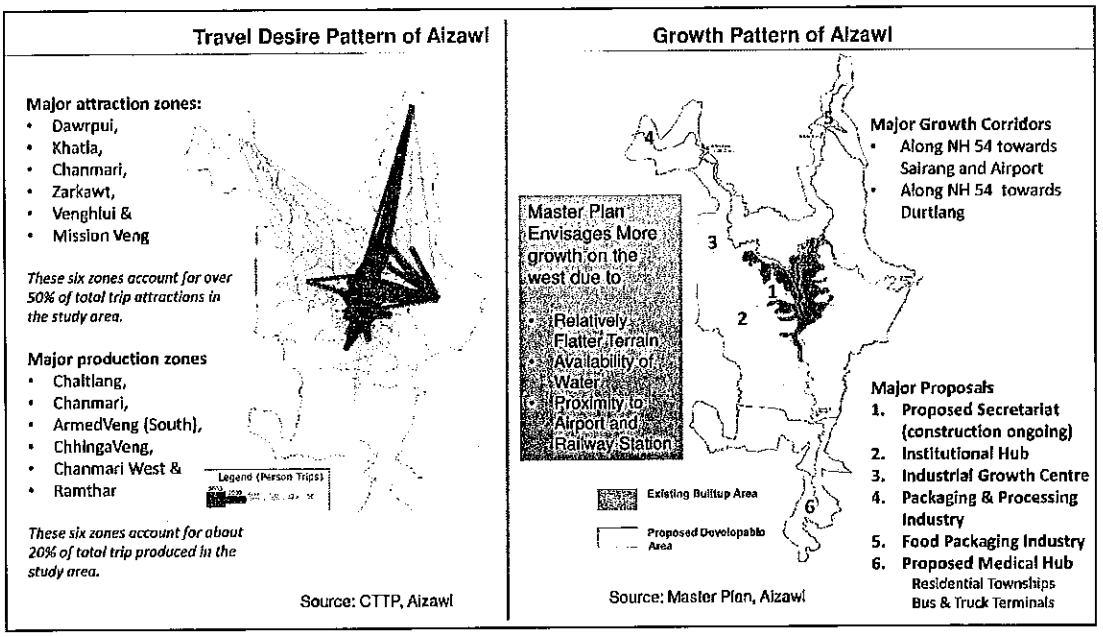
Table 4-4: Population Projection for Aizawl urban area

Year	2001	2007	2012	2017	2022	2027	2032
Urban Population (000's)	238	299	357	420	487	556	629
Predicted Annual Growth Rate (%)	4.0	3.9	3.6	3.3	3.0	2.7	2.5

Source: Comprehensive Traffic & Transportation Plan – Mobility Plan, 2011, Table 6.1

99. According to traffic counts taken for the Mobility Plan, the north-south corridor is the city's busiest corridor with up to 35,000 vehicles and 81,000 passengers per day (2007 figures, both directions – see Appendix 2.3). The east-west roads are less heavily trafficked – typically less than half or one-quarter of this volume. The current travel pattern and future growth trend is shown in Fig 4-1.

Figure 4-1: City's growth and Travel Pattern



100. As discussed in Chapter 2, although traffic volumes on the north-south corridor have increased slightly since 2007, passenger numbers have hardly increased, due to (i) congestion limiting the flow of vehicles at peak periods; (ii) a modal shift away from buses and towards two-wheelers.

101. Predicting future passenger demand is very difficult due to uncertainty about the effects of congestion. Without any constraints from congestion, we would expect traffic growth to increase in line with population growth (i.e. around 2-3% per annum).

102. Therefore to predict the **potential** demand for passenger movement on the main corridors, (i.e. without congestion effects), the following projection was made (Table 4.5):

Table 4-5: Projection of POTENTIAL Passenger Demand along Main Corridors in Aizawl

Passengers per day, both directions	2007 (actual)	2015	2020	2025	2030
North-South corridor	81,000	95,000	105,000	116,000	128,000
East-West corridor	38,000	48,000	56,000	65,000	75,000

Notes:

1. 2007 figures are based on data from Mobility Plan, Table 3.19, and applying average vehicle occupancies to vehicle numbers.

2. East-West corridor is defined as 75% of Bawngkawn main road traffic and 100% of Armed Veng traffic.

3. Growth rates of 2% (north-south corridor) and 3% (east-west corridor) are assumed.

103. The above numbers help in determining Aizawl's future public transport requirements, as they indicate the likely scale and capacity of public transport that might be needed. This is discussed further in the next section, after considering alternative public transport options for Aizawl.

D. Identification and Assessment of Public Transport Options

104. Five public transport modes were considered as possible candidates for Aizawl's future urban transport system:

- Top-supported cable cars (aerial ropeway)
- Bottom-supported cable cars (cable liner and funiculars)
- Ultra-light rail transit
- Light monorail
- Modern bus system with a package of improvements, including bus priorities

105. Light Rail Transit (LRT) and Bus Rapid Transit (BRT) were also initially considered, but these are much larger-scale systems with higher costs and road space requirements. As Aizawl is a small city with only limited road space, these options were ruled out at an early stage and the assessment focused on the lighter options of ultra-light rail transit (ULR) and light monorail, as well as cable cars and an upgraded bus system.

106. The five modes are illustrated in Figure 4.2 below.

Figure 4-2: Public Transport Modes Considered for Aizawl

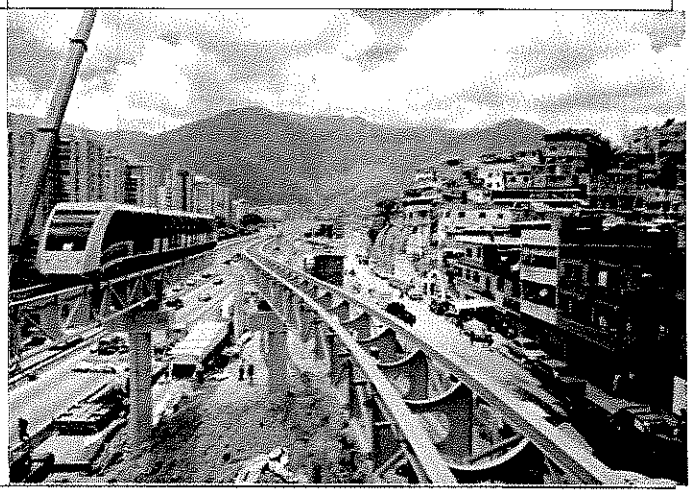
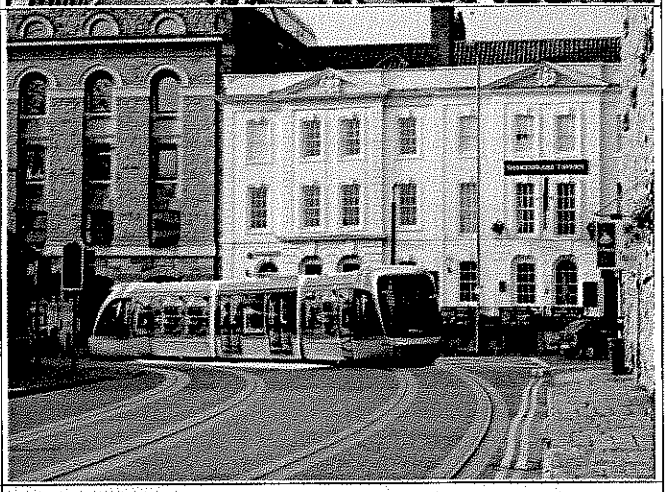
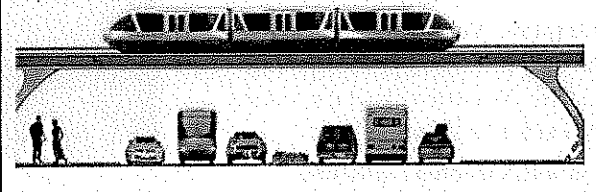
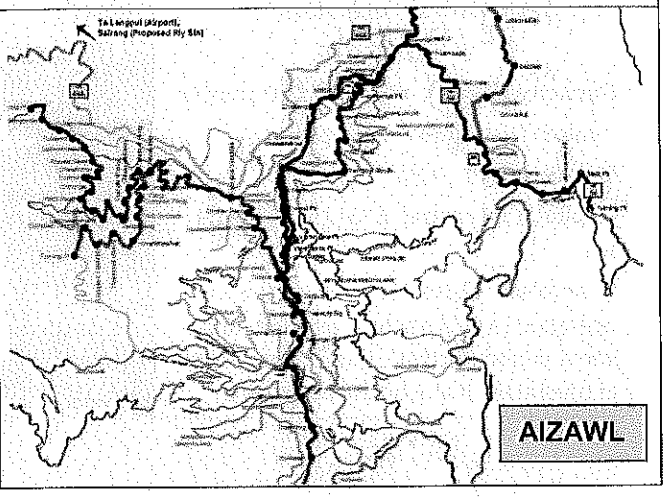
1. Top-Supported Cable Cars (Aerial Ropeways) **Capacity (2-way):** 2,000-8,000 pass/hr **Typical Distances:** 1.5 – 5km **Max Gradient:** 60% **Capital cost range:** $8-20mill per km **Examples:** Venezuela, Brazil, UK, Germany and many more countries. India has over 30 systems in place, mostly small scale for tourism. **At Grade/Elevated :** Elevated	
2. Bottom Supported Cable Cars (e.g. Cable Liners, Funiculars) **Capacity (2-way):** 4000-15,000 pass/hr **Typical Distances:** 1.5 – 5km **Max Gradient:** 10% **Capital cost range:** $15–25millions per km **Examples:** Cable liners: only a few in operation (e.g. Caracas – pictured, and some airport shuttles). Funiculars; many in operation all around the world (see	

photo below). Example of a funicular railway (bottom supported cable car) Max. Gradient: 50% **At Grade/Elevated :** Elevated	
3. Ultra-Light Rail (TRAMS) **Capacity (2-way):** 10,000–15,000 pass/hr **Typical Distances:** 4 – 20km **Max Gradient:** 14% **Capital cost range:** $5–25m per km **Examples**: Modern trams widely used in urban areas throughout Europe. ULR is less common, but has advantages of lower cost, less space and lower infrastructure requirements **At Grade/Elevated :** At grade	
4. Light Monorail **Capacity (2-way):** 8,000-20,000 pass/hr **Typical Distances:** 5 – 20km **Max Gradient:** 12% **Capital cost range:** $18–25m per km **Examples**: Malaysia & Mumbai (India) (ordinary monorail) **At Grade/Elevated :** Elevated	
5. Modern Bus System with a Package of Improvements, including New Buses and Bus Priorities **Capacity (2-way):** Depends on bus type, priorities and frequency. In Aizawl's current congested conditions = 1,200 pass/ hr (30-seaters) With bus lanes/priorities = 3,000-5,000/hr **Typical Distances:** 3 – 30km **Max Gradient:** 22% **Capital cost range:** $0.5–3.5m per km **At Grade/Elevated :** At grade	

107. **Details of the Identified Modes:** Extensive data was collected for each of the modes regarding their technical specifications, cost, transport performance, operational requirements and so on, to give a broad assessment of their suitability for Aizawl. Further details are given in Appendix 4.1.

108. A summary of some of the main parameters is given in Table 4.6 below. Some key points can be noted:

- All of the five modes are technically feasible for Aizawl, though they all have limitations in some way – for example, cable liners and monorail have gradient limitations (10-12%), though ultra-light rail (trams) perform better in this regard (14%). Aerial ropeways are affected by high winds, but (depending on design) can handle wind speeds of up to 100kph.
- The different modes have widely varying costs and capacities. The monorail has the highest capacity but also the highest cost; the bus option is the cheapest and also the most versatile but has less capacity (depending on the extent to which it is affected by traffic congestion).
- The modes vary in their impact on existing road space. Buses and ultra-light rail would run mostly on existing roads. Cable liners and monorail run on separate tracks – however, due to the steep slopes and high density development in Aizawl, the scope for off-road alignments is very limited, and so these modes would probably run along the road and take road space for the track supports. Only aerial ropeways offer the least impact on existing roads and traffic.

Table 4-6: Summary of Main Parameters for Alternative Public Transport Modes for Aizawl

Mode / Parameter	Aerial Ropeway (Cable car)	Cable liner (Bottom-supported cable car)	Ultra-Light Rail	Light Monorail	Modern Bus System with Priorities
At grade or elevated	Elevated	Elevated	At grade	Elevated	At grade
Maximum speed (kph)	30	50	50 to 90	100	94
Operating speed (kph)	16 to 20	25 to 35	30 to 45	30 to 45	5 to 30 (depending on conditions)
Capacity, 2-way (pass/ hr)	2,000 to 8,000	4,000 to 15,000	10,000 to 15,000	8,000 to 20,000	3,000 to 6,000
Capital cost (USD million/km)	5 to 20	12 to 25	5 to 25	18 to 28	0.5 to 2.0
Typical route length (km)	1.5 to 5	1.5 to 5	4 to 20	5 to 20	3 to 30
Typical distance between stops (km)	0.5 to 1.0	0.5 - 0.8	0.3 (can use existing bus stops)	0.6 to 1.2	0.3
Vehicle width (m)	Varies	2.4	2.4 to 2.65	2.35	2.14 (Tata Skool 26 Bus)
Width required at surface (m)	Off road (or can straddle road)	2.0 to 2.5 (for columns)	3	2.0 to 2.5 (for columns)	3
Spacing between columns (m)	200	65	On road	30 to 45	On road
Maximum Gradient (%)	60	10 for cable liners 50 for funiculars	14	12	20
Min. curve radius (m)	90° turns possible at stations	30	15 (or less for smaller cars)	30	12.3

109. **Assessment of the Public Transport Modes:** Assessing the alternative modes involve not only comparing their different parameters, but also examining different potential alignments. To carry out this assessment a two-stage process was adopted. Firstly, the alternative modes were assessed in broad terms against various parameters relating to cost, capacity, transport performance, technical feasibility, environmental and social impact, and so on (see Appendix 4.2). Secondly, three specific alignments were developed to test the suitability of different modes when applied to Aizawl.

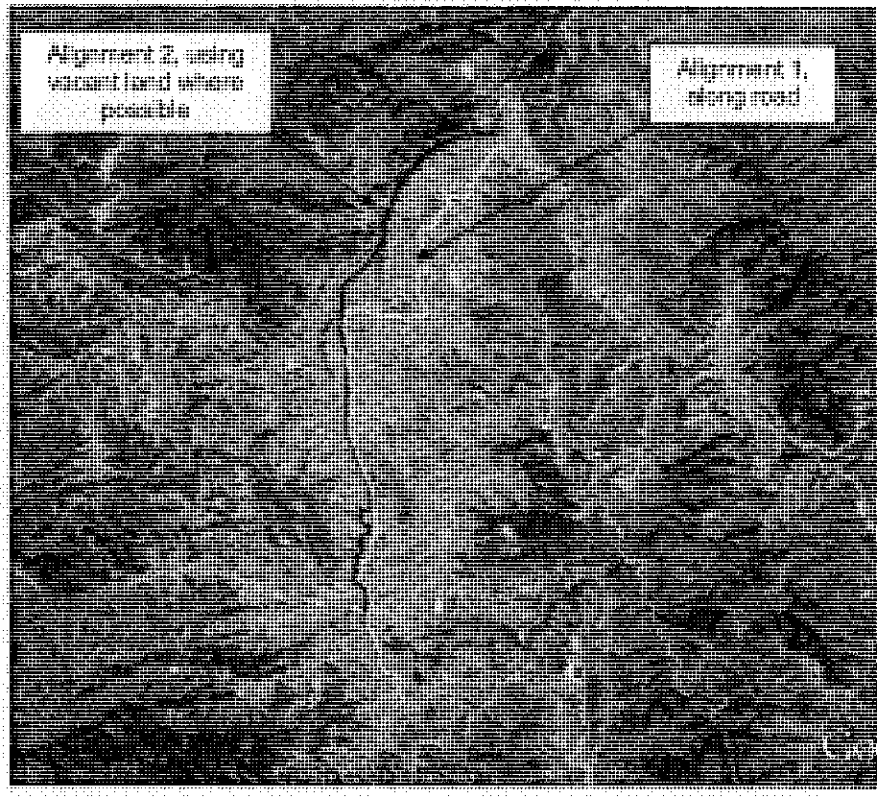
110. The broad assessment against different parameters (Appendix 4.2) did not rule out any of the five transport modes. However, their feasibility or otherwise becomes clearer when applied to specific alignments. The three alignment options were:

Option 1: Light monorail or cable liner along the north-south corridor;

Option 2: Aerial ropeway along the north-south corridor;

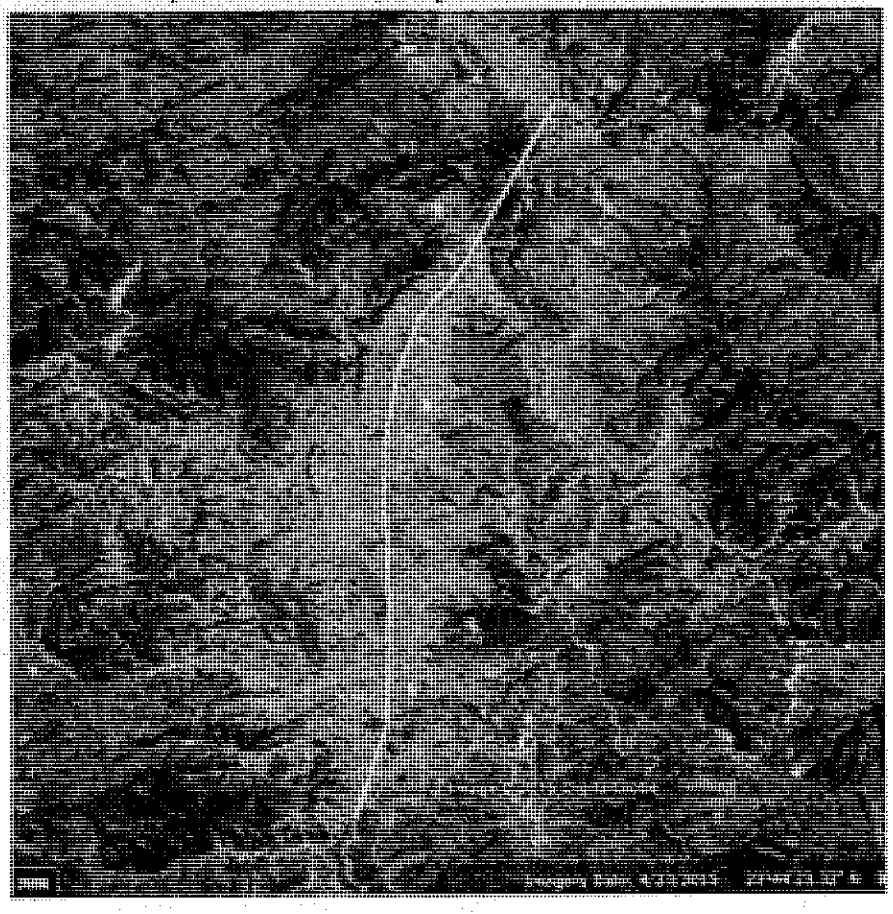
Option 3: High-quality, high-capacity bus service along the north-south corridor, and aerial ropeway along an east-west corridor.

Option 1: Light Monorail or Cable Liner for North-South Corridor



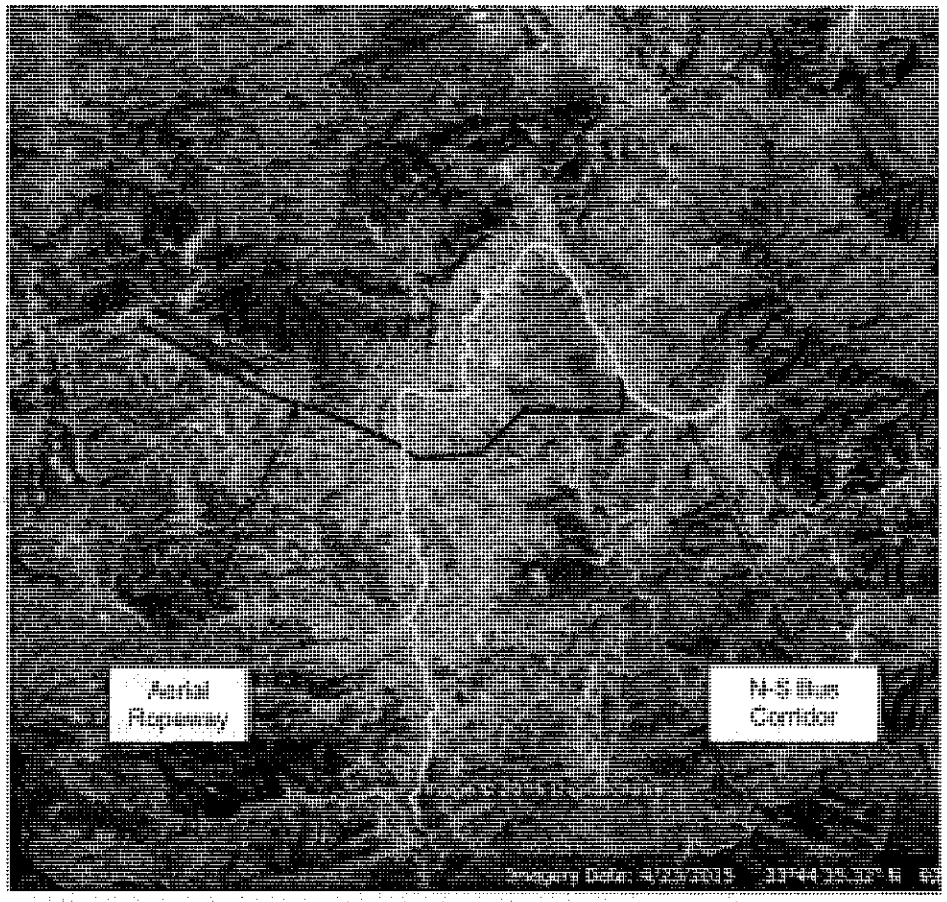
Main Features (Option 1, Monorail or Cable Liner)	
Corridor length:	7.5km, Bangkawn to Kulikawn (yellow route following road), or 6.8km (red route using vacant land)
Typical cost:	At $20mill/km (cable liner) = $150mill (yellow), $136mill (red)
	At $24mill/km (monorail) = $180mill (yellow), $163mill (red)
Typical 2-way capacity:	10,000 pass/hr (cable liner); 20,000 pass/hr (light monorail)

Option 2: Aerial Ropeway for North-South Corridor



Main Features (Option 2, North-South Aerial Ropeway)	
Corridor length:	7.5km, Durtlang to Kulikawn
Typical cost:	At $15mill/km (cable liner) = $112.5mill
Typical 2-way capacity:	6,000 pass/hr

Option 3: High Quality, High Capacity Bus Service on N-S Corridor, and Aerial Ropeway for East-West Corridor



Main Features (Option 3, High Quality Bus Service & East-West Aerial Ropeway)

High Quality, High Capacity Bus Service on N-S Corridor

Corridor length:	10km, Zemabawk to Kulikawn
Typical cost:	At $2.25mill/km = $22.5mill
Typical 2-way capacity:	3,600 pass/hr (when bus priorities have been introduced)

Ropeway on E-W Corridor:

Corridor length:	5.5km, Luangmual to Thuampui (AMC), via Bara Bazar
Typical cost:	At $15mill/km = $82.5mill
Typical 2-way capacity;	6,000 pass/hr

Total Cost:

Bus and Ropeway:	$105mill

Assessment of the Three Alignment / Modal Options

Option 1: Light Monorail or Cable Liner on the North-South Corridor

111. **Alignment:** Cable liners and monorails for Aizawl were investigated in a study by the Mizoram State Government in 2011. It is understood that the 2011 study looked at an alignment that utilized open spaces as much as possible, mostly on steep slopes on the west side of the city (see red alignment in Option 1). The alternative alignment is to put an elevated track along the main highway from Bawngkawn via Ramhlun and Zarkawt all the way south to Kulikawn (see yellow alignment in Option 1).

112. However, both alignments have the following drawbacks:

i. The **red alignment** which utilizes open spaces on the west side does not pass close to the main centres of population and employment, at least in the north (about 30% of alignment length). It would also require substantial demolition of existing properties to connect the track between the open spaces. Also construction of an elevated track on the steep slopes would be very difficult and expensive, due to the difficulty in getting machinery into place. The costs of construction, plus acquisition and demolition of numerous properties to achieve the alignment, would significantly push up the already-high cost of Option 1.

ii. The **road-based (yellow) alignment** also has serious drawbacks:

- The columns or cantilever supports needed to carry the track would take up a significant amount of road space (at least one lane of traffic);
- Construction along the main road would involve many corners and sharp bends. While technically feasible, this would reduce the transit's speed and capacity, and hence performance;
- A rail track running down the main street would be very intrusive for properties along the alignment – perhaps only 1.5m clearance between rail and building frontages in places.[9] If the track was split into two separate sections (to reduce track width), the costs would increase considerably;
- Construction of an elevated track along the main road would cause major traffic disruption for a long period, possibly lasting several years.

113. **Cost:** The cable liner and the light monorail have the highest capacities of the five modes considered, but also the highest costs. Both are relatively untested technology – monorails are not yet widely used in urban areas, and Mumbai's recent experience has not been very successful. The light monorail considered for Aizawl is even less widely used, while the cable liner is mostly seen in modern airport applications. Funiculars are widely used with great success, but mostly at-grade, on steep slopes over short distances. No obvious short-distance alignment was identified for a possible funicular in Aizawl, mainly due to the dense urban development that has already taken place.

114. Due to the newness of the technology and the probable higher costs of construction in Aizawl, the per kilometer costs of a cable liner or monorail would be high, possibly in the region of $20-24 million per kilometer. For a 7.5km alignment between Bawngkawn and Kulikawn the total cost could be around $136-180 million.

115. **Capacity:** The capacity of a cable liner or light monorail would not be justified by the level of demand on the north-south corridor. Presently (2015) the peak volume of bus and taxi passengers combined is about 1,425 per hour per direction (as measured in traffic surveys by this project). The capacity of a cable liner or light monorail varies, but a typical capacity could be around 7,500 persons per hour per

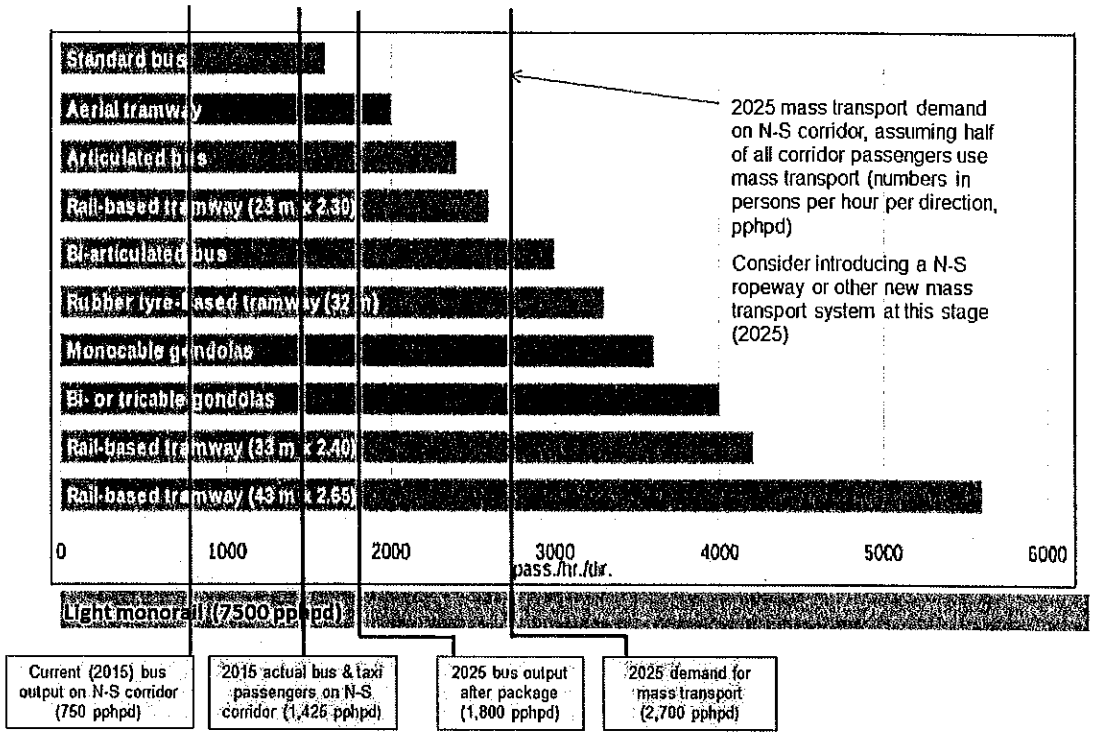
[9] For a light monorail the width of two carriages is at least 5m, while in some places the right of way between buildings is only 8m.

direction (pphpd). (Figure 4.3). Even if demand grows rapidly on the north-south corridor, it would be many years before this level of demand was reached. For example, at 3% annual growth, after 30 years the corridor demand from all bus and taxi users would still be less than HALF of the monorail's capacity (3,460 compared with 7,500 pphpd). Even allowing for modal shift from cars and motorcycles, the demand would still not justify an expensive monorail or cable liner.

116. Moreover, the investment in a cable liner or monorail system is not 'scale-able' – in other words, either the whole system is constructed, or else none. It would not be viable to develop it in stages.

Figure 4-3: Comparison of typical capacities of alternative urban public transport systems

Aizawl's north-south corridor current and future mass transport demand is superimposed, for comparison



Source: J. Bergerhoff and J. Perschon, Journeys Magazine, 2013, Figure 2, quoting CERTU STRMG CETE 2011

Note: Numbers on horizontal axis are in passengers per hour per direction (pphpd)

117. **Strategic Transport Impact:** There are also strategic reasons why a north-south cable liner or monorail is not considered suitable for Aizawl:

i. The system would serve only north-south movements, but not east-west movements. The east-west roads are limited in number, steep, narrow and frequently congested. They are not suitable for large buses and hence feeder services to and from the monorail or cable liner would be mainly by taxis but restricted by congestion.

ii. Investment in a monorail / cable liner on a north-south axis would concentrate growth and development in the congested central areas. This goes against the strategy of the 2010 Master Plan, which is to decentralize growth to outlying areas.

iii. A north-south monorail / cable liner would probably terminate at Bawngkawn (due to the high cost of extending it further to Thuampui or Zemabawk). Bawngkawn is poorly suited for a terminus due to congestion and lack of space for parking and inter-change facilities.

iv. A north-south monorail / cable liner could not easily be expanded into a wider rail network due

to gradient limitations – it would be a stand-alone facility.

v. It is unlikely that a north-south monorail or cable liner would eliminate congestion on the corridor. On the contrary, by attracting passengers from buses, taxis, cars and motorcycles it would free road space to some extent, which would be filled by the growing demand for private transport. In other words, car and motorcycle use would increase on the corridor, leading to continued congestion and likewise on feeder and access routes.

118. For these reasons, the light monorail or cable liner options are not recommended for Aizawl.

Option 2: Aerial Ropeway on the North-South Corridor

119. An aerial ropeway is a cheaper option than a monorail or cable liner, though it has a lower capacity (maximum 4,000 pphpd). However, it has the great advantage that it does not take up road space, and can cross valleys and climb steep gradients up to 60°.

120. **Alignment:** Option 2 involves an aerial ropeway on the north-south corridor between Durtlang and Kulikawn, a straight-line distance of about 7.5km. At $15million per kilometer, this would cost around $112.5million.

121. An advantage of the north-south alignment is that this corridor has the highest passenger demand in Aizawl and is also highly congested. A ropeway terminal at Durtlang would help to push development to the northern outer fringe and intercept national highway traffic approaching from Silchar in the north, thus reducing some of the traffic pressure at the Bangkawn bottleneck. A southern terminal at Kulikawn would do likewise for traffic and development to the south.

122. However, a north-south ropeway has some disadvantages:

i. It does not help east-west movements, which are seriously constrained by topography and congestion.

ii. The ropeway stations would be located at some distance from each other (on average 800m apart), so it would not provide a 'hop-on, hop-off' service but would cater for longer trips – say above 2km.

iii. The stations' catchment area would be constrained by local topography: i.e. steep gradients and narrow roads, limiting the scope for vehicular feeder services and requiring many passengers to walk to the ropeway via steps and stairs. This, and the distance between stations, would limit its zone of influence.

iv. The ropeway would compete with bus services along the north-south corridor, and the success of one could have adverse effects for the other.

v. As with the monorail and cable liner options, a north-south ropeway may not reduce congestion on the corridor. On the contrary, if passengers shift from bus and taxi to the ropeway, this will free road space that will be filled by the growing numbers of cars and motorcycles, with knock-on effects such as pressure on parking and congestion on feeder and local roads.

123. **Cost and Capacity:** At around $112.5million a north-south ropeway would be a high cost investment. Moreover, like the monorail it is not 'scale-able' – the alignment is not suitable for part-development, so it would be 'all or nothing'.

124. If a north-south ropeway is constructed with a capacity of 3,000 persons per hour per direction, it would still operate below capacity during its first few years of operation. For example, if half of all bus and taxi passengers transferred to the ropeway in its first year (2021), this would still be only 710 passengers per direction in the peak hour, or 28% of capacity.

125. **Strategic Transport Impact:** As with Option 1, a ropeway on the north-south corridor will tend to encourage investment and development in Aizawl's congested centre. The areas around the ropeway stations in particular will be attractive for commercial development. On the other hand, it does little to disperse development to the outer fringes, except at the north and south ends, so it does not

significantly support the Master Plan strategy.

126. Therefore a ropeway is not proposed on N-S corridor due to the above mentioned reasons.

Option 3: (1) High Quality, High Capacity Bus System on the North-South Corridor, and (2) Aerial Ropeway on an East-West Corridor

Assessment of the Bus Option

127. Aizawl's bus fleet has actually declined over the past and today is providing only half the services on the north-south corridor that were recorded in 2007. This may be due to increasing congestion which has reduced traffic speeds and made users to use private modes. Fragmented bus ownership and operation also contributes to the underutilization.

128. The bus option would aim at establishing a high quality, high capacity bus service on the north-south corridor and increasing the patronage. This would be done by:

- Introducing bus priorities (bus lanes, bus gates, queue-jump arrangements, etc.) so that buses are less affected by congestion than other traffic;
- Increasing the size of the bus fleet with good quality, modern buses;
- Providing a higher capacity, more frequent services;
- Providing good quality facilities such as bus shelters, passenger information systems, etc.;
- Road and footway improvements, to assist bus (and general traffic) movements and improve pedestrian access to the bus corridor;
- Improvements to the east-west bus services as well, to complement the north-south service;
- Re-organising city-wide bus management to achieve an efficient, unified system.

129. The main advantages and disadvantages of the bus option are discussed below.

130. **Alignment:** The bus option serves a longer north-south corridor (10km between Zemabawk and Kulikawn) than the ropeway option, due to its lower cost. It also serves east-west routes – i.e. it forms a network, which is not available with the other modal options, and the bus network can be easily extended.

131. The bus option also provides a more flexible service along the corridor. It serves both arms of the north-south corridor (e.g. via both Chaltlang and Ramhlun), with stops at frequent intervals. In this respect it is much more accessible than a north-south ropeway or monorail would be, and more suited to the short trip distances that are common in Aizawl (80% are less than 3km, according to the 2007 CMP).

132. Infrastructural improvements to the north-south corridor would also benefit other road users – for example, improved pedestrian facilities, improved traffic management, road repairs and re-construction of junctions for better turning movements.

133. **Cost and Capacity:** The bus option is the lowest cost option. At around $2.25million per kilometer it is less than one-sixth the cost of the ropeway option, and about one-tenth the cost of a monorail or cable liner, per kilometer. The bus option is also highly 'scale-able' – in other words, the size of the bus package can be varied to suit the available funds.

134. The buses' lower capital costs would also be reflected in lower fares compared with the other modes.

135. The main disadvantages of the bus option are firstly, the lower **capacity** compared with the other modes; and secondly, the impact of **traffic congestion**, which could potentially prevent the bus option from achieving its desired output.

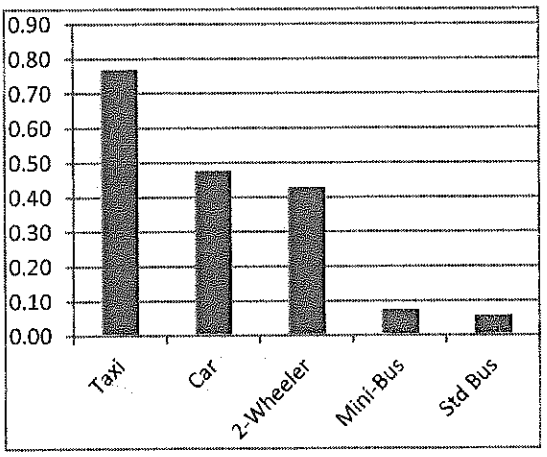
136. At present, the buses on the north-south corridor in Aizawl are achieving about 750 passengers per

hour per direction (pphpd) in the peak hour. This would meet much of the potential demand for travel along the corridor.

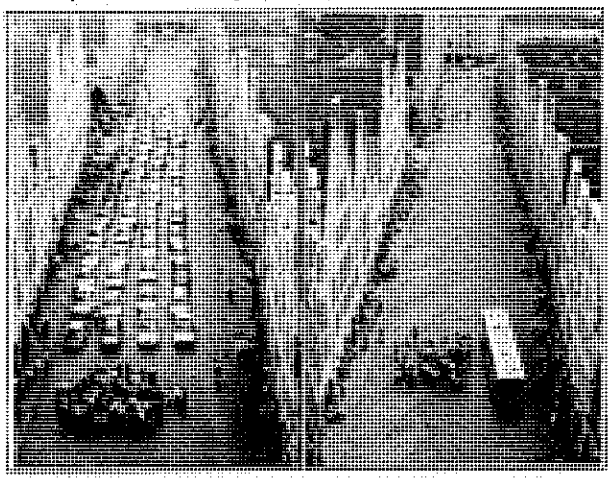
137. However, as Aizawl's population increases, demand on the north-south corridor will increase, and after some years the buses may not have sufficient capacity for this increased demand. At a later stage, perhaps in ten to fifteen years' time, a further significant increase in public transport capacity on the north-south corridor may be needed. Alternative options (for a future increase in public transport capacity) could be: (i) a higher capacity bus service with more priorities, bus lanes and possibly elevated bus-only sections; (ii) an ultra-light tram replacing the buses; (iii) a north-south aerial ropeway.

138. **Strategic Transport Impact:** The bus option fits in well with the Master Plan's strategic policies for Aizawl. Firstly, the bus network serves the outlying areas. Secondly, the bus is a high capacity mode which is very space-efficient for the north-south corridor (see Figure 4.3 below). Thirdly, increased bus services and priorities would not encourage more private cars and motorcycles on the north-south corridor, unlike the monorail and ropeway options: therefore the bus option would help in limiting overall demand for private transport in Aizawl.

Figure 4-4: Comparison of Buses and Other Modes for Space-Efficiency



Average road space required by one passenger using different modes (from the 2011 Aizawl Mobility Plan – figures are in Passenger Car Units per person)



Amount of road space needed for the same number of passengers by cars and one bus

Assessment of the East-West Ropeway Option

139. **Alignment:** The east-west ropeway proposed in Option 3 extends for 5.5km between Thuampui in the east and Luangmual (Solomon's Temple) in the west. It has several advantages over a north-south ropeway:

i. It pushes development further afield, both east and west, which is in support of the Master Plan strategy;

ii. It would not compete with a north-south bus corridor, except for passengers from Thuampui and Zemabawk in the north-east. For the latter the ropeway would offer a quicker journey to Aizawl centre, cutting the journey time from 30-40 minutes to 10 minutes and avoiding the detour through congested Bangkawn.

iii. Elsewhere, the east-west ropeway would complement the north-south bus corridor.

iv. It provides an alternative mode for east-west roads which are very congested and have only limited scope for improved bus services.

v. It would intercept traffic approaching Aizawl on the national highways from the north, east and west and, with park-and-ride facilities, could reduce vehicular traffic entering the city.

vi. The proposed eastern terminus at Thuampui is close to the main city bus terminal and is well-located to intercept traffic approaching from the north and east. It would also serve the growing areas around Thuampui, Zemabawk and Zuangtui.

vii. A western terminus near Soloman's Temple at Luangmual would serve the western areas identified in the Master Plan for major strategic expansion. For example, feeder services could operate between the ropeway terminus and Mizoram University and other growing settlements in the area.

viii. Away from the central areas there is more space for accommodating stations and transport interchanges. Local access to the stations would also be less congested than in Aizawl's central areas.

140. **Cost and Capacity:** The east-west ropeway would be designed with the same capacity and unit cost as the north-south option. However, being 2km shorter, the total capital cost would be about $30 million less ($82.5 million compared with $112.5 million), which makes it more affordable.

141. There would also be a possibility of developing the east-west ropeway in two phases, unlike the north-south option. The first phase could be the eastern wing (Thuampui to Aizawl centre, 2.6km), and the second phase could be Luangmual to Aizawl centre (2.9km). However, the cost of developing the ropeway in two phases would be higher than if all built at once, as the system has to be designed for the eventual capacity.

142. Regarding capacity and ridership, the east-west ropeway would probably carry fewer passengers than a north-south ropeway, at least in the early years. A forecast of future ridership was prepared for both options, and is presented below. The economic viability of the project is presented in Chapter 7.

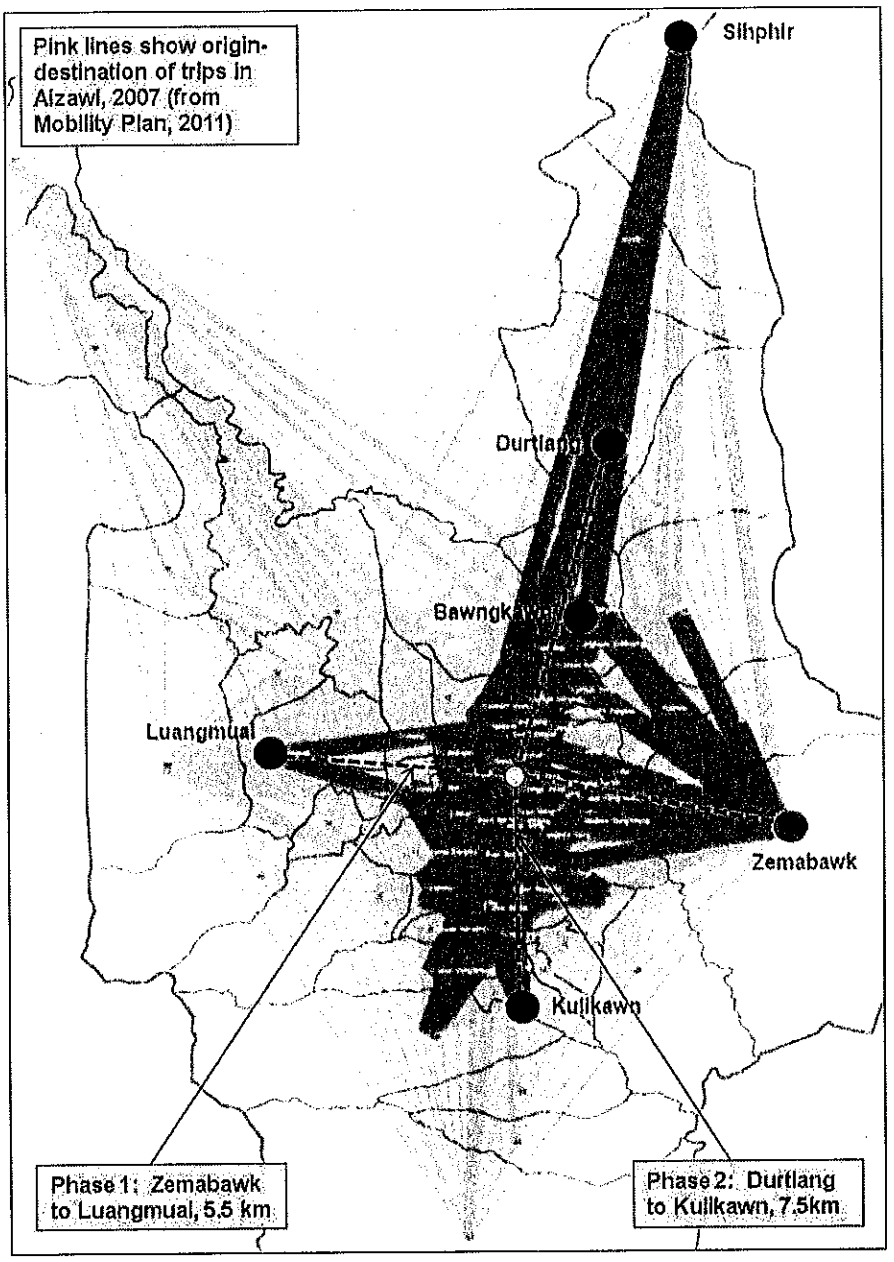
Recommended Option

143. Option 3 (bus package and east-west ropeway) is the recommended option for Aizawl, for the reasons described above; i.e.:

- Cost effective;
- Strategic impact – encouraging development on the outskirts of Aizawl and supporting the Master Plan objectives;
- Potential for the network to be expanded over time;
- Wider benefits – such as improvements to roads and footways through the bus package;
- Does not encourage further traffic growth on the north-south or east-west corridors;
- The proposed bus and ropeway packages complement each other;
- Potential for land-value capture and transit-oriented development with the ropeway option.
- Economically viable.

144. In the longer term, depending on affordability and profitability, the ropeway network could be expanded to include a north-south alignment, as shown in Figure 4.5.

Figure 4-5: Potential long-term ropeway network for Aizawl (Phases 1 and 2)



E. Details of Proposed Bus Package

145. **Aims:** The aim of the proposed bus package is to expand and enhance the role of buses in Aizawl as a mass-transport mode, and reverse the decline that has taken place in recent years. Specifically, the proposed package would aim at increasing peak bus ridership on the north-south corridor from the present 750 to 1,800 passengers per hour per direction (an increase of about 140%), and make buses a more attractive and convenient form of transport that would attract users from other modes such as cars, taxis and motorcycles. The proposals would also include improvements to other bus routes in Aizawl, though the main focus would be on the north-south corridor.

146. **Faster services:** The role of buses in Aizawl would be enhanced by enabling faster services – reducing the delays caused by traffic congestion through introduction of bus lanes, bus priorities and better traffic management; also introducing express services.

147. **Increased services and capacity:** The service would also be enhanced with more buses at peak hours, also at mornings and evenings and on new routes. Peak hour capacity could be increased by operating buses in 'platoons' of two buses, maintaining the existing 2 minute headway.

148. **Improved quality of service:** The standard of bus service in Aizawl would be upgraded through a package of improvements, including new buses, high quality bus shelters, clear bus timetables and bus maps, and improved ticketing.

149. **Improved pedestrian access to bus facilities:** The proposed package would include substantial expenditure on improved footways, stairs, pedestrian crossings and so on, that would benefit bus users and pedestrians generally. An illustration of strategic pedestrian routes that could be upgraded as part of the bus package is shown in Appendix 4.3.

150. **Improved road junctions:** The package would also include a substantial allocation for engineering improvements to critical road junctions. This would involve re-grading some junctions to assist turning, safety and capacity; it could also include traffic signals at some junctions, particularly to support bus priorities.

151. **Institutional changes:** At present, Aizawl's bus services are handicapped by ownership and management being fragmented amongst many different owners. The proposed bus package would include an institutional component to unify the management of Aizawl's buses under a single agency while respecting the interests of the existing bus owners and operators. Further details are given in Chapter 6.

152. **Depots and workshops:** As part of upgrading Aizawl's buses into a modern, unified service, the proposed bus package would include provision of new bus depots with supporting workshops.

Project Components and Cost Breakdown

153. A package of bus improvement measures was developed and presented in the Draft Final Report. These focused primarily on the 10km north-south spine from Kulikawn to Zemabawk, with modest investment (about 20% of the total) proposed for the east-west city routes. After discussions with government representatives, further routes were added to the bus package – in particular, to introduce new bus routes to (i) the airport at Lengpui; (ii) the new railway terminus at Sairang (due to be completed by 2019); and (iii) the new referral hospital at Falkawn.

154. A detailed breakdown of the bus package is given below. For convenience, the package is presented in two parts: (1) the CORE package, which was presented in the Draft Final Report; (2) the SUPPLEMENTARY package, which includes the additional measures proposed by the Government of Mizoram after considering the draft final report.

(1) <u>Details of the CORE Bus Package</u>

155. Specific proposals of the core bus package include:

- Introduction of 370 new Tata / Ashok Leyland buses which will be BS Stage IV compliant (Table 4.7). The number of buses has been estimated based on desired headways of 2 minutes at peak periods, two buses operating together at peak periods (platooning), more intensive daily operation, and allowances for non-operational buses.
- Re-allocation of existing 130 good-for-use buses to other routes, such as the line services on the eastern and western sides of the city.
- Provision of two depots, one in the south and the other in the north side of the city to accommodate about 500 buses.
- Provision of two workshop facilities at the two depots for maintenance, repairs and pollution

checks.

Table 4-7: Summary of proposed Core bus services on North-South Corridor, 2020

Category	Units
No. of buses (new procurement)	370
Headway: peak	2 mins
off peak	5 mins
Bus capacity: seating	24
seating & standing	35
Line capacity: normal (passengers per hour per direction)	1,440
crush	1,880
Hours of operation	04.30 – 21.30
Daily round trips per bus (round trip length is 10km x 2 = 20km)	4

156. A cost estimate for the Core bus package is given in Table 4.8. The overall cost is estimated at Rs. 155 crore (approx. $24 million). The largest single component is road infrastructure (Rs. 61 crore), of which about 84% is for the north-south corridor and the rest for east-west roads. Of this, road junction improvements would be about Rs. 20 crore and footways, stairs and drains about Rs. 22.8 crore.

157. The 370 new buses, at Rs. 13 lakh per bus, would cost around Rs. 48 crore ($7.4 million). The project is expected to run for four years, from design through to construction and implementation, with full operation from Year 5 onwards in 2020. (Table 4.9)

158. Bus lanes may be feasible for about one-quarter of the route. For the remaining sections, bus 'queue jumps' and bus gates may be considered. Traffic signals are proposed at 20 junctions along the corridor, linked to a central traffic control room at the existing SP Traffic office control room.

159. Modern bus shelters are proposed at 50 locations along the north south route and possibly 10 other locations on other east-west routes. Examples are shown in Figure 4.6.

Figure 4-6: Examples of potential bus shelters

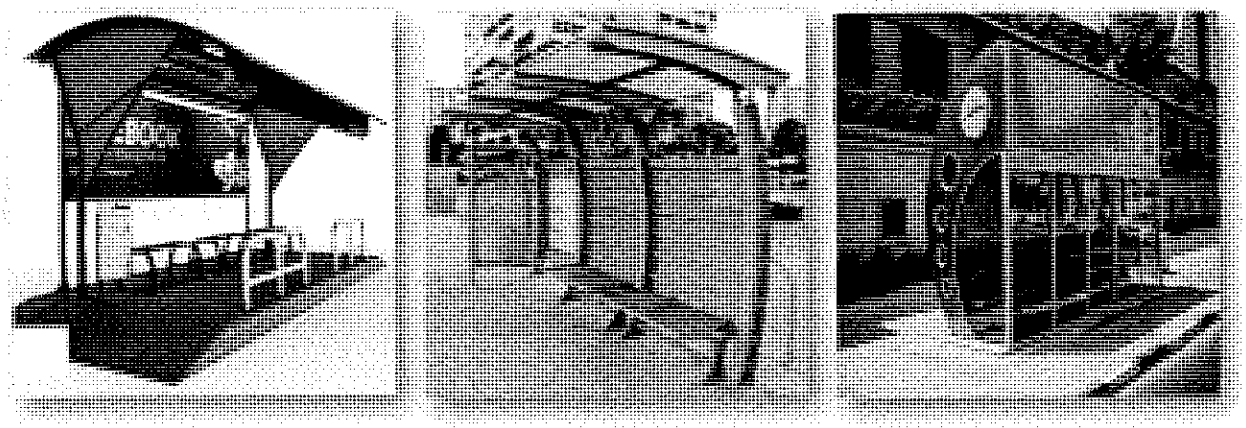


Table 4-8: Core Bus Package Components and Cost

Component		Length (km)	Items (no.)	Cost, (Rs. Crore)	Sub-Totals (Rs. Cr)
Road Infrastructure					
North-South Corridor	Bus lane & priority	3		2.25	
	Road marking	12		0.04	
	Road signs		Various	0.06	
	Traffic signals		20	0.40	
	Central control unit for signals			0.10	
	Bus shelters		50	4.00	
	Footways with drain	8.4		8.40	
	Pedestrian crossings		30	0.45	
	Stair improvement - major		20	10.00	
	Stair improvement - minor		80	4.00	
	Utility relocation			2.00	
	Road / junction re-construction		20	20.00	
	Total Infrastructure Cost for North South route				**51.70**
Other East-West Routes	**Total Infrastructure Cost for Other Routes**				**9.67**
	Project development and consultancy (10%)			6.14	
	Insurance (3%)			1.84	
	Pre-operative expenses (2%)			1.23	
	Contingency (5%)			3.07	
	Total (Proj. Dev, Contingencies, etc.)				**12.28**
Vehicles					
	New buses		370	48.10	
	Depot		2	10.00	
	Workshop		2	12.00	
	Total (Vehicles & Depots)				**70.10**
Operation					
	Information System			0.20	
	Fleet management			4.81	
	Maintenance & repair			4.81	
	Total (Operation)				**9.82**
ALL					
	Total				**153.57**
	Land acquisition (depot & workshop)			**1.0**	
	Rehabilitation & resettlement			**0.6**	
	GRAND TOTAL (CORE BUS PACKAGE)				**155.17**

Table 4-9: Implementation Plan for Core Bus Package

		2016	2017	2018	2019	2020
		Design / Bidding	Construction			Operation
Component	Sub-component	Year 1	Year 2	Year 3	Year 4	Year 5
Road Infra.	Implementation of full package		33%	33%	33%	
	Project development and consultancy (10%)	50%	30%	10%	10%	
	Insurance (3%)	100%				
	Pre-operative expenses (2%)			50%	50%	
	Contingency (5%)		25%	25%	25%	25%
Vehicles	New buses	10%	20%	30%	30%	10%
	Depot		40%	30%	30%	
	Workshop		40%	30%	30%	
Operation	Information System				90%	10%
	Fleet management					100%

160. **Footways, Drains and Stairs:** The bus package will include provision for footways and drains for about 8.4 km of the north south route. Twenty public stairs would be improved with proper tread and rise, hand rails on two sides and middle, and covered wherever possible. For private stairs abutting the roadway, re-alignment and warning bollards are proposed. Such minor stair improvements are proposed for 80 locations.

161. Further details of the proposed bus package, including cost assumptions, year-wise cost breakdown, passenger demand and bus revenue estimates are given in Appendix 4.4. An economic and financial analysis of the bus package is presented in Chapter 6.

Bus Fares

162. The proposed fare structure is shown in Table 4.10. Since a better service will be provided, it seems reasonable that implementation of the bus package will be accompanied by a slight increase in bus fares. As the opening year is assumed to be Year 5, some upwards adjustment is also allowed in the economic and financial analysis (Chapter 6) to take account of inflation.

Table 4-10: Existing and proposed bus fare structure for north-south corridor

Existing Official Bus Fare Structure							
Distance	0-1 km	1- 2 km	2-4 km	4-6 km	6-8 km	8-10 km	> 10 km
Fare (Rs)	5	10	12	15	17	20	25
Proposed Bus Fare Structure after bus improvements (2015 prices)							
Distance	0-1 km	1-3 km	3-5 km	>5 km			
Fare (Rs)	10	15	25	35			

(2) Details of the SUPPLEMENTARY Bus Package

163. In addition to the Core bus package, a SUPPLEMENTARY Bus Package was also developed in response to the government's feedback, adding three metropolitan bus routes to the overall package: (i) Lengpui Airport to city centre; (ii) Sairang Railway Station to city centre; and (iii) Falkawn Referral Hospital to the city centre. In addition, the package allows for high-quality vehicles for these routes, also a small proportion (10%) of AC buses on the main north-south route in Aizawl, and more emphasis on modern information systems and ticketing. A summary of the supplementary bus services is shown in Table 4-11, and cost details are shown in Table 4-12.

Table 4-11: Summary of Extended bus service

Category	Units
No. of buses (new AC bus procurement)	70
Headway: peak	10 mins
Bus capacity: seating	24
seating & standing	35
Line capacity: normal (passengers per hour per direction)	144
crush	210
Hours of operation	0700 – 1900
Daily round trips per bus (avg. round trip length is 25km x 2 = 50km)	3

164. The proposed AC buses have a unit cost of Rs 25 lakh. The supplementary package also includes an additional (third) bus depot and workshop facility. This is considered appropriate for Aizawl, as it will enable bus depots to be provided on the three main corridors leading in to the city.

Table 4-12: Supplementary Bus Package Components and Cost

Component	Sub component	Number	Cost per number	Lump Sum	Total Sub component	Total Component
		Nr.	Rs/nr.	Rs.	Rs crore	Rs crore
Bus route Infra	Bus shelter	140	8,00,000		11.2	
	Footways & crossing at stops			1,10,00,000	1.1	
	Bus stop signing & marking			25,00,000	0.3	
	Infrastructure Cost				**12.3**	
	Project development & implementation (20%)				2.5	
	Total Infrastructure Cost				**2.46**	**14.76**
Vehicles	Buses for 3 routes	70	25,00,000		17.5	
	Additional cost for City AC buses (10% of city buses)	37	11,00,000		4.1	
	Depot (3rd depot)	1	5,00,00,000		5.0	
	Workshop (3rd workshop)	1	6,00,00,000		6.0	

	Vehicle related cost				32.57	32.57
Operation	Information System & ticketing			7,00,00,000	7.0	
	Fleet management	70		1,75,00,000	1.8	
	Maintenance & repair	70		77,00,000	0.8	
	Operation cost					9.52
						56.9
LA & RR	Land acquisition (depot & workshop)					0.6
	Rehabilitation & resettlement					0.4
						57.9

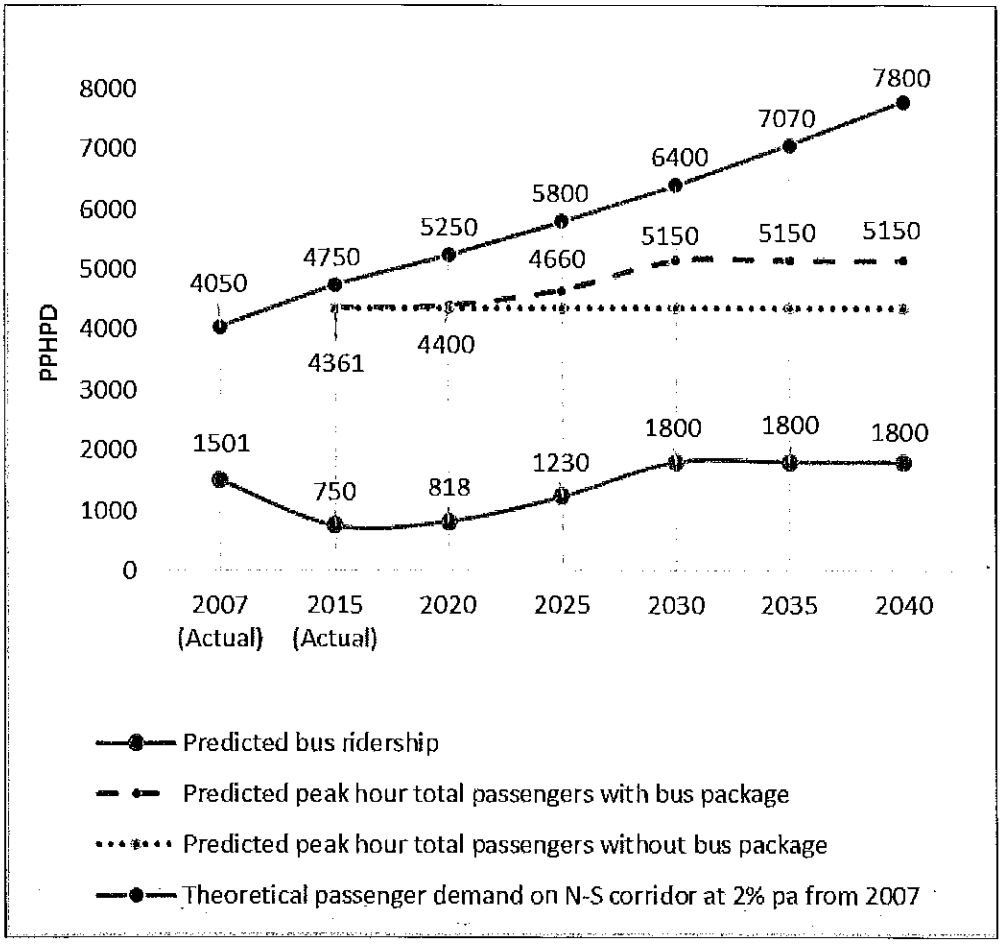
165. The total cost of the supplementary bus package is Rs 57.9 crore ($ 8.9 million). The cost of the full bus package including core package (Rs 155 crore) and supplementary package is Rs 213 crore ($ 32.7 million).

Projections of Bus Ridership and Passenger Demand

166. Figure 4.7 shows the likely impact of the bus project on passenger movement on the north-south corridor. Between 2007 and 2015 bus ridership appears to have decreased significantly (based on traffic surveys). With implementation of the project, ridership would increase steadily over ten years to reach a maximum of 1,800 pphpd by 2030 (refer Figure 4.7). Thereafter it would remain constant, unless further changes were introduced to the bus service to increase capacity.

167. The bus package will allow total peak-hour passenger movement on the n-s corridor to increase between 2020 and 2030. Without the package, it is likely that peak hour passenger movement will not increase significantly, and might even decrease.

Figure 4-7: Projected bus ridership on North-South corridor with bus package, compared with theoretical corridor demand (all passengers)



Notes:

1. *pphpd = passengers per hour per direction*
2. *Data given in Appendix 4.4.*

F. Details of Proposed East-West Aerial Ropeway Package

Alignment

168. The proposed ropeway extends for 5.5km between Thuampui in the east and Chawlhhmun (Solomon's Temple) in the west. It crosses the centre of Aizawl near Power House and the Chief Minister's Office (CMO), and passes through areas such as Ramlun, Armed Veng, Vaivakawn, Zotlang and Luangmual (Figures 4.8, 4.9 and 4.10).

Figure 4-8: Proposed East-West Ropeway (eastern section)

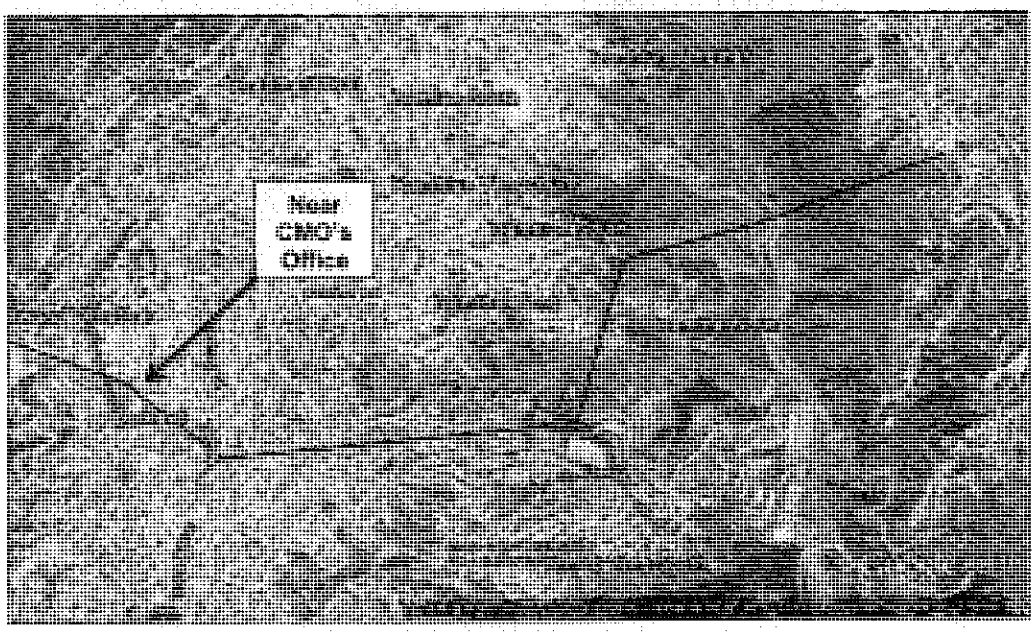


Figure 4-9: Proposed East-West Ropeway (western section)

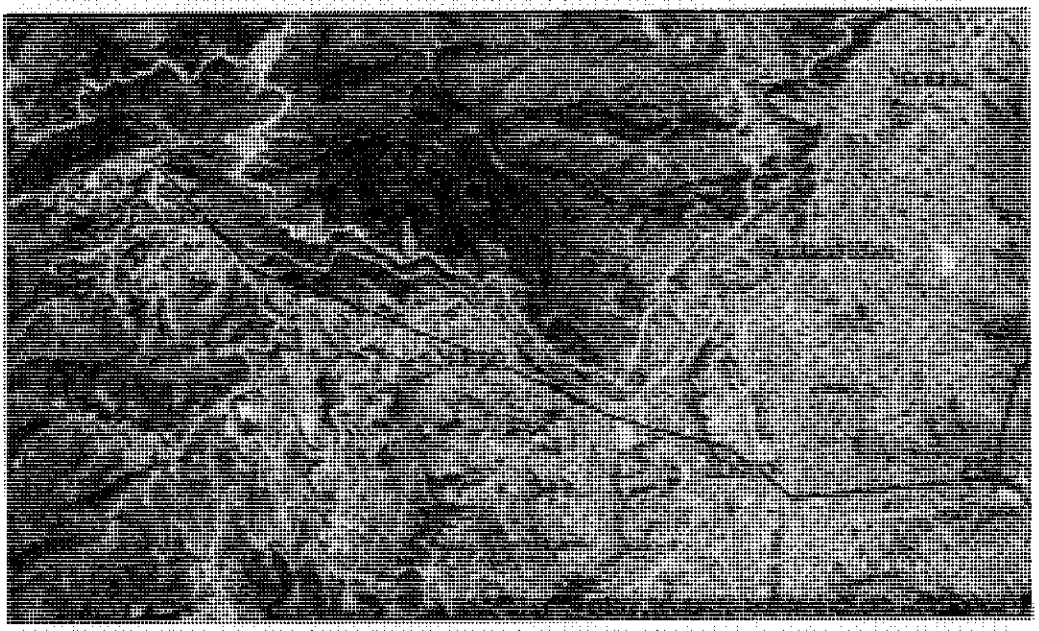
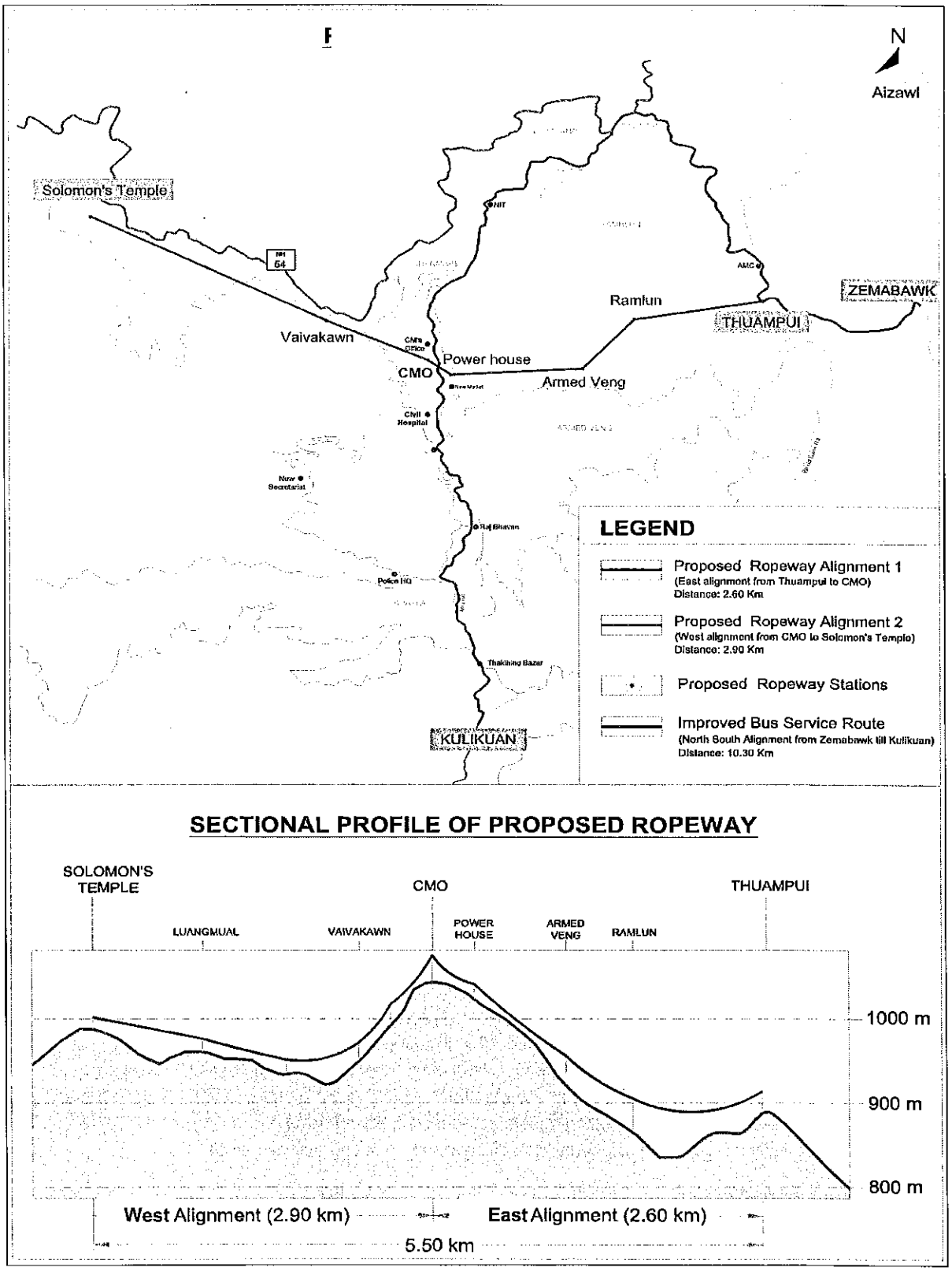


Figure 4-10: Proposed alignment for East-West Ropeway



Stations

169. The consultants visited the route to carry out preliminary feasibility checks – for example, locations for stations, gradients, obstructions (such as power lines), road access and so on. Based on these preliminary investigations, nine potential station locations were identified, as follows (Table 4.13):

Table 4-11: Potential ropeway station locations (from west to east)

Station No.	Location	Distance between stations, from west (m)	Comments
1	Solomon's Temple (terminal)	0	
2	Luangmual	700	
3	Zotlang	750	
4	Vaivakawn	900	Consider rebuilding police station as ropeway terminal building
5	CMO	500	Possible government land available at telecom mast site
6	Power House	320	Government-owned
7	Armed Veng	970	
8	Ramhlun	500	
9	Thuampui (terminal)	940	Consider rebuilding AMC market as ropeway terminal building
	TOTAL DISTANCE	5.580 km	

170. The station locations were identified according to the following parameters:

- Proximity to populated areas to ensure greater access and ridership;
- Availability of plain level land as most of Aizawl is landslide prone;
- Ownership of land (mostly government lands were identified to minimize land acquisition)
- Accessibility to roads and other modes of transport for seamless connectivity
- Checking gradients and clearances required for easy transfer
- Adequate distance from environmentally sensitive zones and military facilities.

171. The stations at Solomon's Temple and Thuampui would serve as terminal stations and a central location could act as a docking station. At several locations the available land was limited, hence here redevelopment of existing buildings might be needed (e.g. Thuampui, Power House, Vaivakawn).

172. Although detailed surveys were not carried out, from initial inspection the alignment appeared feasible, in terms of

- Gradient – maximum gradient of 56% at Thuampui and 44% east of Vaivakawn;
- Clearance above existing buildings – the central section is the most difficult regarding clearance heights, but if the ropeway stations are located on tall buildings (e.g. at Power House), sufficient elevation should be achieved;
- Avoiding sensitive locations such as environmental and defense areas.

System Characteristics

173. The proposed ropeway system would be a **bi-cable detachable gondola.** It is a stable and safe system and has been in use in South America and Europe. Regarding windy conditions, the system can occasionally be affected by strong winds. The maximum recorded wind speed in Aizawl is 83 kph (Appendix 4.8); at this speed, the ropeway operation might need to be slowed down for safety reasons and occasionally shut down for a few hours. Generally, ropeways have safety features built-in for

windy conditions. For this project's financial analysis, it was assumed that the system might be shut down for a maximum of five days in a year.

174. An alternative option is to adopt a tri-cable gondola system which is more stable in high winds (up to 100kph). However, this system is about 50% more expensive than bi-cable. Therefore it could be more economic to accept running the system slowly or closing it for a few days rather than incurring 50% additional capital costs.

175. The system can operate for about 8 km with a single lift and bull wheel. The wheel can be at either end station; the power consumption depends on whether the bull wheel is at high or low elevation of the lift. The terminal stations require electro-mechanical installation for running the ropeway, hence a larger area of around 500 m² is required. The transit stations require less area.

176. **Building the ropeway in stages?** It is possible to build sections of a ropeway in stages and extend it in future, but for this, the whole route has to be planned in advance and constructed accordingly. This means that the per-kilometre cost will be higher because all electro-mechanical devices and stations have to be designed and built for the future system and not the immediate system length. For this study the consultants have assumed that the per kilometre cost of constructing the east-west ropeway in stages would be about 30% more than if the whole ropeway was constructed at a time – i.e. Rs. 130 crore/km compared with Rs. 100 crore/km.

177. It is very important to plan and design the ropeway system carefully because once the system is built, capacity cannot be increased significantly later on. The number of cabins can be reduced to cater for lesser demand, reducing power expense, but the scope for increasing them is limited.

178. **Interchanges between different ropeway lines?** One station can act as an interchange between two distinct ropeways (say east-west and north-south), but the cabins cannot be exchanged between the lines. Passengers would need to get down from one line and walk up to the other line.

179. Further details of the ropeway system's characteristics are given in Tables 4.12 and 4.13. For this project, two different scenarios have been considered: (i) the full 5.5km alignment between Thuampui and Solomon's Temple); (ii) a shorter 2.6km section between Thuampui and CMO's office in the centre of Aizawl. This was done in case the shorter section might be more feasible (in overall cost, ridership, etc.).

Table 4-12: System characteristics of E-W ropeway, LONG alignment (Thuampui to Solomon's Temple)

System	Bi-cable detachable gondola	
Length	5.5	km
Cabin number	140	
Cabin spacing	85	m
Headway	0.32	min
Speed	16.2	km/hr
Cabin capacity	8	Seating
Crush capacity	16	Seating + stand
Line capacity	1,520	Pax / hr /dir
Crush capacity	3,041	Pax / hr /dir
Operation	14	hr
	0800 – 2100 hrs	all days
Power requirement		
Eastern section (2.6 km)	380	kW
Western section (2.8 km)	410	kW

Table 4-13: System characteristics of E-W ropeway, SHORT alignment (Thuampui to CMO's Office)

System	Bi cable detachable gondola	
Length	2.6	km
Cabin number	67	
Cabin spacing	85	m
Headway	0.3	min
Speed	15.6	km/hr
Cabin capacity	8	Seating
Crush capacity	16	Seating + stand
Line capacity	1,464	Pax / hr /dir
Crush capacity	2,928	Pax / hr /dir
Operation	14	hr
	0800 – 2100 hrs	All days
Power requirement	380	kW

System Costs (for Three Scenarios)

180. For the ropeway cost estimates, THREE different scenarios were considered:

(i) the full east-west ropeway (Thuampui to Solomon's Temple, 5.5km);

(ii) the short east-west ropeway (Thuampui to CMO's office, 2.4km);

(iii) north-south alignment (Durtlang to Zemabawk, 7.5km).

Similarly, passenger demand and revenue forecasts were prepared for the three scenarios and used in the financial analysis. The reason was to test which of the three ropeway alignments gave the best returns.

181. **Unit costs:** The per-kilometer capital cost for the ropeways was assumed to be Rs. 100 crore/km (approximately $15.4 mill/km). This figure was obtained from considering: (i) unit costs of ropeways internationally, particularly Medellin Columbia and La Paz Bolivia; (ii) a recent cost estimate for a proposed ropeway in Kohima, Nagaland; (iii) detailed information on ropeways from CERTU and CETE.[10] In adopting this figure, the consultants have tried to be cautious. (For cost, refer Table 4.14).

182. **Detailed cost breakdown and O&M costs:** For the capital cost breakdown and the O&M costs, reference was made to the recent Kohima ropeway proposal, which assumed total O&M costs as 9% of total capital costs, escalated for inflation. (Refer Table 4.17).

[10] "Transport par câble aérien en milieu urbain" by Centre d'études sur les réseaux, les transports, l'urbanisme et les constructions publiques (CERTU) and Centre d'études techniques de l'équipement (CETE).

Table 4-14: Capital cost estimates of alternative ropeway routes

No.	Component	Cost per route (Rs Crore)		
		E-W Long	E-W Short	North South
1	Length of system (km)	5.50	2.40	7.50
2	System components	245.79	139.43	335.16
3	Rotatable spares	26.30	14.92	35.86
4	Demolition / Compensation	6.05	3.43	8.25
5	Civil Work	45.75	25.95	62.38
6	Stations	145.08	82.30	197.84
7	Project development / Supervision	34.09	19.34	46.49
8	Project Consultancy (5%)	25.15	14.27	34.30
9	Preoperative Expenses	2.42	1.37	3.30
10	Insurance	3.36	1.91	4.58
11	Contingency (3%)	16.02	9.09	21.84
	Total	**550.00**	**312.00**	**750.00**
12	Land acquisition for stations	0.30	0.60	1.00
13	Rehabilitation & Resettlement	0.18	0.36	0.60

183. **Land acquisition costs:** The land acquisition cost was estimated by the consultants from local enquires about land prices in various areas of Aizawl (though land acquisition is only a small proportion of the total ropeway costs).

Table 4-15: Operation and maintenance cost of alternative ropeway routes

Sl. No.	Component	1st Year O & M (Rs Cr)			15th Year O & M (Rs Cr)		
		E-W Long	E-W-Short	North-South	E-W-Long	E-W-Short	North-South
1	Power Expenses	8.38	4.75	11.43	9.63	7.96	19.13
2	Operating Expenses	30.57	17.34	41.69	35.14	23.40	56.25
3	Maintenance	6.11	3.47	8.33	7.02	1.87	4.50
4	Major Maintenance	0.00	0.00	0.00	21.78	9.36	22.50
5	Insurance	2.99	1.70	4.07	3.43	2.81	6.75
6	Contingencies	1.43	0.81	1.96	1.65	1.40	3.38
	Total	**49.5**	**28.08**	**67.50**	**78.66**	**46.8**	**112.50**

184. **Implementation Plan:** The implementation plan for the east-west ropeway assumes that the ropeway could be operational within five years (2021), following feasibility study, design, procurement and construction. The proposed implementation plan is given in Table 4.18.

Table 4-16: Implementation plan for full east-west ropeway

		2016	2017	2018	2019	2020	2021
		Feasibility & Bidding	Design	Procurement	Construction	Construction	Start Operation
Component	**Sub-component**		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Yr 1**
Ropeway installation	System components			100%			
	Rotatable spares (1 year)			100%			
	Demolition / Compensation			33%	33%	33%	
	Civil Work			33%	33%	33%	
	Stations			33%	33%	33%	
	Project development / Supervision		25%	25%	25%	25%	
	Project Consultancy		100%				
	Preoperative Expenses				50%	50%	
	Insurance		100%				
	Contingency			33%	33%	33%	
Operation	Power Expenses			20%	20%	20%	100%
	Operating Expenses						100%
	Maintenance						100%
	Major Maintenance						
	Insurance						100%
	Contingencies						

Ropeway Fares

185. For the economic and financial assessment (Chapter 6), passenger demand and revenue from fares (and other sources) was estimated. The ropeway fare structure was selected based on the current bus fare, taxi fare and shared-taxi fares for similar distances in Aizawl, and is shown in Table 4.19.

Table 4-17: Proposed fare structure (2015 prices)

Stage	0-1 km	1-3 km	>3km
Rs	20	40	60

Note: In the economic and financial analysis (Chapter 6), the above fares were increased by about 5% per annum up to the start of operation (assumed in 2021), to allow for annual price inflation.

Passenger Demand

186. Future passenger demand is very difficult to predict because of the limited availability of traffic counts for east-west roads, and also uncertainty about existing and future population levels. A rough estimate was made using traffic counts from three locations: Bawngkawn (on the national highway), where the consultants commissioned a 16-hour count; Vaivakawn (where the consultants commissioned a 2 hour turning count) and Armed Veng (the latter based on 2007 traffic data from the Mobility Plan and factored up to 2015).

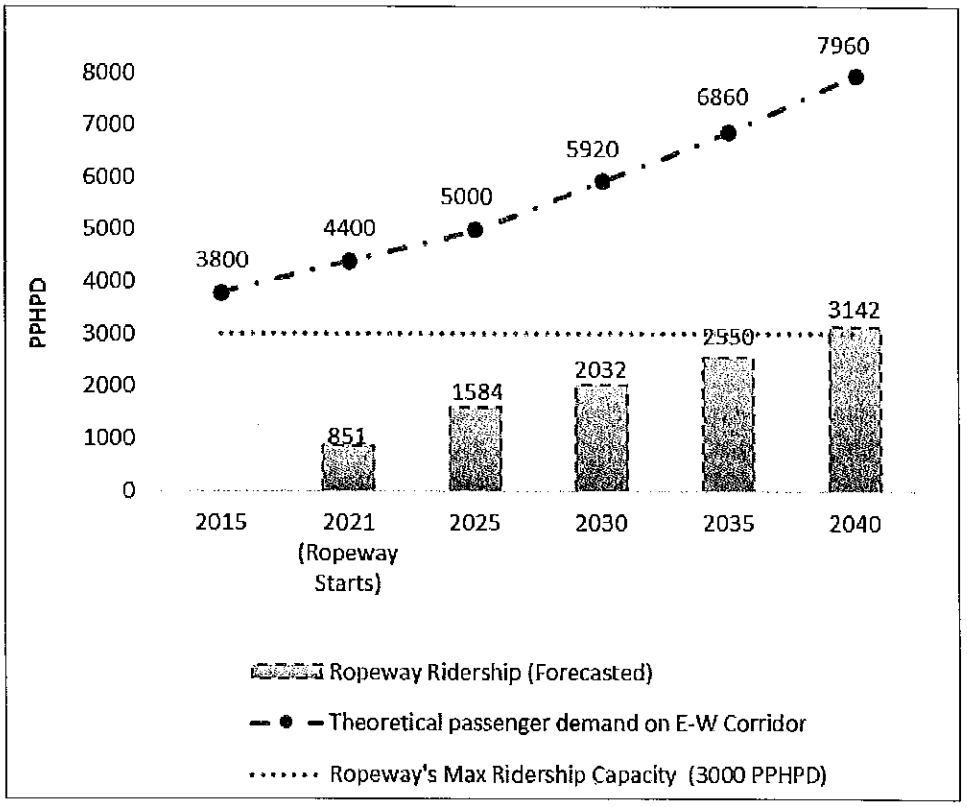
187. The traffic data was then projected forward at 3% growth per annum, and assumptions made about the extent of modal shift to the ropeway and the level of 'induced travel'. The results are presented in Figures 4.11 and 4.12 below.

188. The consultants' estimates suggest that:

- The current peak passenger demand (all modes) on the east-west corridor is around 2,400 people per hour per direction (pphpd) on the short section (Thuampui to city centre), and 3,800 pphpd on the long section (effectively two separate arms which meet in the centre).
- The short east-west ropeway would still be only half its capacity of 3,000 pphpd after fifteen years (2035).
- The long east-west ropeway appears to be better utilized, but this is because of adding together the passenger traffic on the two arms. However, at the centre of Aizawl the ropeway passenger volumes would be close to capacity (3,000 pphpd) after fifteen years.
- In both cases the ropeway will make a significant contribution to total passenger demand on the east-west corridor – about one-third of total demand by 2035.

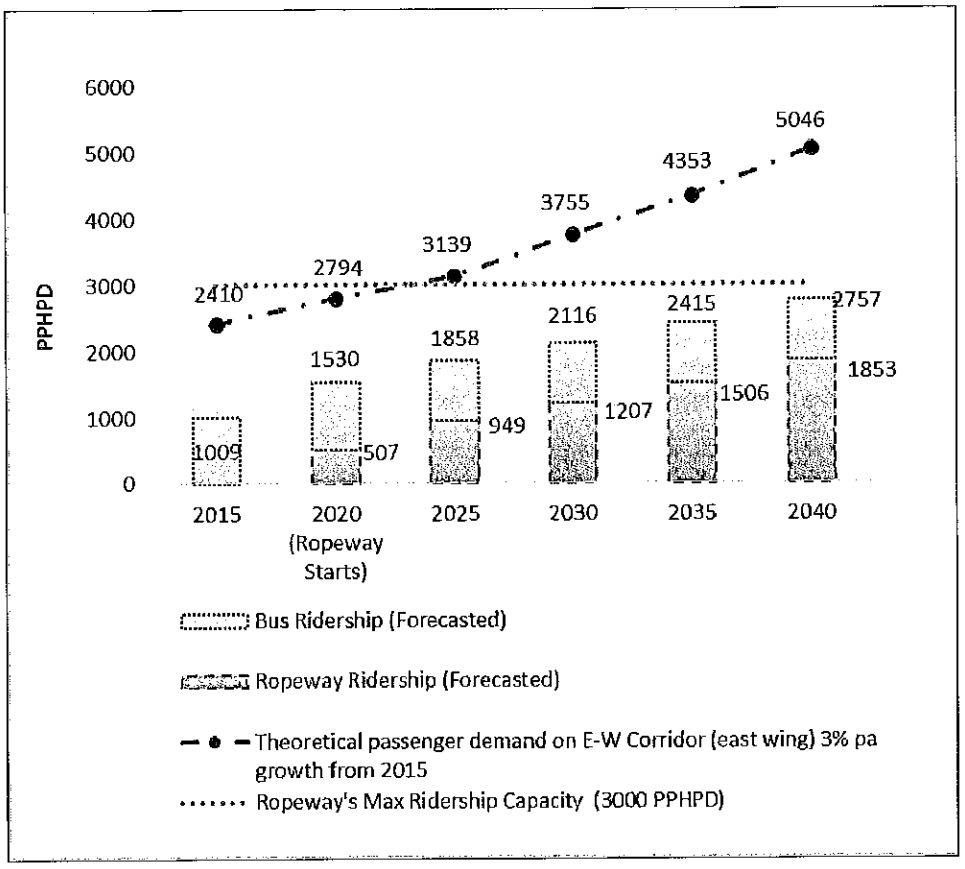
189. A full economic and financial analysis is given in Chapter 6.

Figure 4-11: Projected ridership on LONG east-west ropeway compared with total demand



pphpd = Passengers per hour per direction

Figure 4-12: Projected ridership on SHORT east-west ropeway compared with total demand



pphpd = Passengers per hour per direction

190. The cost details of three ropeway options are given in Appendix 4.5. The power requirement for the proposed ropeway is given in Appendix 4.7 and wind effect on ropeways is presented in Appendix 4.8.

Projected Revenues

191. Revenue for the ropeway package was estimated considering daily ridership, average length of travel, proposed fare structure at constant price and considering 345 days of operation in a year (allowing 10-15 days in a year for maintenance and five days of closure due to wind and power supply issues).

192. Nearly all of the revenues come from passenger fares. A small amount of revenue is expected to come from commercial development, advertising and parking at the station area. The projected revenues (all sources) are shown in Table 4.20.

Table 4-18: Projected annual revenues and O+M costs of three ropeway options

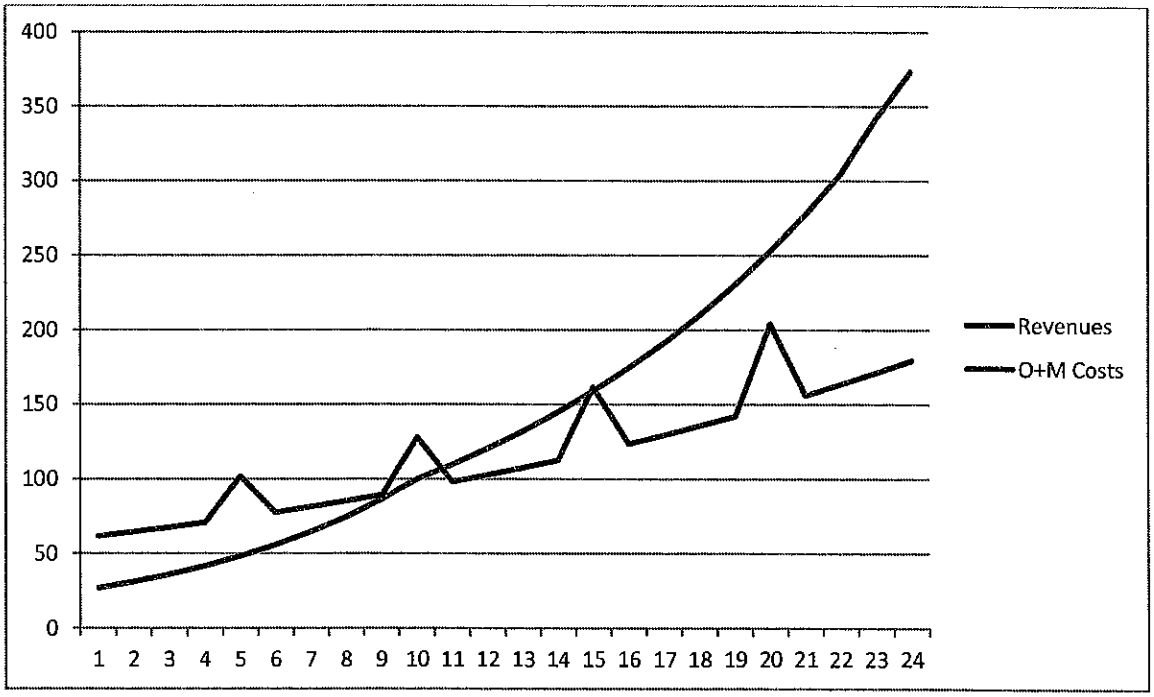
Year from Starting	East-West Long (Rs. Cr.)		East-West Short (Rs. Cr.)		North-South (Rs. Cr.)	
	Annual Revenues	Annual O+M Costs	Annual Revenues	Annual O+M Costs	Annual Revenues	Annual O+M Costs
2	34	64	16	38	40	89
6	59	77	32	49	62	108
11	114	98	60	61	106	136
16	179	123	93	77	156	171
21	283	156	145	97	231	216
25	409	257	208	137	316	299

For data source, see Volume 3, Appendix 6.2, Tables (4), (6) and (8). See also Fig. 4-13 below.

193. Comparing projected revenues with annual O&M costs for the three alternative ropeway alignments, it appears that initially none of the options would cover their operating costs. However, in time all three options would recover their O+M costs, and the proposed option (East-West Long Route) performs best in this regard, with revenues exceeding O+M costs after about ten years. (See Figure 4-13).

194. Further details of econcomic and financial viability are given in Chapter 6 (Economic and Financial Assesstment), and also in Volume 3, Appendix 6.

Figure 4-13: East-West LONG Ropeway – Projected annual revenues and O+M costs



Note: Cost figures (vertical axis) are in Rs. Crore

Land Value Capture and Transit-Oriented Development

195. One of the main benefits of constructing an east-west ropeway is to decentralize development away from the congested centre of Aizawl. If a ropeway goes ahead, it will have a significant impact on land and property values both around the stations and in the outlying areas that become more accessible because of the mass transit system.

196. There will be potential for the government agencies in Aizawl, especially the Aizawl Municipal Corporation, to tap into this rise in land values, to capture some of the increase for the public benefit and also to help offset the costs of the mass transit in the long-term.

197. **Land Value Capture** is an innovative technique through which some of the increase in the property value is pooled into the municipal finances to offset the incurred costs of developing the transport. Areas around the proposed transit stations can be expected to witness a surge in property prices, due to growing urban demand. To capture this rise, the current taxation policy of Aizawl Municipal Corporation needs to be revisited.

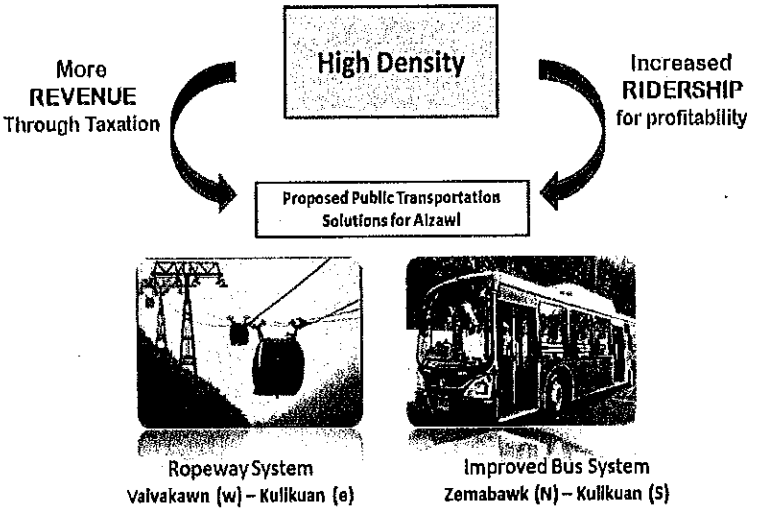
198. There are many case studies in India and worldwide where the land near the transit corridors (the zone of influence) has been taxed and funds paid into the fund for setting up the transport systems. One such example is the BRTS project near Pune (see Box).

Pimpri Chinchwad Municipal Corporation (PCMC) had developed a 130 km of bus based (BRTS) mass transit corridors and has set up an Urban Transport Fund (UTF) to fund the project. The UTF is managed by a SPV wholly owned by PCMC.
A zone of 100 meter on either side of the corridor is designated as BRT influence zone.

- Loading of Transferable Development Rights (TDR)
- Building permission Charges in the zone
- Incremental Property Taxes
- Advertisements and lease of utility ducts

199. In Aizawl, the land rates are much higher along the north-south ridge compared to the lower areas in the valley and the land rates are expected to increase with the new public transportations systems. A suitable influence zone near these new transit corridors should be identified and earmarked in the master plan as the primary influence zone and these areas should be developed as high density corridors with mixed land use.

200. Higher density would mean more Floor Area Ratio (FAR) and more revenue earnings (to be collected by AMC and passed on to the agency/corporation set up for ropeways). Ridership can also be improved by high density developments in the catchment areas. Maximum density has to be ascertained by considering the geology, soil bearing capacity, existing support urban infrastructure, road width and other important considerations.



201. Aizawl is a relatively small sized city; therefore heavy taxation of zones near public transport may not be justified. A good approach would be to increase the property taxation of the entire city by a uniform

rate, with relatively higher rates for the transit influence zone. The idea is that citizens living near the transit corridors shouldn't be overly burdened but at the same time the monetary benefits that's accrued due to rise in property rates has to be shared with the city.

202. **Revenue Potential at Stations:** The proposed ropeway project is expected to have 9 stations. It is estimated that at least 4,500 m² of the station area can be used for commercial development or leased out as office spaces or for parking (Refer Table 4.21). The potential earning in a year is estimated at Rs. 1 crore, which could probably offset some of the maintenance costs.

Table 4-19: Estimation of revenue potential at ropeway stations

Sl. No	Station Name	Plot Area (m²)	Built-up on GF (m²)	Floors	Total B.U.A (m²)	Area for Revenue Generation (m²)	Revenue Source
1	Thuampui (Terminal)	500	425	3	1275	425	Office/Commercial/ Parking space
2	Ramlun	500	425	3	1275	425	Commercial/Parking
3	Armed Veng	800	680	3	2040	680	Commercial/Parking
4	Powerhouse (proposed interchange)	400	340	4	1360	680	Commercial/Parking
5	CMO (Docking station)	1500	1275	2	2550	1275	Office/Commercial/ Parking space
6	Vaivakawn	350	298	3	892.5	298	Commercial/Parking
7	Zotlang	tbc					tbc
8	Luangmual	tbc					tbc
9	Solomon's Temple (Terminal)	800	680	3	2040	680	Commercial/Parking
	TOTAL					4463	

Note: Commercial and office rentals in Aizawl assumed as Rs. 172/m² per month

5. ECO-FRIENDLY PUBLIC TRANSPORT OPTIONS

A. Review of Existing Situation in Aizawl

203. The project's terms of reference instructed the consultants to:

- Propose any applicable eco-friendly transport modes for public buses and taxis.
- Propose investment plans for related infrastructure such as charging stations and vehicle maintenance workshops.
- Assess briefly the medium/long term impact of such vehicles' usage on the urban environment.

204. The main reasons for seeking to promote eco-friendly transport in Aizawl include:

1. To improve air quality for Aizawl's residents by reducing toxic emissions that affect health and mortality (e.g. carbon monoxide, nitrous oxides, sulphur dioxide, hydrocarbons, particulate matter, lead, etc.);
2. To reduce greenhouse gas emissions (such as CO2, nitrous oxide, methane and others) that are contributing to global warming;
3. To reduce dependency on imported fuels, especially imported oil and gas;
4. To increase long-term economic security by moving towards renewable, sustainable energy sources.

205. To assess the most appropriate measures, the consultants reviewed the national and international literature to identify a 'long-list' of potential eco-fuels and vehicle types, and then carried out a rapid assessment of their suitability for Aizawl. The details were presented in the Initial Assessment Report and also in Appendix 5.1 of this report.

206. The consultants also interviewed government officers, bus and taxi operators and oil company personnel to gather information about vehicles, fuels, and regulatory processes in Aizawl. The interviewees included:

- Government organisations: Mizoram Pollution Control Board; Dept. of Transport; SP Traffic; Mizoram State Transport Authority; Zoram Energy Development Authority (ZEDA).
- Bus / taxi operators: Aizawl Bus Owners' Association; Aizawl Line Bus Association; Zoram Taxi Drivers' Association.
- Oil company representatives: IOCL Area Manager; HPCL Sales Manager.

207. The most likely options (the 'short-list') were then examined in greater detail, and the results and recommendations are presented in this report. First, however, the existing situation in Aizawl with regards to vehicles, fuels and regulatory mechanisms is reviewed below.

Overview of Existing Vehicles and Fuels

208. **Vehicle Fleet:** Currently there are about 106,000 vehicles in Aizawl.[11] Of these, nearly two-thirds (67,000) are two-wheelers and about 22% (24,000) are light motor vehicles, mainly private cars. Taxis and light goods vehicles together account for a further 9%, with about 4,500 vehicles each. There were 600 buses registered in the district in 2015, of which half belonged to government institutions (i.e. not for general public use). Heavy goods vehicles accounted for about 2,400 vehicles.

209. **Fuels:** Two types of fuel are available in Aizawl – petrol and diesel. All of the two-wheelers are powered by petrol. Cars and jeeps are either petrol or diesel-powered (most of the jeeps, including Sumo taxis, are diesel, and most of the cars are petrol). All buses and trucks running in Aizawl are

[11] Source: Directorate of Transport, Aizawl

diesel-powered.

210. Compressed Natural Gas (CNG) and Liquefied Petroleum Gas (LPG) for vehicle use are not available in Aizawl, though LPG cylinders are widely available for domestic purposes, brought in from Guwahati and sold at a subsidized price.

211. **Fuel Distribution:** There are 12 vehicle fuel stations in Aizawl city, which sell both diesel and petrol. Except for one, all are supplied by the Indian Oil Corporation (IOC) from Bethuchi in Guwahati. The other station, at Singson on Sairang Road, is supplied by Hindustan Petroleum.

Emission Standards and the Regulatory Infrastructure

212. **Bharat Emission Standards:** Emission standards for new vehicles in Mizoram follow the national (Bharat) standards. These standards reflect European regulations and were first introduced in 2000. Since then the norms have been strengthened: in 2010 Bharat Stage III was introduced across the country and the stricter Bharat Stage IV in 15 major cities. In 2016 Bharat Stage IV standards will apply everywhere for new motorcycle models and in April 2017 for all new motorcycles. Under Bharat IV the limits for motorcycle hydrocarbon and NO_x emissions will be reduced by about 23%–60% compared with BS III, depending on motorcycle category. Similar tightening is also taking place with other vehicles, and Bharat Stage V may be introduced soon in some cities.

213. **Mizoram's Emission Standards:** Mizoram's emission standards are still Bharat Stage III, which is equivalent to the European Euro 3 standard set in 2000. (Europe has now moved on to Euro 6, requiring significantly lower levels of NOx and particulates). Hence the standard for new vehicles in Aizawl is still relatively relaxed.

214. **Emission Testing in Aizawl:** Vehicle emissions and overall air quality is monitored in Aizawl by the Mizoram Pollution Control Board, which follows guidelines issued by the Central Pollution Control Board. The Mizoram Board has an Environmental Information System (ENVIS) with data on its web site. It has four air quality monitoring stations in Aizawl, and also four vehicle emission testing stations (Table 5-1). Officially, vehicle checking is required every six months and a pass certificate must be kept by the vehicle owner. If a vehicle fails an emission test, seven days are given for repair and re-testing. Each testing centre is manned by two persons, but in practice their work is constrained by limited staff and funds.[12]

Table 5-1: Air Quality and Vehicle Emission Testing Stations in Aizawl

Air Quality Monitoring Stations	Leipuitlang	Bawngkawn	Dawrpui	Khatla
Vehicle Emissions Testing Stations	Zemabawk	Bawngkawn	Khatla	Ngaizel

Source: Mizoram Pollution Control Board. (Note: stations are shown from north to south)

215. **Air Quality in Aizawl:** Data on ambient air quality in Aizawl was obtained from the Mizoram Board, as measured at the four stations (Table 5-2). Aizawl's ambient air quality is generally quite good except for particulate matter (PM_{10} - tiny black soot particles that are associated with increased breathing difficulties, heart disease and cancer). The average monthly level of particulates in March and April was at or above the Indian standard (annual average) at three of the four monitoring stations – Khatla, Bangkawn and Dawrpui, and the maximum levels were greatly in excess of the annual mean standard.

12 If every vehicle in Aizawl was tested as per rules, each staff member would have to test about 110 vehicles per day.

Table 5-2: Ambient Air Quality in April 2015

Sl. No.	Sampling location	Observed values in µgm / m^3					
		RSPM (PM_{10})		NO_2		SO_2	
		Mean	Max	Mean	Max	Mean	Max
1	Khatla	58	88	10.1	21.5	0.5	1.3
2	Laipuitlang	32	44	0.7	4.1	0.1	0.5
3	Bawngkawn	65	91	12.3	16.9	0.1	0.7
4	Dawrpui	75	119	25.1	38.4	0.7	3.1
5	National Ambient Air Quality Standard - annual average	60		40		50	

Source: Mizoram Pollution Control Board

216. Particulate matter (PM_{10}) is closely associated with diesel engines, and the levels at some roadsides could be even higher than the monthly maximums recorded at the four monitoring stations. This is a matter for concern: people on some main roads, especially on the steep hills, experience high levels of diesel pollution that leave a black residue in the nostrils and which can be injurious to health in the long term.

217. There is a strong case, therefore, for tighter controls over existing vehicle emissions in Aizawl and encouragement of cleaner vehicles and fuels in the future.

B. Assessment of Long-List of Options for Eco-Friendly Public Transport

218. From the review of national and international literature on eco-friendly fuels, a 'long-list' of possible options for Aizawl was developed (Table 5-3). The list is long and complex and the benefits are not always clear-cut. The whole life-cycle of production, distribution, consumption and disposal of both vehicles and fuels has to be taken into account. For example, electric-powered vehicles re-charged from coal-fired power stations have a negative environmental impact. Similarly, bio-fuels obtained from specially-grown agricultural crops can reduce overall food availability and also consume energy in their production.

Table 5-3: Long-List of Possible Eco-Friendly Fuels for Road Transport in Aizawl

Serial No.	Fuel Source
1	Low-Emission Diesel
2	Hybrid Electric Battery/Diesel
3	All-Electric (Battery-Powered)
4	LPG (Liquefied Petroleum Gas or 'Auto-Gas')
5	CNG (Compressed Natural Gas)
6	LNG (Liquefied Natural Gas)
7	Bio-Fuels: (i) Bio-Ethanol; (ii) Bio-Diesel; (iii) Other Bio-Fuels
8	Ethanol, Methanol, and other Alcohols
9	Hydrogen Fuel Cell
10	Others eco-fuels: e.g. DME, P-series fuel, Purinox, Hythane

Note: Further details of the above fuels are given in Appendix 5, Volume 3

Initial Assessment – Eco-Fuels and Vehicles

219. All of the above fuels were potential candidates for Aizawl as they are already being used or tested in India and overseas. To assess their potential for Aizawl, an assessment matrix was developed which included the following criteria:

- Technical feasibility (e.g. availability of fuel and vehicles, scope for use with existing vehicles);
- Capital costs and availability of subsidies;
- Vehicle maintenance and running costs
- Impact on vehicle performance (speed, acceleration, gradients);
- Safety in fuel distribution, storage and use;
- Previous experience and level of take-up in India and internationally.

220. The various options were then assessed against these criteria, to narrow the options down to the most likely candidates. (Appendix 5.2).

221. Some options could be ruled out at an early stage because they are still too experimental, both internationally as well as in India. **Hydrogen fuel cells, DME, P-series fuel and Purinox** were in this category. For example, in 2011 there were only 100 hydrogen fuel-cell buses world-wide, and in California only about 300 FCEV's (fuel cell electric vehicles). In India, Mahindra has developed a few dual hydrogen fuel cell / diesel SUV's, but these are still at the research and development stage.

222. **Bio-fuels** [13] were also ruled out at this initial stage, for several reasons. Although it has been Government of India policy since 2009 to achieve 20% substitution of petrol and diesel consumption by bio-fuels by 2017, the take-up has been very limited, despite a number of pilot projects with city bus fleets (e.g. Bangalore, Karnataka, Haryana (Gurgaon), Gujarat, Nagpur and Chennai – see Appendix 5.3 for further details). The main reasons have been: (i) limited availability of bio-fuels (which are in competition with other commercial applications): (ii) uncertainty over supplies; (iii) limited distribution network; (iv) higher cost of bio-fuels compared with (subsidised) diesel; (v) lack of national level financial incentives to switch to bio-fuels.

223. With the limited availability of bio-fuels in Mizoram and their slow take-up in larger Indian cities despite numerous pilot projects, it was considered that this would be too much of an experimental approach for Aizawl, at least in the short to medium term.

224. **CNG and LNG** were also ruled out at an early stage due to supply constraints. LNG (Liquefied Natural Gas) comes from the same source as CNG (i.e. natural gas, mainly methane) but is stored in liquid form at much higher pressure. It is not widely available in India, and world-wide is only in the early stages of becoming a mainstream fuel for transportation needs (just starting in the USA and about 100,000 LNG-powered vehicles in China in 2014 – Wikipedia). Its relatively high cost of production and need for storage in expensive cryogenic tanks has prevented its widespread use in commercial applications.

225. **CNG** would have been an obvious candidate for Aizawl, if it were not for the supply constraints. It is widely used in transport in a number of Indian cities (e.g. Delhi, Mumbai, but not Kolkata) and half of the vehicles in Pakistan run on CNG. However, the cost of developing a gas pipeline from the Assam or Tripura fields would be prohibitive and is not currently an option.

226. **All-electric vehicles:** At first these would seem a real option for Aizawl, as all-electric vehicles are manufactured in India (buses, cars and motor-cycles), and their technical performance has been tested and shown to be satisfactory, even in Aizawl. In 2011 a Reva electric car was purchased by ZEDA[14]

[13] The term 'bio-fuels' covers a wide range of liquid and gaseous fuels derived from bio-mass resources. They include ethanol and bio-diesel.

[14] Zoram Energy Development Agency

and tested for three years in the University of Mizoram Energy Park and on city roads. It was found that the car could run for 60 km on full charge and full charging took about 8 hours. The tests showed that the car was suitable for Aizawl terrain and conditions.

227. The Government of India has been promoting electric vehicles for some time, and the recent National Electric Mobility Mission Plan (2013) set a target of 5 to 7 million electric vehicles by 2020. In support of this target, various financial incentives have been introduced, including grants for electric vehicle purchase [15] and tax concessions such as VAT exemption and reduced import duty on parts.

228. However, the **all-electric vehicle option** was not included in the proposed short-list for this project, for the following reasons:

1. High capital cost of vehicles, up to double the price of petrol and diesel-fueled vehicles.[16] Availability of subsidies from Government of India has also been erratic, due to frequent policy changes.
2. Technology is still relatively new for India – for example, India's first all-electric bus was introduced only last year (2014) in Bangalore, but the pilot project was shelved because the Bangalore Municipal Transport Corporation could not afford the Rs.3cr ($0.47mill) cost of the buses.
3. All-electric vehicles are proving less popular in western countries compared with hybrid electric / petrol or diesel-powered vehicles.
4. Electric power supply in Aizawl is erratic, with demand greatly exceeding supply and frequent power cuts;
5. Electricity for re-charging is mainly drawn from coal-powered stations (71% nationally), which seriously compromises the overall environmental benefits of all-electric cars.

Options considered for the Eco-Vehicles 'Short-list'

229. The remaining three options that were taken forward to the 'short-list' of possible eco-friendly fuels and vehicles for Aizawl were:

- **Hybrid-electric powered vehicles** – This is one of the rapidly emerging technologies, both in western countries and in India, and Tata already makes the buses. Hybrid vehicles have an advantage over all-electric vehicles in that they are more flexible in re-charging requirements and range of operation. The numbers of hybrid vehicles being sold in western countries (including Japan) greatly exceeds the number of all-electric vehicles.
- **LPG** – Liquefied Petroleum Gas is already being used in Aizawl for domestic purposes, is available from Guwahati, and has been introduced in some vehicles in Kolkata.
- **Low emission diesel (for buses, jeeps and trucks)** – This is coming up fast in western countries, and depending on the national government's policies, could be a future option for new vehicles in Aizawl.

230. In addition, a fourth option is to strengthen the **existing pollution monitoring and enforcement mechanisms in Aizawl.**

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[15] Rs. 75 crore was allocated in FY15-16 for electric vehicles under the FAME scheme (Faster Adoption and Manufacture of Electric Vehicles). The grants for purchasing electric vehicles are set at Rs. 11,000 to 1.38 lakh for 4-wheel cars, Rs. 30-66 lakh for buses, and Rs. 3,500 to 29,000 for motorcycles. PTO... (9/4/2015, Anante Geete, http://www.firstpost.com/business/fame-india-govt-scheme)

[16] For example, the all-electric e-20 car produced by Mahindra retails at Rs.7.5 lakh, which is 70% more than the Maruti Swift (Rs.4.4 lakh) and 210% more than the Maruti Suzuki Alto (Rs.2.4 lakh)

C. Assessment of Short-List of Options

Liquefied Petroleum Gas (LPG)

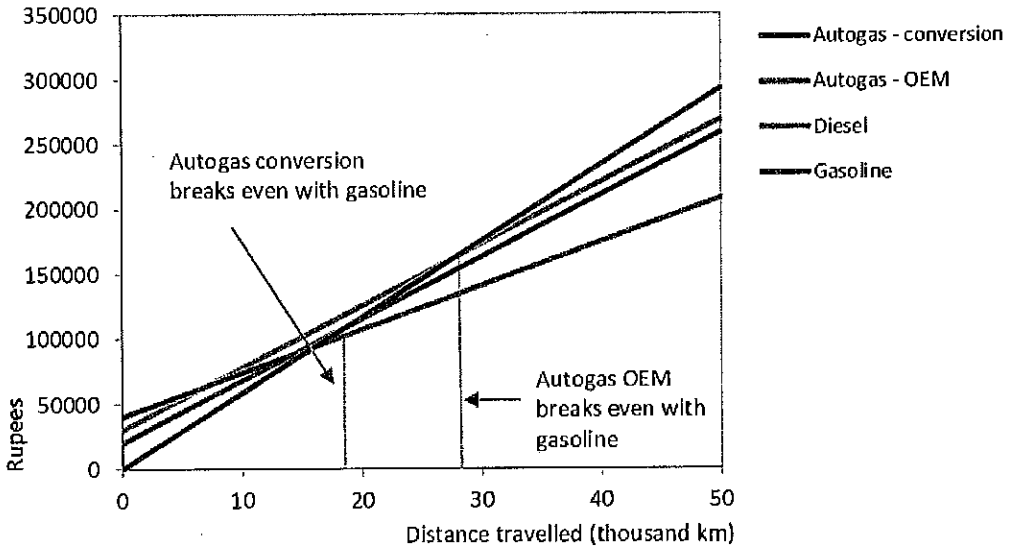
231. LPG (also known as 'autogas') would at first seem a strong possibility for Aizawl. The fuel is a mixture of propane and butane and considered a 'green' fuel because it produces fewer particulates than diesel and about 15% less CO_2 than petrol. World-wide, it is the third most widely used auto fuel after petrol and diesel (over 600 million cars), and is also widely used in India (over 2 million vehicles) where demand has grown rapidly since 2000 due to lower taxes and prices compared with petrol. LPG is produced at the oil refinery in Guwahati, Assam, and Aizawl receives LPG for domestic cooking purposes, though none for motor transport.

232. There have been many initiatives in India to convert motor vehicles to LPG: for example, in Kolkata in 2003 LPG was made mandatory for auto-rickshaws and in 2009 the city banned old buses and offered subsidies for newer buses to convert to LPG. Recently, the Kadamba Transport Corporation in Goa (KTCL) has been carrying out a feasibility study of converting its entire fleet of 543 diesel buses to LPG, primarily for air pollution reasons (rather than cheaper fuel)..

233. However, despite the above, LPG is NOT recommended for Aizawl for the following reasons:

1. The adoption of LPG as a vehicle fuel in India has been primarily due to (i) adoption being made mandatory for some vehicles, particularly auto-rickshaws (e.g. Kolkata, Bangalore, Pune and other places); (ii) LPG has been cheaper than petrol due to lower taxes.
2. However, where adoption has not been mandatory, bus operators have been reluctant to convert to LPG due to higher running costs compared with diesel. Over the past six years the price of LPG has averaged about 92% of that of diesel, and it is estimated that above 17,000 km (total distance travelled), diesel is the cheaper option (Figure 5.1).

Figure 5-1: Running costs of a non-commercial light delivery vehicle, India (2013)



Source: http://www.auto-gas.net/india#.VdNlaJem2d4, 'LPG Transport Use in India'

3. The higher operating cost is the main reason why the conversion of diesel buses to LPG in Kolkata has not been sustained, despite the availability of conversion subsidies, and almost no buses are currently using LPG.
4. Distribution of LPG for vehicle use in Aizawl would require setting up filling stations, and the distribution costs would be high. There is also a risk of subsidized domestic LPG being illegally used as auto-gas in petrol-driven vehicles. This has been a widespread problem in India in

recent years, with actual auto-gas use probably three times higher than the official auto-gas sales (source: as for Fig. 5.1). Illegal bottling of LPG cylinders for auto-gas use is highly dangerous and should not be encouraged.

5. Discussions with representatives of the India Oil Company, the main producers and distributors of LPG in India, indicated that they have no plans to distribute LPG for vehicle use in Aizawl due to the above reasons (cost, safety, etc.), and so this option is not recommended for this project.

Hybrid-Electric Powered Vehicles

234. Hybrid electric powered buses are appearing in many countries, especially in developed countries, though they are still somewhat experimental and not yet seen on a large scale. They are now manufactured in India by both Tata and Askok Leyland (in larger 32-seater versions, both diesel-electric and CNG-electric), and the manufacturers claim a 30% reduction in emissions. The hybrid electric buses are also eligible for government grants under the FAME programme (see Appendix 5.3).

235. However, hybrid electric buses are not recommended for Aizawl, for the following reasons:

1. Smaller sized hybrid electric buses (similar to the Tata 407's and Starbuses used in Aizawl) are not yet available in India, and unlikely to be manufactured here for some time due the limited demand for this size of bus.
2. Hybrid electric buses are significantly more expensive than ordinary diesel-powered buses, even in developed countries. With smaller sized buses currently unavailable in India, the vehicle cost would be even higher.
3. The newness of the technology also brings risks in terms of vehicle performance and repairs and maintenance. In London, a recent programme to introduce 500 hybrid-electric double-decker buses, about 6% of the city's total bus fleet, encountered major technical problems with the electric batteries, leading to under-performing buses and complete replacement of the batteries by the manufacturers. In Aizawl, any technical problems would be compounded by the relative under-development of the local motor industry, which would struggle to address any major problems.
4. The electricity supply in Aizawl is very erratic, with demand exceeding supply and frequent power cuts. Re-charging of the electric batteries could be problematical during daytime.

236. Overall, it is considered that introduction of hybrid electric buses in Aizawl would involve substantial additional costs, both in vehicles and supporting infrastructure; and also significant technical risks relating to vehicle performance and repairs and maintenance.

237. The consultants also do not recommend small-scale pilot testing of hybrid-electric buses in Aizawl; this would be more suitable for larger cities in India with bigger bus fleets and more extensive technical support.

238. Regarding taxis, the hybrid electric vehicles would not be suitable for the Sumo inter-district taxis, which make long distance trips to and from Aizawl. For the petrol-driven city taxis, the hybrid electric technology might be constrained by limited space for batteries in the smaller vehicles (Maruti 800, Alto 800 and others); also, the environmental gains of replacing petrol-driven vehicles with hybrid-electric vehicles would be limited.

Low Emission Diesel

239. There is a major trend around the world to reduce sulphur levels in diesel fuel, giving two main benefits: (i) reduction in black soot particles, one of the main emissions of diesel fuels; (ii) enabling wider application of emission-reduction technologies (which do not work with high sulphur fuels).

240. Ultra-low sulphur diesel has a sulphur content of 15 parts per million (ppm) or less, and has been

standard in Europe for several years and also in the USA since 2010. In India, up to 2010 most diesel fuel had a sulphur content of 500 ppm. Interviews with Indian Oil representatives indicated that the diesel currently supplied to Aizawl is of Bharat Stage III (BS III) standard with sulphur levels below 350 ppm. Twelve large cities in India are currently receiving diesel fuel to BS IV standard (50ppm), and BS V standard (10ppm) is scheduled for introduction in 2020.

241. Indian manufacturers of heavy-duty diesel vehicles have generally utilized one of two emission-reduction technologies to achieve compliance with BS-IV. One technology, Exhaust Gas Recirculation or EGR, focuses on reducing emissions from within the combustion chamber while the other, Selective Catalytic Reduction or SCR, focuses on post-treatment of exhaust gases. Although both technologies are effective at reducing pollution emissions, SCR technology has been more popular in India for two reasons: (i) more fuel-efficient; (ii) limited availability of low sulphur diesel for EGR engines.

242. The unavailability of low sulphur fuel has therefore prevented widespread adoption of EGR in India, and SCR has been the dominant BS-IV technology for buses in large Indian cities.

Recommendations

243. In Aizawl, BS IV standard diesel will be introduced after a few years, according to Indian Oil representatives. For this project, it is recommended that:

1. The introduction of BS IV standard diesel is brought forward on a priority basis.
2. BS V standard diesel is introduced at the same time in Aizawl as in larger cities elsewhere in India.
3. Any major purchases of buses for Aizawl should include a requirement for emission-reduction technology to be incorporated in the vehicle specification.
4. When BS IV diesel becomes available in Aizawl, then a 'low emission zone' should be declared in the city's central area and all vehicles entering the central area must be BS IV compliant.
5. Immediate steps should be taken to strengthen the pollution monitoring and vehicle testing capability in Aizawl, involving particularly the Mizoram Pollution Control Board, the Department of Transport and the Traffic Police (see Section D below).

D. Strengthening of Existing Regulatory Processes for Pollution Control

244. Responsibility for control of vehicle emissions in Aizawl primarily involves three organisations:

- Mizoram Pollution Control Board – monitoring air quality and carrying out six-monthly emission tests on all vehicles;
- Department of Transport – registration of drivers and motor vehicles, issuing annual vehicle fitness certificates, and issuing route permits (on behalf of the State Transport Authority);
- Traffic Police – enforcement of traffic rules and vehicle fitness, including black smoke prevention.

245. Other relevant agencies include the Consumer Affairs Department (monitoring filling stations for fuel adulteration), Aizawl Municipal Corporation (trade licenses and operation of bus and truck terminals), and the state-owned oil companies (fuel standards and distribution).

246. Currently taxis, buses and trucks are required to have a fitness certificate from the Transport Directorate once a year and pollution certificate from the PCB twice a year. However, there are questions about the level of enforcement: according to various transport operators, emission checks are rarely done, and vehicles are almost never stopped for emitting black smoke. Replacement of taxis and buses does not happen regularly and buses older than10 years are allowed to ply on the road, causing air pollution. Transport operators also identified an issue regarding adulteration of diesel and petrol.

247. While the introduction of improved fuel vehicle technology depends on national level policies, a significant improvement to air quality (especially PM10's) can be achieved locally by improved the checking, monitoring, and enforcement of existing rules regarding vehicle fitness and vehicle emissions.

248. Improved traffic management and demand management can also make a significant contribution. For example, a shift in demand from private vehicles to cleaner public transport will reduce per capita emissions, and other traffic management measures such as reducing the extent to which taxis drive around the city looking for parking spaces (because they are greatly restricted in where they can wait for passengers) will also help to reduce emissions and improve air quality.

Recommendations (for improved monitoring, enforcement and control of vehicular pollution)

249. Recommendations for improvement in local monitoring and enforcement:

Department of Transport:

1. Strict enforcement of vehicle maintenance during fitness test.
2. More liberal approach to replacement of buses / taxis at regular and defined intervals.
3. Discontinuation of vehicles more than 10-15 years old, with proper enforcement.
4. Training to Dept. of Transport staff in air quality issues and national pollution control policies

Pollution Control Board:

5. Strict monitoring of pollution clearance certificates, especially on heavier and older vehicles (buses, trucks, maxi-cabs).
6. Checking of emission of trucks or checking current emission certificates at entry points to the city and imposing fines if standards are not met.
7. Expansion of PCB staff and supporting equipment, with training in the use, maintenance and quick repair of emission testing machines.
8. Setting up mobile emission check points by awarding contracts to private test agencies.
9. Adoption of Bharat Stage IV standards for all new vehicles in Aizawl.

Traffic Police:

10. Taking action on vehicles emitting black smoke.
11. Regular spot checks on vehicle fitness certificates and pollution certificates.
12. Training to police personnel in emission standards and pollution control.

General Traffic Management:

13. Establishing a 'Low Emission Zone' in Aizawl's central areas, with tougher controls and restrictions on badly-polluting vehicles entering the zone.
14. Other traffic management measures, such as a tougher approach to private on-street parking (fewer spaces and higher charges), and a more flexible approach to taxi parking.
15. Supporting the introduction of private radio taxi services or a mobile application service for on-demand taxis so that number of taxis driving around can be reduced.

6. ECONOMIC AND FINANCIAL ASSESSMENT

A. Introduction

250. The project's terms of reference instructed the consultants to: 'Conduct economic analysis of the proposed medium to long terms investment projects as a part of pre-feasibility studies, and conduct a financial sustainability assessment including budget assessment of the Mizoram Government to implement the proposed investments and plans'.

251. This chapter presents the consultants' economic and financial assessment of the two main proposals for medium to long-term improvements, namely:

1. **Bus system** improvements on the north-south corridor, Zemabawk to Kulikawn, length 10km, plus lesser improvements to east-west bus services. (This is described as the Core Bus Package)[17]
2. An **east-west aerial ropeway** between Thuampui and Chawwlhhmun (Solomon's Temple), length 5.5km.

252. In the event that alternative ropeway alignments might be more profitable or more affordable to the Government of Mizoram, two other ropeway alignments were also assessed for their economic and financial viability:

3. A **shorter east-west ropeway** between Thuampui and the centre of Aizawl near the Chief Minister's Office (the 'short' E-W option, length 2.4km);
4. A **north-south ropeway** between Durtlang and Kulikawn (length 7.5km).

B. Approach to the Assessment

253. The analysis in this chapter was undertaken in accordance with the available guidelines, including Guidelines for the Economic Analysis of Projects, and Framework for the Economic and Financial Appraisal of Urban Development Sector Projects.

254. The approach is complex, and involves many uncertainties and assumptions: for example:

- Future population and traffic growth rates?
- Existing and future traffic volumes on particular roads?
- Willingness of passengers to adopt the public transport modes (depending on cost, speed, convenience, comfort, etc).
- Cost of the infrastructure – capital costs and operating costs? Since mass transit ropeways are not yet operating in India, there is no good data on which to base the project costs. For example, internationally, the unit cost of constructing urban transit ropeways has varied from $13m per km (Medellin, Columbia) to $88m per km (London). In Kohima, a recent ropeway proposal was costed at Rs.95 crore per km (approx. $14.7m per km). For this Aizawl project, a unit cost of Rs.100 crore per km was assumed (approx. $15m per km).
- How to value the benefits? For example, some major benefits such as cleaner air due to less polluting transport and decentralizing Aizawl's urban development are not easily measured or costed, and thus not included here.
- What discount rate to use? A high discount rate emphasizes short-term costs and profitability

[17] The Core Bus Package was presented in the Draft Final Report in January 2016. Subsequent feedback from the Government of Mizoram resulted in a Supplementary Bus Package being added to the overall bus proposals, which includes three longer bus routes to the Airport, new railway terminus at Sairang and new Referral Hospital at Falkawn, plus increased emphasis on modern bus technology (ticketing, GPs, etc) – see Chapter 4 above. The economic and financial analysis in this Chapter 6 refers to the Core Package only.

but puts a lower value on long-term benefits (including sustainability).

255. Details of the methodology adopted for the economic assessment are given in Appendix 6.1. Here, the conclusions of the assessment are summarized.

C. Economic Analysis

256. Some of the key inputs and assumptions for the economic assessment are given in Table 6.1.

Table 6-1: Key inputs and assumptions for the economic assessment

Base Year	2015
Starting Year	2020 (buses), 2021 (ropeway)
Operating Period, for assessment purposes	30 years (to 2050)
Discount Rate (economic opportunity cost of capital)	12%
Financial values converted to economic values	Shadow wage rate factor (SWRF), 0.8 Shadow exchange rate factor (SERF) , 1.03 After adjusting for unskilled labor, foreign cost, and removing taxes etc, the conversion factor for economic cost is worked out to 0.83
Growth rate for working population in Aizawl	2.1% per annum
Value of work time (per hour) – for estimating the value of travel time savings	Rs 46.79 per hour
Value of non-work time (per hour)	Rs.14.04 per hour
Vehicle operating costs (Rs.per km) – for estimating the vehicle operating cost savings	Various – see Appendix 6.1 e.g. Two-wheelers, Rs.2.3/km; Cars, Rs.6.7/km; Taxis, Rs.7.7/km; Buses, Rs.26.9/km

257. The financial cost of the ropeway options was based on an assumed unit cost of Rs.100 crore per km ($15m per km). For the east-west short corridor option, a higher unit cost of Rs.130 crore/km was adopted, as it was assumed to be designed with capacity for future extension.

258. The financial cost of the bus option was obtained by summing the cost of the various package components (e.g. cost of buses, traffic signals, etc). The financial and economic costs are shown in Table 6.2.

Table 6.2: Details of Project Financial and Economic Costs, (2015-16 prices)

Details	Length (Km)	Financial Cost (Rs. Million)	Economic Cost (Rs. Million)
1. Bus Corridor Core Package	10	1541.59	1280.6
2. Ropeway Corridor Package:			
• East-West Long Corridor	5.5	5501.8	4586.0
• East-West Short Corridor	2.4	3123.6	2603.7
• North-South Corridor	7.5	7506.0	6256.66

*Note: * - Land acquisition costs and applicable taxes are excluded for Economic Analysis. Also shadow price for unskilled labour wages and import cost were considered for economic cost conversion.*

Project Benefits

259. The proposed options can be expected to divert passengers from the existing modes like car, two wheeler and taxis due to better speed and comfort. The improvements will benefit the users in terms of better service quality and reduced travel time. Accordingly, the economic benefits considered in the present analysis include:

- Bus Corridor Package:
  a. Value of Travel Time Savings
  b. Value of vehicle operating cost (VOC) savings
- Ropeway Corridor Package:
  a. Value of Travel Time Savings
     i. For passengers who shift to ropeway
     ii. For the remaining road users due to reduction in congestion
  b. Value of vehicle operating cost (VOC) savings
     i. For passengers who shifted to Ropeway
     ii. For the remaining road users due to reduction in congestion

260. The above economic benefits were estimated on an annual basis for each of the options.

Results of the Economic Analysis

261. As part of the economic analysis, the feasibility parameters and the results of sensitivity tests are shown in Table 6.3. A more detailed economic feasibility analysis is given in Appendix 6.1.

Table 6-2: Summary of Economic Analysis Results

Details	EIRR %	ENPV INR Million @ 12%	Economic Benefit-to-cost Ratio	Switching Value %
A. Core Bus Package				
Base Case	**19.1%**	**509.39**	**1.340**	
20% Construction Cost increase	16.3%	357.12	1.217	67%
20% O&M Cost increase	17.1%	362.40	1.221	69%
20% Benefit decrease	13.6%	108.25	1.072	25%
Delay in operation by one year	15.4%	286.05	1.191	
B. Ropeway Package				
OPTION 1: East West Long Corridor				
Base Case	**24.9%**	**5,632.50**	**2.230**	
20% Construction Cost increase	22.5%	5,134.34	2.011	226%
20% O&M Cost increase	23.7%	5,214.83	2.044	270%
20% Benefit decrease	20.7%	3,590.18	1.784	55%
Delay in operation by one year	21.2%	4,442.41	1.970	
OPTION 2: East West Short Corridor				
Base Case	**17.6%**	**1,272.37**	**1.468**	
20% Construction Cost increase	15.9%	989.55	1.329	90%
20% O&M Cost increase	16.3%	1,010.94	1.339	97%
20% Benefit decrease	14.2%	473.64	1.174	32%
Delay in operation by one year	15.3%	807.71	1.297	
OPTION 3: North South Short Corridor				
Base Case	**15.7%**	**1,674.07**	**1.266**	
20% Construction Cost increase	13.9%	994.44	1.143	49%
20% O&M Cost increase	14.3%	1,093.97	1.159	58%
20% Benefit decrease	12.2%	79.53	1.013	21%
Delay in operation by one year	13.5%	769.08	1.122	

262. The evaluation found that all of the proposed medium-to-long-term improvement packages were

economically viable, with their calculated EIRR values exceeding the economic opportunity cost of capital (EOCC) of 12%. The sensitivity analysis demonstrated the robustness of these results, along with the identification of risk areas which need to be focused on during implementation. For the ropeway options, the East-West Long Corridor (Thuampui to Chawlhhmun) was found to be the preferred one with a higher EIRR among the three options considered, though the remaining two options were also found feasible with EIRR more than the minimum required 12%.

263. Furthermore, for the proposed investment, the calculated EIRR value is considered a minimum estimate of the economic return, as there are other economic benefits such as travel comfort, tourism benefits, decongestion and reduction in accidents on the impacted road corridors, dispersal of city growth and environmental improvements that have not been quantified.

D. Financial Analysis

264. Financial Analysis of a project generally consists of (i) Project Analysis, and (ii) Entity Analysis.

(i) Project Analysis: This analysis will be made only for the project which generates revenue. In order to ascertain the self-sustenance of the remunerative project, a separate project cash flow will be prepared and an assessment would be made based on the financial indicators such as FIRR, NPV and debt service ratios.

(ii). Entity Analysis: wherein the financial strength and the capacity of the organization who implements the project will be assessed based on the past financials,

265. In this case, the identified projects (Bus Way and Rope Way) are revenue generating and hence project analysis will be carried out. Further the project will be implemented by the state government. Even though the projects generate revenue, there are risks associated with the revenue. Hence, in case of shortfall in revenue to meet the expenses then the project has to depend on its owner, in this case the state government. Thus entity analysis will be carried out on the state government's financial capacity based on the standards prevailing in the country for sovereign bodies.

Project Financial Analysis

266. The viability of the project depends upon

(i) Project Cost;
(ii) Passenger growth rates;
(iii) Tariff/User Charges;
(iv) Other source of income such as exploitation of real estate space both for advertisement and commercial purpose;
(v) Cost of funds; and
(vi) Tax rates

267. The main objective of the financial analysis is to examine the viability of implementing the project on PPP basis. The analysis attempts to ascertain the extent to which the investment can be recovered though the fare box income and other commercial activities. The viability of the project is evaluated on the basis of project FIRR and Equity IRR.

268. Project Cost: The base cost for the project is the engineering cost which includes contingency but excludes other expenses such as pre-operative cost, financing cost, escalation cost, and interest during construction. Based on assumptions about phasing and funding, the others costs are estimated and the landed project cost is arrived at (refer Table 6.4).

269. It should be noted that these additions to the base cost allow for uncertainties and unpredicted costs, and therefore provide a more robust estimate for the overall financial capital cost.

Table 6-3: Landed Project Cost

Components	Buses (Core Package)	Rope Way		
		EW – Long Corridor	EW – Short Corridor	NS Corridor
	Rs. in Million			
Base cost including contingency	1,536	5,500	3,120	7,500
Financing Cost	3.5	13.1	7.4	17.9
Escalation Cost	191	934	530	1,274
IDC	63	236	134	322
Landed Project Cost	**1,794**	**6,683**	**3,791**	**9,113**

Note: The above table refers to the Core Bus Package, and does not include the Supplementary Bus Package of Rs. 579 million that was added after Draft Final Report discussions with the Government of Mizoram – see Chapter 4.E, section 163 for details.

Sources of Funds

270. The existing multilateral funding practices are assumed for the present project. Accordingly, ADB will fund at 80:20 basis in which 80% will be ADB loan and the remaining 20% by state share. In the 80% ADB loan, 90% will be passed on to state by Govt. of India (GoI) as grant (72%) and the balance 10% of the loan i.e. 8% as loan to state, as followed for North Eastern States. Thus a total 28% of the project will be the state's responsibility and the balance 72% as grant from GoI.

271. For implementation, the state responsibility of 28% (8% loan + 20% state share) is expected to be funded through market loans with 70:30 ratio. Thus the equity participation will be of 8.4% (30% of 28%) of the total project cost and remaining 19.6% (70% of 28%) will be state loan from market. Thus the following funding pattern (Table 6.5) will result for the state that is going to implement these projects. The proposed means of finance is presented in Table 6.5.

Table 6-4: Funding Pattern

ADB Funding Pattern	
ADB Loan	80.0%
State Share	20.0%
Total	100.0%
GOI to State as per Northern Eastern States Policy	
Grant from GOI *(90% of ADB Loan)*	72.0%
State Contribution *(10% of ADB Loan + 20% State Share)*	28.0%
Total	100.0%
Final Funding Pattern to Project	
Grant from GOI *(90% of ADB Loan)*	72.0%
Second loan by State *(Internal Market Borrowing by State : 30% of State Contribution)*	19.6%
Equity by State *(State Own Fund : 70% of State Contribution)*	8.4%
Total	100.0%

Table 6.6: Means of Finance

Means	Proportion	Core Bus Package	Ropeway Package		
			EW Long Corridor	EW Short Corridor	NS Corridor
		Rs. In Million			
Equity	8.40%	150	561	318	765
Grant	72.00%	1,292	4,812	2,730	6,562
Debt	19.60%	352	1,310	743	1,786
Total Project Cost		**1,794**	**6,683**	**3,791**	**9,113**

Sources of Income

272. The major sources of income are:

(i) Fare box

(ii) Rent from commercial space in stations of rope way

(iii) Rent from advertisement space in both ropeway and road based public transport

(i) Fare Box

273. The future bus fare structure is assumed slightly higher than the existing bus fares – this reflects the improved service provided through the proposed bus package. Similarly, the proposed ropeway fares are higher than the bus fares, as it is non-conventional public transport offering a faster and higher quality service. The fare structure for 2015 is given in Table 6.7 below.

Table 6-5: Fare based on Stages (2015)

	Stage 1	Stage 2	Stage 3	Stage 4	Weighted Average
Buses (Core Package)					
% of Travellers	20%	40%	35%	5%	
Fare (Rs./Trip)	10	15	25	35	18.5
Distance (KM)	1	3	5	7	
Ropeway					
EW – Long Corridor					
% of Travellers	20%	60%	20%	-	
Fare (Rs.)	20	40	60	-	40
Distance (KM)	1	3	5.5	-	
EW – Short Corridor					
% of Travellers	30%	70%	-	-	
Fare (Rs.)	20	40	-	-	34
Distance (KM)	2	2.4	-	-	
NS – Corridor					
% of Travellers	20%	30%	50%		
Fare (Rs.)	20	40	60	-	46
Distance (KM)	2	3.5	5	-	

Note: The above fares are in 2015 prices. For the financial analysis, increases of approximately 5% per annum were added to the fares to allow for inflation up to the year of starting operations (i.e. up to 2020 for bus package and 2021 for ropeway package)

Predicted Passenger Trips on the Corridors

274. Predictions for daily passenger volumes on the alternative systems are shown in Table 6.8. They were based on estimates for stages for each corridor (see Appendix 4.4 and 4.5 for details).

Table 6-6: Daily passenger trips in starting years (2020, 2021)

	Total Passengers per Day (2-way) in Starting Year	Starting Year
Buses (Core Package)	15,080	2020
Ropeway:		
EW – Long Corridor	16,739	2021
EW – Short Corridor	10,148	2021
NS – Corridor	21,258	2021

275. Subsequent passenger growth on the different systems was then estimated with assumptions about (i) modal shift from existing traffic (two-wheelers, taxis etc.); (ii) 'induced demand' – i.e. new trips generated by the new systems; (iii) for the ropeway options a small additional ridership was added to allow for the 'novelty' factor – e.g. day-trippers and leisure journeys.

276. Modal shift is very difficult to estimate, especially as traffic flows are increasingly affected by congestion. For the demand estimates, it was assumed that modal shift would grow for about five

years and then stabilize due to congestion effects (i.e. roads at capacity). Thereafter, the largest share of passenger demand would come from 'induced demand' – new passengers and new trips.

277. Passenger growth was also constrained by the transport system's capacity. For buses, peak capacity on the north-south corridor was assumed at 1,800 pphpd (passengers per hour per direction), and predicted to occur within ten years of implementing the bus package – see Figures 4.7. The ropeway peak capacity was assumed at 3,000 pphpd, and a north-south ropeway might reach this within fifteen years and the long east-west ropeway within twenty years. The short east-west ropeway was expected to remain within capacity throughout the 30-year forecast.

(ii) Revenue from Commercial Space at Stations

278. It was assumed that 10,000 m² of commercial space would be available per ropeway corridor with a rental income of about Rs. 150/ m² /month, increasing 15% every three years. Further, a one-time refundable deposit equivalent to a six months' rent is assumed to be collected from the tenants, generating interest of about 7.5% p.a. The occupancy rate for the commercial space was conservatively assumed as 75%.

(iii) Revenue from Advertising

279. The public transport organisation can utilize both moving as well as fixed space for advertisements which will fetch more revenue and can cross-subsidize the ticket fare. It was assumed about 10,000 m² of advertising space on each corridor with an income of about Rs. 75/ m²/month, increasing about 15% every three years. In order to make a conservative assessment, the space utilization rate for the ad space was assumed as 75%.

Operations and Maintenance Costs (O&M)

280. The operations and maintenance expenses assumed for each of the project options are shown in Appendices 4.4 and 4.5, and used in this analysis.

Assumptions for the Financial Analysis

281. Key assumptions for the financial analysis are given in Table 6.9.

Table 6-7: Assumptions for Financial Analysis

Parameter	Units/ Components	Core Bus Package	Rope Way		
			EW – Long Corridor	EW – Short Corridor	NS Corridor
Means of Finance	Equity	8.40%	8.40%	8.40%	8.40%
	Grant	72.00%	72.00%	72.00%	72.00%
	Debt	19.60%	19.60%	19.60%	19.60%
Interest on Debt	%	12%	12%	12%	12%
Cost of Grant	%	0%	0%	0%	0%
Cost of Equity	%	15%	15%	15%	15%
Debt – Tenor	Years	13	13	13	13
Principal Moratorium	Years	4	5	5	5
Analysis period	Years	30	30	30	30
Implementation Period	Years	4	5	5	5

Parameter	Units/ Components	Core Bus Package	Rope Way		
			EW – Long Corridor	EW – Short Corridor	NS Corridor
Escalation	Index	WPI	WPI	WPI	WPI
Income Tax Rebate		10 years (100% exemption for 10 years out of block of 15 years). However MAT is applicable.			
Depreciation (SLM)	Civil	60 Years	60 Years	60 Years	60 Years
	Equipment's	15 Years	15 Years	15 Years	15 Years
	Others	5 Years	5 Years	5 Years	5 Years
Depreciation (WDV)	Civil	10%	10%	10%	10%
	Equipment's	30%	30%	30%	30%
	Others	30%	30%	30%	30%

Results of the Project Financial Analysis

282. The results of the financial analysis are shown in Table 6.10.

Table 6-8: Financial Indicators

Financial Indicators	Criteria	Core Bus Package	Non Road Based – Rope Way		
			EW – Long Corridor	EW – Short Corridor	NS – Corridor
Project IRR (%)	> 3.6%	2.8%	- 5.2%	-7.9%	No Result
Equity IRR (%)	> 15%	8.7%	- 4.5%	- 7.5%	No Result
Project NPV (Rs. Mill.)	> 0	256.51	-11,082	-7,700	-23,584
Equity NPV (Rs. Mill.)	> 0	164.48	-2,731	-1,760	-4,694

283. The analysis indicated that the project IRR was less than the weighted average cost of capital (WACC = 3.6%) for all sub projects. For all options the equity IRR also was less than the minimum required rate of return (of 15%). The main reason is due to the assumption that reinvestment based on depreciation is fully done by the equity holder. Thus from the perspective of the equity investor, none of the options are financially attractive with the given sources of income/funds.

284. However if grant is also available for reinvestment following depreciation, then the project may become attractive for equity investors.

285. The bus project may also be attractive for equity investor even without grant for re-investment, if the bus fare growth rate is raised from the assumed level of 5% p.a. to 5.5% p.a.

E. Assessment of State Financial Capacity to Support a Major Public Transport Project

286. **General:** An assessment of state finance was given in the Initial Assessment Report and is summarized here. The main purpose of this assessment is to assess the carrying capacity of the state to absorb the possible funding implications and to review the potential funding sources to implement the projects in Aizawl.

287. **State Fiscal Capacity**: Four years' budget data of Mizoram State for the period FY 2013 to FY 2016 was reviewed (see Appendix 6.2). This indicated that the Government of Mizoram (GoM) experiences fiscal constraints though the situation has been improving, due to the following reasons:

(i) Revenue: The state is depending more on the grants from the central government, as its tax revenue was only 22.8% and 4.1% from non-tax revenue sources. This trend needs to be corrected by creating more tax base for the state. However, the dependency of the state on central grant reduced from 73.1% in FY 2013 to 60.7% in FY2016. The state is projected to receive a higher share in central taxes (from 32% to 42%) during FY 2016–FY 2020 as a special package under 14th Finance Commission recommendations and accordingly the tax revenue of the state is projected to increase from INR 4,990 million (FY2016) to 10,000 million (FY2020). In addition to this, the state will receive a revenue deficit grant from central government totaling INR 139,440 million during this period, according to the 14th Finance Commission recommendations.

(ii) Expenditure. Non-economic expenditure including general and social services in the state remains high thereby limiting the state's capacity for development financing in economic services, However, the capital outlay of the state as percentage of its NSDP (Net State Domestic Product) was found increasing during the past from 13% in FY2013 to 25% in FY2016 and this shows the state's focus in economic development through infrastructure investment. Also the debt liability to NSDP as percentage decreased from 63.5% (FY2013) to 30.7% (FY2015). Together these indicate that Mizoram State is in a better position to improve its capital investment including supporting infrastructure like urban development and transport through possible funding sources.

(iv) Deficit. The debt to NSDP ratio of the state is 30.7% as of March 2015, which is close to all states (21.2%). Mizoram state has shown fiscal consolidation in accordance with the requirements of FRBM Act from 2006 and its revenue balance as a percentage of NSDP has improved from 0.6% in FY2013 to 42.5% in FY2016 (Table 6.11).

Table 6-9: Fiscal Performance Indicators for Mizoram State

Details	2012-13 Actuals	2013-14 Actuals	2014-15 RE	2015-16 BE
NSDP (INR Million)	46,883	50,667	54,756	59,175
Revenue Balance/NSDP	0.6%	4.6%	-9.5%	42.5%
Fiscal Deficit/NSDP	13.6%	10.4%	9.7%	67.0%
Capital outlay/NSDP	13.0%	6.3%	19.9%	24.8%
Debt Liabilities/NSDP	63.5%	38.2%	30.7%	NA
State own revenue/NSDP	21.5%	21.5%	22.1%	45.8%

Source:

1. Annual Financial Statement (Budget) 2014-2015, 11 November, 2014, Govt. of Mizoram

2. Annual Financial Statement (Budget) 2015-2016, 19 March, 2015, Govt. of Mizoram

3. Hand Book of Statistics on the Indian Economy, 2013-14, Reserve Bank of India

NSDP – Net State Domestic Product; BE- Budget Estimates; RE - Revised Budget Estimates

288. The Mizoram Fiscal Responsibility and Budget Management (FRBM Act) Act, 2006 was updated to align the requirements and stipulations recommended by Thirteenth Finance Commission. As per this Mizoram FRBM Act, the State finance is expected to maintain Revenue account in surplus, fiscal deficit and outstanding debt at 4.1 per cent and 79.2 per cent of corresponding GSDP (Gross State Domestic Product) respectively during 2013-14. However, the fiscal performance of the state had much improved performance in terms of all indicators stipulated by the FRBM Act requirements, shown above in Table 7.11. In FY 2015, the debt liability to NSDP was reduced much further to 30.7% against the target of 74.8%. During the year 2015 the state had commitments of additional loans from different sources to the tune of INR 3500 million. With this committed loan liability, the state was found with a capacity to absorb additional loan for about INR 20,000 million during the FY 2015 (Table 6.12). Considering the requirements of the state to (i) reduce the fiscal deficit further and (ii) the likely reduction in the debt liability target under FRBM Act in the future, the space for additional state borrowing may reduce further. However on a safer side it can be concluded that the state can absorb a low cost loan to the tune of about INR 5,000 million to INR 10,000 million to fund infrastructure projects.

Table 6-10: Borrowing Capacity Assessment for Mizoram State

Details	2014-15
NSDP Rs Million	54,756
Debt Liabilities/NSDP	30.7%
Existing Debt Liabilities Rs Million	16,810
Thirteenth FC Target of Debt Liability / NSDP %	74.80%
Maximum limit for Debt Liability Rs Million	40,957
Proposed additional loan by State from open market, NABARD and NCDC (Approx.) Rs Million	3,500
Additional space available for borrowing Rs Million	20,647
Assuming 50% of the additional space available - Rs Million	10,324

289. State expenditure on urban development and roads & bridges has increased in the recent past underlining the state strategy in developing basic infrastructure in the state. However the share of road transport expenditure found to be neglected and this needs to be corrected to meet the current transportation requirements in the state.

Available Funding Options

290. **Government of India development programmes:** The Govt. Of India (GoI) has announced a few new schemes to support urban development investment requirements and they include (i) Smart City Program; (ii) Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and (iii) Heritage City Development and Augmentation Yojana (HIRIDAY). Aizawl will be eligible for development fund support from the first two categories by virtue of population criteria and being a capital city. Under Smart City Program, each city will have an investment of INR 10,000 million over a five year period, in which GoI will support only 50% by grant and the balance to be contributed by the state / urban local body (ULB). Under AMRUT, cities with <10 lakh population like Aizawl will get 50% grant from GoI and the balance from ULB/state for water, sewer, septage, storm water, urban transport projects and 100% grant from GoI for other capacity-building, and PIU,PMU, DPR preparation costs. According to the available guidelines, there are no special treatments for North Eastern States including Mizoram. However these states are requesting for special treatment from GoI, similar to the earlier schemes like JnNURM, as their financial positions will not support for the required 50% state contribution.

291. **Multilateral agency funding:** Funding from multilateral agencies like ADB, World Bank is another

option for infrastructure investment requirements. Urban infrastructure investment through ADB and highway projects with World Bank support are the few among many multilateral funded programs under implementation in the state. Under these schemes, Mizoram as Special Category State used to get 90% grant in the loan component and this will reduce the financial burden of the state.

292. **North East Region funding:** The Ministry of Development for North East Region (DONER) is the other possible funding support source for Mizoram as it coordinates all development requirements of the eight states in the North East Region with GoI. Vision 2020 prepared by DONER outlines the development strategy for the north-east region including Mizoram. DONER's Plan allocation has steadily increased from Rs.10,199 million in 2002-03 to Rs.23,328 million in 2014-15. In addition, the Ministry is following up mobilization of external aid for catalyzing development and provides an interest-free loan to North Eastern Development Finance Corporation Ltd. (NEDFi) – a financial institution – which provides credit and other facilities to industrial enterprises, infrastructure projects etc in NE region.

293. **Public private partnership (PPP)** is another form through which infrastructure requirements can be leveraged with private investment. The state government has recently brought out a Policy on Public Private Partnership (PPP) that provides a guideline to agencies for operationalizing PPP in infrastructure development initiatives. Possible revenue-earning sub-projects like off-street parking facilities can be considered for this model.

F. Conclusions

290. **Economic Analysis:**

- All of the packages considered for the medium to long term were found to be economically viable.
- This is based on the minimum quantifiable benefits (namely, savings in travel time and vehicle operating costs). Thus if the wider benefits such as decentralizing city growth, environmental benefits (e.g. reduced air pollution, noise, greenhouse gases and traffic impacts), and positive tourism impacts are taken into account, the TOTAL project economic benefit will be significantly higher.
- For the ropeway options, the East-West Long Corridor (Thuampui to Chawlhhmun) 5.5km was found to be the preferred one with a higher EIRR among the three options considered, though the remaining two options were also found feasible with EIRR more than the minimum required 12%.
- The East-West Long Corridor performed best because it had the highest per capita benefit of vehicle operating cost and travel time savings. This is mainly due to the large difference between existing road trip length and the proposed ropeway trip length. The East-West Long Corridor also performed best in terms of city decentralization.
- The sensitivity analysis (Table 6.3) demonstrated that the results were robust, and identified the main areas of risk to be considered during implementation – particularly (i) risk of lower-than-predicted passenger volumes and diverted traffic, followed by (ii) impact of cost over-runs.

291. **Financial Analysis:**

Bus project:

1. For commercial operation by private operator or by state undertaking, the project is financially not viable as the equity IRR (8.7%) was less than the expected rate of return of 15%.
2. However, if the operation is run by the state department without tax implications and with an expected rate of return of 8%, then the project is found to be financially viable.

Ropeway project:

1. All of the ropeway options are found to be financially not viable for operation by private operator / state undertaking or by state department, as their project IRRs and equity IRRs could not meet the minimum requirements.
2. Among the three ropeway options, the East-West Long Corridor had the better financial result, with full O&M cost recovery predicted from the 9th year of operation (Figure . If implemented by a state department without any tax implications, then partial capital cost recovery is also possible during the analysis period.
3. The other two ropeway options (E-W Short and N-S corridor) showed slower O&M cost recovery during the analysis period, (from the 12th and 19th year respectively – see Vol. 3, Appendix 6.2).
4. The projects' financial benefits come primarily from fares, and the financial analysis is very sensitive to the number of passengers carried, the average trip length and the proposed level of fares. If these turn out to be higher than those used for this pre-feasibility study, then the financial results will improve accordingly.

292. **State Financial Capability Assessment:**

1. Though Mizoram State has a fiscal deficit, this is reducing and is in line with the State's FRBM Targets. Based on the targets and the current level of its debt, the additional absorbing capacity for the Mizoram State is estimated to be in the range of about INR 5,000 Million to INR 10,000 million.
2. If the bus project (including supplementary proposals) and the East-West Long Corridor project were implemented jointly with the funding pattern suggested in the analysis, the state government's financial impact in the capital cost would be about Rs. 2,572 mill ($38.6 million), representing 28.4% of the combined project cost of Rs. 9,056 mill ($135.8 million).[18]
3. Project investment requirement for both projects taken together by Mizoram State is therefore considered to be within the state's borrowing capacity. Hence the state could consider taking up these projects with a suitable debt mechanism to meet the required state investment portion, or with a mix of partial debt and the balance from its own fund

292. **Private Sector Participation:**

1. Private sector participation offers several benefits, such as: (i) supplementing government funding for infrastructure projects; (ii) use of advanced technology and (iii) improved operational efficiency. The participation can take different forms, such as Management contract; Leasing concessions (DBOT, BOT, Annuity etc); and Private ownership.
2. The DBOT/BOT traditional concession models is one possibility for the proposed bus project, in which the private sector would operate the system as concessionaire while the state would monitor as the asset owner. If the bus operation was planned as a state undertaking, private sector participation could be considered for specific services in the form of 'management contract' to improve the operational efficiency.
3. For the ropeway operation, the traditional concession model would not seem feasible on financial grounds, as seen in the above sections. Hence annuity / hybrid annuity-based models could be considered, in which funding support from ADB / Govt. of India would be suitably combined with annuity payment from the state government. This would help to tide out the financial impact on the state government

[18] The bus package is assumed at Rs.2,373 million (landed project cost, including supplementary package), and the E-W long ropeway package is estimated at Rs. 6,683 million

7. PRELIMINARY ASSESSMENT OF ENVIRONMENTAL AND SOCIAL IMPACTS

A. Environmental Impacts

294. The following chapter gives a brief outline of the main environmental and social impacts of the project, which are mostly positive. The main environmental impacts are summarised in Table 7.1:

Table 7-1: Environmental impacts

Project Activity	Positive Impact	Negative Impact
• Construction of East-West Aerial Ropeway (Long, 5.5km)	• Control of vehicular movement resulting in lesser pollution	• Movement of heavy construction equipment and accessories resulting in additional air and noise pollution • Emission of dust and pollutants • Road closures and detours resulting in road distance to travel and more vehicular pollution over construction period
• Operation of Aerial Ropeway	• Shift of people from private vehicles like 2-wheelers, taxis and cars leading to less vehicles on the road and less pollution • Reduction in traffic congestion resulting in less vehicular pollution and improved air quality • Encouragement of walking and using mass transport resulting in reduced congestion and reduced air pollution • Ropeway power source is electricity, of which a high proportion is derived from renewable sources (hydro-electric power from within the region)	• Increase in demand for electricity to run the system resulting in negative impacts at the source of non-renewable electricity production
• Improvement of bus service and bus-related road infrastructure in NS	• New buses with improved technical efficiency and lower emissions • Increased bus use resulting in fewer vehicles on road and less air pollution • Encouragement of walking to access and use public transport resulting in less air pollution	• Buses may emit additional pollutants if not properly maintained and monitored

295. There are net overall positive environmental impacts resulting from introduction of aerial ropeway. After five years of operation (2025), the east-west Long ropeway might carry 31,000 passengers per day, of whom over half (16,750) might have switched from other more polluting modes – e.g. car, taxi, two-wheeler. This will contribute to improved air quality.

296. Introduction of more modern buses with improved technical efficiency and lower emissions will also contribute to reduced air pollution in Aizawl. Improved speed and service and comfort will also

encourage modal shift and reduced vehicle emissions and oil consumption. .

B. Social Impacts

297. The positive and negative social impacts are summarized in Table 7.2:

Table 7-2: Main Social impacts

Project Activity	Positive Impact	Negative Impact
• Construction of Aerial Ropeway	• Increase in employment of construction workers	• Residents of households residing near construction zone may be affected • Impacts related to land acquisition like loss of livelihood and property will be minimized through adequate compensation. • The affected people need to be compensated as per entitlement framework
• Operation of Aerial Ropeway	• Training and employment of operators • Better urban economic, environmental and living conditions • Better urban transport planning resulting in improved accessibility, connectivity and mobility • Wider dispersal of urban population, leading to less congestion in central areas and roads • More employment generation and economic development through transit oriented commercial development	• May cause some visual and noise disturbance to residents of nearby households
• Improvement of bus service and bus related road infrastructure	• Additional employment for operation of bus service • Comfortable journey in improved buses • Saving travel time due to bus priority • Comfortable bus shelters for waiting • More walkways integrated with bus stops • Reduced incidence of road accidents (with lower casualty rates for bus users)	• Private vehicle users may be inconvenienced

298. The positive and The acquisition of land and houses for the east-west ropeway is expected to be minimal. Approximately 500 m² of land is required at each station area. For the intermediate towers, land required will be only 100 m²for each tower, with very limited land acquisition (and in many cases none).

299. A positive impact will result from office and commercial development in the station building and the adjacent area. The pattern of travel will change over time resulting in more sustainable transport.

8. INSTITUTIONAL ARRANGEMENTS FOR URBAN TRANSPORT IN AIZAWL

A. Introduction

300. The project's terms of reference instructed the consultants to: 'Propose appropriate institutional framework to prepare and implement the proposed measures and investment projects through the capacity assessment of relevant government agents.'

301. The main measures for urban transport in Aizawl proposed under this project relate to:

- Strategic urban transport planning and co-ordination.
- Public transport planning, design and operation, especially:
  - (i) City bus services – improved and expanded;
  - (ii) Aerial ropeway (cable car) – introduction and operation.
- Traffic engineering and management improvements through short-term, low cost measures.
- Improved regulation, monitoring and enforcement of air quality relating to urban transport in Aizawl.

302. These institutional functions are now considered below (except for air quality issues, which were discussed in Chapter 5). To assess the capacity of the various government organisations, information was collected regarding their activities, staffing, equipment, funding, and co-ordination arrangements. A summary of data collected is given in Appendix 7, and the conclusions are presented below.

B. Strategic Urban Transport Planning and Coordination in Aizawl

303. **Existing Situation:** Until recently, strategic urban transport planning and co-ordination in Aizawl has largely been an ad hoc process without clearly defined institutional responsibilities.

304. Co-ordination is currently done at both strategic and local levels mainly through committees and authorities, including:

- Co-ordination Committee on Traffic Management (for Aizawl)
- State Transport Authority – issues permits for bus routes in the city and districts
- Aizawl Road Authority – for approval of road projects
- AMC Traffic Management Committee – for parking issues

305. The **Co-ordination Committee on Traffic Management** was first established in 1995 under the chairmanship of PWD to co-ordinate road construction, repairs and street utilities. Later its scope was widened to include all departments concerned with traffic management and the lead role given to the police's Traffic Unit with the Home Minister as chairman. This committee currently has 16 members (see Appendix 6) and is the main policy-making body for traffic management in Aizawl. It sometimes also makes recommendations for large-scale transport infrastructure (such as ropeways, terminals, multi-storey car parks, etc.).

306. The strategic urban transport planning function in Aizawl has been shared by several organisations. For example, the Aizawl Master Plan (2010) was prepared by consultants for the Aizawl Development Authority (ADA), which was under the State Ministry of Planning (though ADA was dissolved in 2012 and its planning staff transferred to AMC). The 2011 Aizawl Mobility Plan was co-ordinated by the Public Works Department (PWD).

307. The **Urban Development and Poverty Alleviation Department (UD&PA)** is responsible for strategic urban planning in Aizawl (and other districts in Mizoram), and also co-ordinates major infrastructure bids under JNNURM, AMRUT and Smart Cities. It has recently been designated as the urban transport planning authority for Aizawl.

308. **Aizawl Municipal Corporation**, established in 2008 and upgraded to Corporation status in 2015, also has a planning role, with a small town planning team mainly concerned with building permits and enforcement. (Refer Appendix – 7 for existing Institutional Setup)

Options for Future Strategic Urban Transport Planning and Co-ordination

309. Aizawl's strategic urban transport planning and co-ordination functions need to be strengthened to cope with the growing demands of an expanding city. This is also a requirement for funding support under the recent AMRUT and Smart Cities initiatives.

310. There are several options for Aizawl, including:

1. Establishing a Unified Metropolitan Transport Authority (UMTA);
2. Developing a strategic transport planning function within AMC;
3. Strengthening UD&PA's role.

311. It is worth noting that previous plans for Aizawl have recommended different approaches. The 2010 Master Plan recommended an Urban Transport Management Authority (Section 6.3.7), while the 2011 Mobility Plan recommended a cross-departmental advisory committee under UD&PA (Section 9.2.1).

312. **Option 1, Establishing a UMTA:** India's National Urban Transport Policy of 2006 recommended setting up of a Unified Metropolitan Transport Authority (UMTA) for all million-plus cities so that urban mobility could be planned in an integrated manner. The UMTA would act as an umbrella body to promote public transport through formulation of policies, programmes, rules and regulations related to urban transit. Since 2006, several cities have set up such authorities including Hyderabad, Chennai, Bengaluru, Mysore at the city/metropolitan level; and Rajasthan, Odisha, Jharkhand, Uttar Pradesh and Madhya Pradesh at the state level for urban areas. In the north-east, Kohima conceptualized an UMTA in 2011 and passed an ordinance, but this has not yet been implemented.

313. However, establishment of an UMTA is not recommended for Aizawl at this stage, as the city is relatively small in size, its population is below half-a-million, and its urban public transport system is relatively small. The concept of UMTA is ideally meant for large urban areas with multiple modes of transport and large scale urbanization and congestion issues. Usually the conglomerations have core areas which are governed by a Municipality and urban fringes typically under a Development Authority. A single agency such as an UMTA helps to co-ordinate these different stakeholders.

314. Aizawl has not yet reached this level of urban complexity, hence the creation of a new organization or UMTA is not recommended by this project.

315. **Option 2, Developing strategic transport planning under AMC:** In developed countries, it is quite common for strategic urban transport planning to be carried out by the city authority. This approach has some advantages, for example local accountability, local knowledge, continuity, creating a link between payment and use of urban services, and so on. However, this option is not recommended for Aizawl for the time being, because AMC's functions are still at an early stage of development and would, in effect, require starting from scratch.

316. **Option 3, Developing strategic transport planning within UD&PA** is recommended for the short to medium term (say 5-10 years). UD&PA is already the main organization responsible for strategic urban planning in Aizawl and has recently been designated as the urban transport authority. UD&PA is under the Ministry of Planning and already has the lead role in co-ordinating applications to national programmes such as AMRUT and Smart Cities. At the national level, the urban transport planning function is under the Ministry of Urban Development, which also fits well with UD&PA's functions.

317. The jurisdictional boundary for strategic urban transport planning would be the Aizawl planning area. A special team within UD&PA specifically for Aizawl can be formed to take up the strategic urban transport function. This will require capacity building of the agency over the next few years. The team would be guided by a city-wide co-ordination committee, much as at present.

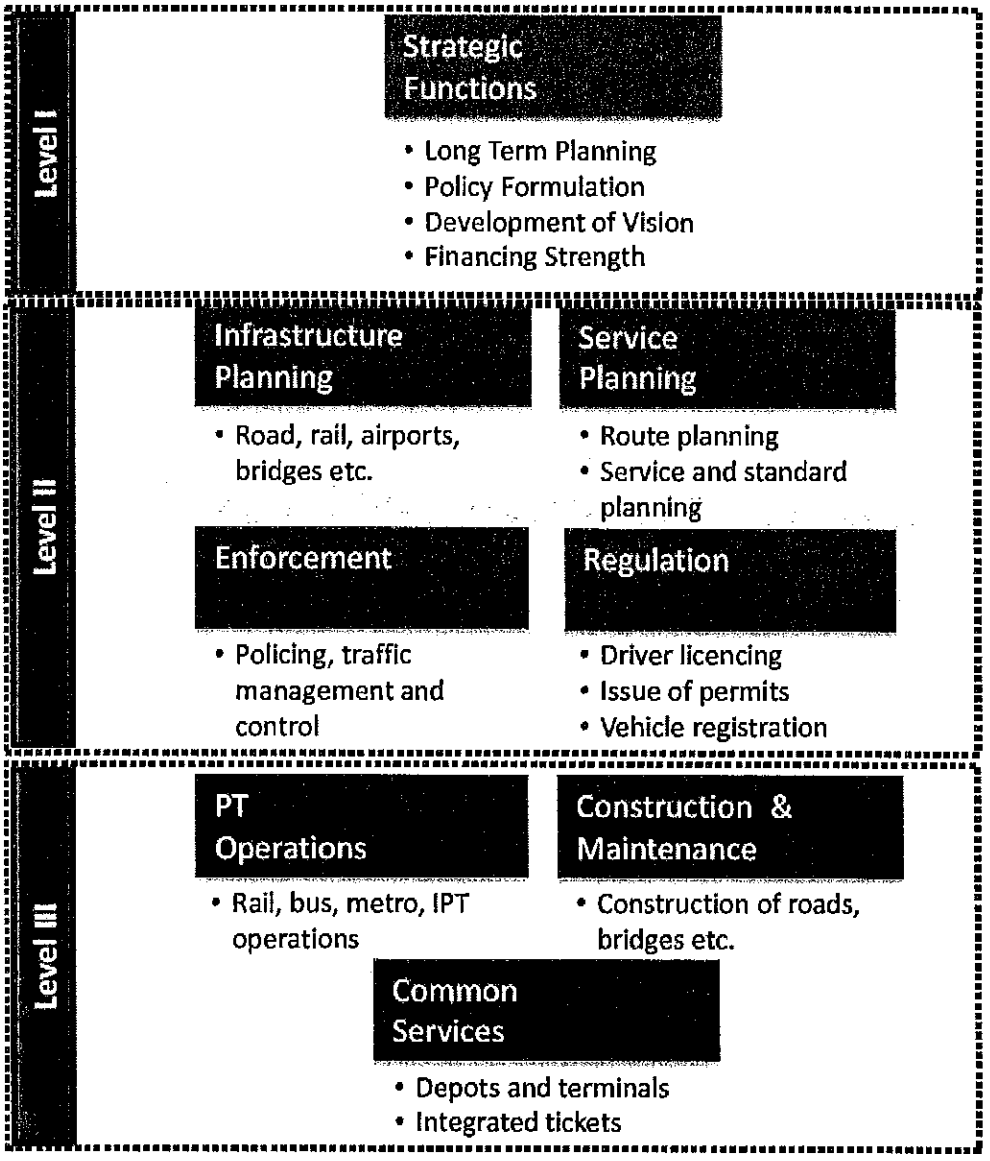
318. This dedicated, trained group for Aizawl could either transition to an UMTA after a few years, or else become part of AMC, as happened with the Aizawl Development Authority.

C. Functional Hierarchy for Urban Transport in Aizawl

319. Urban transport functions in Aizawl can be broadly classified in a hierarchy with the following three levels as depicted in Figure 8.1:

Level I	Strategic planning functions;
Level II	Infrastructure and service planning, enforcement and regulatory functions;
Level III	Service delivery (construction /maintenance of infrastructure and common services, public transport operations, etc.).

Figure 8-1: Hierarchy of functions for urban transport



Source: Review of Unified Metropolitan Transport Authorities in India, a Report by the Institute of Urban Transport (India)

320. **Level I** is the strategic planning function, preparing the long term vision for Aizawl. This includes long term plans, creating a futuristic vision for the city, identifying financing options to achieve the vision, and creating suitable policies that also lead the city towards desired results. (This is the role proposed for UD&PA above).

321. **Level II** functions involve urban transport infrastructure and service planning, and also regulatory and enforcement measures. These are diverse in nature involving many different organisations: for example, service planning includes elements such as transport demand assessment, network and route design, traffic management policies and control. Regulatory measures such as driver licensing, vehicle registration, issuance of permits, setting of public transport fares and enforcement are also part of the Level II functions.

322. **Level III:** The third level of functions is the actual delivery of services. These include infrastructure construction and maintenance, which impact the user directly. Operations of bus, ropeway, taxis etc. are also service delivery functions, including running of depots and terminals, common ticketing, data management, passenger information and so on.

323. Level II and Level II functions for public transport are considered in Section D below, while functions involving road infrastructure, traffic management and enforcement are discussed in Section E.

D. Future Institutional Arrangements for Public Transport in Aizawl

324. **Existing Situation:** There are already extensive arrangements in place for planning, regulating and operating public transport in Aizawl. Key functions are performed by:

- The **State Transport Authority** – issues permits for routes and approves the fare structure for buses and taxis. (The Director, Transport Department acts as secretary to this authority).
- The **Transport Department** registers vehicles and drivers, issues permits to commercial vehicles, buses and taxis, collects fees and maintains records.
- The **Co-ordination Committee for Traffic Management** guides traffic management measures in Aizawl, which are implemented through the Traffic Police, Aizawl Municipal Corporation, PWD and Dept. of Transport.
- **Aizawl Municipal Corporation** is responsible for management of bus and truck terminals.

325. The private sector also has a major role as the main operator of buses, taxis and maxi-cabs (Sumo jeeps). In addition, there are numerous buses owned and operated by government and semi-government organisations (e.g. colleges, university) for staff and students. The Mizoram State Transport, under the Transport Department, also provides some inter-district bus services.

326. None of the above agencies, however, are in a position to take on a major bus improvement project or ropeway development project in Aizawl. Firstly, they have limited staff numbers and are already fully engaged in their regular departmental functions. Secondly, the planning, design and implementation of the proposed bus and ropeway projects will require specialist skills which are not generally found in these organisations.

Proposal for an Aizawl Mass Transport Company / Authority

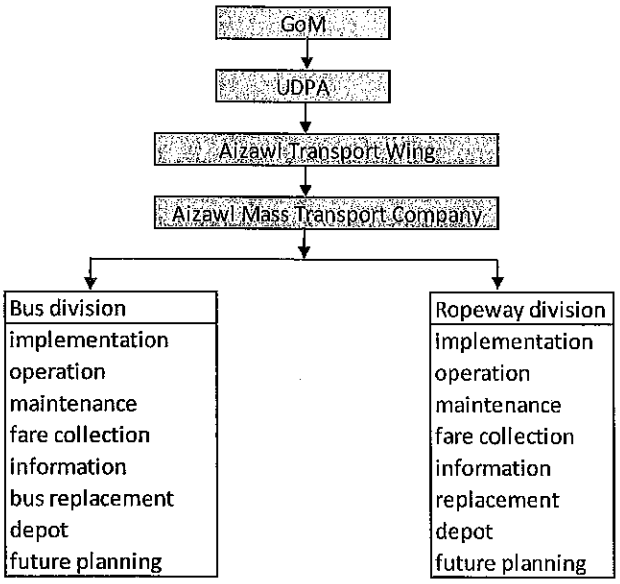
327. For the implementation, operation, maintenance and improvement of the proposed bus and ropeway systems, an Aizawl Mass Transport Company or Authority is proposed. Since UD&PA is responsible for the overall urban transport planning function in Aizawl, it is proposed that the mass transport organisation would be under UD&PA, either as a company registered under the Companies Act 2013 or as a government authority.

328. The Aizawl Mass Transport Company/Authority would have a governing body for policy and decision making, with officials from relevant government agencies on the board, such as the Secretary, Finance; Secretary, Urban Development; Mayor, Aizawl Municipal Corporation; Director, Transport Department;

PWD, Traffic Police, TCPO, Pollution Control Board and others as relevant.

329. There would also be a full-time managing body headed by a managing director and staffed by professional engineers, planners and managers. It would be responsible firstly for overseeing the planning, design and implementation of the bus and ropeway projects, and then subsequently for the future oversight and co-ordination of bus and ropeway operations in Aizawl. The proposed organisational structure is shown in Figure 8.2.

Figure 8-2: Proposed Organisational Structure for Aizawl Mass Transport Company/Authority



330. The Company would have two divisions – bus and ropeway. The planning, implementation and operation of bus and ropeway system would be under these two divisions. The future planning would also be undertaken by the divisions in co-ordination with relevant government organisations such as Dept. of Transport, AMC, PWD, Traffic Police, TCPO and others.

331. The future relationship between the existing bus owners and the Mass Transport Company/Authority, represented by the Bus Division, will have to be worked out, and various alternative options are available. The range of options, and the most appropriate option for Aizawl, can be considered in the next project stage (full feasibility study), if the pre-feasibility proposals of this report are taken forward.

332. Likewise, the detailed structure and functions of the Ropeway Division will need to be worked out – for example, it could be contracted out to a private operator, or run as a government agency, or some other arrangement.

333. For the bus and ropeway projects proposed under this project, the next stages of feasibility study and bidding for the detailed design can be taken forward by the UDPA, while the proposed Aizawl Mass Transport Corporation/Authority should be established early on in this process.

334. Once the Company/Authority is operational, it can take on the work of developing and implementing the bus and ropeway projects and co-ordinating their subsequent operations. The Company can, for example, have contractual arrangement with private organisations to manage, operate and maintain the systems.

E. Local Level Transport Planning, Traffic Engineering and Management

Division of responsibilities between AMC and state government organisations

335. AMC was established in 2008 and is seven years old, and recently (2015) was upgraded to Municipal Corporation status, but its transport and traffic responsibilities are still shared with state government organisations, with AMC playing the minor role. For example, city roads are still constructed and maintained by PWD, and AMC is only responsible for ancillary work such as footways, stairs, footbridges, off-street car parks, bus shelters, and minor roads constructed by local councils.

336. Traffic management and control is still largely carried out by the Traffic Police, who are responsible for traffic control infrastructure such as police control points, road markings, road signs and even islands. In one respect, on-street parking, AMC has taken on a bigger role – since 2012 it has taken over the regulation of on-street parking and (in consultation with the Traffic Police) designates parking spaces, and sets and collects parking charges (through private contractors). However, AMC does not have parking enforcement powers which still reside with the police, and there have been discussions between the two organisations about who should lead on parking control.

337. In another area, town planning, AMC has responsibilities but only in a secondary role – in this case to UD&PA. When AMC was established, staff from the Aizawl Development Authority (ADA) were transferred. AMC is now responsible for building control, under its town planning department. But the latter is mainly concerned with building approvals and enforcement, and area-wide city planning is lagging. Before being disbanded, ADA had intended to prepare zonal plans for Aizawl's 10 planning zones. But none have been prepared so far. UD&PA, which is responsible for urban planning for the whole of Mizoram, is still the main agency responsible for Aizawl's city planning, including the planning of major infrastructure projects. But the status of detailed local area planning in Aizawl is unclear.

338. Limited staff numbers: Reflecting its limited role in the above areas (city roads, traffic management, and city planning), AMC currently has only limited staff in both the engineering department and town planning team, and its capacity for these functions is a key issue that needs to be addressed.

Proposals for strengthening local transport planning, engineering and traffic management in Aizawl

339. The Level II and III urban transport functions are labour-intensive and need significant manpower and equipment resources to be performed effectively. The key activities include:

- Planning of local urban transport projects.
- Engineering works – roads, drains, footways, utilities, traffic control facilities, etc.;
- Parking management and enforcement.
- Traffic management.
- Traffic control systems (including traffic signals and UTC, unified traffic control).
- Integration of land use planning and transport.
- Travel demand management.
- Consultations with stakeholders and local communities.
- Financial matters relating to urban transport.
- Transit-oriented development.

340. With so many different functions to perform, it is not surprising that adequate staff resources and equipment are needed. To illustrate these requirements, in London a typical local government council (one of 32 in the capital city) with a population of around 2.75 lakh (i.e. only two-thirds that of Aizawl) has a dedicated transport and traffic engineering team of around 15 professionals, plus supporting staff. AMC, by comparison, has just 7 professionals in its Engineering Department, but no traffic engineers or transport planners.

341. It is the consultants' view that strengthening the local transport planning, traffic engineering and management functions in Aizawl will depend particularly on strengthening the capability of Aizawl Municipal Corporation. This is also the approach promoted by the national AMRUT and Smart Cities programmes.

342. The benefits of developing AMC's capabilities for urban transport include:

- greater local accountability and responsiveness to local needs;
- greater potential for harnessing local energies and contributions to urban transport improvements;
- potentially greater support from the local community (to an organization and proposals that are is locally-based);
- a closer link between the cost of urban transport improvements and payments for them (through local taxes, user charges, etc.);
- organizational continuity; and
- local knowledge.

Recommendations

1. AMC's engineering department to be strengthened with a combined transport planning and traffic engineering unit.
2. AMC to recruit staff for this unit and existing staff to receive training in traffic engineering techniques, plus supporting equipment (computer software, etc.).
3. Engineering staff from PWD who are currently responsible for Aizawl's roads to be transferred to AMC (i.e. PWD's Aizawl Road North Division and Road South Division).
4. AMC to prepare detailed zonal plans (combining both land use and transport) for the city – either 10 zones (as previously proposed by ADA) or 5 zones corresponding the Engineering Department's five operational zones.
5. Zonal Consultative Committees to be set up for each of the zones, to help steer the plan preparation.
6. AMC to start developing capacity in traffic signal control, in preparation for their possible introduction in Aizawl as part of a bus improvements package.
7. AMC to start developing its capacity for management and implementation of Transit Oriented Development, in preparation for the possible introduction of ropeway public transport in the city.

9: Conclusion

343. The terms of reference for the ADB-funded TA 'Supporting Sustainable Urban Transport in Aizawl City' instructed the consultants to identify low-cost measures to improve the traffic situation in Aizawl in the short term (2-3 years), and to assess the potential for improving Aizawl's transport system in the medium-to-long term through public transport investment, eco-friendly vehicles and capacity-building in government institutions.

344. An important part of the project involved consultations with Government of Mizoram officers and also stakeholders representing transport operators and civic society in Aizawl. Accordingly, numerous meetings and presentations were held with Government officers, (see Chapter 1, Section C), and also two stakeholder consultation workshops were held in September 2015 and January 2016, to present the study findings and obtain feedback from a cross-section of stakeholders.

345. Details of the two stakeholder workshops are given in Volume 3, Appendix 8. Generally, there was a high level of support for the proposals developed both for the short-term and for the medium/long-term improvements, and also many comments and fine-tuning measures were proposed.

346. Following submission of the draft final report in January 2016 and the second stakeholder workshop that followed, follow-up meetings were held with Government officers representing various organisations concerned with transport in Aizawl, including UD&PA, PWD, Traffic Police and AMC. The main comments on the draft final report were (i) support for the general proposals; (ii) request for expansion of the proposed bus package. (See Chapter 4.E. for details).

347. With this positive response, the proposals contained in this report (including Volumes 2 and 3) are recommended to ADB.