Appendix

Appendix A-1: Candidate Projects for Thimphu

(1) Project Note: T-1

1. Project Title: Structure Plan Revision

2. Background and Necessity

(1) Current Condition・Challenge

Thimphu Structure Plan (TSP), completed in 2003, identified the overall planning principles and its subsequent land use plan within the Municipal boundary. However the plan was based on the population size of 100,000, whereas today it is expected to be more than 200,000 within 15 years due to the rapid urbanization. Therefore there is a growing gap in various aspects, and it is much needed to review the accomplishments and bottlenecks and to plan the city for the target of population in order to maintain the efficiency. The inherent nature of the structure plan has weakness in the planning of urban infrastructure particularly in water supply and sewerage. There should be tight relationship between sector-wise planning such as water, sewerage and urban transport, and land use planning.

The national census will be undertaken in 2015. The revision of population forecast and urban boundary annexation of Thimphu should be initiated in a small scale, possibly by one urban planner expert on a short-term basis. After obtaining the population census data in 2015, a full-fledged review process should start.

CASBEE born in JAPAN is a tool to evaluate quantitatively how cities are healthier in terms of environment. With time series, self-comparison could lead for improvement of development path. Therefore introducing CASBEE to revision of TSP will be integrated approach of Japanese methodology for urban environmental improvement.

(2) Related Projects

World Bank and ADB have been assisting in implementation of 6 LAPs out of planned 27 LAPs.

3. Project Outline

(1) Objectives

Revision of Thimphu Structure Plan to create a package of urban infrastructure development projects for future development

(2) Location

Thimphu Thromde

(3) Scope

The scope will be two phased if it is to be implemented immediately

1) Phase I: Short Term Consultancy I
   - Review of Urban Development 2003-2013
   - Review of Structure Plan 2004
   - Review and improvement between linkage between Structure Plan and Local Area Plan
   - Urban boundary review of Thimphu for future incorporation
   - Preparation of census blocks for 2015 and population forecast procedure for Thimphu
   - Population tracking system development linking other database such as cadastral database

2) Short Term Consultancy II
   - Training course on introduction of CABEE: Environmental City Indexation Approach

3) Phase II: Structure Plan Revision for Urban Development Project of Thimphu
   a) Population forecast by district
   b) Land Use and City Boundary Plan
   c) Water Supply Plan
   d) Sewerage Treatment Plan
   e) Road Development Plan
   f) Footpath Development and City Beautification Implementation Program

g) Utility Rearrangement Plan
h) Investment and Operation Costing
i) Citizen Participation and Social Development Plan
j) Environmental Assessment
k) Implementation and Monitoring Plan

4. Estimated Cost

Short term consultancy I: US $ 0.15 million
Short term consultancy and Training II: US$ 0.1 million
Structure Plan Revision:

Project Cost Estimate — Unit: US$ in Million

	Quantity	Unit Cost		Cost
Consulting Fee	30 - 60	$ 0.015 million	=	$ 0.5 - $ 0.9
Local Consultant	20%	of consulting	=	$ 0.1 - $ 0.2
Travel Cost	40%	of consulting	=	$ 0.2 - $ 0.4
Overhead	40%	of consulting	=	$ 0.2 - $ 0.4
Direct Expense	20%	of consulting	=	$ 0.1 - $ 0.2
Total				$ 1.0 - $ 2.0

5. Implementation Schedule

1) Short Term Consultancy I: one year
2) Short Term Consultancy II: 6 months

Structure Pan Revision: 6 months to 18 months depending on the scope

6. Implementation Agency

MoWHS/Thimphu Thromde

7. Outputs/Impacts

- Creation of higher population absorption capacity for Thimphu while maintaining harmony with environment and society
- Improvement of urban infrastructure plans
- Prioritization of implementation programs
- Improvement of implementation capacities for Thromde

8. Environmental/Social Impacts

- A positive impact with environmentally improved urban areas
- Phase I does not require environmental assessment while Phase II will require it since the structure plan may affect social environment. Land acquisition and resettlement will be clarified during Phase II.

9. Potential Risks

Lack of implementation capacities in cities

10. Constraints and Challenges

Timing with on-going urban infrastructure development projects by other donors.
Ideally the study scope should include T-7 Water and Sewerage Master Plan and part of T-6 Local Area Planning and Implementation for Core Thimphu.

(2) Project Note T-2

1. Project Title: Lungtenzampa Bridge Renovation

2. Background and Necessity of the Project

(1) Current Condition・Challenge

After 20 years since its construction, it is reported that the existing Lungtenzampa Bridge has defects and has been sinking, and people are anxious to use this bridge. When rain is heavy, rainwater is captured at the sunken parts of the bridge and dirty stagnant water is splashed to

pedestrians by passing vehicles. In addition congestion is observed only around the bridge as it is the main bridge in the center of the city during peak hours.

The congestion is caused mainly because of crisscrossing traffic between the Expressway ramps and adjoining two streets of Norzin Lam and Dzongchoten Lam. There is a large inflow of student pedestrians during peak hours, posing danger of accidents with pedestrians. Therefore, high demand exists for the renovation of this bridge.

(2) Related Projects

1993: The existing bridge was built by India more than 20 years ago, as a Bhutan-India Friendship Bridge.
2004: A study by a Swiss engineer on the renewal of the bridge. (Attachment-1)
2005: A study by a Japanese engineering company (Keikan Gijyutu Center Ltd.) on the external appearance of the renewed bridge. (Attachment-2)
Currently, the Thimphu Thromde (City) has a plan to renew the bridge (not received yet).
2001－2014: JICA The Project for Reconstruction of Bridges Phase I –III (grant)

3. Project Outline

(1) Objectives

- Replacement of an old gateway bridge to Thimphu
- To improve the traffic flow along the west side of the bridge in order to ease traffic congestion
- To improve safety for pedestrians, especially students commuting to schools across the bridge

(2) Location

Lungtenphu Thimphu

(3) Scope

1) Preparatory Study
- Analysis of traffic flows including pedestrians,
- Basic design of the new bridge, widening of Chang Lam Road and re-alignment of the access roads
- Options for the existing bridge (either to demolish the existing bridge or to utilize as open space, such as walkways, parking spaces. In case of utilizing the existing bridge, there is a need for the analysis of the vertical load bearing capacity and design of the rehabilitation.)
- geological survey,
- topographical survey
- hydrological surveys
- environmental/social survey

2) Basic Design
3) Detailed Design and Preparation of Procurement Documents,
4) Bid and Construction

4. Estimated Cost

1) Construction of the new bridges over the existing bridge (A), including demolition or rehabilitation of the existing bridge (Breakdown assumptions of the new bridges: North Bridge 230m, South Bridge 280m, Access Bridge 50m, Width of Bridge 6m (one traffic lane 3.75m, one sidewalk 2.25m): **US$ 12 million**
2) Widening of Chang Lam Road(B) and Re-alignment of Access Roads (C): **US$ 1 million**

3) Contingency **US$ 1 million**
4) Total **US$ 14 million**

5. Implementation Schedule

1) Preparatory Study: 6 months
2) Detailed Design and Preparation of Procurement Documents and Bid: One year
3) Construction: one and half years

6. Implementation Agency

Thimphu Thromde

7. Outputs/Impacts

- Elimination of traffic congestion at the western connection of the bridge to the city roads
- Provision of a safe passage for automobile and pedestrian traffic across the Wang Chuu River in Thimphu
- Protection of school children in crossing commuting traffics
- Improvement of the appearance of gateway to the capital city of Bhutan

8. Environmental/Social Impacts

- Positive impact- Improvement of safety, energy efficiency and environmental impact (exhaust gas, etc.), due to the reduction of traffic congestion around the bridge.
- Neither land acquisition nor resettlement can be avoided depending on the route alignment (see the proposed routes above in Scope).
- IEE is required which will be done during preparatory study. The bridge will be two lane road, with the width of 6m

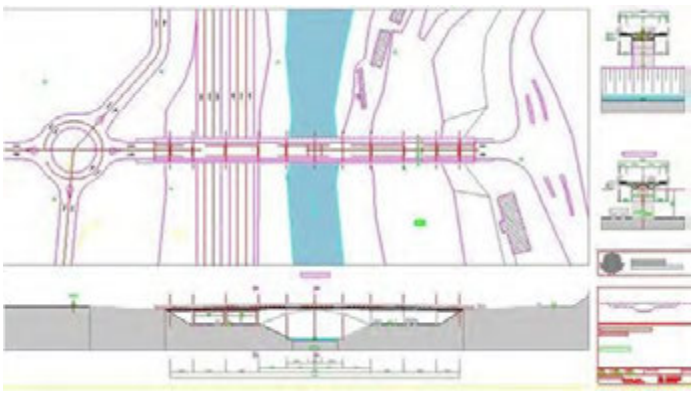
9. Potential Risks

- Misunderstanding with Indian Government on the replacement of the old bridge (There is a report that the Indian Embassy expressed no objection for the Japanese participation on the previous sounding.
- Not getting approval or transfer of necessary land by the concerned landowners for the renovation if the route alignment crosses private lands. However the route can be so arranged to avoid the acquisition requirement of private lands.
- Traffic congestion during the time of construction

10. Constraints and Challenges

- Traffic control during construction period.
- The bride originally donated by India should not affect the bilateral relationship.

Attachment-1: A Swiss engineer did a study on the renewal of the bridge in 2004. The study includes a plan that improves the traffic flow at the west side of the bridge. However, it may take a long time to acquire the land for a new wide roundabout at the west side of the bridge.



Attachment-2: A Japanese Engineering Company (Keikan Gijyutu Center Ltd.) conducted a study on external appearance of the renewed bridge in 2005. This study focused on the scenic feature of a new bridge and did not include the improvement of traffic flow on the west side of the bridge.

(3) Project Note T-3

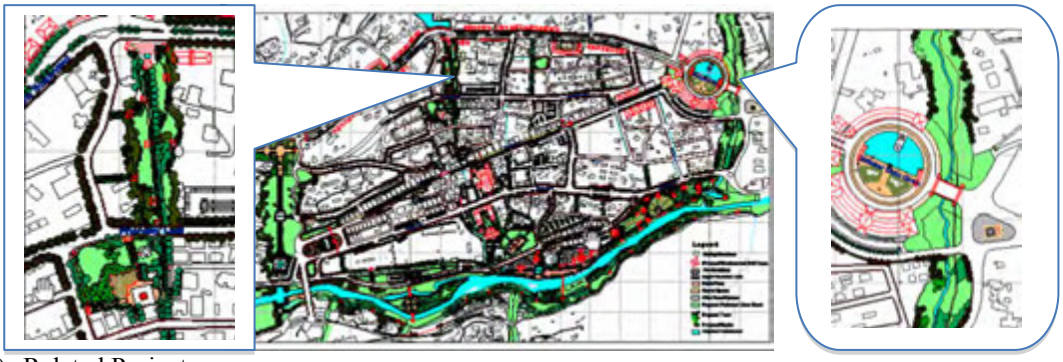
1. Project Title: Motithang Area Wastewater Treatment

2. Background and Necessity

(1) Current Condition・Challenge

Motithang is the uphill part of the central areas of Thimphu city without sewer connections. The wastewater generated from Motithang area is disposed through side drains which are heavily polluted and often spill into residences in the lower areas. As a result, the main river of Wang Chhu of Thimphu is increasingly getting polluted. Wastewater from Motithang travels through the core commercial areas of Thimphu. Order and filthy water have degraded the originally clean creaks into polluted water streams. The Structure Plan 2004 of Thimphu envisages conversion of these drains into green footpaths as shown in Attachment 1. Also these drains often overflow to create temporary flooding of the main streets of Thimphu during the time of heavy rains. The inconvenience and insanitary conditions need to be solved by creating more water retention capacities and installation of independent rainwater and sewerage drainage networks. To solve this situation a local wastewater treatment plant or connecting sewage trunks to Babesa WWTP with its expansion need to be investigated as well.

Attachment 1: Green Footpath Plan in Structure Plan over Two Existing Drains



(2) Related Projects

- LAP is being implemented by financial assistance of ADB, and ADB is planning to extend existing WWTP at Babesa to cover the growing needs of increasing population of southern four LAPs (Changbangdu, Lungtenphu, Simtokha and Babesa).
- World Bank is also financing the construction of a WWTP in Dechencholing.

3. Project Outline

(1) Objectives

Provision of full sewerage treatment to residents in Motithang

(2) Location

Motithang Thimphu

(3) Scope

1) Feasibility Study

- Demand forecast of sewerage disposal for the core area
- Review of Babesa WWTP Project
- Economic optimization of two alternatives of a) sewer connection pipe to the Babesa WWTP and b) a localized wastewater treatment system for Motithang
- IEE for localized wastewater treatment system

Detailed Design and Cost Estimation

Construction

4. Estimated Cost

The cost varies depending on the scope and choice of technologies

5. Implementation Schedule

1) Feasibility Study: 4 months

Design: 6 months

Construction: one year and half

6. Implementation Agency

Thimphu Thromde

7. Outputs/Impacts

- Provide hygienic wastewater disposal system to the residents of Motithang
- Eliminate intrusion of wastewater to residents in the districts below Motithang
- Improvement of drainage water pollution that runs in the center of the city.
- Allow creation of green footpath along the current drainage as planned by the Structure Plan

8. Environmental/Social Impacts

- A positive impact with environmentally improved urban areas since the coverage of wastewater system will increase
- Within the F/S, IEE has to be done for localized wastewater treatment plant. Whether land acquisition is necessary will be clarified during the course of the study.

9. Potential Risks

- ADB Babesa project may not be capable of accommodating the trunk sewer connection for sewage treatment.

10. Constraints and Challenges

- Availability of accurate network data

(4) Project Note T-4

1. Project Title: 24 x 7 Water Supply Improvement

2. Background and Necessity

(1) Current Condition・Challenge

Thimphu is endowed with abundant water resources. However the residents receive water supply on an intermittent basis. The intermittent water supply is the cause of water contamination and the customers need to establish a private storage system. The service connections are often laid within the roadside drains which are heavily contaminated. Coupled with the negative pressures within the pipes during the service down times, the current system has the chance of allowing foul water intrusion into the distribution system thereby increasing the risks of spreading water-born diseases among water supply customers.

The current pipe materials are mostly galvanized iron which is susceptible to corrosion over years of use. The majority of the pipes were installed during 1990s and its useful life has expired. Thus the replacement of the pipes is becoming an imperative.

The current reservoirs of the distribution network fall short in capacities for continuous water supply.

(2) Related Projects

- ADB, World Bank Projects are under implementation in south and north of Thimphu
- ADB: Water supply to the areas with LAP of Lungtenphu, Simtokha, Babesa and Changbangdu Urban Villages,
- World Bank: Water supply to the areas with the LAP of Dechencholing and Langjophakha

3. Project Outline

(1) Objectives

Provision of full continuous water supply throughout the city

(2) Location

Thimphu Thromde

(3) Scope

1) Investigative study:

- Pipe alignment survey
- Survey of other underground facilities such as electric, communication cables.
- Diagnosis of current conditions of water distribution system with the introduction of District Metered Areas for water auditing
- Rehabilitation plan including strategy of replacement of galvanized pipes
- Implementation plan
- Survey of CWS with supply problems and diagnosis

Design and Cost Estimation

Construction

4. Estimated Cost

The cost cannot be determined till the scope is defined by a feasibility study or basic plan.

5. Implementation Schedule

1) Feasibility study: 6 months

Design and Cost Estimation: 8 months

Construction: 2 years

6. Implementation Agency

Thimphu Thromde

7. Outputs/Impacts

- Elimination of groundwater intrusion into distribution pipe network
- Improvement of hygiene of water supply
- Reduction of water storage and water lifting cost of customers

8. Environmental/Social Impacts

- A positive impact with environmentally improved urban areas
- In principle no environmental assessment is required. However it may be required some study since it may affect social environment negatively.

9. Potential Risks

- Traffic and passage disturbance or some other disturbance to underground utility lines during the replacement work

10. Constraints and Challenges

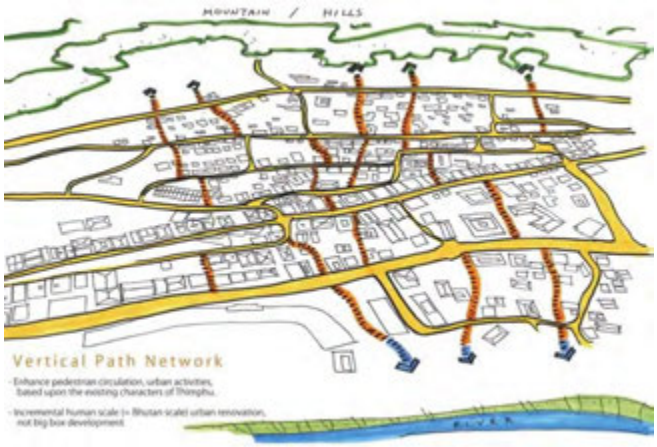
- Minimization of disturbance to traffic and utility realignment by thorough planning

(5) Project Note T-5

1. Project Title: Footpath Development and City Beautification

2. Background and Necessity

(1) Current Condition・Challenge



Thimphu is a beautiful city where automobiles move slowly, and people can walk with less stress without fear of traffic accident. However, sidewalks and the pedestrians' walkways are not constructed in a user-friendly manner; surface is rough with holes and protuberances with sudden up and down steps. In order to be friendlier town with better environment, improvement of walkways are necessary. In addition there is a growing

need to create job opportunities in Thimphu as the unemployment among the young is growing at an alarming rate. One of the most job generating sectors is tourism which potentials are not fully tapped in Thimphu.

(2) Related Projects

T-3 Motithang Wastewater Treatment Project as sewage drain is one of the critical impediments to the green corridor along water ways.

3. Project Outline

(1) Objectives

Improvement of pedestrian access routes with enhancement of walking experience in the city

(2) Location

Allies of Thimphu

(3) Scope

1) Citizen participation: holding of workshops, seminars, study tours etc.
2) Local training on participatory planning and community development
3) Development of project proposal development manual
4) Competition for enhancement design proposals
5) Implementation of improvement of pedestrian access as pilot projects

4. Estimated Cost

Project Cost Estimate — Unit: US $ in Million

	Quantity	Unit Cost		Cost
Exposure trip to Japan	5 - 10	$ 0.02 million		$ 0.10 - $ 0.200
Japanese experts to Bhutan	3 - 5	$ 0.02 million		$ 0.06 - $ 0.100
Consulting Fee	10 - 15	$ 0.015 million	=	$ 0.15 - $ 0.225
Local Consultant	20%	of consulting	=	$0.03 - $ 0.045
Travel Cost	40%	of consulting	=	$0.06 - $ 0.090
Overhead	40%	of consulting	=	$0.06 - $ 0.090
Direct Expense	20%	of consulting	=	$0.03 - $ 0.045
Pilot Project	2 - 3	$ 0.02 million	=	$ 0.04 - $ 0.06
Total				$ 0.53 - $ 0.855

5. Implementation Schedule

1) Citizen participation: 12 months

Competition for enhancement design proposals: 8 months

Implementation of improvement of pedestrian access as pilot projects: 12 months

6. Implementation Agency

Thimphu Thromde

7. Outputs/Impacts

- Improved connectivity to major locations by walking
- Reduction of incentives for increased use of automobiles
- Improvement of sidewalks and walkways
- Increase of fun to walk and of walking experience both for residents and tourists

8. Environmental/Social Impacts

- A positive impact with environmentally improved urban areas
- During the construction the shops might have negative impacts
- No IEE is required in principle as long as the modification is minimal.
- Neither land acquisition nor resettlement is necessary

Attachment-1: Conceptual Image / Courtesy of Landscape Architect, Mr. Shunji Suzuki

9. Potential Risks

- Not sufficient commitment from the private sector and participation
- Not sufficient funds to maintain the clean environment of the developed project footpaths.

10. Constraints and Challenges

Implementation of T-3 Motithang Wastewater Treatment is complementary to this project. Without clean drainage and its conversion into clean stream the environment to the footpaths will not be congenial to the self-reinforcing development of footpaths and surrounding commercial establishments.

(6) Project Note T-6

1. Project Title: Local Area Planning and Implementation for Core Thimphu

2. Background and Necessity

(1) Current Condition・Challenge

Due to funding by ADB And WB on the peripheries, the core areas of Thimphu are lagging in development. The situation is precipitating the linear urban sprawl to the north and south of the city. There are six areas with LAPs without funding and fifteen areas without LAPs or funding.

(2) Related Projects

ADB: LAP of Lungtenphu, Simtokha, Babesa and Changbangdu Urban Villages,
World Bank: Dechencholing and Langjophaka

3. Project Outline

(1) Objectives

- Creating of more urban areas
- Development of more compact city

(2) Location

Central areas of Thimphu

(3) Scope

1) Basic survey: hydrology, geology, topography, demography, land ownership, and social conditions

Local Area Planning: land plots and road network plans

Local Area Planning: development of water supply, sewerage, electricity, communication infrastructure

Environmental Assessment

Preparation of bid documents including detailed design for implementation

Tender

Construction

4. Estimated Cost

Project Cost Estimate — Unit: US$ in Million

	Quantity			Unit Cost			Cost		
Foreign Consultants	30	- 60	MM	$ 0.03	million	=	$ 0.90	-	$ 1.80
Local Consultant	40%			of consulting		=	$ 0.36	-	$ 0.72
Urban Development	10	- 15	LAP	$ 1.00	million	=	$ 10.00	-	$ 15.00
Water Supply	5	15	MLD	$ 0.20	million		$1.00	-	$ 3.00
Sewerage	5	15	MLD	$ 0.50	million		$2.50	-	$ 7.50
Road Development	30	80	km	$ 0.30	million		$9.00	-	$ 24.00
Others			20%	of all above			$4.75	-	$ 10.40
Total							$ 28.51	-	$ 62.42

5. Implementation Schedule

1) Local Area Planning and EIA: 24 months

Construction: 36 months

6. Implementation Agency

Thimphu Thromde

7. Outputs/Impacts

- Continuous water supply on 24x7 basis
- Elimination of groundwater intrusion into distribution pipe network
- Improvement of hygiene of water supply
- Reduction of need for private water storage and water lifting

8. Environmental/Social Impacts

- A positive impact with environmentally improved urban areas
- Environmental Assessment is required since the LAP will include various sub-components. The contents of assessment will be fixed during implementation of diagnosis of LAP
- Land acquisition will be clarified during the implementation of diagnosis of LAP

9. Potential Risks

- Delay in implementation due to not reaching consensus on land pooling
- Cost overrun

10. Constraints and Challenges

If Revision of Structure Plan is implemented, the study scope of this project should constitute a part of the Revised Structure Plan.

(7) Project Note T-7

1. Project Title: Water and Sewerage Master Plan

2. Background and Necessity

(1) Current Condition・Challenge

Rapid urbanization and lack of master plan for utilities within the Structure Plan system makes the responsibility for the local area plan to add a small plan for water supply and sewerage. These patchworks are creating disjointed networks for the city, depriving the overall efficiency of the city management. Despite abundant water sources, there are patches of water shortage areas within the city due to lack of capacities of each water supply system.

In Thimphu some areas with water supply are not covered with sewer network. City drainage is polluted giving order and heath risks in the central part of the city.

(2) Related Projects

ADB, World Bank Projects are under implementation in some areas of Thimphu
ADB: Water supply to the areas with LAP of Lungtenphu, Simtokha, Babesa and Changbangdu Urban Villages,
World Bank: Water supply to the areas with the LAP of Dechencholing and Langjophaka

3. Project Outline

(1) Objectives

Provision of overall long term plans for water supply and sewerage

(2) Location

Thimphu Thromde

(3) Scope

1) Population estimate: review of Structure Plan and make plans for population target in the future for all the local areas
2) Hydrological and topographical study: assess all the potential water sources and topographical data.
3) Option development: review all the population allocation, hydrology, topography to develop several options from one-city wide network to several decentralized systems for water and sewerage.
4) Wastewater treatment options: examination of appropriate technologies for Bhutan
5) Hydraulic network analysis: a computer simulation model of water distribution network
6) Economic and risk analysis: evaluation of all the options from economic efficiency and risk management
7) Implementation plan: develop financial and management plans for implementation on phase-wise basis in order to accommodate changes in projected scenarios
8) Capacity development: provide basic training on master planning, hydraulics and network planning.

4. Estimated Cost

Project Cost Estimate — Unit: US$ in Million

	Quantity	Unit Cost		Cost
Consulting Fee	25 - 35	$ 0.02 million	=	$ 0.38 - $ 0.525
Local Consultant	20%	of consulting	=	$ 0.08 - $ 0.105
Travel Cost	40%	of consulting	=	$ 0.15 - $ 0.210
Overhead	40%	of consulting	=	$ 0.15 - $ 0.210
Direct Expense	20%	of consulting	=	$ 0.08 - $ 0.105
Total				$0.825 - $1.155

5. Implementation Schedule

Study: 12 months

6. Implementation Agency

Thimphu Thromde

7. Outputs/Impacts

- Improved efficiency in water and sewerage service
- Elimination of water shortage in newly developed areas
- Elimination of water pollution in drainage

8. Environmental/Social Impacts

- A positive impact with environmentally improved urban areas
- The study itself does not require any environmental assessment. However if the study

incorporates pre F/S of infrastructure facility, then IEE also must be included.
- No foreseen land acquisition nor resettlement

9. Potential Risks

If the revision of Structure Plan and this project are implemented separately, there is a risk of mismatch and discrepancies in the plan as was the case in the past.

10. Constraints and Challenges

If Revision of Structure Plan is implemented, the scope of this project should make a part of the T-1 Structure Plan Revision.

(8) Project Note T-8

1. Project Title: Begana Water Supply Project

2. Background and Necessity

(1) Current Condition・Challenge

Due to rapid urbanization in Thimphu, some newly developed areas of Thimphu are suffering from water shortages. Traditionally, the water schemes in Thimphu have been developed on a small valley basis, lateral to the main river of Wang Chhu. This approach is economical but equilibrating the local demand and supply for water is becoming increasingly difficult. The demand analysis undertaken in Chapter 3 shows that there may be a shortage of up to 10 MLD of water in central/northern areas of Thimphu in the next decade or so if the current urban development continues.

As one for all solution, there has been a plan to source water directly from the upstream of Wang Chhu at around Begana area. While World Bank has been working on the development of Taba district of Thimphu, the city requested the WB to investigate the possibility of undertaking a larger water scheme covering beyond Taba including Samteling, Jongshina, and Yangtenphug to accommodate future urban developments in more central areas. The negotiation is still underway and the conclusion on the scope is expected to reach in December 2013. If WB does not finance the project or the scale is limited, there will be a need to finance this project in the near future.

(2) Related Projects

World Bank: Water supply to the areas with the LAP of Dechencholing and Langjophaka

3. Project Outline

(1) Objectives

Provision of treated water supply to the northern and central districts of Thimphu

(2) Location

Thimphu Thromde

(3) Scope

1) Demand estimate: review of population estimate with options
2) Hydrological and topographical study: assess Wang Chhu water and topographical data.
3) Hydrological network analysis of existing and future distribution networks
4) Basic design
5) Economic and risk analysis: evaluation of all the options from economic efficiency and risk management
6) Environmental Impact Assessment on social and natural surrounding conditions.
7) Implementation plan: develop financial and management plans for implementation on phase-wise basis in order to accommodate changes in projected scenarios

4. Estimated Cost

US$ 5 – 10 million

5. Implementation Schedule

1) Feasibility Study: 6 months
2) Detail Design: 12 months
3) Construction: 12 months

6. Implementation Agency

Thimphu Thromde

7. Outputs/Impacts

Provide sufficient safe water to Thimphu Thromde for the next 15 -20 years

8. Environmental/Social Impacts

- A positive impact with environmentally improved urban areas
- EIA will be necessary since the project location is within the national park, although the facility to be built will be basically intake which is small and the area required is about 30m x 30m or less.
- No foreseen resettlement

9. Potential Risks

If the revision of Structure Plan and this project are implemented separately, there is a risk of mismatch and discrepancies in the plan as was the case in the past.

10. Constraints and Challenges

- There should be population projection forecast consultancy to work with urban planners and census department.
- The cost is relatively small for a loan project but is suitable for a grant project in scale. But due to economic return on investment, it might not be justifiable as a grant project.
- If the city decides to set a proper course of long term development through master plan establishment, this project should be incorporated as one of candidate projects. However, if water supply to Taba and its peripheral districts are needed immediately due to planned urban developments, the work needs to be undertaken as a priority.

(9) Project Note T-9

1. Project Title: Transport Demand Management (TDM) Project

2. Background and Necessity

(1) Current Condition・Challenge

Due to rapid urbanization in Thimphu, there is a sign of traffic congestions in the city. During the peak hours, the main street of Norzin Lam, and Chang Lam, traffics move slowly at a snail's pace. Given the growth of automobile ownership and increases in urban population, the future traffic demand will lead to overcapacity of the main streets of the central Thimphu. However, due to severe lack of urban land in Thimphu, the acquisition of right-of-ways for the expansion of urban road arteries is not a possibility. Only pragmatic approach to the problem of increasing urban traffic is to promote public transit and encourage modal shifts to buses and walking by both providing incentives for public transits while penalizing the use of private automobiles.

The elements of TDM are well studied already. There should be clear understanding of importance of implementation sequences. For example, if a parking building development project is more conducive for traffic increases. Parking fee hikes are very effective abatement measures but the political repercussions may stifle the implementation of other measures. The automobile exclusion street program would have a similar effect. The development of public transit must proceed first and then there should be fine tuning of other regulatory measures.

(2) Related Projects

- IFC, Bhutan Urban Transport System: System Selection and Eco-Friendly Feasibility Report, 2011
- MoWHS, Dept of Urban Development and Transport Service, "Thimphu Urban Transport Study", 2009

3. Project Outline

(1) Objectives

- Reduction of automobile traffics to the central part of Thimphu to maintain and improve the urban environment in the future
- Establishment of operation of BRT system

(2) Location

Thimphu Thromde

(3) Scope

1) Transport Demand Management Study

- Development of Thimphu TDM Model for policy impact evaluation
- Establishment of regular traffic count system and review of urban transport model
- Demand estimation for parking spaces and bus passengers
- Simulation of policy impacts on Transport Demand Management policy packages

including public transit introduction, bus fare subsidies, parking fees, automobile exclusion zones, and traffic control.
- Basic design of bus route, bus depots and stations, also charging stations in case of introduction of electric bus systems
- Development of a monitoring system of demand management
- Environmental assessment of the system
- Financial and institutional assessment
- Development of PPP model and operation

Tender preparation and procurement supervision
- bus systems
- PPP operator

Implementation and monitoring
- Traffic monitoring and modal impact assessment
- Monitoring of BRT, ridership, service levels and financial performance

4. Estimated Cost

1) Transport Demand Management Study: US$ 0.8 million
2) Bus Rapid Transit System: US$ 2.5 million
3) Bus infrastructure development: USD$ 0.5 million
4) Thimphu TDM Model: US$ 0.2 million

5. Implementation Schedule

1) Transport Demand Management Study including the development of Thimphu TDM model: 8 months

Bus Rapid Transit System: tender 6 months
TDM monitoring and evaluation: 2 years

6. Implementation Agency

Thimphu Thromde

7. Outputs/Impacts

- Introduction of TDM system with monitoring capabilities
- Establishment of Thimphu TDM model
- Development of public bus system
- Modal shift to bus transport from automobiles

8. Environmental/Social Impacts

- Reduction of global warming gas emission from the transport sector in Thimphu
- Improved transport access for lower income people, elderly, children and handicapped.
- Less traffic jams in the city
- Less need for parking space and better use of urban land
- IEE may be necessary when the system affects the social environment negatively.
- Neither land acquisition nor resettlement is foreseen

9. Potential Risks

- Not enough passengers or revenue for sustainable operation of public transits
- Not enough impacts to reduce private automobile vehicles
- Not adequate route coverage to generate adequate passengers for the public transits
- Bus tariff not low enough to generate adequate passengers
- The traffic may increase too much to slow the traffic that the speed of public transits are too slow to be widely accepted by the public
- Not enough institutional capacity to implement the package of policies in a coherent manner

10. Constraints and Challenges

- The TDM measures should be implemented in an interactive manner so that the policy mix will have consistent effects on the reduction of traffic reduction in the central part of Thimphu.

- Road lanes are limited to one lane in Norzin Lam thus no space for dedicated bus lane
- There are already 2-3 private operators in serving the routes between the core and suburbs; There should not be unfair intervention to the transport market to discourage the private sector development.
- In case of introducing electric buses, the infrastructure of electricity charging stations and replacement of batteries need to be factored into the long term plan. The corresponding fund requirement will increase sizably.

Appendix A-2 Candidate Projects for Phuentsholing

(10) Project Note P-1

1. Project Title: Om Chhu Flood/Landslide Control with Sabo Technologies

2. Background and Necessity

(1) Current Condition・Challenge

Towards north area from Phuentsholing stand steep Himalayan mountains. These mountains block the Southwest monsoons to bring heavy rainfalls of over 4000mm per year. Due to weak soils combined with heavy rains and frequent earthquakes, the areas are prone to landslides and floods. In particular, in the year 2000, flood occurred in both Am Mo Chhu and Om Chhu Rivers to damage utility infrastructures, washed away markets and inflicted casualty of more than 40 in the city. The Om Chhu River has a steep grade of more than 15% on the average. Water basin management of rapid steep rivers require special set of technologies only developed in Japan. The body of the technologies is called "Sabo."

RGOB has recognized the importance of Sabo technologies and approached JICA in the past for technological transfer. Disaster management is crucial in sound urban development to ensure safety of human lives and urban facilities.

(2) Related Projects

With UNDP, a project is under preparation in order to stop landslide in north side of Phuentsholing

3. Project Outline

(1) Objectives

Control of damages occurred by flooding and landslides in the Omu Chuu basin where Phuentsholing is located

(2) Location

Along Om Chuu river in Phuentsholing

(3) Scope

1) Phase I: Training on Sabo technologies: workshop, seminar and training in Japan

Establishment of hydrological measurement station in Om Chhu and data collection

- measurement equipment and one short term consultant

Phase II: TA-oriented Development Study of Debris Flow and Flood Control of Om Chhu

- Hydrological/geological analysis
- Selection of appropriate technologies with local materials and minimum costs
- Sabo control implementation program
- Early warning system plan
- Institutional development including land use control, and building license
- Public awareness campaign
- Environmental Assessment preparation

Phase III: Pilot Project Construction

Technology Transfer

4. Estimated Cost

1) Training on Assistance on Sabo technologies: US$ 0.1 million

Establishment of hydrological measurement station in Om Chhu: US$ 0.06 million

TA-oriented Development Study+Pilot Project + Technology Transfer

Project Cost Estimate — Unit: Yen Million

	Quantity	Unit Cost		Cost
Consulting Fee	35 - 50	$ 0.015 million	=	$ 0.53 - $ 0.750
Local Consultant	20%	of consulting	=	$ 0.11 - $ 0.150
Travel Cost	40%	of consulting	=	$ 0.21 - $ 0.300
Overhead	40%	of consulting	=	$ 0.21 - $ 0.300
Pilot/Demo Project	2 - 5	$ 0.500 million	=	$1.00 - $ 2.500
Direct Expense	20%	of consulting	=	$0.11 - $ 0.150
Total				$2.16 - $ 4.150

5. Implementation Schedule

1) Training: 3 months x 4
2) Hydrological station and measurement: 3 years
3) TA-oriented Development Study+Pilot Project + Technology Transfer: 30 months

6.Implementation Agency

MoWHS, Phuentsholing Thromde

7.Outputs/Impacts

- Protect the life of residents of Phuentsholing city and the urban infrastructures.
- Secure the urban space for development
- Reduce recurrent damages caused by debris flow and flooding
- It could be a model for other areas for disaster prevention
- Increase water retention capacity of Om Chhu basin
- Creation of river side recreational facilities

8. Environmental/Social Impacts

- A positive impact with environmentally improved urban areas
- IEE will be necessary for the Phase III which will be prepared in Phase II
- At this moment relocation of people is basically unnecessary. However diagnosis will be done in Phase II and it will be clarified.
- Blockage of fish migration must also taken into account for environmental examination

9.Potential Risks

Residential developments in Phuentsholing may encroach into more hazard-prone areas without control and the risks and corresponding mitigation measures may increase drastically

10.Constraints and Challenges

Where and how to place strict control of residential developments

(11) Project Note P- 2

1.Project Title: Wastewater Treatment Expansion

2.Background and Necessity

(1) Current Condition・Challenge

The existing WWTP is located at the mouth of Om Chhu with the connection to Amo Chuu. The designed capacity of the current WWTP is 60% of population, and the capacity expansion will be urgently needed in view of future population growth. With expected urbanization and population increase, sewerage coverage must be expanded as well. Since the current treatment is lagoon type, it is possible to increase its capacity by incorporating aeration in order to improve environment and diplomatic relations with India as the wastewater, treated or untreated goes straight to the Indian side.

(2) Related Projects

DANIDA Wastewater Project in Phuentsholing and Thimphu

3.Project Outline

(1) Objectives
Provision of full sewerage treatment to residents in Phuentsholing
Provision of more urban land in the core city area
(2) Location
Phuentsholing
(3) Scope
1) City-wide plan review
2) Feasibility study: location and alternative treatment options for WWTP
3) Design and Cost Estimation
4) Construction

4.Estimated Cost

US $ 5 - $ 8 million

5.Implementation Schedule

1) City-wide plan review: 3 months
2) Feasibility study including EIA: 5 months
3) Design and Cost Estimation: 8 months
4) Construction: 12 months

6.Implementation Agency

Phuentsholing Thromde

7.Outputs/Impacts

- Provide hygienic wastewater treatment system to all the residents of Phuentsholing
- Reuse of the land currently used for the existing wastewater treatment
- Cost effective sewerage treatment system

8.Environmental/Social Impacts

- A positive impact with environmentally improved urban areas
- IEE will be necessary for the new treatment plant which must be included in F/S
- No foreseen land acquisition nor resettlement

9.Potential Risks

- Flood may damage the facilities constructed.

10.Constraints and Challenges

- The reclamation of Amo Chuu is needed for the acquisition of land for construction.

(12) Project Note P-3

1.Project Title: Water Supply System Rehabilitation

2 .Background and Necessity

(1) Current Condition・Challenge

Phuentsholing is endowed with abundant water resources. However the residents receive water supply on an intermittent basis. The current water treatment system lacks in design capacity to purify turbid water during monsoon season. The treatment plant and the intermittent water supply could be causing water contamination.

The current reservoirs of the distribution network fall short in capacities for continuous water supply.

(2) Related Past/Ongoing Projects

None

3.Project Outline

(1) Objectives

Provision of hygienic continuous water supply throughout the city

(2) Location

Phuentsholing

(3) Scope

1) City-wide plan review
2) Feasibility study: Diagnosis of current conditions of water treatment plants and water distribution system with the introduction of District Metered Areas for water auditing

3) Design and Cost Estimation
4) Construction

4. Estimated Cost

-

5.I implementation Schedule

1) City-wide plan review: 5 months
2) Feasibility study: 5 months
3) Design and Cost Estimation: 5 months
4) Construction: 2 years

6. Implementation Agency

Phuentsholing Thromde

7. Outputs/Impacts

- Continuous water supply on 24 x 7 basis
- Eliminate groundwater intrusion into distribution pipe network
- Improve hygiene of water supply
- Reduce storage and water lifting cost of customers

8. Environmental/Social Impacts

- A positive impact with environmentally improved urban areas
- IEE must be included in the F/S for the physical investment
- No foreseen land acquisition nor resettlement

9. Potential Risks

None

10. Constraints and Challenges

There may be space constraints for rehabilitation of water treatment plants or erection of additional reservoirs.

(13) Project Note P-4

1.Project Title: Relocation Upgrading of Farmers Market to Michi No Eki

2. Background and Necessity

(1) Current Condition・Challenge

The current central vegetable market is located at the planned route for the ring road. There are three alternative sites identified for relocation by the Survey Team. The best commercial potential is the vacant space next to the Bus Terminal.

The challenge that the city of Phuentsholing faces is to compete better with the Indian Jaigaon so as to make the best use of trades and traffics with India.

Japan has a long tradition of local branding and local industry development through community participation. One Village One Product Movement and Michi-no-Eki to discover local resources and encourage local entrepreneurship to promote development of local products and commerce.

(2) Related Projects

-

3.Project Outline

(1) Objectives

Establishment of new farmer's market to enhance commercial activities of Phuentsholing

(2) Location

Phuentsholing

(3) Scope

1) Citizen participation: holding of workshops, seminars, study tours etc.

One village One Product movement plan
Local resource identification study
Competition for enhancement design proposals
Detail Design/Tender Preparation
Implementation of enhancement

4.Estimated Cost

Project Cost Estimate — Unit: Yen Million

	Quantity	Unit Cost		Cost
Exposure trip to Japan	5 - 10	$ 0.02 million		$ 0.10 - $ 0.200
Japanese experts to Bhutan	3 - 5	$ 0.02 million		$ 0.06 - $ 0.100
Consulting Fee	5 - 10	$ 0.02 million	=	$ 0.08 - $ 0.150
Local Consultant	20%	of consulting	=	$0.02 - $ 0.030
Travel Cost	40%	of consulting	=	$0.03 - $ 0.060
Overhead	40%	of consulting	=	$0.03 - $ 0.060
Direct Expense	20%	of consulting	=	$0.02 - $ 0.030
Michi no Eki Construction	1	$ 0.20 million	=	$ 0.20 - $ 0.20
Total				$ 0.53 - $ 0.830

5.Implementation Schedule

Citizen participation and One Village One Product movement: 12 months
Local resource identification/competition/tender preparation: 12 months
Construction: 6 months

6.Implementation Agency

Phuentsholing Thromde

7.Outputs/Impacts

- Creation of new commercial + transport hub in the city
- Increased sales of local produce and handicrafts etc.
- Promotion of Bhutan Brand + Phuentsholing Brand

8.Environmental/Social Impacts

- No land acquisition is necessary since the proposed area is in the government land.
- The plan proposes about 0.3 ha of space
- IEE may be necessary
- Neither land acquisition nor resettlement is necessary as long as the site will be aside of the RSTAS Terminal

9.Potential Risks

Less than expected visitors for expanded scope of products and services.

10.Constraints and Challenges

RSTA may not approve the inclusion of Michi-no-Eki in their vacant land.

(14) Project Note P-5

1.Project Title: Om Chhu Old Bridge Renovation

2.Background and Necessity

(1) Current Condition・Challenge

The Om Chhu Bridge is the only bridge that connects the northern and southern sides of the city. The bridge constructed in the year 2003 is now showing a sign of fatigue due to heavy traffic over the bridge for which the citizens voice their concern for safety of passage. The bridge will connect to the junction between the planned ring road and the highway to Samtse, and there is a RSTA bus terminal in the northeastern corner of the junction. Therefore it will become a transportation hub in the future. The bridge should be renovated to ensure the safety of passengers as well as to promote economic and social activities of Phuentsholing. There are two options to the renovation:

Option-1: To rehabilitate the bridge

Option-2: To build a new bridge along the east side of the existing bridge and
To utilize the existing bridge as open space for pedestrians

(2) Related Projects

-SASEC Road Connectivity Project by ADB
- Samtse Highway by Bhutanese Government (under construction)
- 2001－2014： JICA The Project for Reconstruction of Bridges Phase I –III (grant)

3.Project Outline

(1) Objectives

Protection of passenger safety over the bridge as well as the provision of capacity for the future traffic increases

(2) Location

Phuentsholing

(3) Scope

1) Preparatory Study
- Site investigations, including a geological survey, topographical survey, hydrological survey, environmental/social surveys and surveys of remaining loading capacity/durability, etc.
- Demand forecast
- Renovation option study: Option-1(Rehabilitating the bridge) and Option-2 (Building a new bridge

Basic Design
Detailed Design and Preparation of Procurement Documents,
Bid
Construction

4.Estimated Cost

1) Bridge Construction, including the utilization of the existing bridge: **US$ 1. 1 million**
- Bridge: Length 40m, Width 7.5m (2 traffic lanes 3.75m x 2)

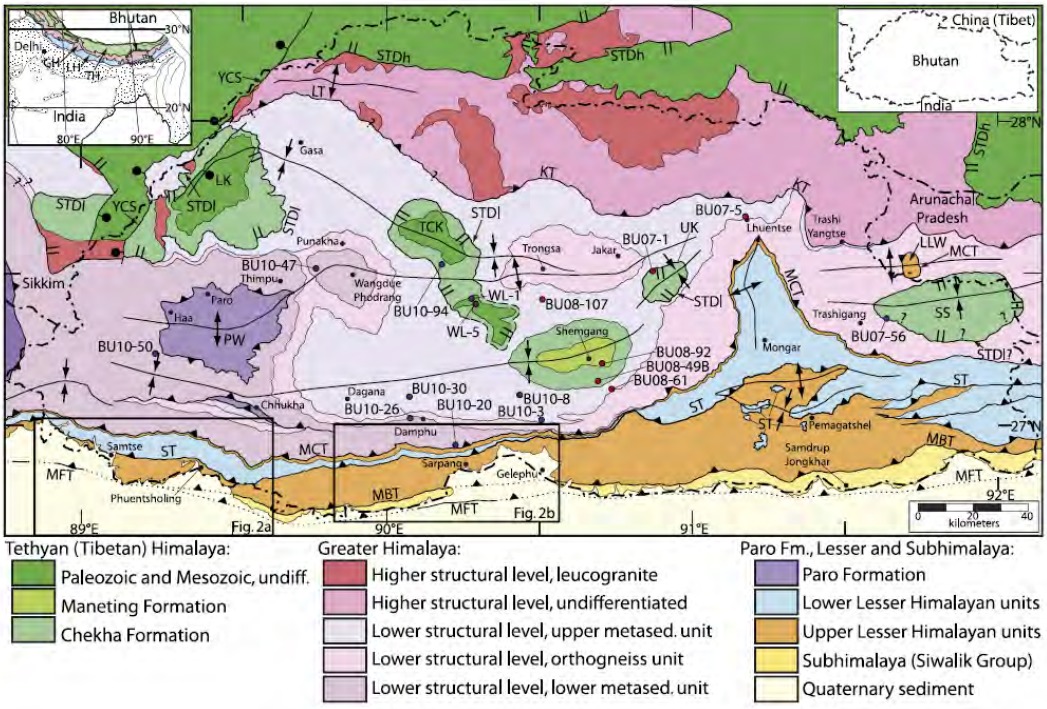
2) Access Road Rehabilitation: **US$ 0.2 million**
- Length (north)150m + (roundabout)50m + (south)30m = 230m
- Width 11m (2 traffic lanes 3.75m x 2 + 2 side walks1.75m x 2)

3) Improvement of surrounding areas: **US$ 0.5 million**
4) Contingency: **US$ 0.2 million**
5) Total: **US$ 2 million**

5.Implementation Schedule
1)Preparatory Study: 4 months 2)Detailed Design and Preparation of Procurement Documents and Bid: 8 months 3)Construction: 12 months
6.Implementation Agency
Phuentsholing Thromde
7.Outputs/Impacts
- Safety of passengers and cargos - Efficient circulation of traffics - Promotion of local commerce and social activities
8.Environmental/Social Impacts
- Positive impacts on human safety - Neither land acquisition nor resettlement is necessary - No IEE is required as long as the alignment will not be altered
9.Potential Risks
Provision of passage across the river Om Chhu during the time of construction: the first ring road bridge should provide alternative passage during the time of construction
10.Constraints and Challenges
If alternate passage is not available at the time of construction, some provision for passage needs to be provided with modified construction method.

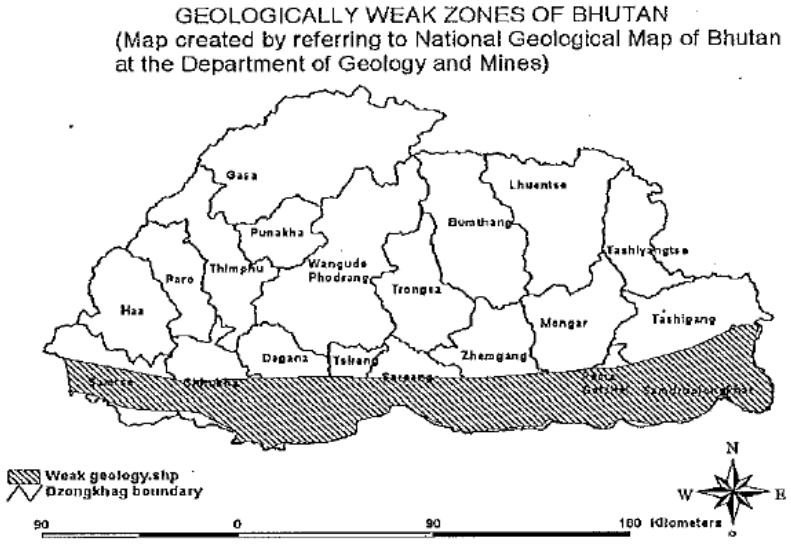
APPENDIX B: GEOLOGICAL MAP OF BHUTAN

Map1 Geology of Bhutan



Source: Documenting basin scale, geometry and provenance through detrial geochemical data: Lessons from Neoproterozoic to Ordovician Lesser, Greater, and Tethyan Himalayan Strata of Bhutan, N.McQuarrie, S.P.Long, T.Tobgay, JN Nesbit, G Gehrels, MN Ducea

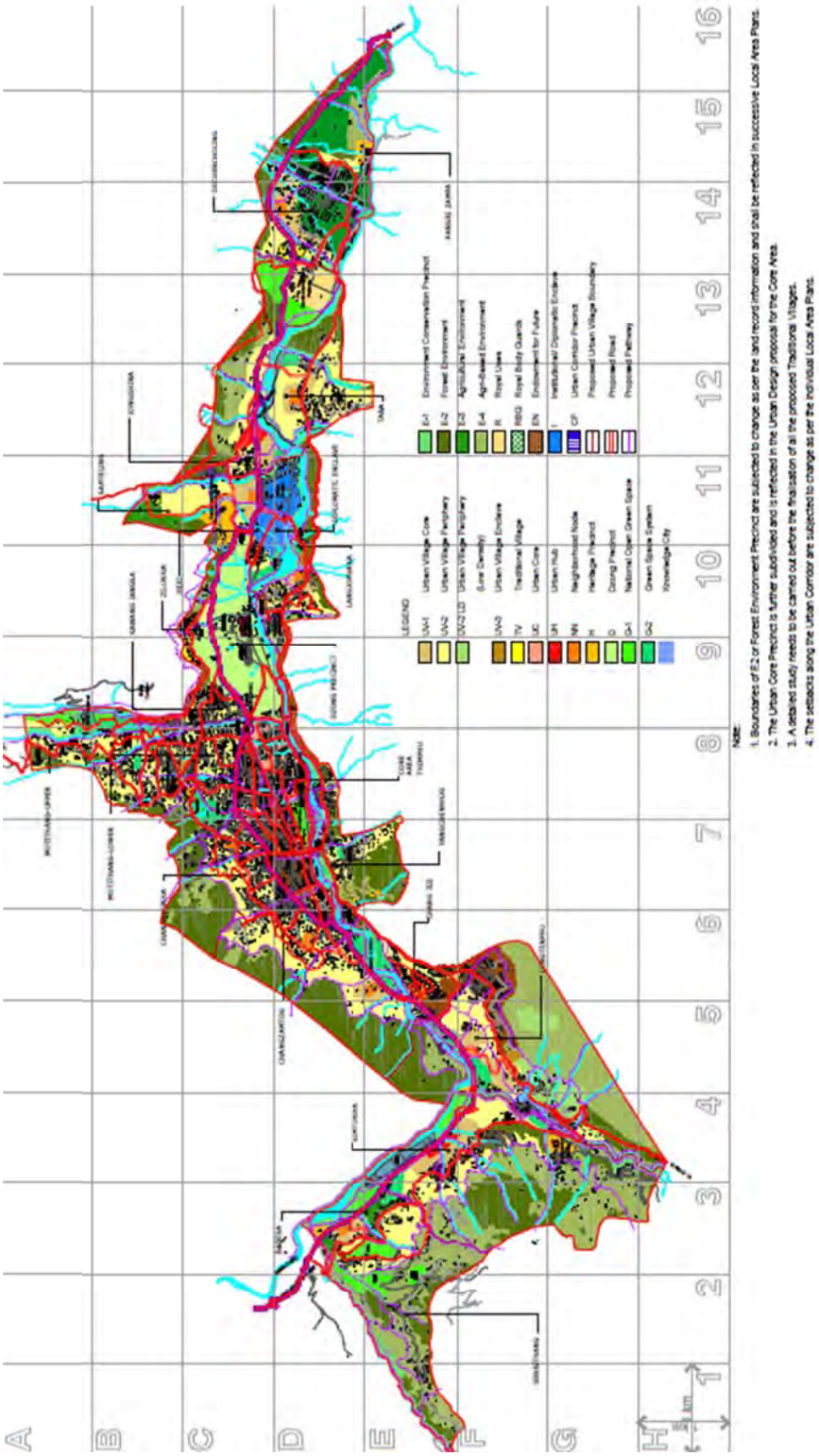
Map 2 Geologically Weak Zones of Bhutan



Source: National Soil Center 2006

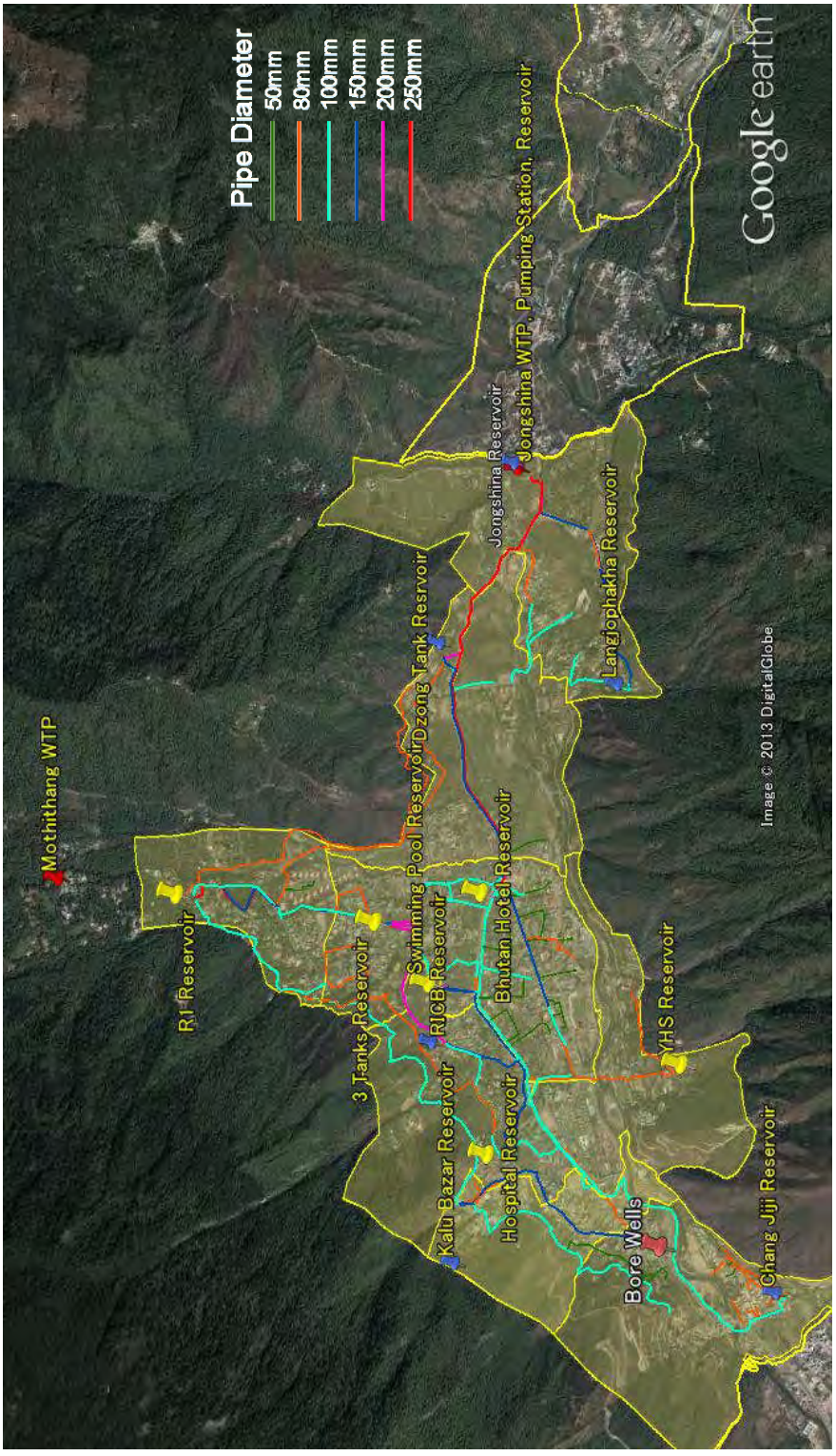
Source: Thimphu City State of Environment 2008

Appendix C-1: Land Use Plan in Thimphu Structure Plan



Source: Thimphu Structure Plan（2002-2027）

Appendix C-2: Major Water Supply Facilities in Thimphu



Source: Thimphu Thromde

Appendix D: Drought Analysis

1. Objective of Analysis

To evaluate the water source potential of the water intakes of the water treatment plant, rough specific discharge of rivers in Bhutan is estimated based on available river flow data.

2. Methods of Analysis

10-year-drought-runoff at the point of water intake is adopted as a safe yield (minimum water source potential) of the water source according to common practice in Japan. 10-year-drought runoff is obtained from 10% non-exceedence probablility function of discharge by assuming that the annual drought flow (tenth least flow in year) is normally distributed.

3. Data Analyzed

Data obtained from Hydrology Division, Department Hydromet Services, Ministry of Economic Affairs, are used for the analysis. The data cover data of 10 gauging stations. Characteristics of the gauging stations are show in Table 1 and their locations are shown in Figure 1. Data of each gauging station contains every day flow data for the period indicated in the table.

Table D-1 Characteristics of Gauging Stations

Station No.	Station Name	Location				Data	
		Latitude	Longitude	Elevation (m)	Area (km2)	Start	End
12800045	Lungtenphug on Thimphu Chhu	27:26:48	89:39:40	2,260	663	1991	2011
12490045	Tamchu on Wang Chhu	27:14:36	89:31:38	1,990	2,520	2003	2011
12350073	Chimakoti Dam on Wang Chhu	27:06:34	89:32:02	1,820	3,550	1976	2011
12460045	Haa on Haa Chh	27:22:16	89:17:08	2,700	320	2000	2011
12530045	Paro on Paro Chhu	27:26:00	89:25:30	2,255	1,049	1989	2011
11210045	Doyagang on Amochhu	26:53:12	89:20:06	355	3,650	2006	2011
13700045	Yebesa on Mo Chhu	27:37:59	89:49:03	1,230	2,320	1991	2011
13830045	Dokarna on Phochhu	27:39:12	89:52:54	1,290	NA	2008	2011
13490045	Wangdi Rapids on Pho+Mo Chhu	27:27:45	89:54:11	1,190	6,271	1991	2011
13320045	Toritar on Sunkosh	27:00:21	90:04:36	320	8,593	2006	2011

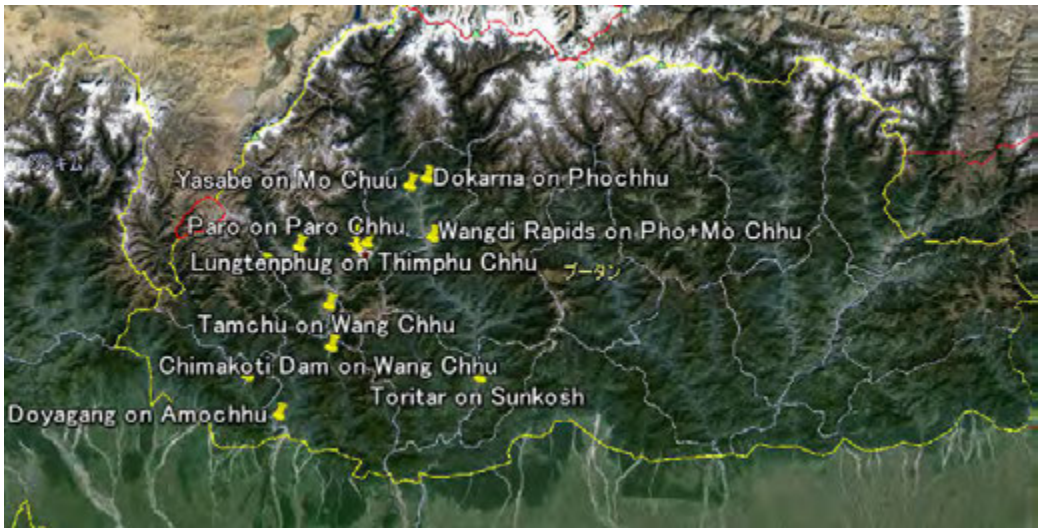


Figure D-1 Location of Gauging Stations

4. Flow Regime of each Gauging Station

Annual flow regimes (high, mean low and drought flows) of each gauging station are shown in the Attachment 1.

5. Distribution of Drought Flow and 10% Non-Exceedence Probable Flow

Assuming the normal distribution, drought flow of each year is plotted on the normal probability distribution graph paper as shown in the Attachment-2, 10 year non-exceedence probable flow is read out from 10% of exceedance line.

6. 10-Year-Drought-Runoff

10 year drought flow and specific run off (run off/100 km^2 of the catchment) are as shown in Table 2. Specific run off in the Wang Chhu system is about 50 % of those of other river systems. This is probably because of less precipitations in the catchment compared to other rivers.

Table D-2 10 Year Drought Flow and Specific Run OFF

Station No.	Station Name	Drought Run Off (10 year-probability) m^3/sec	Specific Run Off ($m^3/sec/100km^2$)	River System
12800045	Lungtenphug on Thimphu Chhu	3.2	0.48	Wang Chhu
12490045	Tamchu on Wang Chhu	10.7	0.42	Wang Chhu
12350073	Chimakoti Dam on Wang Chhu	17.0	0.48	Wang Chhu
12460045	Haa on Haa Chh	0.9	0.27	Wang Chhu
12530045	Paro on Paro Chhu	4.2	0.40	Wang Chhu
11210045	Doyagang on Amochhu	26.5	0.73	Amo Chhu
13700045	Yebesa on Mo Chhu	18.0	0.78	Mo Chhu
13830045	Dokarna on Phochhu	8.3	-	Mo Chhu
13490045	Wangdi Rapids on Pho+Mo Chhu	56.0	0.89	Mo Chhu
13320045	Toritar on Sunkosh	81.0	0.94	Mo Chhu

Appendix D: Flow Regime 1

Name of River: Wang Chhu

Station Name: Tamchu on Wang Chhu

Year	Run off			
	High(95)	Mean(185)	Low (275)	Drought(355)
2003	97.834	27.106	16.41	11.995
2004	91.879	30.585	16.741	13.357
2005	53.545	24.417	15.072	11.768
2006	109.806	27.317	16.792	13.201
2007	62.586	27.555	15.478	11.483
2008	110.055	32.888	17.453	12.377
2009	82.549	42.28	21.942	17.867
2010	96.732	39.737	22.708	18.335
2011	112.162	42.389	22.83	18.599

Name of River: Haa Chhu

Station Name: Haa on Haa Chhu

Year	Run off			
	High(95)	Mean(185)	Low (275)	Drought(355)
2000	11.201	3.898	2.57	2.214
2001	9.649	4.416	2.092	1.695
2002	8.544	3.664	2.13	1.845
2003	9.74	3.788	2.385	1.985
2004	7.441	3.368	2.337	2.07
2005	6.703	3.476	2.352	1.996
2006	8.16	3.808	2.317	1.895
2007	7.151	4.047	2.873	2.345
2008	9.045	3.893	2.887	2.351
2009	4.245	2.825	2.173	0.985
2010	5.786	2.183	1.327	0.747
2011	6.067	2.704	1.258	1.102

Name of River: Wang Chhu

Station Name: Chimakoti Dam

Year	Run off			
	High(95)	Mean(185)	Low (275)	Drought(355)
1976	106.94	53.85	18.81	13.89
1977	161.28	56.76	28.34	20.63
1978	161.74	75.17	35.56	26.98
1979	91.55	38.39	29.97	20.89
1980	146.69	50.85	31.36	19.39
1981	151.79	56.8	40.03	16.28
1982	127.34	60.47	37.98	23.52
1983	147.96	74.36	24.96	19.62
1984	210.81	68.38	24.08	19.31
1985	203.91	66.82	24.78	22.14
1987	162.637	53.709	33.547	21.59
1988	120.28	42	28.92	23.49
1989	216.67	63.96	35.37	22.76
1990	134.65	61.34	29.91	23.24
1991	138.28	45.14	32.22	24.16
1992	95.917	37.459	25.27	20.92
1993	133.81	56.35	26.46	20.37
1994	111.089	44.09	29.151	23.494
1995	170.846	57.206	32.665	21.522
1996	150.65	54.283	36.303	27.566
1997	129.605	49.1	28.73	23.562
1998	120.247	52.049	28.237	19.838
1999	186.933	61.097	25.721	19.614
2000	168.419	52.9	32.024	25.89
2001	149.161	56.352	25.159	19.932
2002	113.954	46.4	27.597	21.819
2003	173.358	54.263	32.859	22.948
2004	144.923	55.848	32.269	26.308
2005	111.585	49.176	30.421	24.979
2006	144.67	47.799	28.487	21.408
2007	98.009	45.74	28.838	23.393
2008	140.2	43.216	24.777	19.305
2009	106.133	45.425	27.581	19.657
2010	139.557	48.74	28.949	20.994

Name of River: Pho+Mo Chhu

Station Name: Wangdi Rapids on Pho+Mo Chhu

Year	Run off			
	High(95)	Mean(185)	Low (275)	Drought(355)
1992	338.668	143.967	83.102	58.922
1993	376.375	171.678	73.986	59.028
1994	361.728	148.896	82.361	62.441
1995	465.062	181.079	83.982	63.739
1996	521.709	177.683	87.059	62.624
1997	457.621	150.283	83.237	63.502
1998	397.842	175.796	80.773	59.746
1999	523.259	160.737	77.417	58.995
2000	560.088	155.228	88.224	63.654
2001	444.267	163.111	82.437	59.985
2002	361.982	138.691	78.079	59.454
2003	486.582	151.282	81.892	58.044
2004	471.098	157.723	83.454	61.674
2005	385.54	163.525	90.564	73.476
2006	496.14	152.372	84.932	68.261
2007	367.622	171.415	91.416	69.286
2008	469.455	166.152	86.457	63.151
2009	403.995	152.851	84.296	63.463
2010	544.864	164.9	92.802	60.448
2011	424.611	163.473	82.213	64.149

Name of River: Sunkosh Chhu

Station Name: Toritar on Sunkosh

Year	Run off			
	High(95)	Mean(185)	Low (275)	Drought(355)
2006	616.546	191.492	108.382	85.194
2007	483.593	197.429	122.114	84.645
2008	618.175	212.009	110.24	83.973
2009	Data missing			
2010	652.739	240.437	127.277	96.227
2011	485.788	221.765	122.469	91.512

Name of River: Paro Chhu

Station Name: Paro

Year	Run off			
	High(95)	Mean(185)	Low (275)	Drought(355)
1989	65.83	20.7	11.07	7.03
1990	56.72	13.89	8.34	5.79
1991	45.44	12.38	8.61	6.73
1992	34.82	14.18	10.01	8.54
1993	43.23	13.45	10.01	7.24
1994	30.33	13.76	10.42	8.38
1995	35.87	17.56	11.53	8.99
1996	34.85	16.87	12.4	9.75
1997	23.01	13.76	10.42	6.65
1998	21.4	10.27	5.92	4.95
1999	39.309	12.701	5.728	4.32
2000	43.612	15.232	8.548	5.205
2001	30.769	9.751	7.197	5.537
2002	24.179	7.577	5.08	3.911
2003	41.082	10.87	5.459	4.228
2004	43.91	13.345	6.53	5.175
2005	28.921	11.456	6.622	5.724
2006	43.414	14.096	7.348	5.384
2007	29.082	13.345	8.329	6.425
2008	48.623	12.327	7.258	5.484
2009	31.212	10.933	7.121	5.484
2010	Data missing			
2011	34.71	12.727	7.989	4.063

Name of River: Amo chhu

Station Name: Doyagang

Year	Run off			
	High(95)	Mean(185)	Low (275)	Drought(355)
2007	242.196	88.757	55.948	43.565
2008	283.74	82.731	45.511	30.746
2009	223.619	113.382	47.257	31.808
2010	351.801	128.011	53.701	30.188
2011	178.219	92.045	46.579	37.777

Name of River: Phochhu

Station Name: Dokarna

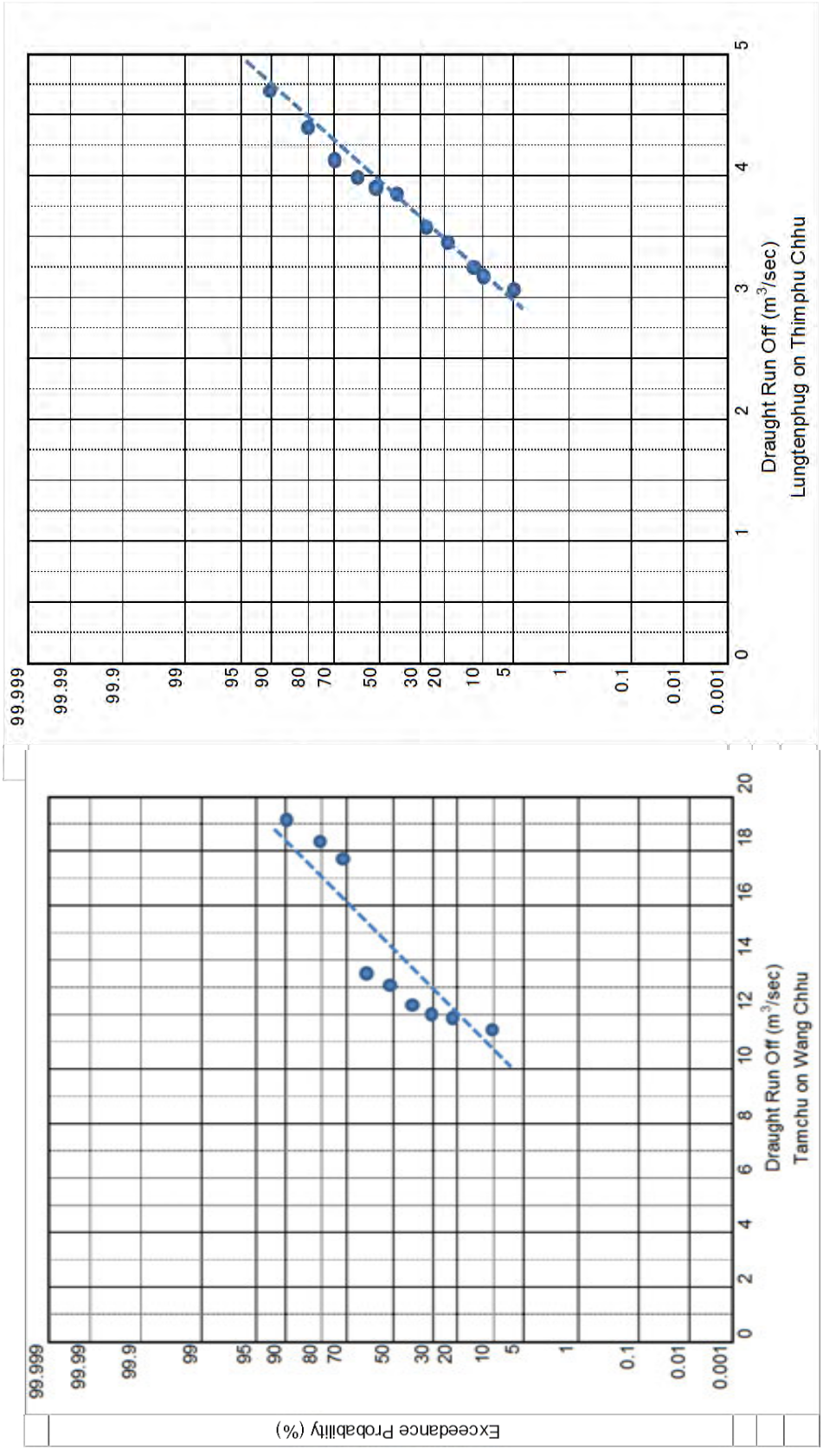
Year	Run off			
	High(95)	Mean(185)	Low (275)	Drought(355)
2008	Data Missing			
2009	57.575	24.662	13.074	11.093
2010	71.571	29.54	18.154	14.562
2011	52.648	24.422	15.833	12.835

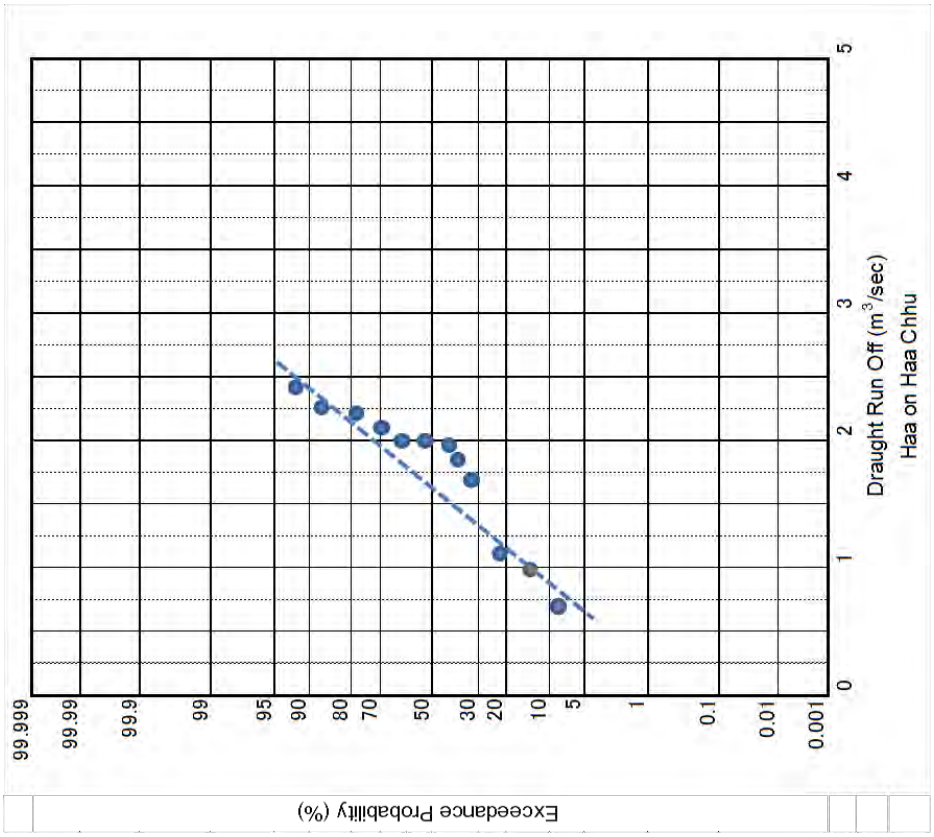
Name of River: Mo Chhu

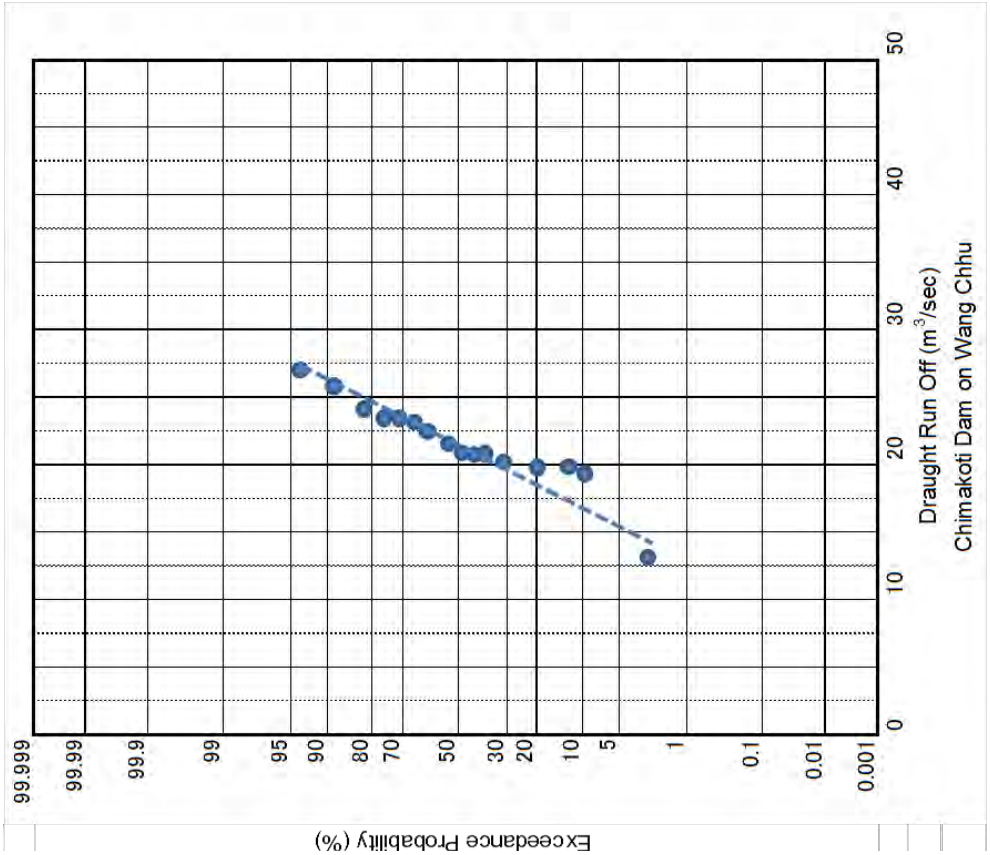
Station Name: Yebesa on Mo Chhu

Year	Run off			
	High(95)	Mean(185)	Low (275)	Drought(355)
1992	138.093	61.78	34.809	23.792
1993	166.998	69.501	30.485	24.315
1994	136.08	53.634	29.843	24.041
1995	191.316	64.465	34.132	22.353
1996	179.056	61.098	32.255	24.195
1997	176.802	56.345	30.303	23.098
1998	187.387	71.991	27.794	22.864
1999	220.445	68	28.729	20.591
2000	258.553	62.641	30.506	22.475
2001	194.289	63.365	29.806	22.171
2002	158.075	54.29	28.64	22.333
2003	209.735	60.501	31.472	21.655
2004	213.881	62.513	31.129	23.557
2005	149.561	55.178	30.628	24.086
2006	199.822	56.346	27.977	23.21
2007	146.2	63.464	31.061	24.564
2008	193.151	61.772	31.647	22.094
2009	Data missing			
2010	220.661	53.949	27.476	20.827
2011	155.947	53.892	23.292	18.817

Appendix D: Distribution of Draught Flow




Exceedance Probability (%)
99.999
99.99
99.9
99
95
90
80
70
50
30
20
10
5
1
0.1
0.01
0.001
0
1
2
3
4
5
Draught Run Off (m3/sec)
Haa on Haa Chhu


Exceedance Probability (%)
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99.99
99.9
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20
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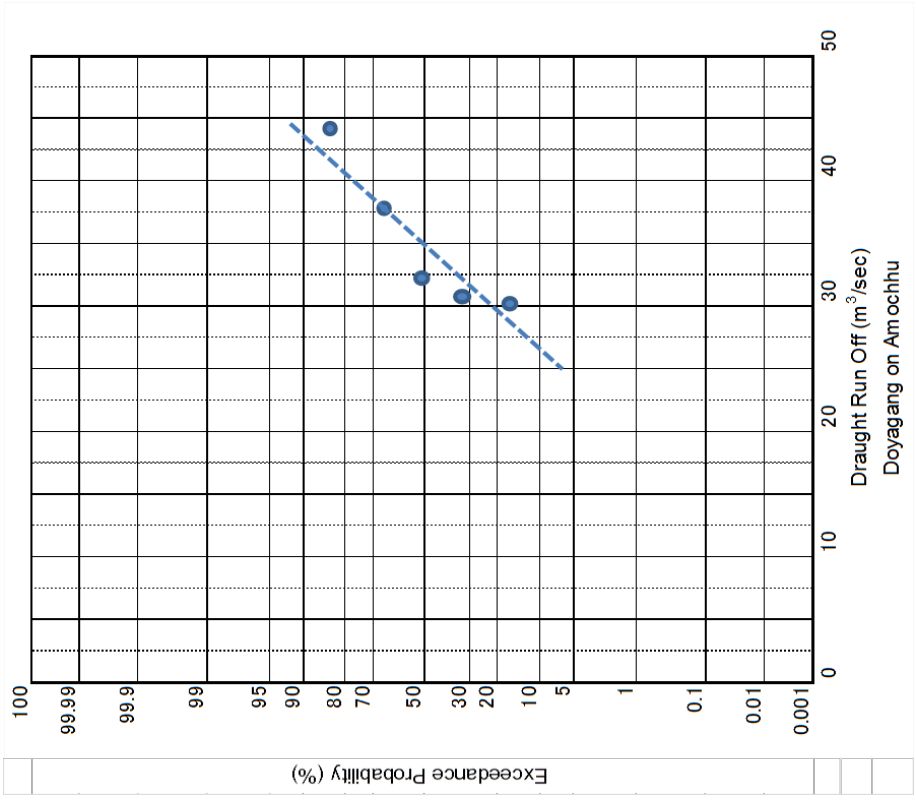
10
20
30
40
50
Draught Run Off (m3/sec)
Chimakoti Dam on Wang Chhu


Exceedance Probability (%)
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99.9
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90
80
70
50
30
20
10
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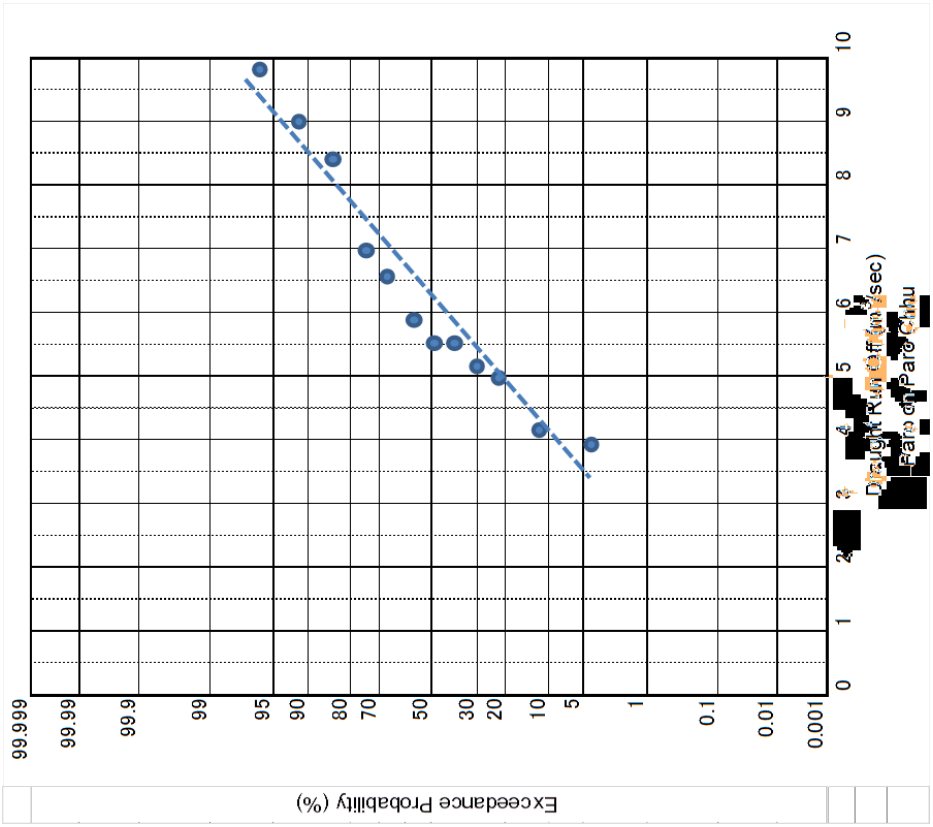
0.001
0
10
20
30
40
50
Draught Run Off (m3/sec)
Doyagang on Amochhu


Exceedance Probability (%)
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99.99
99.9
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95
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80
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0.01
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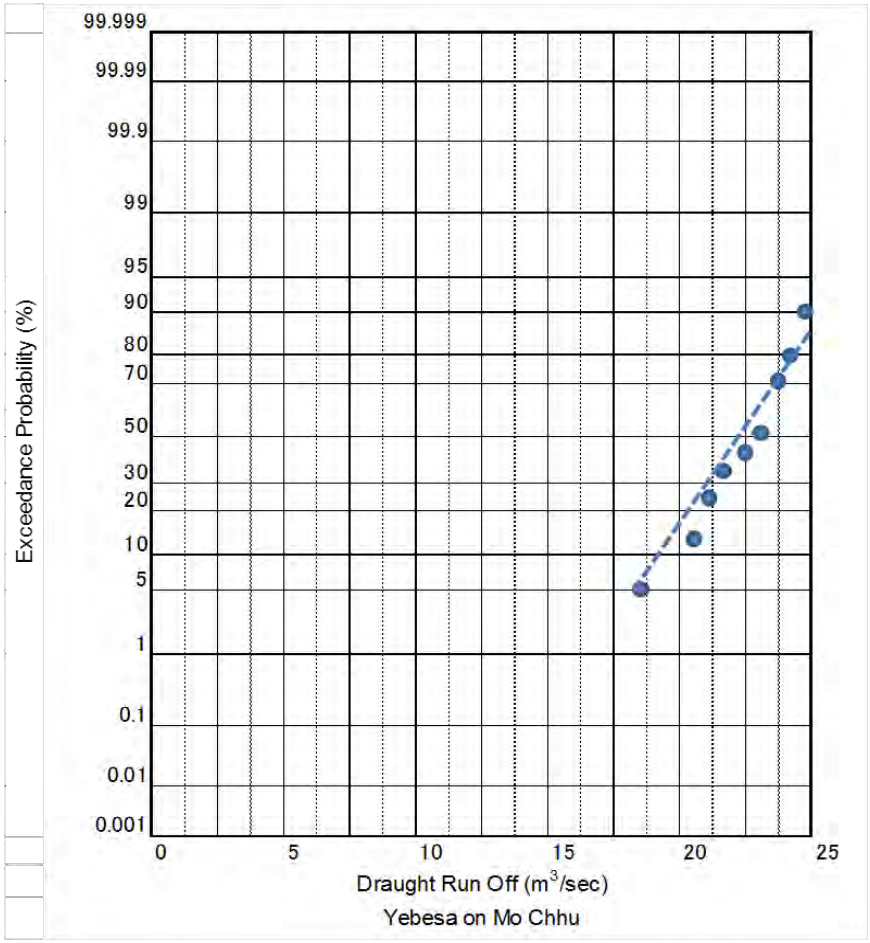
2
3
4
5
6
7
8
9
10
Draught Run Off (m3/sec)
Paro on Paro Chhu


99.999
99.99
99.9
99
95
90
80
70
50
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20
10
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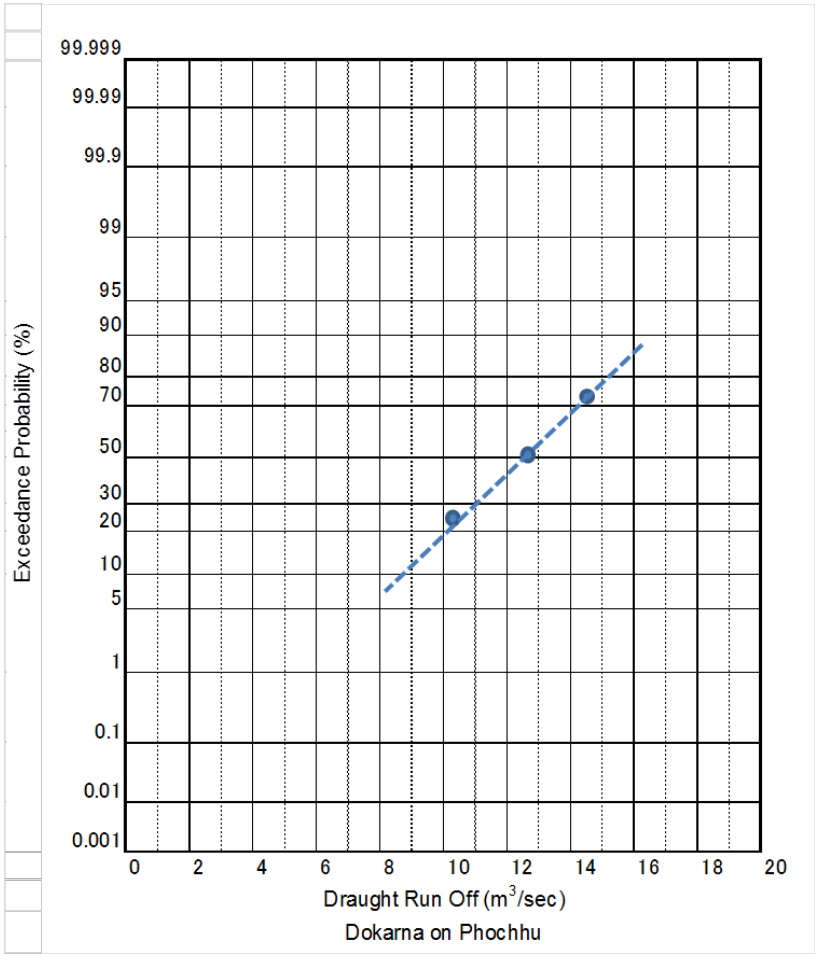
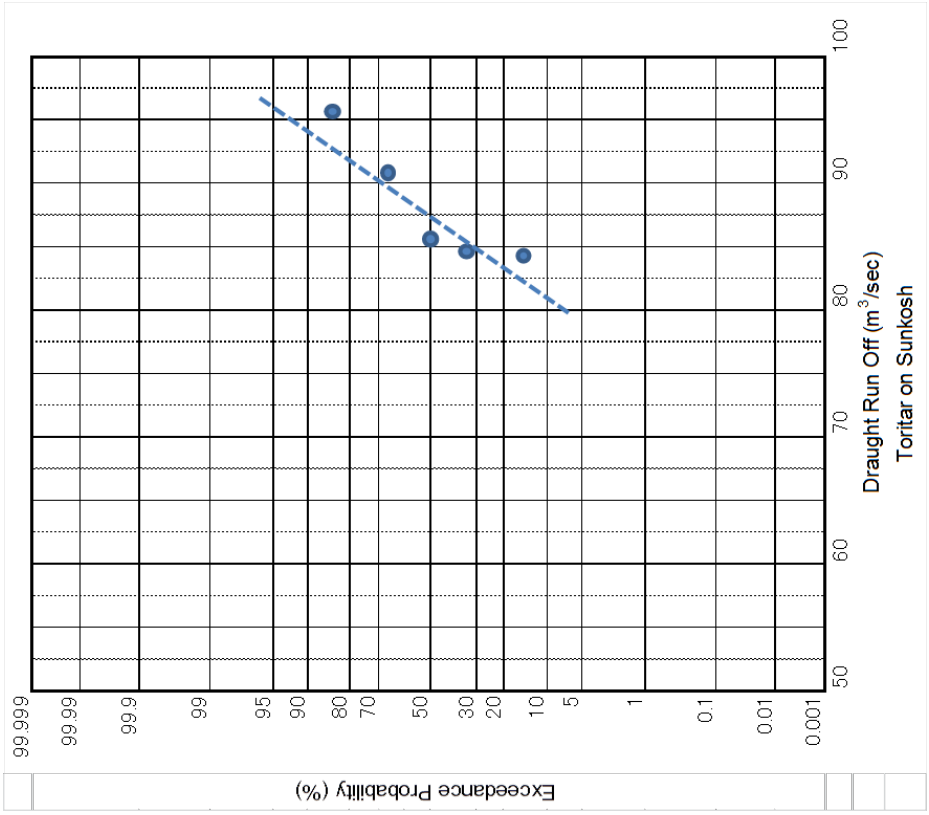
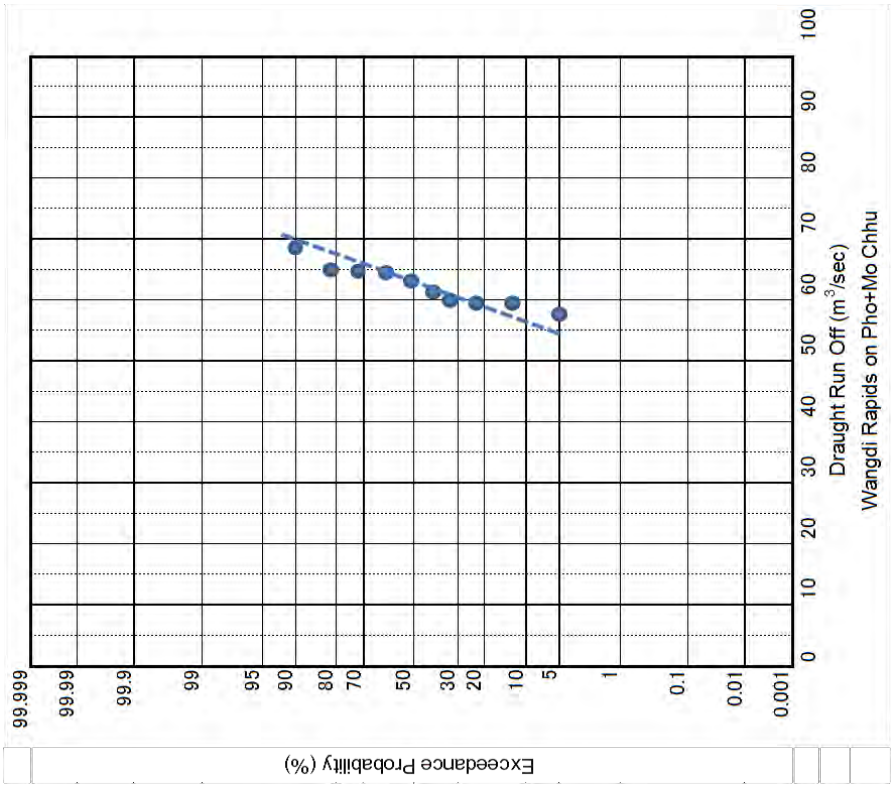
1
0.1
0.01
0.001
Exceedance Probability (%)
0
5
10
15
20
25
Draught Run Off (m3/sec)
Yebesa on Mo Chhu


99.999
99.99
99.9
99
95
90
80
70
50
30
20
10
5
1
0.1
0.01
0.001
Exceedance Probability (%)
0
2
4
6
8
10
12
14
16
18
20
Draught Run Off (m3/sec)
Dokarna on Phochhu


Exceedance Probability (%)
99.999
99.99
99.9
99
95
90
80
70
50
30
20
10
5
1
0.1
0.01
0.001
50
60
70
80
90
100
Draught Run Off (m3/sec)
Toritar on Sunkosh


Exceedance Probability (%)
99.999
99.99
99.9
99
95
90
80
70
50
30
20
10
5
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
90
100
Draught Run Off (m3/sec)
Wangdi Rapids on Pho+Mo Chhu

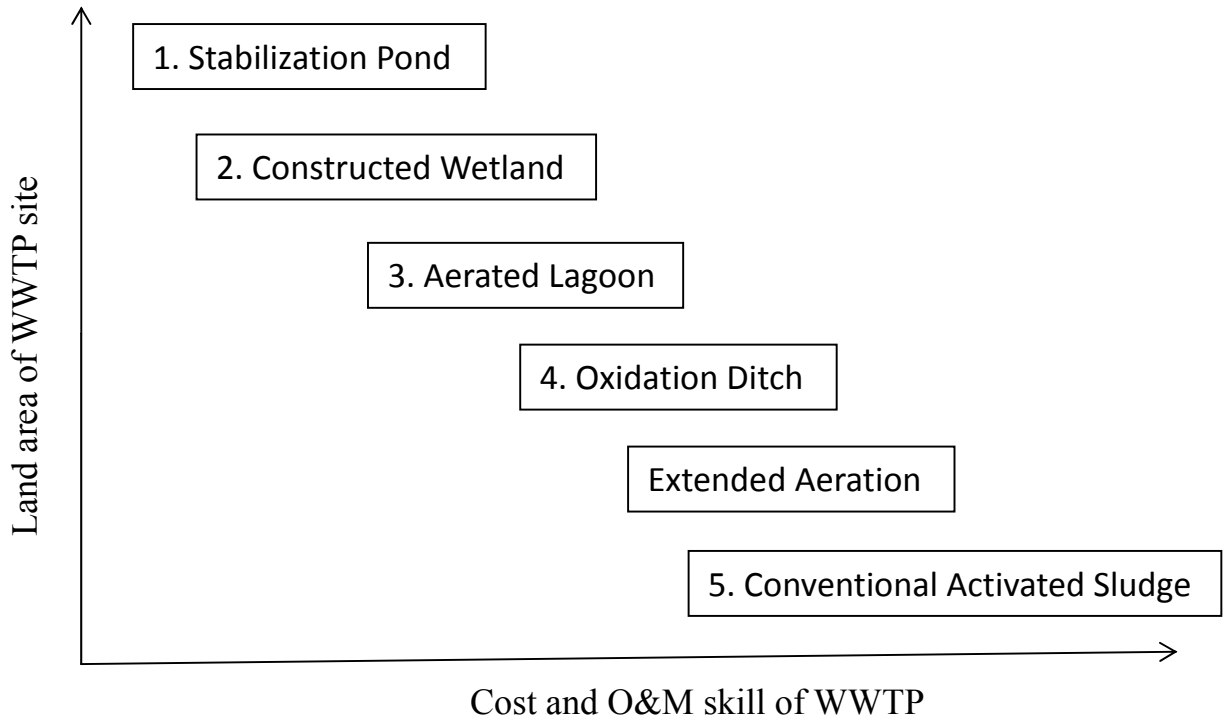
APPENDIX E: Introduction of Wastewater Treatment Process

The wastewater treatment process shall be selected considering the following factors:

(1) Quantity and quality of raw wastewater including their fluctuation
(2) Effluent standards to be applied to the receiving water body
(3) The present and future water use in the receiving water body
(4) Reuse plan of treated wastewater
(5) Location of the wastewater treatment plant site
(6) Available land area for the wastewater treatment plant
(7) Construction cost, operation/maintenance cost and easiness of operation
(8) Legal conditions to be applied to the wastewater treatment plant site

Low cost and easy operation/maintenance treatment process, such as Stabilization Pond, Aerated Lagoon, Constructed Wetland and Oxidation Ditch requires large space in general. In the other extreme end of the X-axis, Conventional Activated Sludge process and other similar processes require high cost and skilled operation/maintenance, but requires less space as shown in the following figure.

Most economical and pragmatic treatment process needs to be selected from an overall optimization of cost, ease in operation/maintenance, reliability in treatment process and space availability.

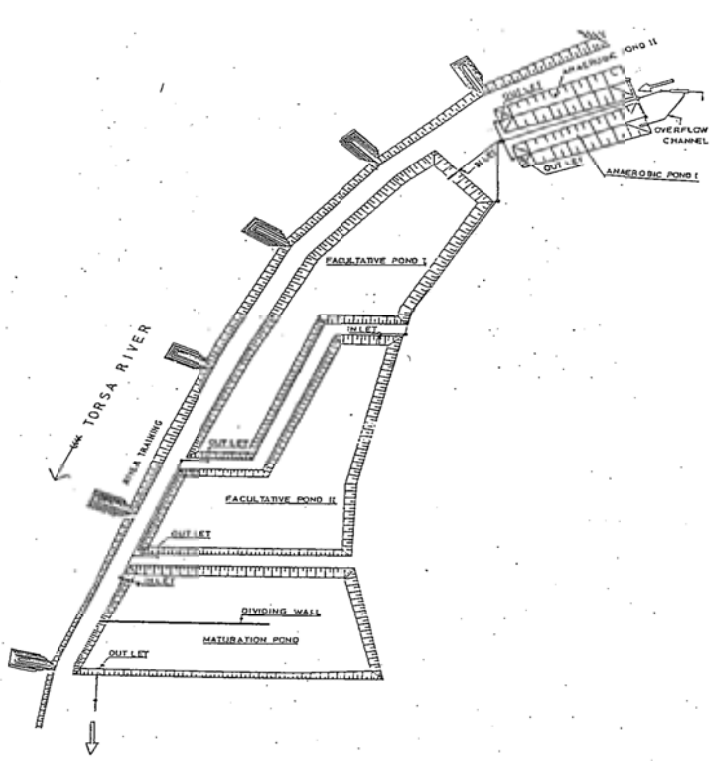


Source: JICA Study Team

1. Stabilization Pond Process

The stabilization pond is a process that is easy to maintain by low cost.
There are three types of ponds in the stabilization pond process.

- Anaerobic pond performs breakdown of the complex organic matter by anaerobic bacteria.
- Facultative pond consists of a major upper layer containing dissolved oxygen (aerobic layer) and a lower layer devoid of oxygen (anaerobic layer). In the upper layer, algae and both facultative and aerobic bacteria coexist.
- Maturation pond is an aerobic pond whose prime function is to remove further pathogenic agents from a treated effluent. It also removes some suspended matter and some nutrients, and further reduce the concentration of biodegradable organic matter.



Source: Phuentsholing Thromde

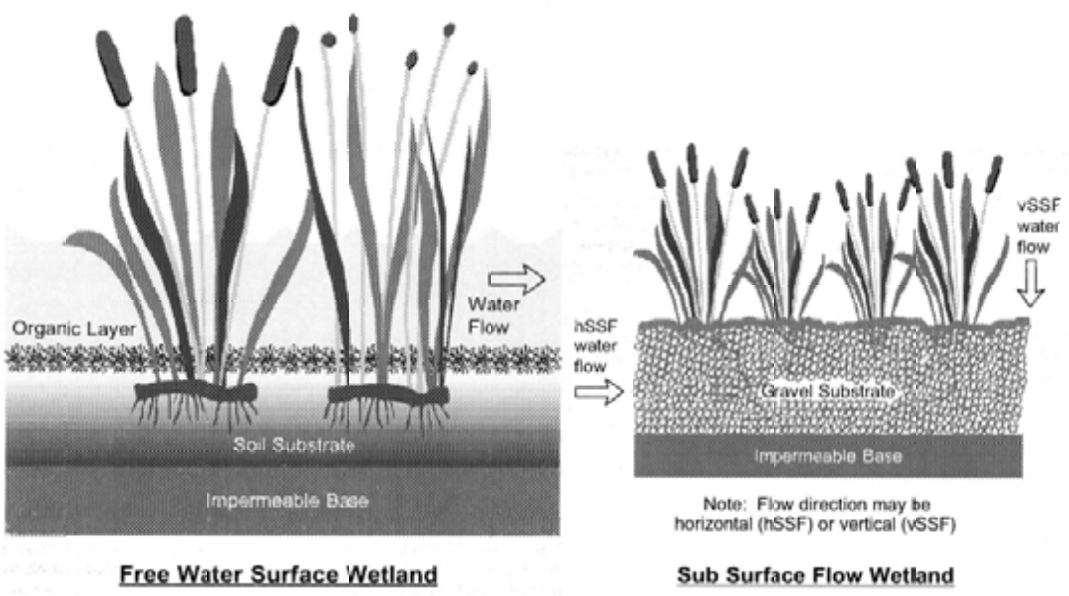
Source: JICA Study Team

Layout of Existing Phuentsholing WWTP (left) and Anaerobic Pond (right-top), Facultative Pond (right-center) and Maturation Pond (right-bottom) of the WWTP

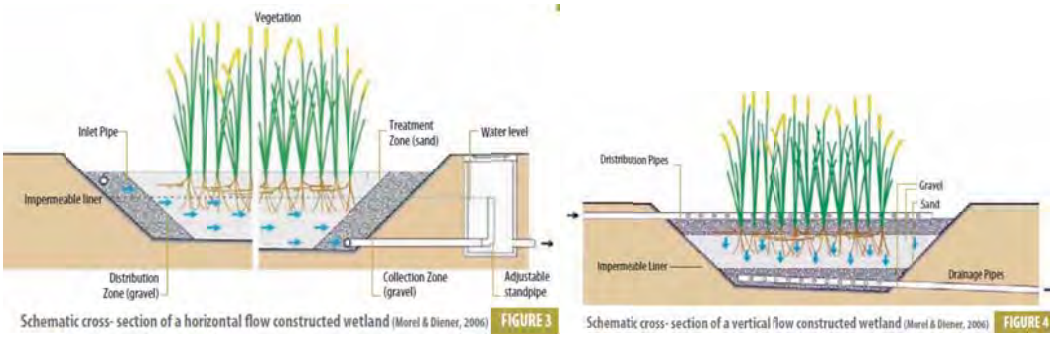
2. Constructed Wetland Process

Constructed wetland is a natural, low-cost, eco-technological biological wastewater treatment technology, which is now standing as the potential alternative or supplementary systems for the treatment of wastewater.

A constructed wetland is a shallow basin filled with some sort of filter material, usually sand or gravel, and planted with vegetation tolerant of saturated conditions. Wastewater is introduced into the basin and flows over the surface or through the substrate, and is discharged out of the basin through a structure which controls the depth of the wastewater in the wetland.



Source: Guideline for Low-Cost Sewerage Systems in Developing Countries (draft), August 2004, IDI-Japan



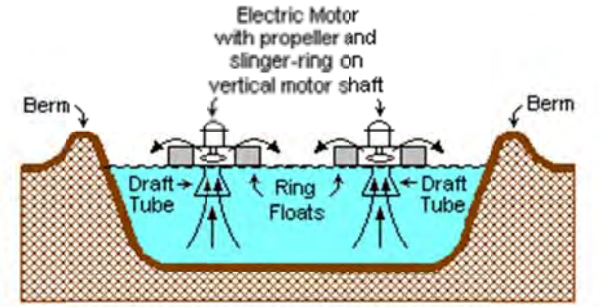
Source: Constructed Wetland Manual, UN-HABITAT, 2008


Source: UVM Constructed Wetland Research Center


Source: Constructed Wetland Manual, UN-HABITAT, 2008

3. Aerated Lagoon Process

Aerated lagoons are structurally similar to stabilization ponds. This process has a shorter retention time than the stabilization pond system by enforcement of oxidation. Aerated lagoons are activated sludge units operated without sludge return. Aerated lagoons are now usually designed as completely mixed non-return activated sludge units. Floating aerators are most used to supply the necessary oxygen and mixing power.

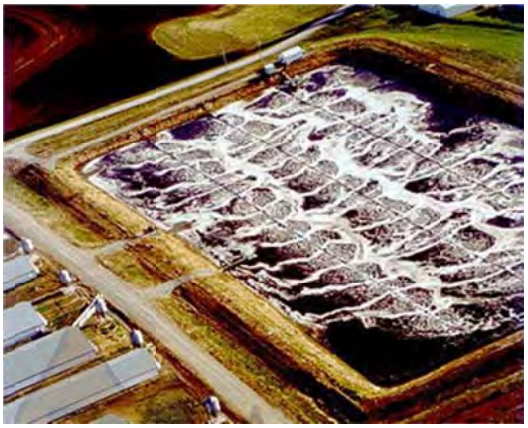


A TYPICAL SURFACE – AERATED BASIN

Note: The ring floats are tethered to posts on the berms.

Source: Aerated lagoon, Wikipedia

Source: A lagoon system, Maine



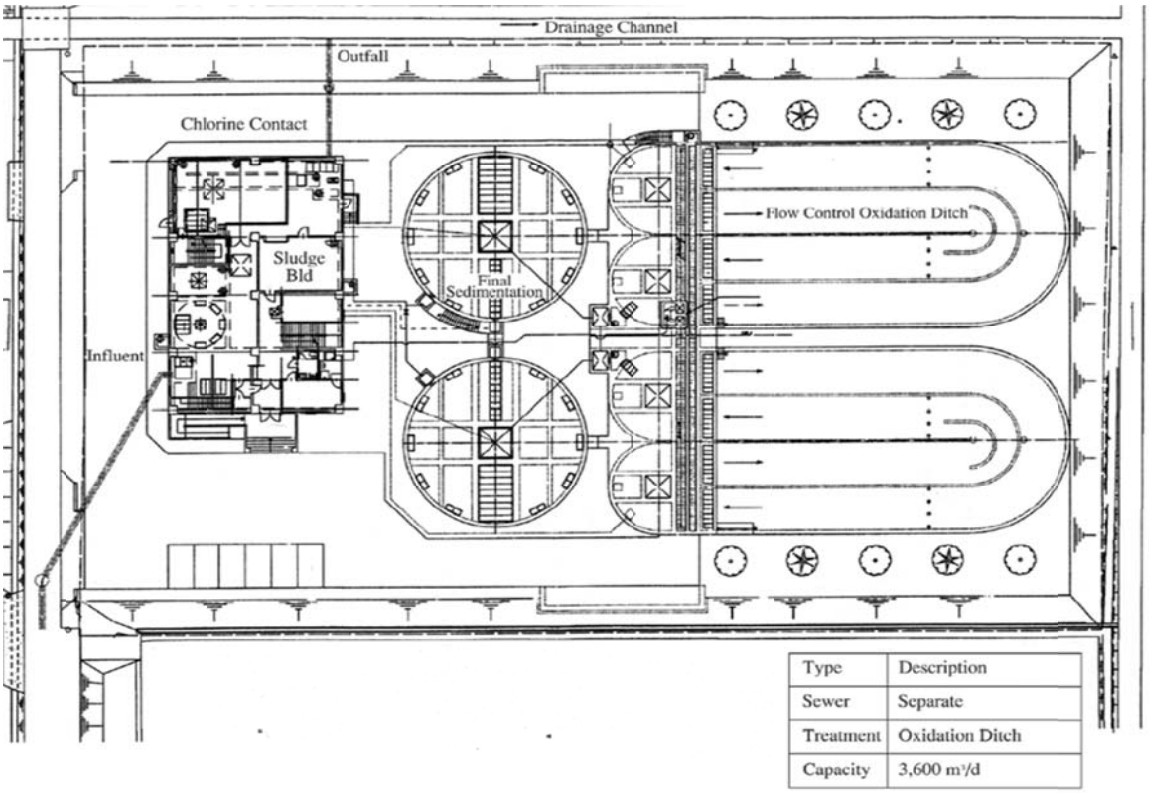
Source: Aerated lagoon, Wikipedia

Source: Virginia Dept. of Health

4. Oxidation Ditch Process

Oxidation ditch process was developed in Netherlands for small towns, which is essentially an extended-aeration process. It is used in many small European towns and has found a variety of different applications in the United States. It is also used in the small-scale plants in Japan.

A schematic of a typical oxidation ditch is shown in the following figure. It consists of a ring-shaped channel about 1 to 3 m deep and final settling tank. Aeration mixers are placed to provide aeration and circulation. The screened wastewater enters the reactor and is aerated by the mixer, and circulates at about 0.3 to 0.6 m/s.



Type	Description
Sewer	Separate
Treatment	Oxidation Ditch
Capacity	3,600 m³/d

Source: Design Standard for Municipal Wastewater Treatment Plants, Japan Sewage Works Association

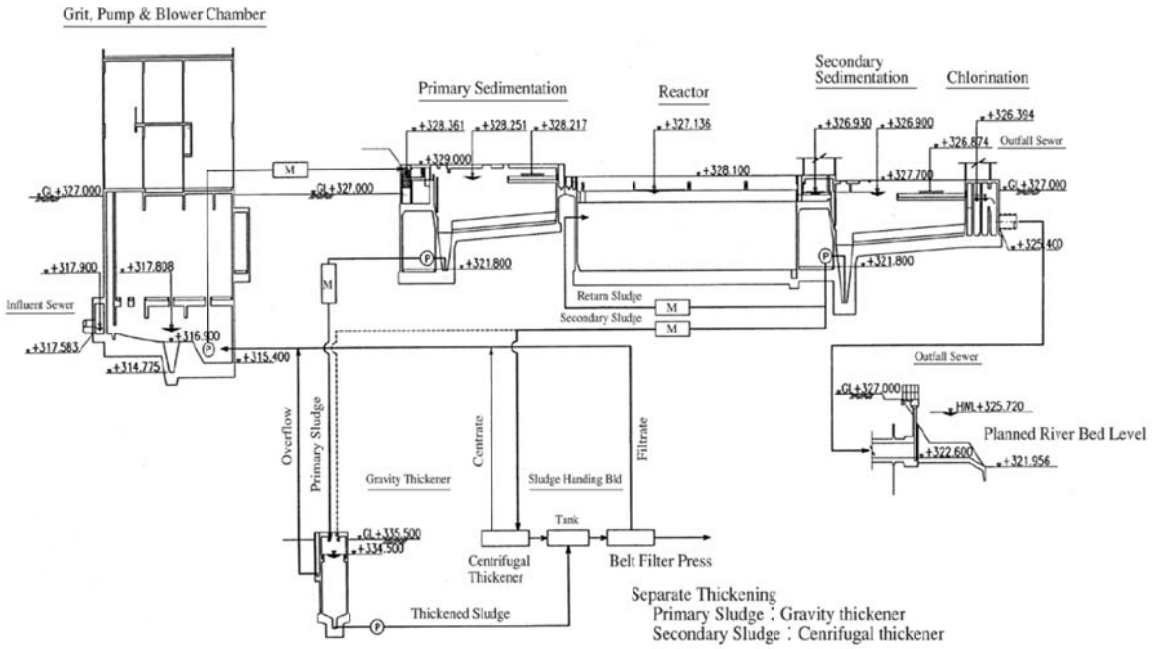
Source: Niihari Mura, Japan

Source: Hitachi Plant System

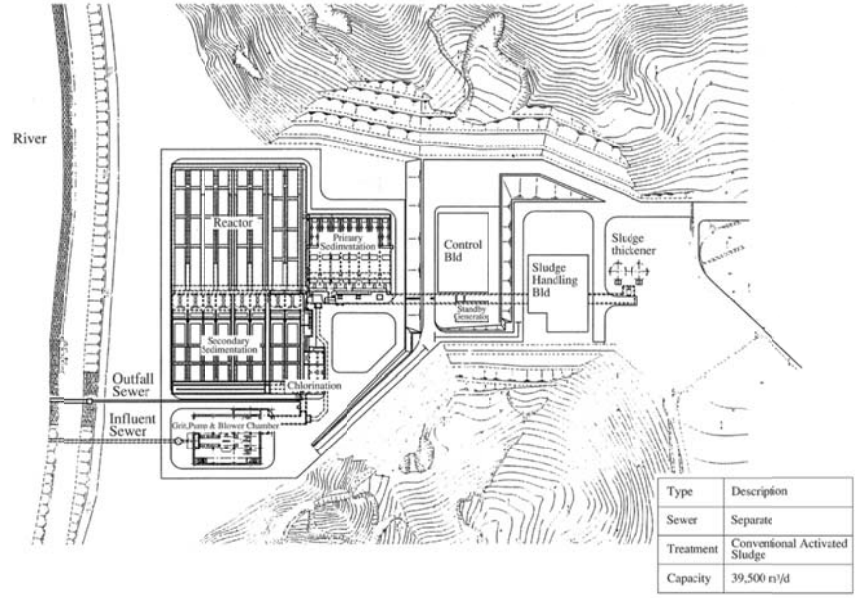
5. Conventional Activated Sludge Process

The typical flow chart of a wastewater treatment plant adopting conventional activated sludge process is shown in the following figure. The wastewater treatment facility consists of pretreatment facility, pumping facility, primary sedimentation tank, reactor, secondary sedimentation tank and chlorination facility. In some cases, additional advanced treatment facilities are included to meet the further stringent effluent standards.

The term conventional activated sludge typically applies to a plug flow system with a BOD-SS loading of about 0.2 - 0.4 kgBOD_5/kg SS/day. This system can remove 90 to 95% of BOD_5 from MLSS concentrations ranging 1,500 - 2,000 mg/L. Both influent settled wastewater and recycled sludge enter the tank at the head end. Those are aerated for a period of about 6 hrs. and mixed by the action of diffused or mechanical aeration, which is constant as the mixed liquor moves down the tank. During this period, adsorption, flocculation, and oxidation of the organic matter take place. The mixed liquor is settled in the activated-sludge settling tank, and sludge is returned at a rate of approximately 25- to 50 percent of the influent flow rate.



Source: Design Standard for Municipal Wastewater Treatment Plants, Japan Sewage Works Association



Source: Design Standard for Municipal Wastewater Treatment Plants, Japan Sewage Works Association

Source: Yamagata City, Japan

Source: Takamatsu City, Japan

Source: Yokohama City, Japan

APPENDIX F: Transport Survey

1. Survey Outline

1.1 Objective

As part of the Data Collection Survey, JICA Study Team conducts Traffic Count Survey and Interview Survey to traffic users in Thimphu and Phuentsholing. Results of these surveys are used for; (i) assessment and projection of traffic volume on bottleneck sections; (ii) comprehension of urban transport behavior in Thimphu and Phuentsholing; and (iii) identification of urban transport problems and demands of users.

1.2 Traffic Count Survey

(1) Target

Survey time:	7:00~19:00 (12 hours) of 1 weekday (Tuesday-Thursday)and 1 weekend day
Target vehicle:	7 types Passenger vehicle, Taxi, Bus, Mini truck, Medium and heavy truck (6 and more wheels), Motorcycle, Others Pedestrian should be counted in Thimphu.

(2) Location

7 specified road sections in Thimphu; and
3 specified road sections in Phuentsholing

Thimphu

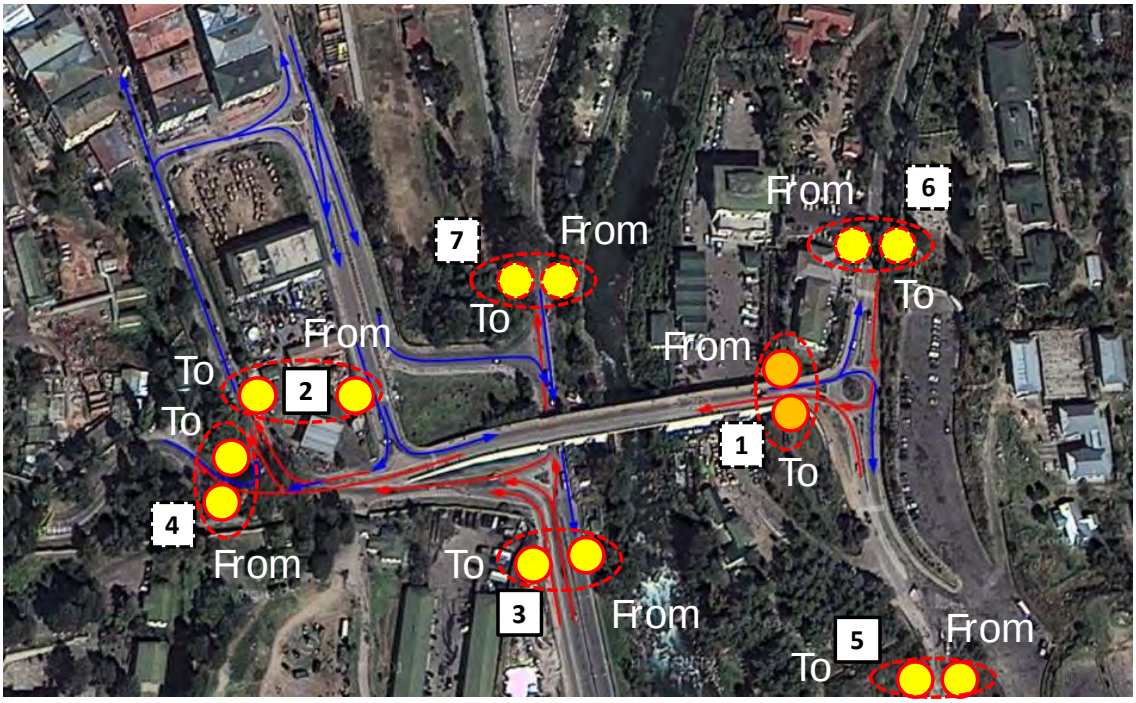


Figure F- 1 Survey locations in Thimphu

Phuentsholing

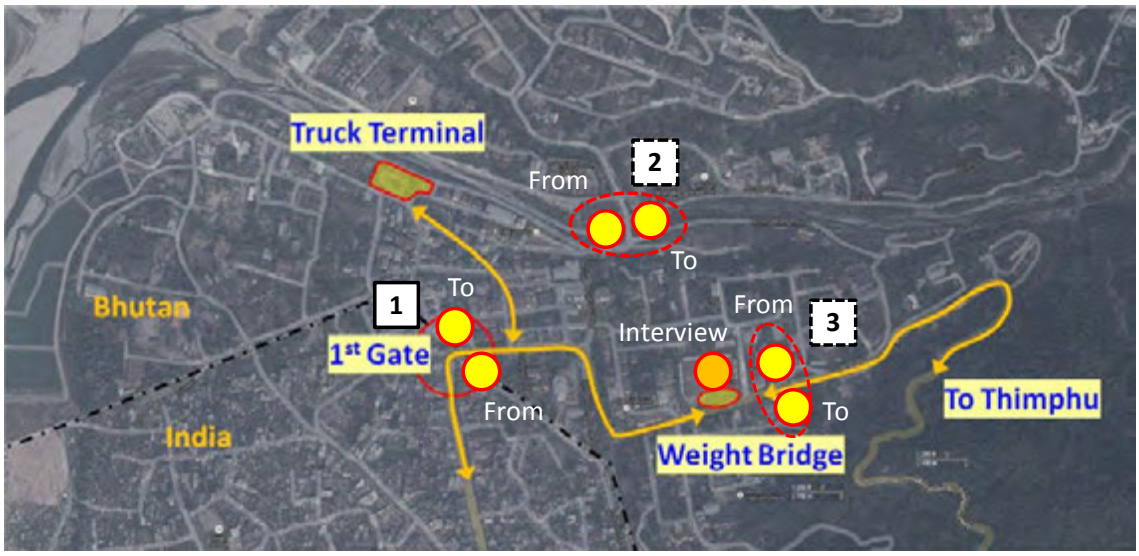


Figure F- 2 Survey locations in Phuentsholing

(3) Methodology

- Surveyors count the number of vehicle by direction and vehicle type.
- Counting is done manually by using prepared survey sheets.
- Data record is at 15 minutes intervals.

(4) Occupancy Survey

- Occupancy of vehicles shall be recorded in 1 out of 7 counting points in Thimphu as part of traffic count survey.
- Target vehicle types are passenger vehicle, taxi, and bus.
- Attributes of occupancy ratio are; only driver; with passenger (less than 1/2); and with passenger (more than 1/2).

1.3 Interview Survey

(1) Target

Survey time: 7:00~19:00 (12 hours)
of 1 weekday (Tuesday-Thursday)and 1 weekend day

Target respondent: 1 out of every 10 user accessing to the survey location
(approximately 10% of the total)

(2) Location

1 specified locations in Phuentsholing

(3) Methodology

- Surveyors collect answer to the prepared questionnaire from 1 out of every 30 users accessing to the survey location.
- Data shall be recorded in the prepared form following preset coding scheme.

1.4 Survey Schedule

3 weeks are scheduled for this survey from preparation to data entry as shown in the following table.

Table F- 1 Survey schedule

Week	Date		Planned Activity
Week 1	19 Aug.	Mon	Mobilization of surveyors
	20 Aug.	Tue	Site check
	21 Aug.	Wed	Orientation
	22 Aug.	Thu	Finalization of survey materials
	23 Aug.	Fri	Training
	24 Aug.	Sat	Final preparation
	25 Aug.	Sun	**Weekend survey in Thimphu**
Week 2	26 Aug.	Mon	Data entry
	27 Aug.	Tue	**Weekday survey in Thimphu**
	28 Aug.	Wed	Move to Phuentsholing
	29 Aug.	Thu	**Weekday survey in Phuentsholing**
	30 Aug.	Fri	Data entry
	31 Aug.	Sat	
	1 Sep.	Sun	**Weekend survey in Phuentsholing**
Week 3	2 Sep.	Mon	Data entry
	3 Sep.	Tue	Data entry
	4 Sep.	Wed	Data delivery and check
	5 Sep.	Thu	Data correction
	6 Sep.	Fri	Final submission
	7 Sep.	Sat	
	8 Sep.	Sun	

2. Traffic Count

2.1 Survey Sheet

(1) Vehicle Count

Survey Sheet [VEHICLE COUNT]

City: | Location No.: | Direction: (To or From Core) | Date: (dd/mm/yy) | Shift No.: (1~4) | Weather:

Surveyor Name: | Manager Name: | Data Entry by:

Time	1. Passenger Vehicle	2. Taxi	3. Bus	4. Mini Truck	5. Medium and Heavy Truck	6. Motorcycle	7. Others
From :00 To :15							
From :15 To :30							
From :30 To :45							
From :45 To :00							
From :00 To :15							
From :15 To :30							
From :30 To :45							
From :45 To :00							
From :00 To :15							
From :15 To :30							
From :30 To :45							
From :45 To :00							

(2) Occupancy Survey

Survey Sheet [OCCUPANCY]

City: *Thimphu* Location No.: *1* Direction: (To or From Core) Date: (dd/mm/yy) Shift No.: (1~4) Weather:

Surveyor Name: Manager Name: Data Entry by:

Time	1. Passenger Vehicle			2. Taxi			3. Bus			4. Mini Truck	5. Medium and Heavy Truck	6. Motorcycle	7. Others
	Driver Only	With Passenger (Less than 1/2)	With Passenger (More than 1/2)	Driver Only	With Passenger (Less than 1/2)	With Passenger (More than 1/2)	Driver Only	With Passenger (Less than 1/2)	With Passenger (More than 1/2)				
From :00 To :15													
From :15 To :30													
From :30 To :45													
From :45 To :00													
From :00 To :15													
From :15 To :30													
From :30 To :45													
From :45 To :00													
From :00 To :15													
From :15 To :30													
From :30 To :45													
From :45 To :00													

(3) Pedestrian Count

Survey Sheet [PEDESTRIAN COUNT]

City:	*Thimphu*	**Location No.:**	*1*		
Date: (dd/mm/yy)		**Shift No.:** (1~4)		**Weather:**	
Surveyor Name:		**Manager Name:**		**Data Entry by:**	

Time	UP to Core Area	DOWN from Core Area
From :00 To :15		
From :15 To :30		
From :30 To :45		
From :45 To :00		
From :00 To :15		
From :15 To :30		
From :30 To :45		
From :45 To :00		
From :00 To :15		
From :15 To :30		
From :30 To :45		
From :45 To :00		

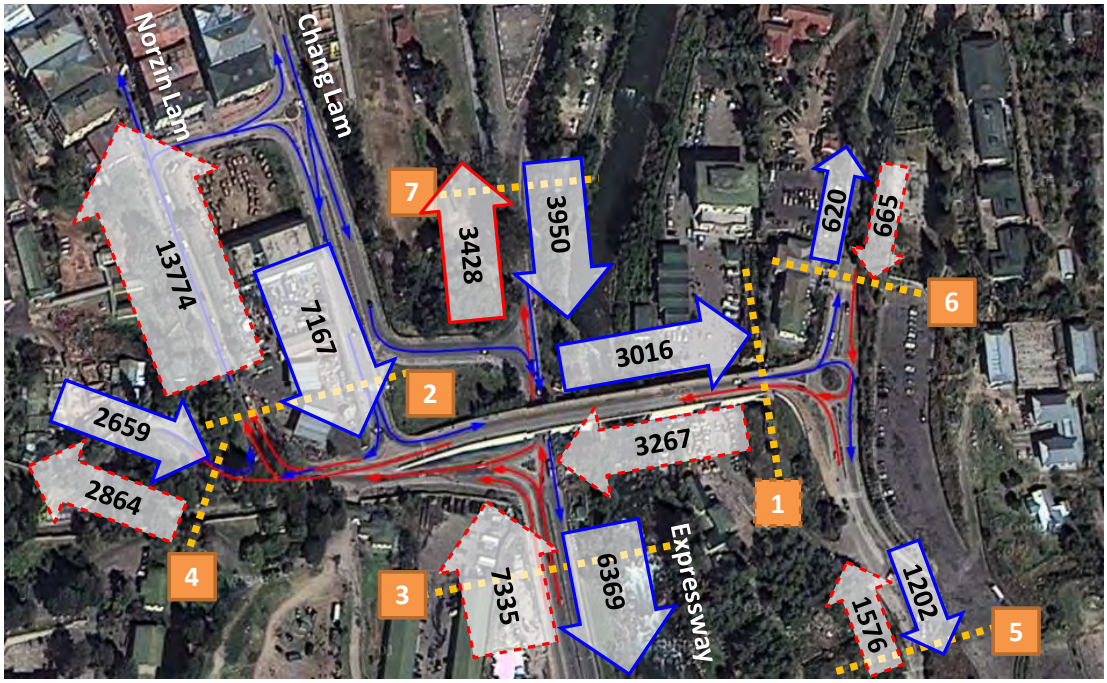
2.2 Result

(1) Vehicle Count in Thimphu

Summary of Traffic Movement

Unit: vehicles (sum of all vehicle types)

Figure F- 3 Traffic movement in a weekday (12 hours)



Unit: vehicles (sum of all vehicle types)

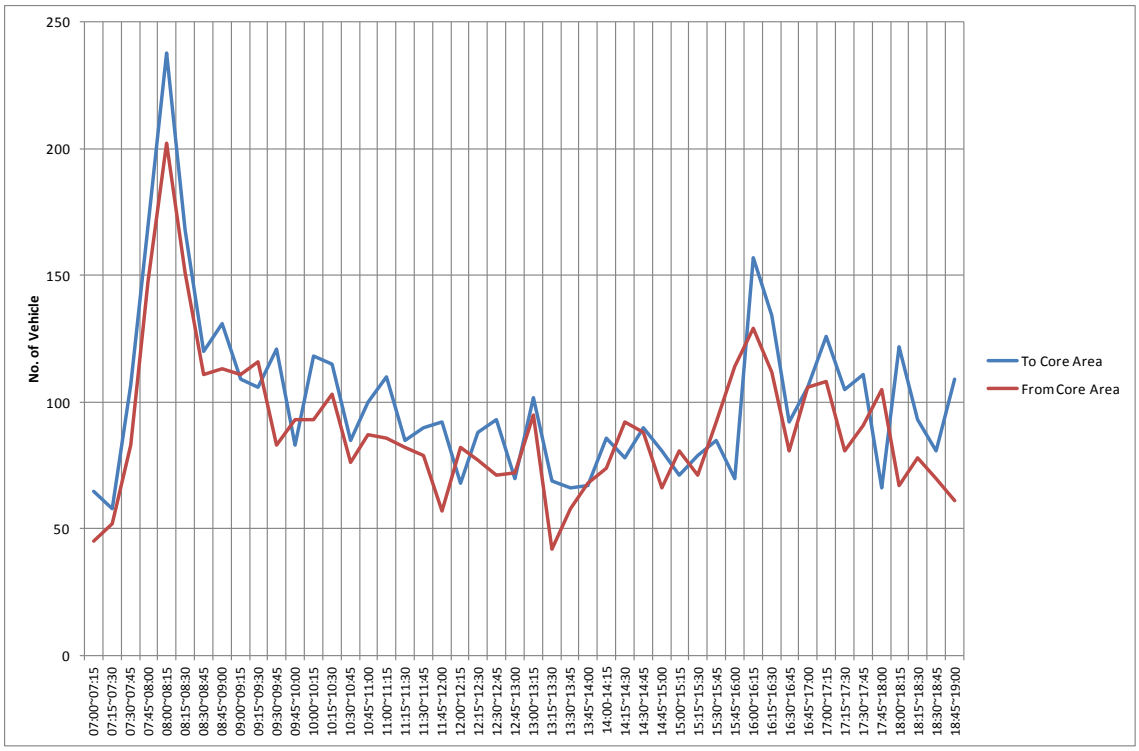
Figure F- 4 Traffic movement in a weekend day (12 hours)

Table F- 2: Traffic volume and peak hour ration at survey points

#	Direction	Weekday			Weekend		
		12 hours (veh.)	Morning peak	Evening peak	12 hours (veh.)	Morning peak	Evening peak
1	To Core	4,836	13.6%	10.1%	3,267	7.0%	10.3%
	From Core	4,303	13.4%	9.9%	3,016	6.6%	10.5%
2	To Core	16,272	12.5%	10.0%	13,774	5.9%	8.0%
	From Core	9,879	10.2%	9.3%	7,167	6.5%	9.5%
3	To Core	8,490	15.3%	8.3%	7,335	6.0%	11.3%
	From Core	7,244	8.3%	10.6%	6,369	5.8%	9.4%
4	To Core	3,755	10.1%	10.5%	2,659	5.5%	11.1%
	From Core	4,081	13.4%	9.4%	2,864	5.1%	10.8%
5	To Core	1,929	14.4%	8.6%	1,576	5.7%	10.0%
	From Core	1,419	9.9%	10.1%	1,202	6.7%	9.1%
6	To Core	1,493	9.7%	9.6%	665	8.7%	9.2%
	From Core	1,484	14.8%	8.0%	620	6.8%	10.0%
7	To Core	2,516	14.5%	8.6%	3,428	5.7%	11.7%
	From Core	3,075	7.0%	10.0%	3,950	4.1%	11.0%

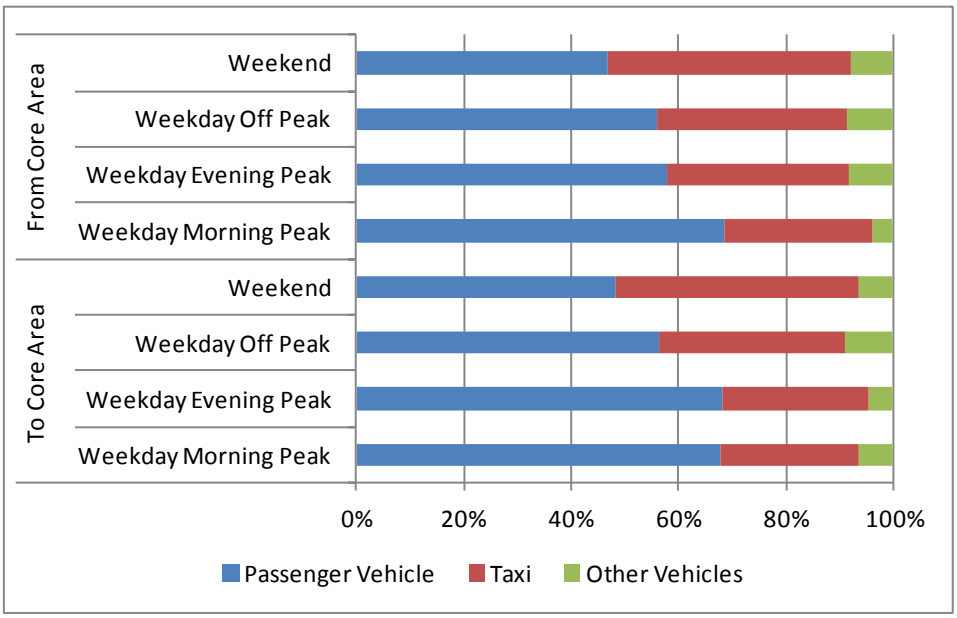
Source: JICA Study Team

Counting Point 1



Unit: vehicles (sum of all vehicle types)

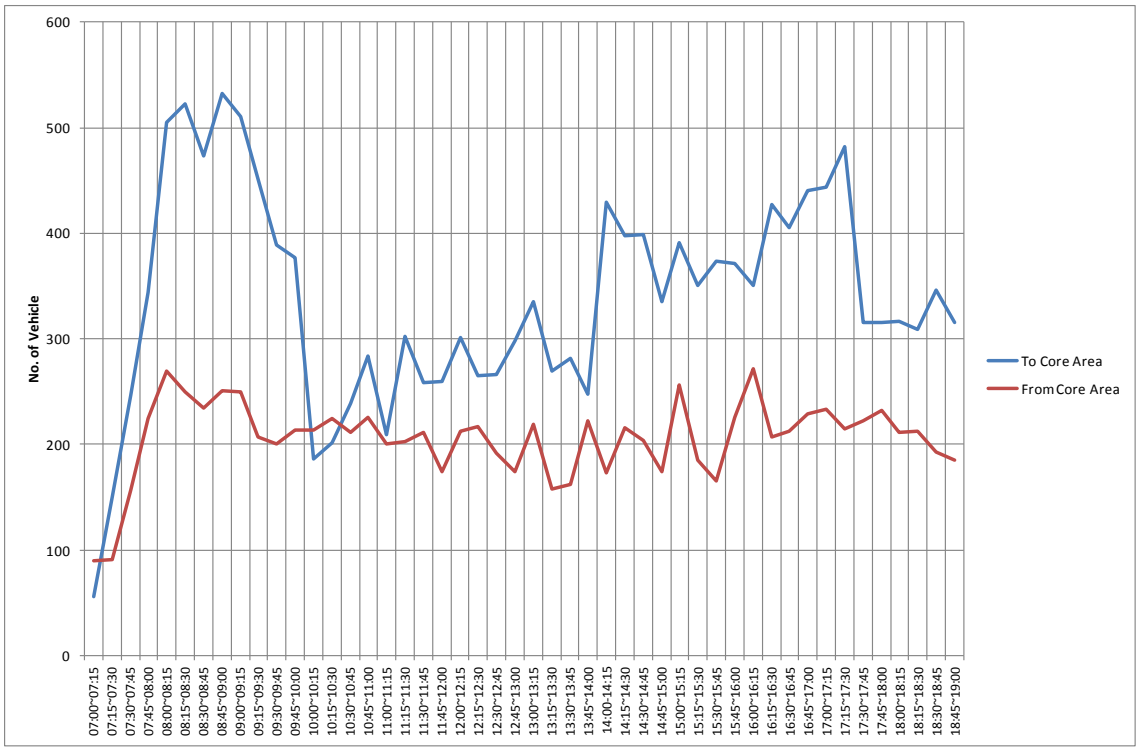
Figure F- 5 Weekday counting result on the point no.1



Note: morning peak from 8:00 to 9:00, evening peak from 16:00 to 17:00

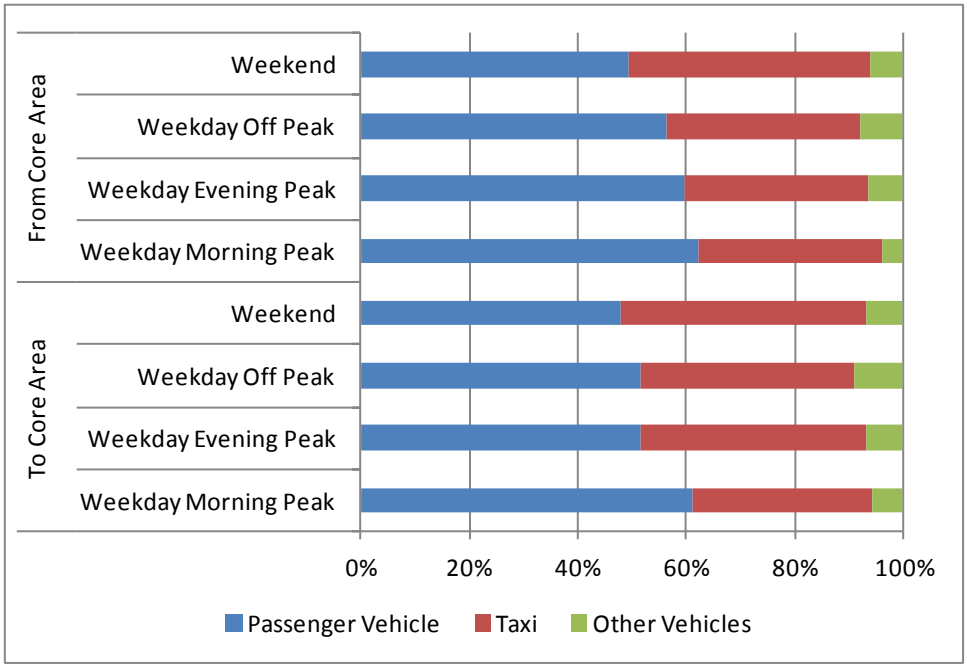
Figure F- 6 Share of vehicle type on the point no.1

Counting Point 2



Unit: vehicles (sum of all vehicle types)

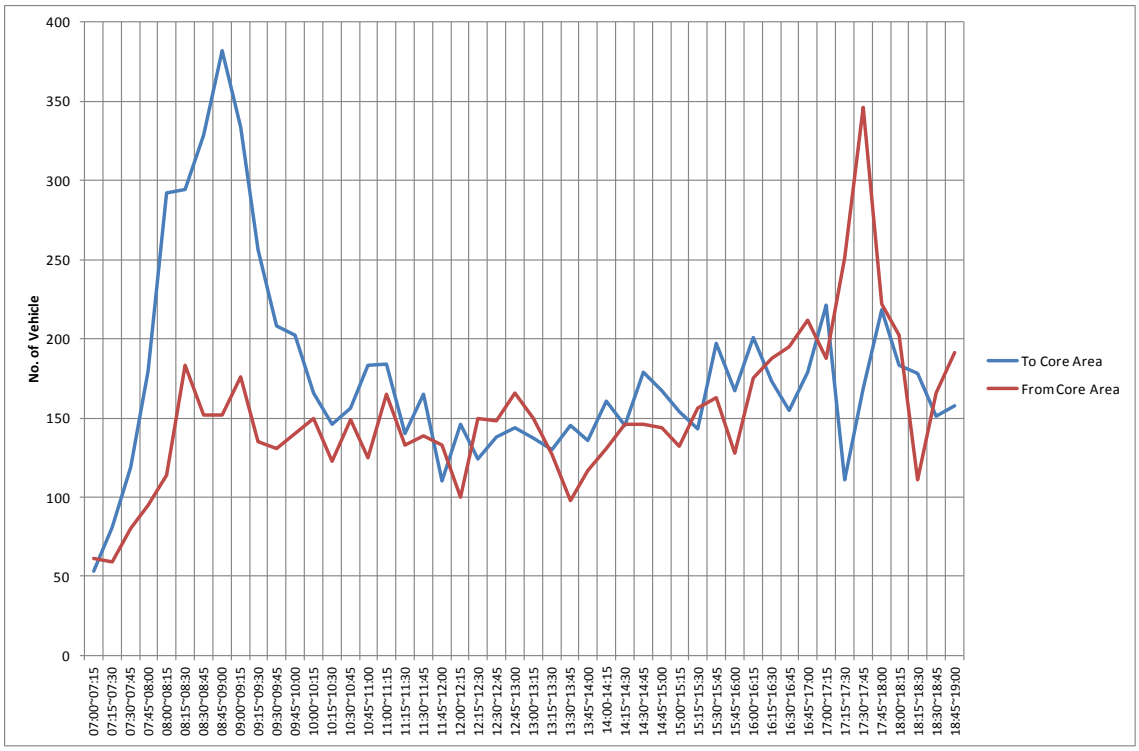
Figure F- 7 Weekday counting result on the point no.2



Note: morning peak from 8:00 to 9:00, evening peak from 16:00 to 17:00

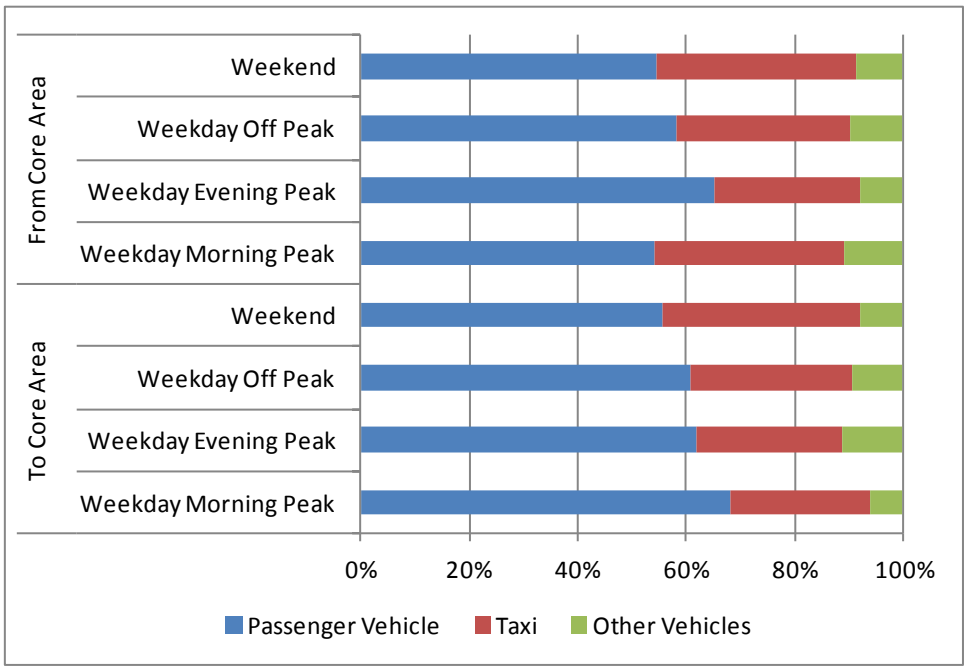
Figure F- 8 Share of vehicle type on the point no.2

Counting Point 3



Unit: vehicles (sum of all vehicle types)

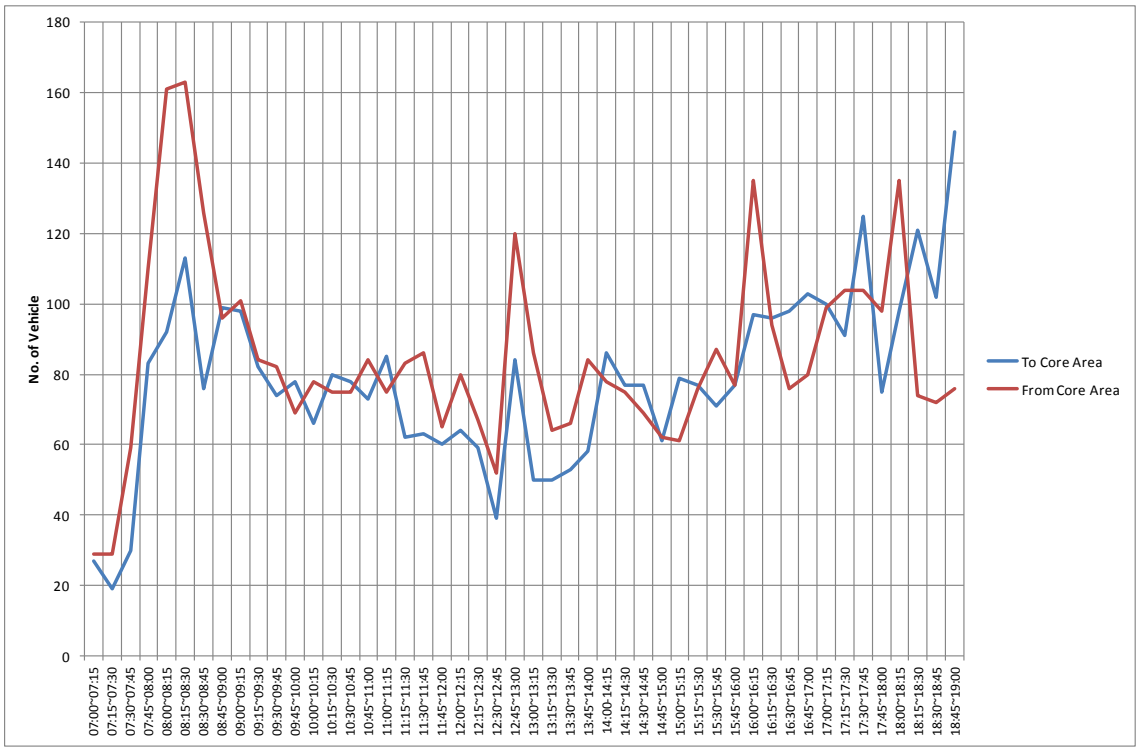
Figure F- 9 Weekday counting result on the point no.3



Note: morning peak from 8:00 to 9:00, evening peak from 16:00 to 17:00

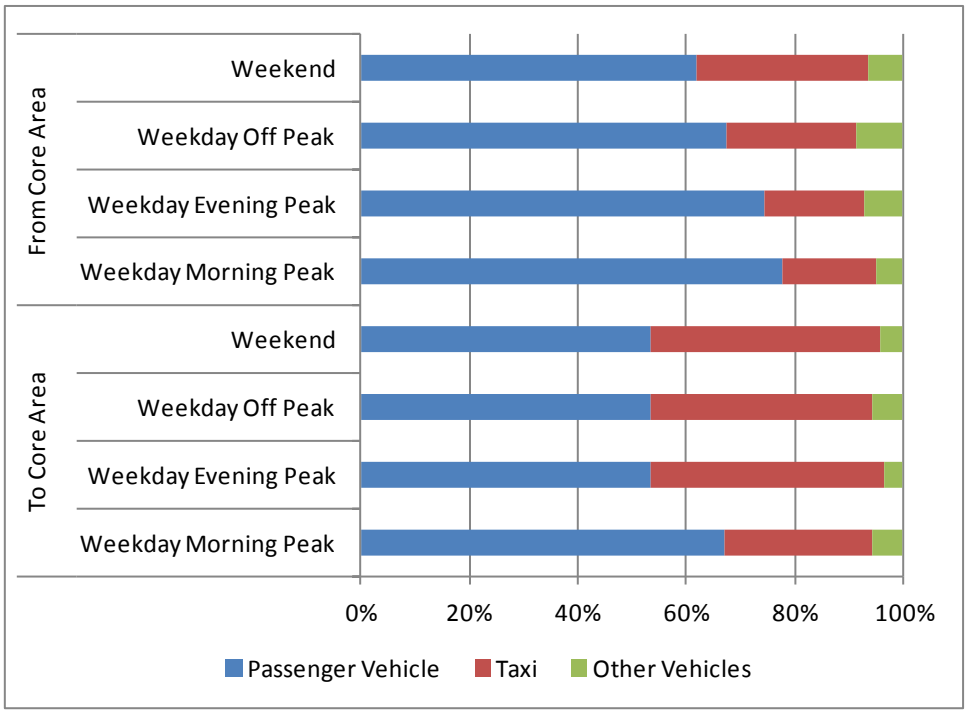
Figure F- 10 Share of vehicle type on the point no.3

Counting Point 4



Unit: vehicles (sum of all vehicle types)

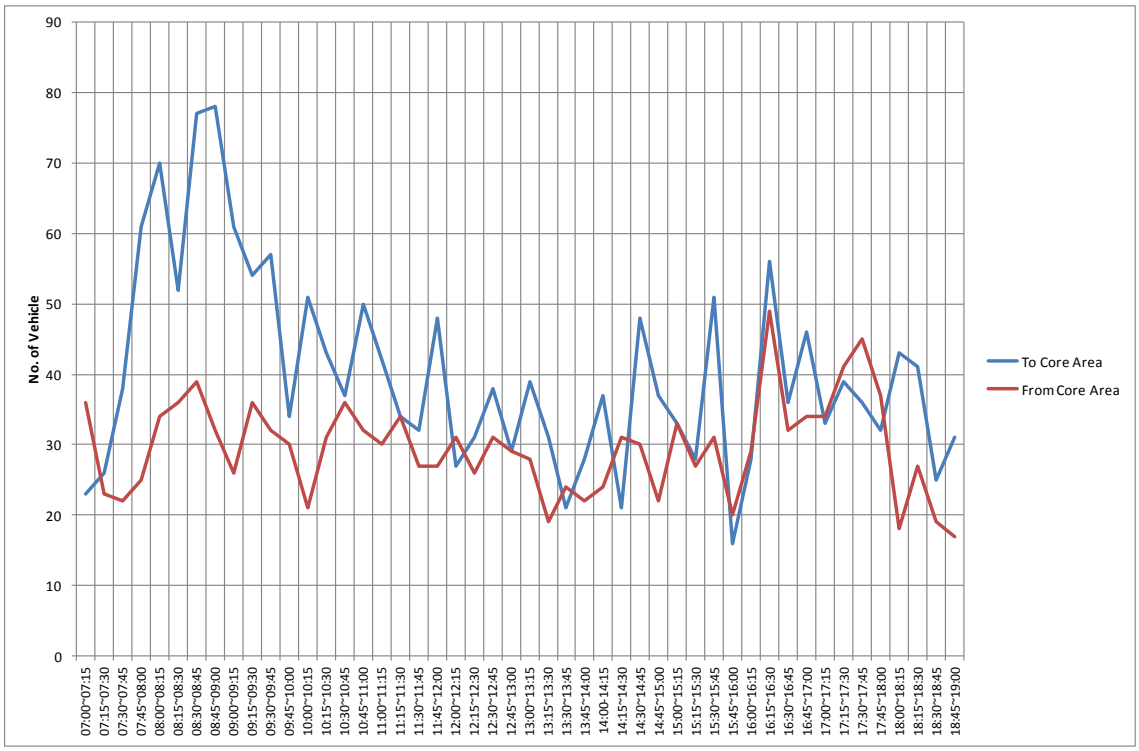
Figure F- 11 Weekday counting result on the point no.4



Note: morning peak from 8:00 to 9:00, evening peak from 16:00 to 17:00

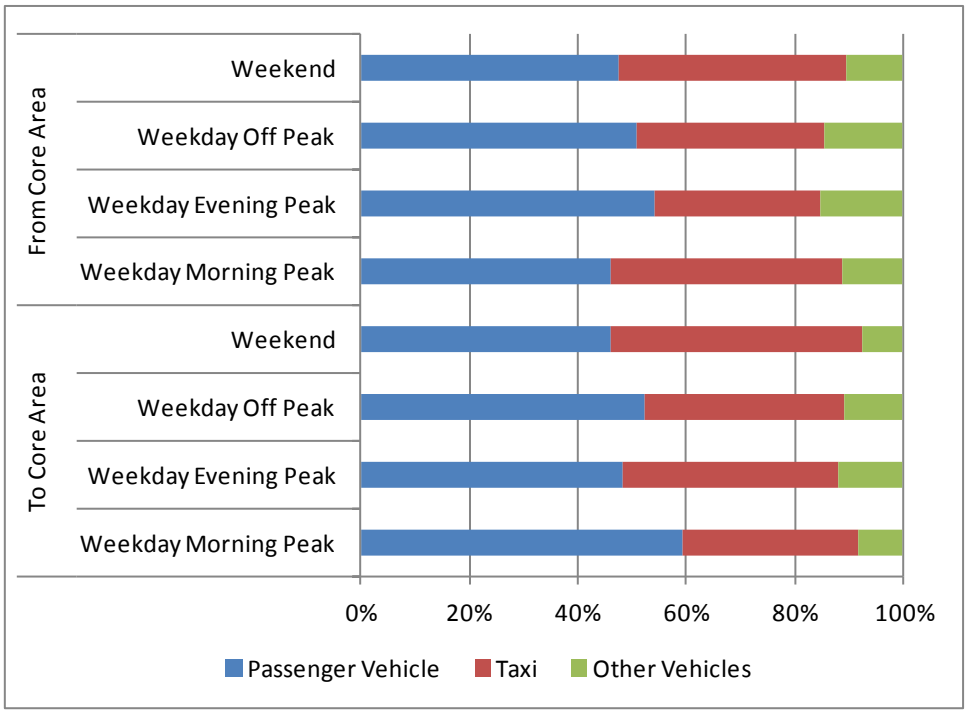
Figure F- 12 Share of vehicle type on the point no.4

Counting Point 5



Unit: vehicles (sum of all vehicle types)

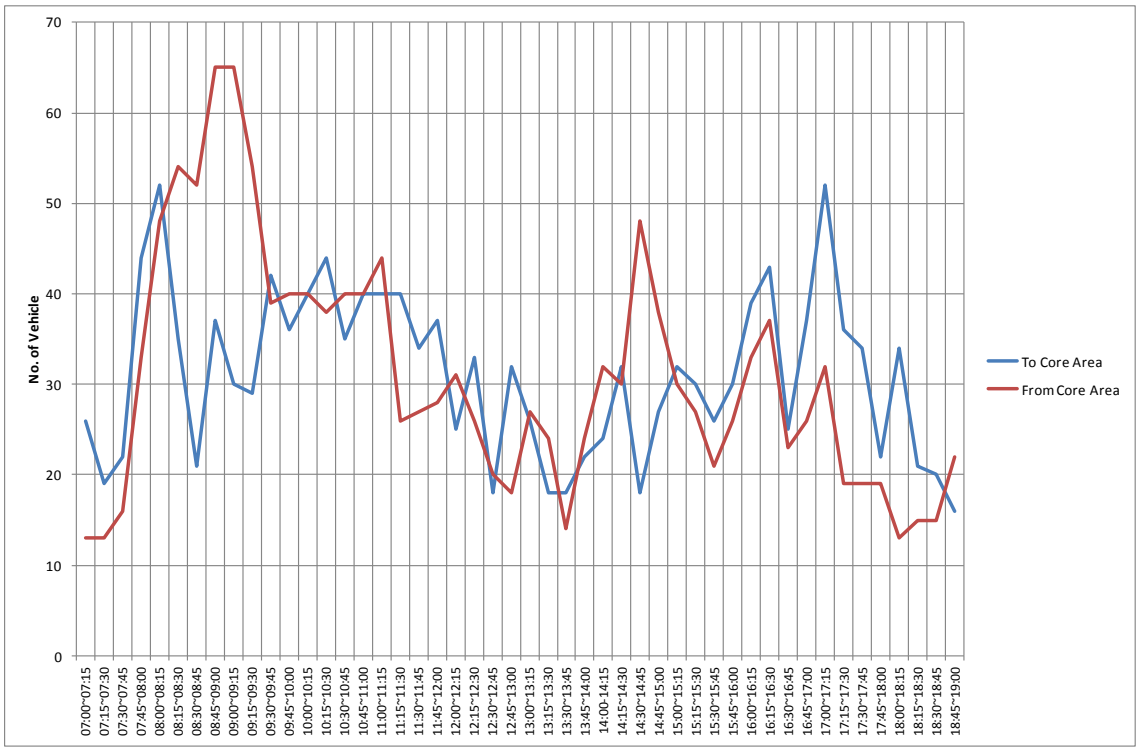
Figure F- 13 Weekday counting result on the point no.5



Note: morning peak from 8:00 to 9:00, evening peak from 16:00 to 17:00

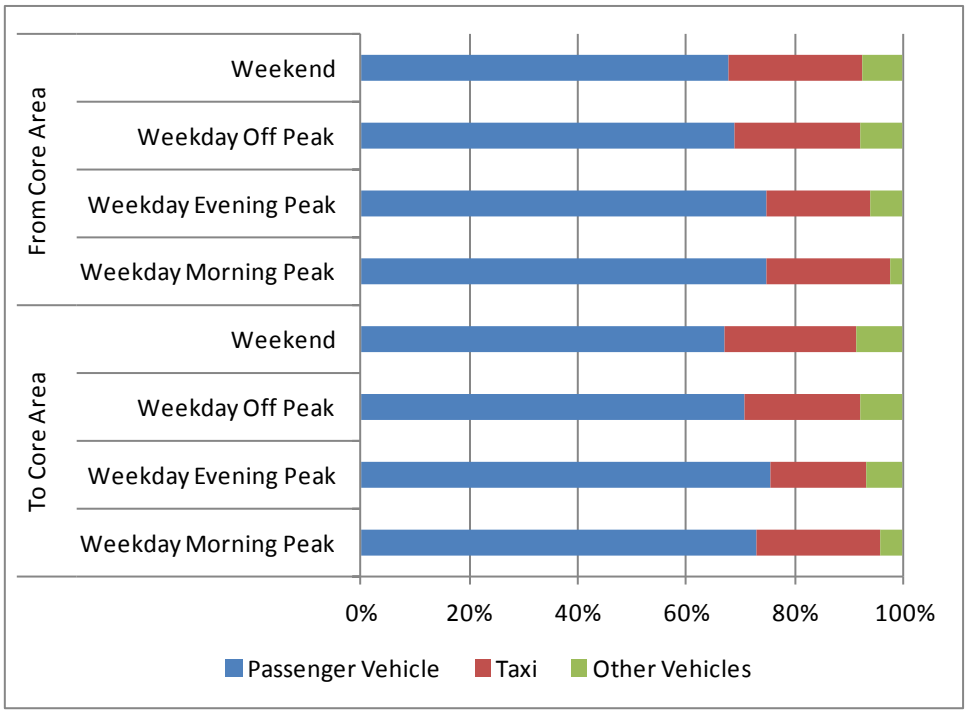
Figure F- 14 Share of vehicle type on the point no.5

Counting Point 6



Unit: vehicles (sum of all vehicle types)

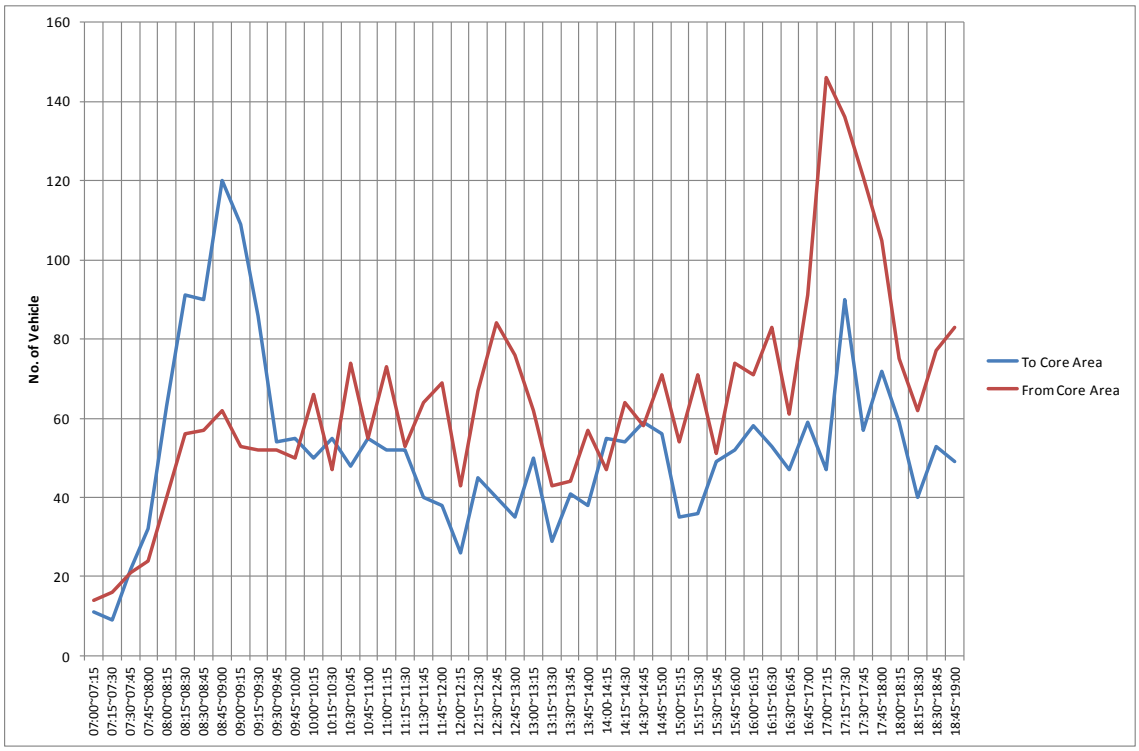
Figure F- 15 Weekday counting result on the point no.6



Note: morning peak from 8:00 to 9:00, evening peak from 16:00 to 17:00

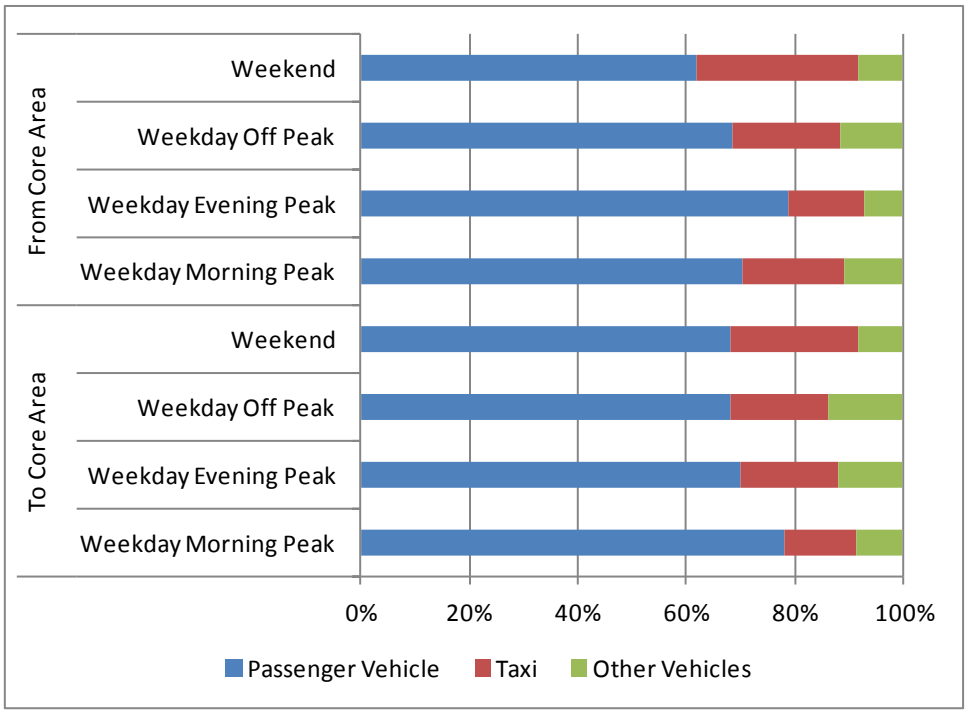
Figure F- 16 Share of vehicle type on the point no.6

Counting Point 7



Unit: vehicles (sum of all vehicle types)

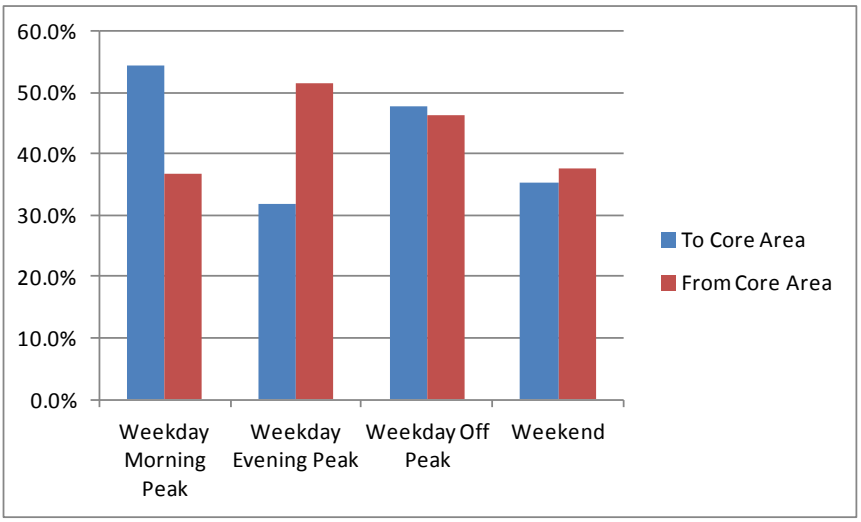
Figure F- 17 Weekday counting result on the point no.7



Note: morning peak from 8:00 to 9:00, evening peak from 16:00 to 17:00

Figure F- 18 Share of vehicle type on the point no.7

(2) **Occupancy Count**



Note: morning peak from 8:00 to 9:00, evening peak from 16:00 to 17:00

Figure F- 19 Empty vehicle ratio on Lungtenzampa Bridge

(3) Pedestrian Count

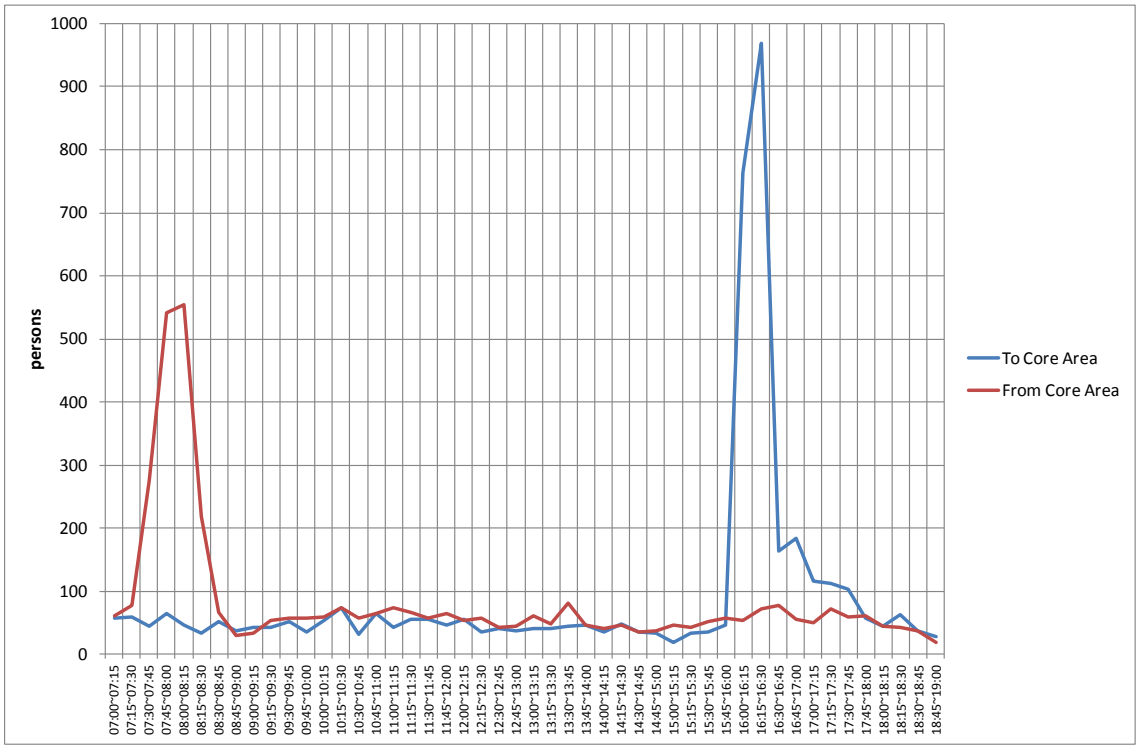


Figure F- 20 Weekday Pedestrian Flow

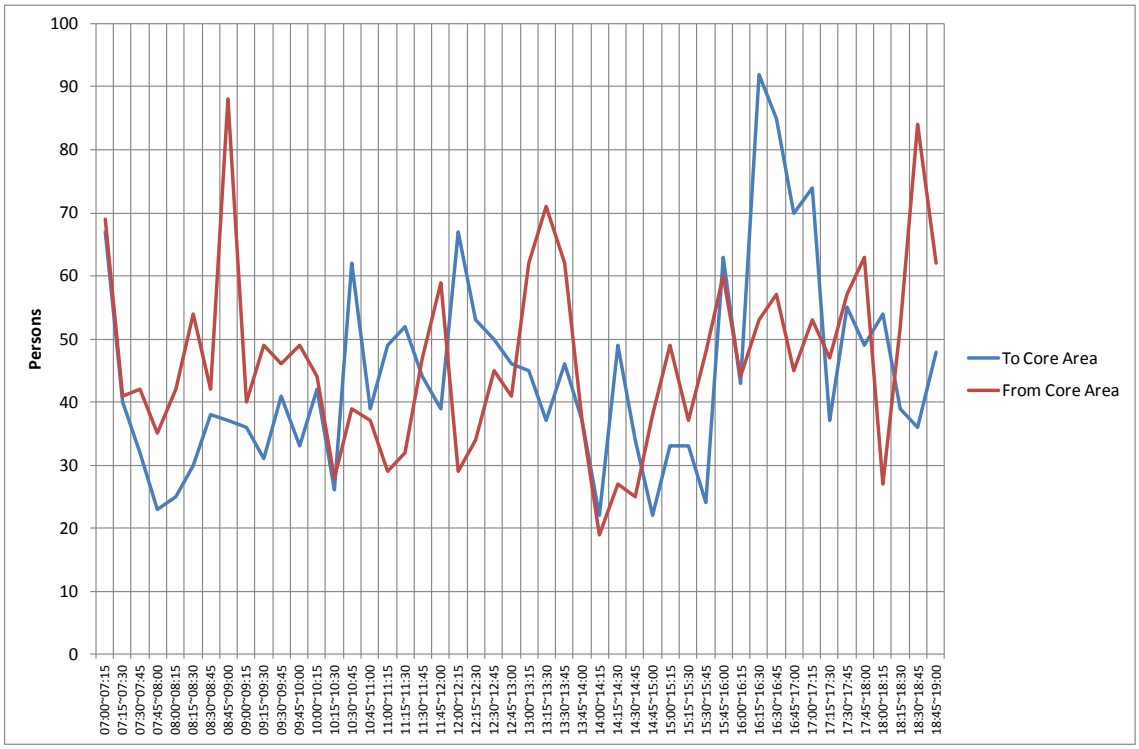
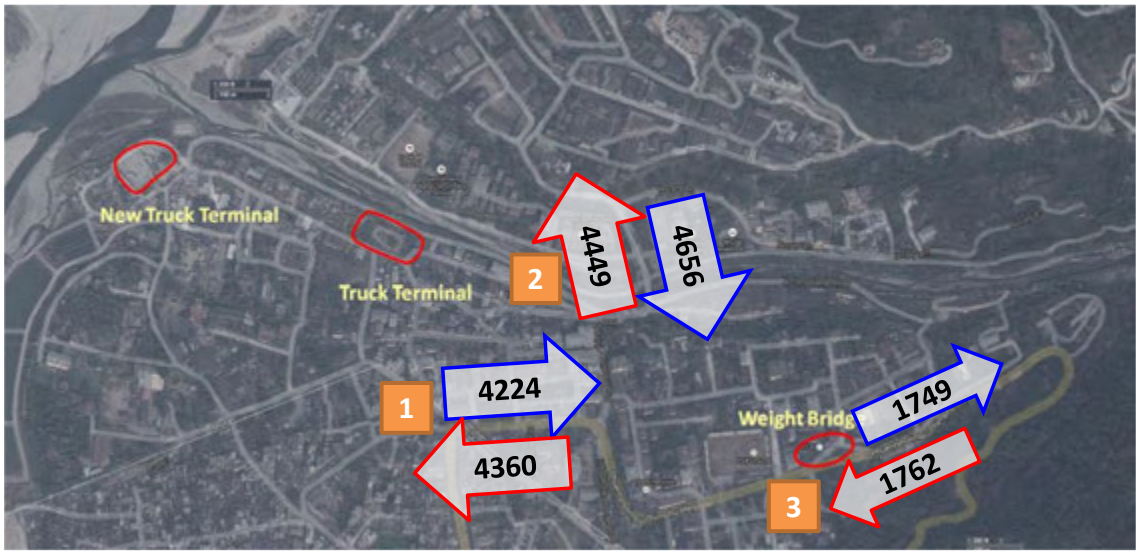


Figure F- 21 Weekend Day Pedestrian Flow

(4) Vehicle Count in Phuentsholing



Unit: vehicles (sum of all 4 wheeler vehicles)

Figure F- 22 Traffic movement of 4 wheeler vehicles in a weekday (12 hours)

Unit: vehicles (sum of all 4 wheeler vehicles)

Figure F- 23 Traffic movement of 4 wheeler vehicles in a weekend day (12 hours)

Counting Point 1

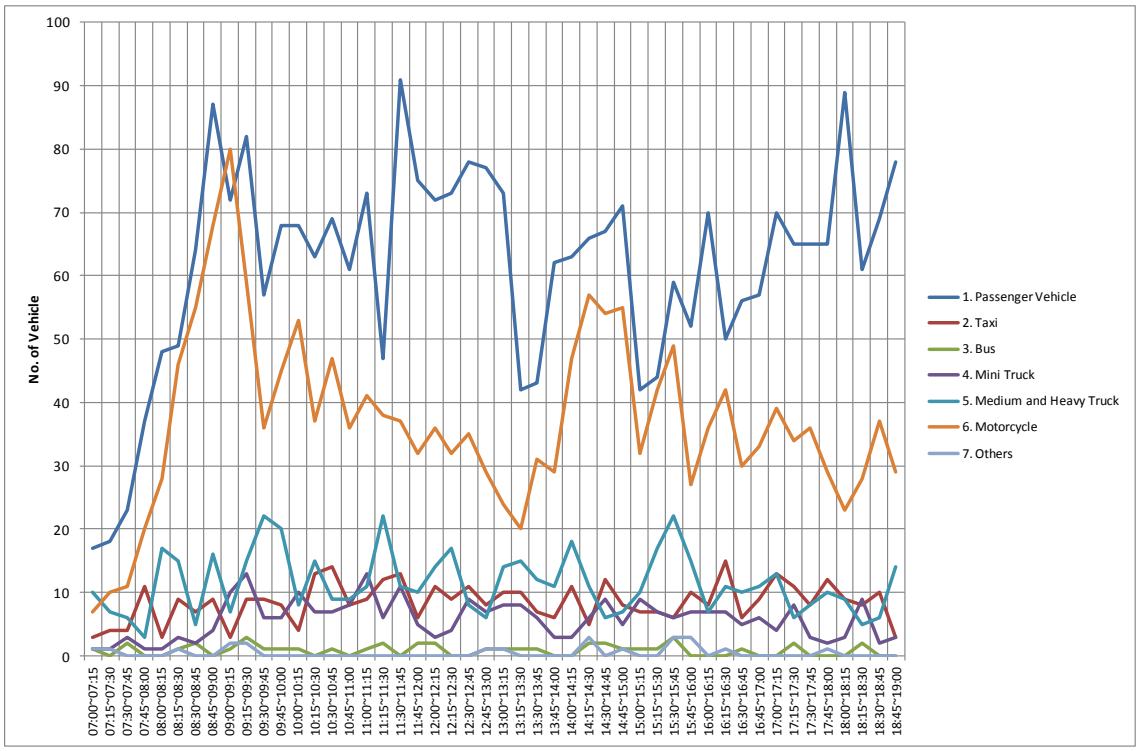


Figure F- 24 Weekday counting result by vehicle type on the point no.1 (to city core)

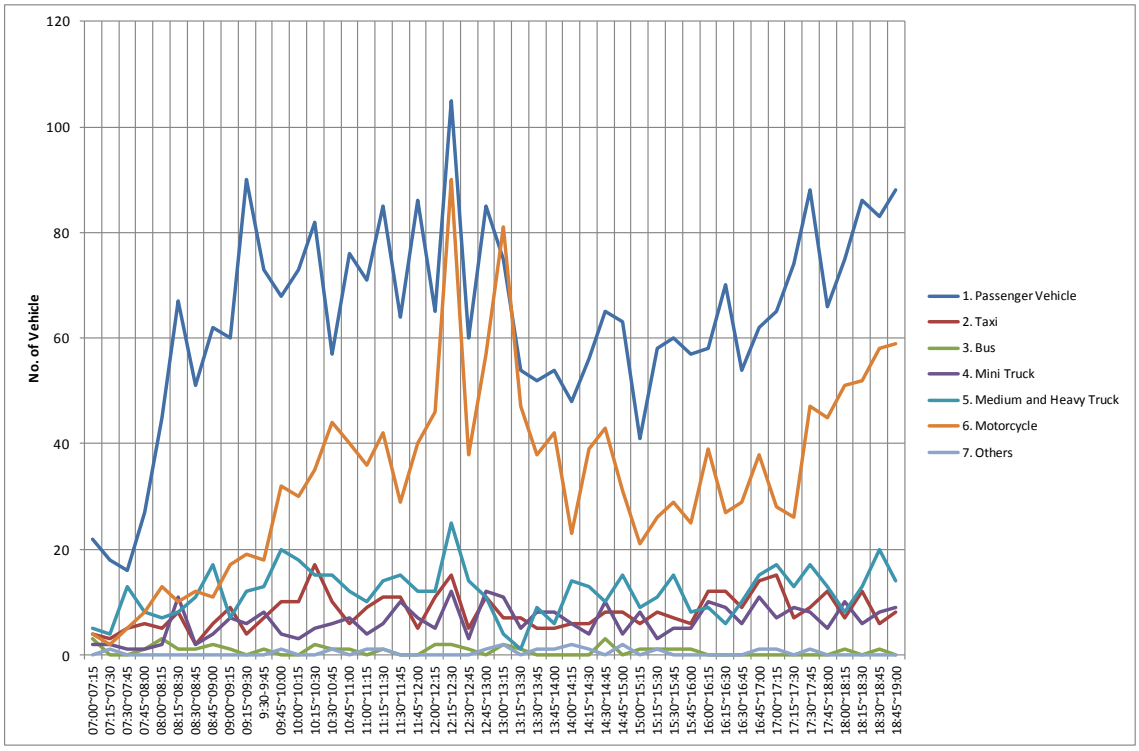


Figure F- 25 Weekday counting result by vehicle type on the point no.1 (from city core)

Counting Point 2

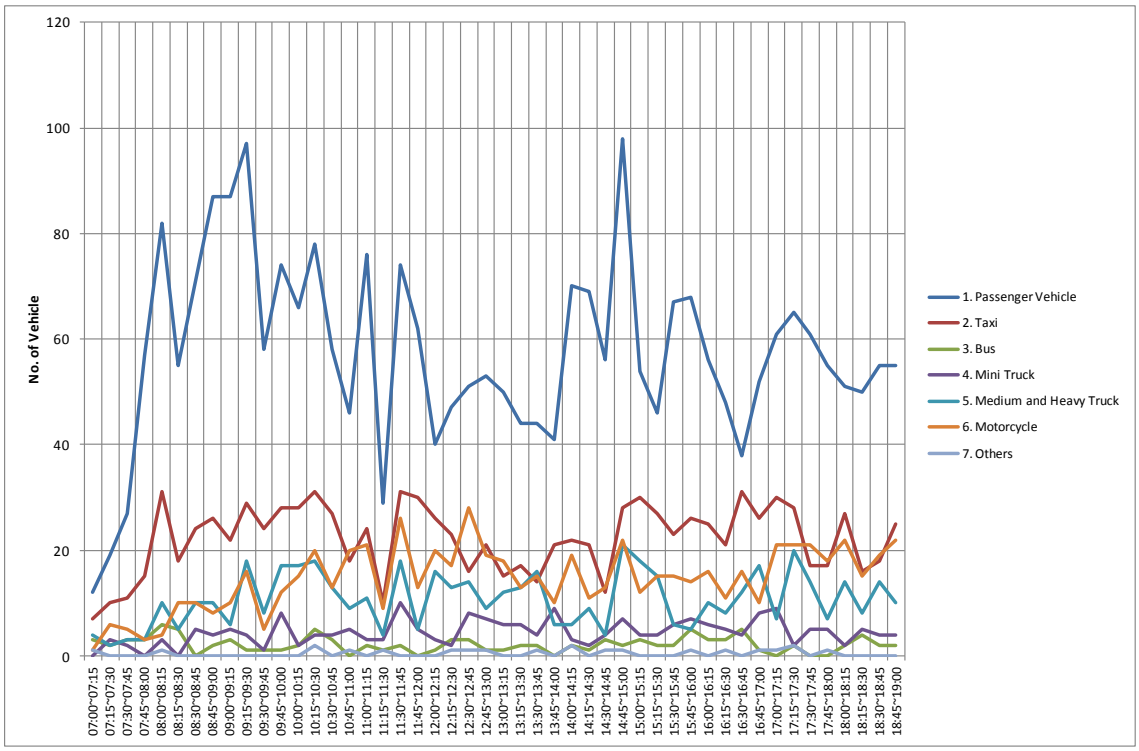


Figure F- 26 Weekday counting result by vehicle type on the point no.2 (to city core)

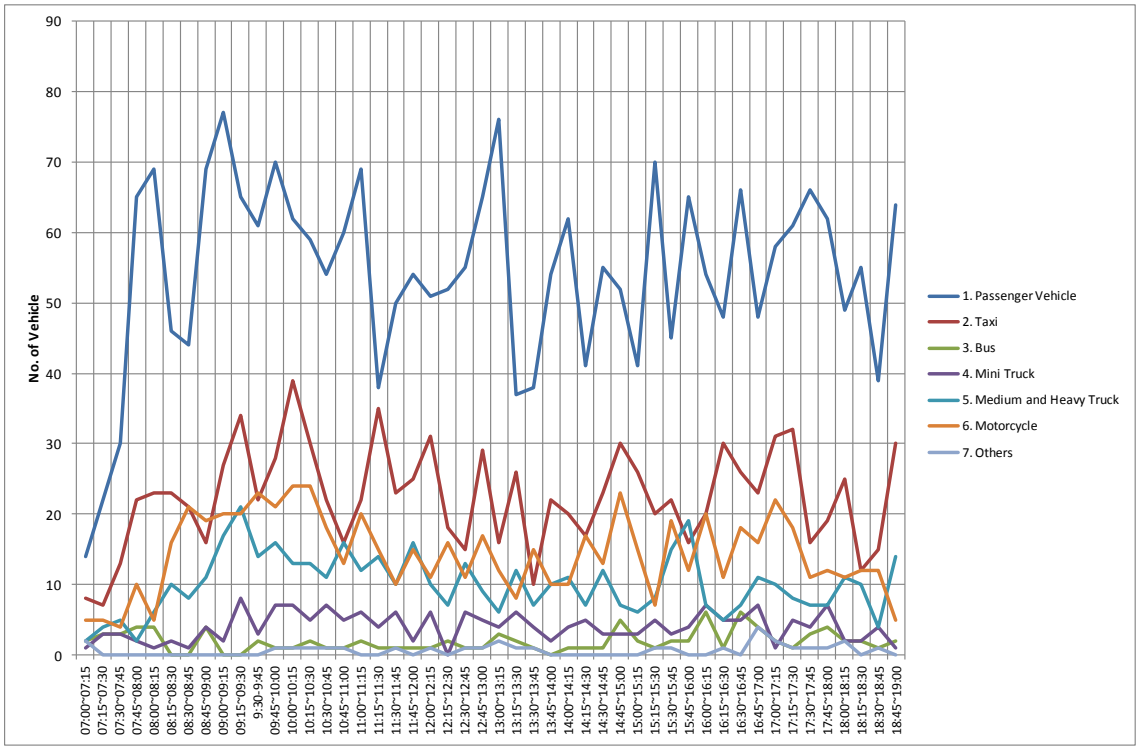


Figure F- 27 Weekday counting result by vehicle type on the point no.2 (from city core)

Counting Point 3

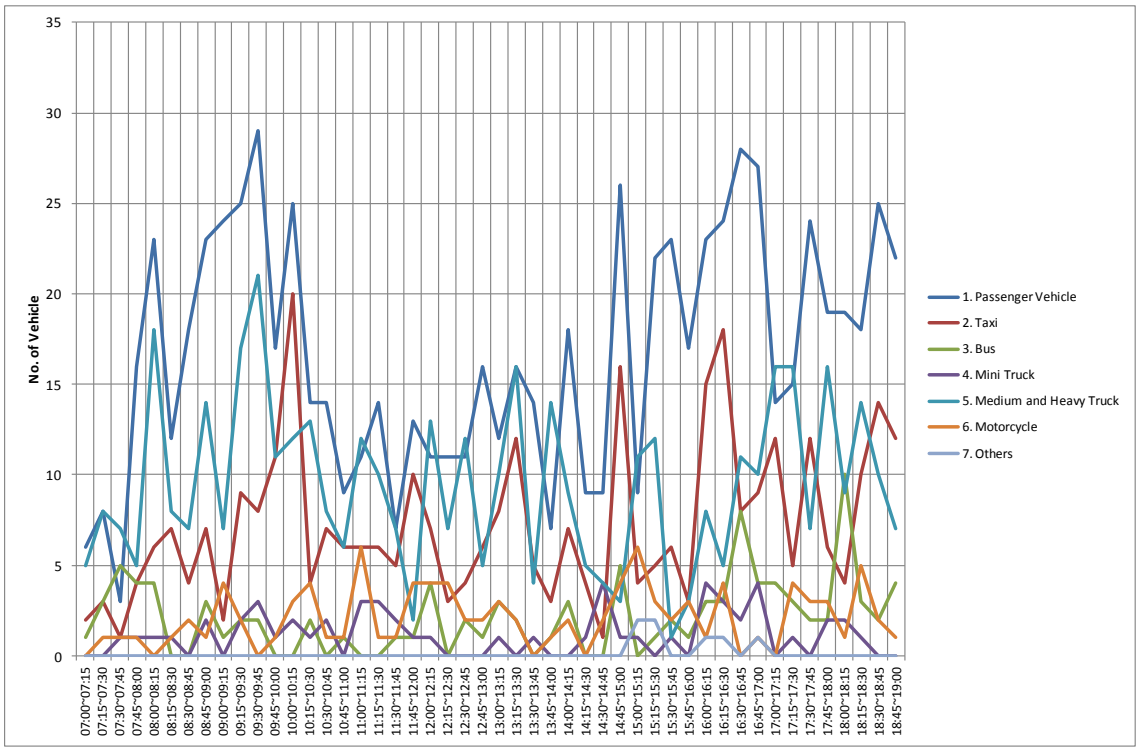


Figure F- 28 Weekday counting result by vehicle type on the point no.3 (to city core)

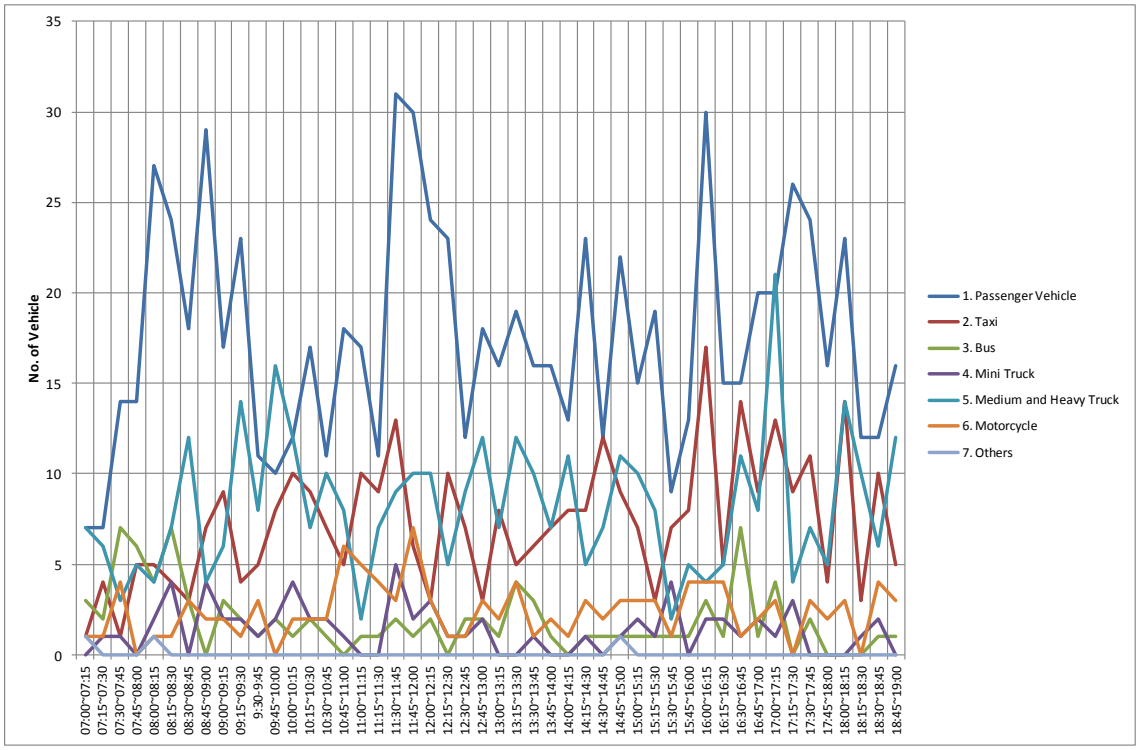


Figure F- 29 Weekday counting result by vehicle type on the point no.3 (from city core)

3. Interview Result

3.1 Survey Sheet

Survey Sheet [INTERVIEW]

"I am a surveyor under survey on urban development funded by Japan (JICA: Japan International Cooperation Agency). Would you please give me time for quick interview just for 3-5 minutes? Purpose of the interviw is to understand traffic movement around Phuentsholing city for future project formulation. The interview will be completely confidential and we will never use the individual data but will use data as aggregation."

City:		**Location No.:**		**Date:** (dd/mm/yy)		**Shift No.:** (1~4)		**Weather:**	
Surveyor Name:			**Manager Name:**				**Data Entry by:**		

S/N	Time (24 hours)	Vehicle Type	Vehicle Nationality	Place of Loading	Place of Unloading	Trip Direction	Movement in Phuentsholing
		Surveyor's observation	*Number plate*	*"Where did you load this cargo?"*	*"Where do you unload this cargo?"*	*"Are you on the way of delivery or returning after unload?"*	*"If you stop at Phuentsholing city, please tell your purpose." (multiple answer)*

[Vehicle Type]
1. Passenger Vehicle
2. Taxi
3. Bus
4. Mini Truck
5. Medium and Heavy Truck
6. Motorcycle
7. Others

[Vehicle Nationality]
1. Bhutanese
2. Non-Bhutanese

[Place of Loading and Unloading]
1. Phuentsholing
2. Pasakha and around
3. Samtse (Dzongkhag)
4. Thimphu and Bhutan hinterland
5. India and third countries

[Trip Direction]
1. On delivery
2. On returning

[Movement in Phuentsholing]
1. Customs clearance
2. Loading/unloading
3. Break
4. Vehicle maintenance
5. Others
6. No stop

3.2 Result

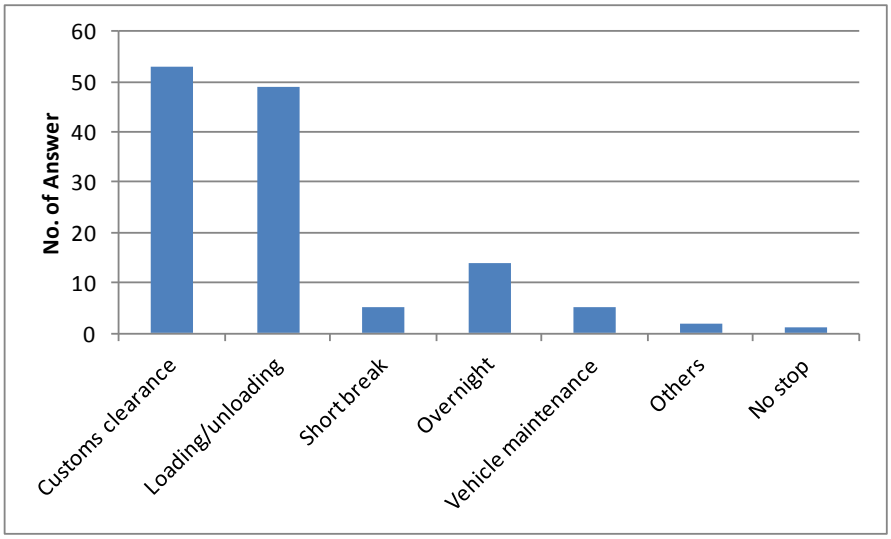
	Number
Bhutanese Number	28
Non-Bhutanese Number	28

Figure F- 30 Vehicle nationality (2 days total)

Trip Direction		No.
Valid answer		31
Inward		27
	To Pasakha	8
	To Thimphu and Inland Bhutan	10
	Stop at Phuentsholing	9
Outward		3
N/A		1

Note: Inward stands for upward direction to inland Bhutan.
Outward stands for the opposite (downward) direction.

Figure F- 31 Result of route interview (weekday)



Note: multiple answers

Figure F- 32 Purpose of stop in Phuentsholing (2 days total)

APPENDIX G: River Basin Disaster Management With SABO Technologies

1. Condition of Phuentsholing

Phuentsholing is in severe environmental condition and is in Danger:

Reason 1: Heavy Rain Annual Rain Fall 4,400mm (Average 1998-2011)
Reason 2: Weak Soil South of Bhutan is in Weak Soil

Result of environmental condition ⇒ Land Slide, Erosion, River Flooding, City Inundation, Damage to Infrastructure

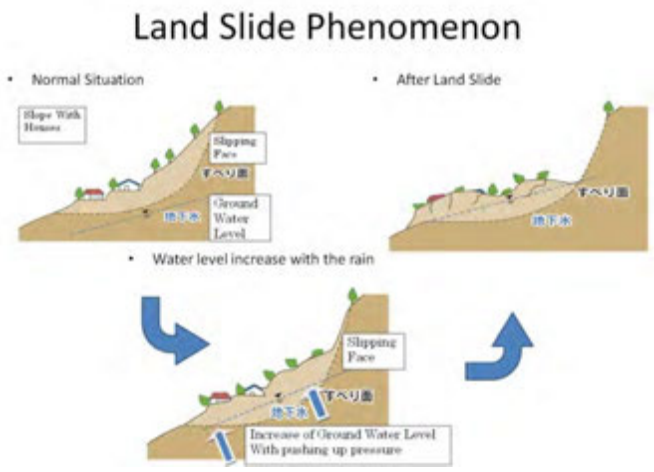
Damage of Embankment at Om Chhu

Damaged Road to Pasakha

Huge Rocks at downstream of Om Chhu

Land Slide at upperstream of Om Chhu

2. Land Slide Mechanism and Hillside Engineering Works

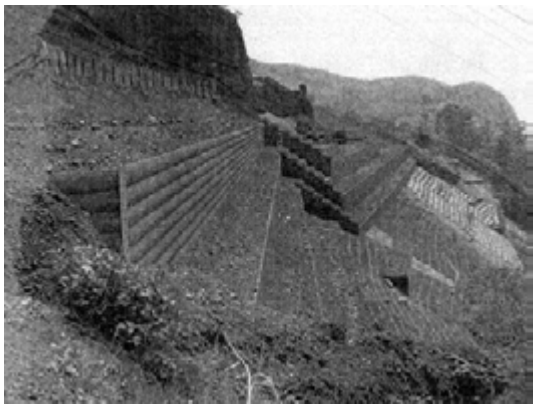


Source: Based on Shikoku Mt. Sabo Office HP

Hillside Engineering Works (Terrace Making) to prevent land slide

Terrace Making by local woods for Afforestation at Tanakami Mt, Shiga

Source: Yodogawa River Office MLIT, HP



Terrace Making as Sabo at Mt Oonagi Tochigi Pref.

Source: Kasen Kogaku, Yutaka Takahashi

Source: Dhosha saigai no Jittai, Katsutaro Yano

Check dam made by local wood

3. Various Structures for River Control

Jogangi River

River bed stabilization

Source: Toyama Just Now HP,
Yoshihiko, Ono

Various Structures for river control

River flow control Structures
Middle and Below are river runs through type

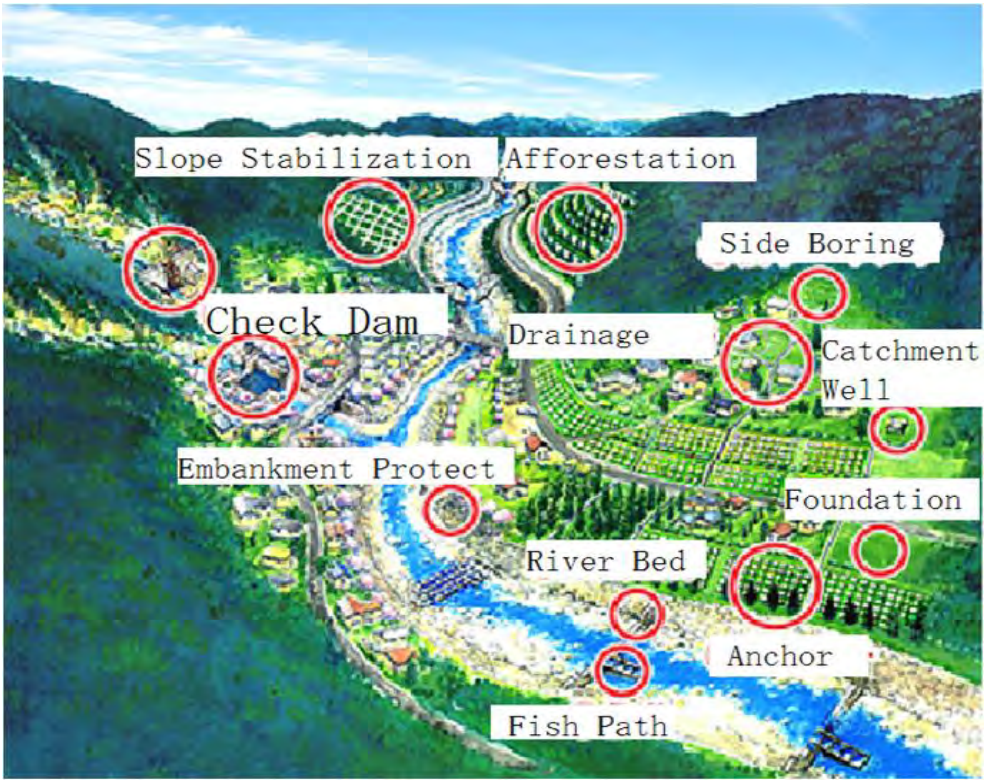
Source: Dosha Saigaino Jittai,
Katsutaro Yano
Zenkoku Sabo Chisui Kyokai

4 By-Product of Sabo Dam

Sabo Dam converted to Recreation Park at Ojironomori Meisui Park

Source: Istumo Navi,
Ojironomori Meisui Park HP

5. Illustration of Sabo Technology

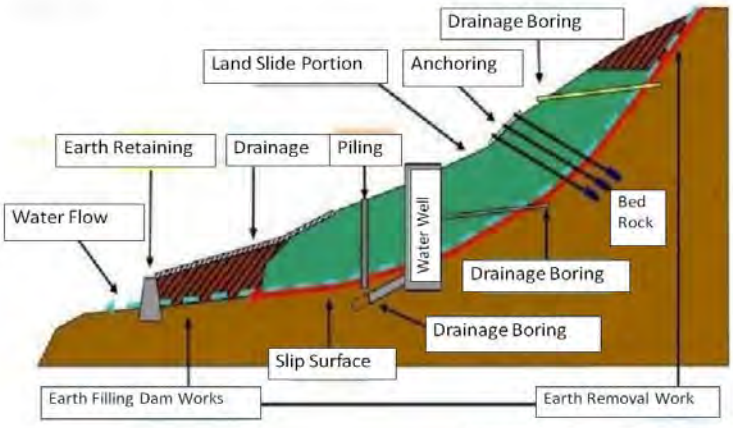


Combination of Various Technologies

Source: Shikoku Mt Sabo Office HP

6. Illustration of Slope Stabilization

Example of Slope Stabilization



Source: Hokkaido Regional Forest Office HP, Forestry Agency, MoAFF, Japan

7. Suggestion for Future Improvement