Province Government

Bagmati Province

Ministry of Physical Infrastructure Development

Transport Infrastructure Directorate

Hetauda, Makawanpur, Nepal

Draft

Guidelines

For

Survey Works including Preparation of Detailed Project Report (DPR) of Roads

2021

Hetauda, Nepal

PREAMBLES

Bagmati Province is one of the seven provinces of Nepal, formed on 20 September 2015 following Schedule of 4 of the constitution of Nepal. It is situated at the center of the country that includes the capital of Nepal, Kathmandu. The province is located in between Tibet (China) in the north and province 2 in the south. The province covers an area of 20,300 sq.km and 13 districts of the 77 districts of Nepal. At the local level, there are 3 metropolitan cities, 1 sub-metropolitan city, 41 urban municipalities, and 74 rural municipalities in the province. The population of the province is 5,529,452 as per the census of 2011.

Bagmati Province Government, Ministry of Physical Infrastructure Development, **Transport Infrastructure Directorate** is responsible for the planning, implementation, and maintenance activities related to provincial roads and bridges within the province. For qualitative and sustainable development of roads and uniform and consistency in the road design process and preparation of detailed project report of the road project, this **Guideline for Survey, Design, and Preparation of Detailed Project Report (DPR) of Road, 2077** is prepared. This guideline aims to provide technical assistance for the preparation of DPR of all roads within Bagmati province.

Very special gratitude goes to Chief Minister**Mr. DormaniPaudel, Chief Minister,** Minister of Ministry of Physical Infrastructure Development of Bagmati Province, **Mr. RameshworPhuyal, and Mr. SanjeebBaral, Secretary,** Ministry of Physical Infrastructure Development of Bagmati Province who gave suggestions and feedback during the preparation of this guideline. I would also like to acknowledge many appreciations the crucial role of **Mr. Aashish Khadka**, a Road Expert who worked actively to prepare this guideline. I would also like to thank **SDE Mr. Navin Kumar Singh,** Road Expert **Er. Ram Babu Paudyal**, **Er. Prabin Karki**, Account Officer **Rajesh Thapa,** and other colleagues for their comments that helped in improving this guideline.

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Dr. SahadevBahadur Bhandari

Acting Director

ABBREVIATIONS AND ACRONYMS

MoPID	Ministry of Physical Infrastructure Development, Bagmati Province, Nepal
TID	Transport Infrastructure Directorate
QAP	Quality Assurance Plan
SEZ	Special Economic Zone
BM	Bench Mark
GIS	Geographic Information System
DGPS	Digital Global Positioning System
GPS	Global Positioning System
DTM	Digital Terrain Model
TBM	Temporary Bench Mark
DCPT	Dynamic Cone Penetration Test
TA	Technical Approval
FS	Financial Sanction
DPR	Detailed Project Report
BOT	Build-Operate-Transfer Contract,
E,N,Z	Easting, Northing and Reduced Level
TRL	Transport Research Laboratory
CBR	California Bearing Ratio
DOR	Department of Road
IDF	Intensity Duration Frequency
IRC	Indian Road Congress
RSA	Road Safety Audit
IEE	Initial Environmental Examination
EAI	Environmental Impact Assessment
RP	Resettlement Plan
IPP	Indigenous People Plan

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1 INTRODUCTION

Preparation of road projects involves a chain of activities, such as field surveys and investigations, selection of alignment, carrying out various designs, preparation of drawings and estimates, etc. To be compatible with technical requirements, consistent with the economy, every project must be prepared after thorough investigations and collecting all relevant information, and evaluating all possible alternatives.

The extent and quality of survey and investigations have a strong influence on the selection of the most cost-effective design, estimation of quantities cost, and execution of the job itself. As such, the accuracy and completeness of surveys deserve very special attention in project preparation. The objective can be achieved by carrying out the project preparation work either departmentally or with the help of consultants. In any case, it should be ensured that experts having the required knowledge are deployed on the work. The use of modern instruments and survey techniques ensuresa high degree of accuracy and can speed up the work. A quality Assurance Plan (QAP) is required to be drawn before the start of field investigations.

Adequate funds should be earmarked for the work of survey, investigation, and project preparation. Estimation of the realistic fund and time requirement needed for project preparation will go a long way in making the project preparation a success. It will be found that in the long run, such investment pays more than for itself in the form of well prepared and cost-effective projects, orderly schedule of work, and timely completion.

Systematic presentation of project details is no less important. The project document is the very basis of technical, administrative, and financial sanction of a project. It is also crucial for the accurate execution of work in the field. The project should, therefore, be comprehensive enough for proper appreciation of the proposals as well as an easy understanding of the details. This manual lays down guidelines both for surveys and investigations and presentations of the project details.

1.1 Objectives

The objective of this guideline is to provide planners and designers with sufficientinformation on the fundamentalsunderpinning the planning and design ofroads to allow them to understand thecontext of their projects and the bases fordecisions taken. It brings together theissues to be considered and discusses, in ageneral sense, environmental considerations, transport planningprinciples, engineering considerations, andpublic consultation.

The structure of this guideline is addressed in terms of requisite outputs of roads which are:

- Safer Road
- Efficient and effective transport
- Fair access and amenity and
- Social and environmental and management

1.2 Content

The content of this guidelines is;

- Stages in Project Preparation
- Field Survey
- Design
- Environmental Assessment
- Social Assessment

2 STAGES IN PROJECT PREPARATION

Broadly, the stages involved in the preparation and sanction of the project are:

1. Initial Identification
2. Screening
3. Ranking and Prioritization
4. Pre-feasibility study
5. Feasibility study
6. Detailed Study and Preparation of Detailed Project Report (DPR)

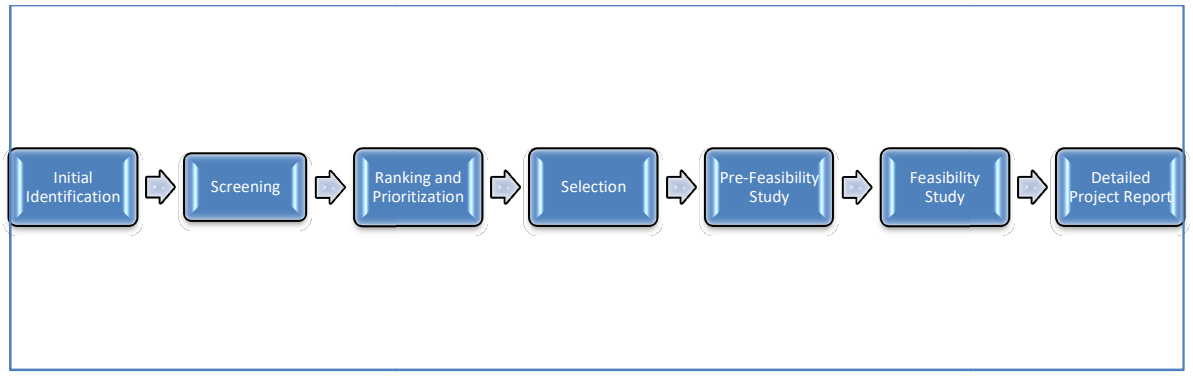


Figure 2.1 : Stages in Project Preparation

2.1 Initial Identification

The initial identification step is the preparation of a list of proposed roads to be improved or maintained. The initial list, will in most cases be prepared with the involvement of local communities or political representation.

2.2 Screening

A Project Screening is a preliminary assessment or examination of the project suitability for the selection and application process for further study that evaluates or investigates a large number of project candidates to identify the rationale of project.The Project Screening may conduct by different procedures and methods to compare the strengths and weaknesses. The factors for screening of project are:

I. Populations served by project (min.500 PP)
II. Its linkage to growth centers or settlements
III. Connectivity with respect to inter province/inter district/ National Highways/Provincial Highways/Transport terminals.
IV. Providing access to industry/SEZ/ fishing/agriculture/ tourist/ religious/heritage places
V. Connectivity to economically backward areas.

The project will be selected for further study if the road alignment meets any one of the above criteria from I to V.

2.3 Ranking and Prioritization

After screening of project, the next step is project is ranking and prioritization of roads.A network consists of several links. It is not possible to construct all roads at a time due to resource and time constraint. Therefore, each link in a network should be prioritized. An overall ranking of the

necessary in order to decide which road should receive priority and in what order. Theprinciple criteria for ranking and prioritization criteria for road project consist of the following index:

a) Rough Estimates of Project Cost
b) Number of Population Served/Benefited

- **Rough Estimates of Project Cost**

The rough estimates of the roads, the cost of the different interventions based on inventory survey needs to be estimated. For this purpose, use is made of standard costs or unit rates as per DOR Norms and Guidelines. These guidelines provide a set of standard unit rates based on an analysis of previous road projects which may be used as an initial estimation of the costs involved. However, it is recommended to verify these standard costs with the actual average costs according to the districts, as costs tend to vary greatly from one district to the next.

It is strongly recommended to use one single standard cost for the whole district and to avoid making detailed calculations for each road or intervention, as that will cost a lot of time and money and is not necessary for this level of planning.

- **Number of Population Served/Benefited**

The population served is defined as the total population of all Municipalities and Rural Municipalities.Population data is collected for each local bodies (total population only). The total population served by each road as the sum of the populations of the different RM linked by the road concerned as an estimation of the population served by each road.

2.4 Scoring and Ranking of Candidate Roads

Based on the total estimated cost and the number of populations benefited, the roads are ranked and prioritized for further study.Prioritization of the road projects shall be given in order of total scoring order.

Based on the prioritization of the local road and availability of budget of each year, further study program shall be formulated.

2.5 Pre-feasibility Study

In some cases, especially for externally funded and BOT projects, it may be necessary to prepare a pre-feasibility report to enable a funding agency or private financier to appreciate the broad features of the project, the levels of financial involvement, and probable returns. This may be done based ona reconnaissance survey by collecting information on the present status of the road, deficiency/distress identification, development potential, environmental impact, traffic data (present and future), an approximate estimation of cost, and economic analysis. The economic analysis may involve traffic allocation studies, assessment of resource generation potential, funding pattern, and risk. The location of toll plaza sites may also need to be identified.

2.6 Feasibility Study

The Feasibility Study is intended to establish whether the proposal is acceptable in terms of soundness of engineering design and expected benefits from the project for the investments involved. The Feasibility Report enables the funding agency to accord approval to the project. When the international funding is involved, the Feasibility Study forms a basis for an investment.

2.7 Detailed Engineering Study

The Detailed Engineering covers detailed alignment surveys, soil and materials surveys, pavement design studies, drainage studies, environment management plan based on environmental impact assessment studies, detailed drawings, estimates, and implementation schedules and documents. Based on such work, Technical Approval and Financial Sanction (TA and FS) are accorded to the project, enabling it to be executed.

The sequence of survey operations and project preparation may thus, have to be structured to meet the specific needs of the project, its funding option, and the requirements of the authority sponsoring it.

3 FIELD SURVEYS FOR ROADS

Preparation of road projects involves a chain of activities, such as, field surveys and investigations, selection of alignment, carrying out various designs, preparation of drawings and estimates, etc.To be compatible with technical requirements, consistent with economy, it is essential that every project should be prepared after thorough investigations and collecting all relevant information and evaluating all possible alternatives. The extent and quality of investigations have a strong influence on selection of the most cost-effective design, estimation of quantities cost and execution of the job itself. As such, accuracy and completeness of surveys deserves very special attention in project preparation. The objective can be achieved by carrying out the project preparation work either departmentally or with the help of consultants. In any case, it should be ensured that experts having the required knowledge are deployed on the work. Use of modern instruments and survey techniques ensure high degree of accuracy and can speed up the work. Quality Assurance Plan is required to be drawn before the start of field investigations. Adequate funds should be earmarked for the work of survey, investigation and project preparation. Estimation of realistic fund and time requirement needed for project preparation will go a long way in making the project preparation a success. It will be found that in the long run, such investment pays more than for itself in the form of well prepared and cost effective projects, orderly schedule of work and timely completion. Systematic presentation of project details is no less important.

3.1 Guiding Principles of Route Selection and Alignment Improvement

The fundamental principle of route selection and alignment improvement is to achievethe least overall cost on transportation, having regard to the costs of initial construction of the highway facility, its maintenance, and road user cost, while at the same time, satisfying the social and environmental requirements. To achieve this objective, it will be necessary to make a detailed investigation before the location is finally decided.

Factors that should be kept in view in the process are listed in **Appendix-I**

Where the project involves improvements to an existing road, every effort should be directed towards the inherent deficiencies concerning

- Plan and profile
- Sight distance/visibility in horizontal as well vertical plan
- Carriageway, shoulder, and roadway width
- Cross-drainage structures
- Roadside drainage provisions as well as area drainage consideration
- Safety features.

Apart from engineering factors, the environmental and social impact of the proposal should be fully kept in view in terms of such aspects as air pollution, damage to life systems, soil erosion, drainage pattern, landscaping, disruption of local communities, resettlement, land acquisition, etc.

3.2 Reconnaissance Survey

The main objective of the reconnaissance survey is to examine the general character of the area to determine the most feasible routes or routes, for further more detailed investigations. Data collected should be adequate to examine the feasibility of all the different routes in question, as also to furnish the Engineer-in-charge with approximate estimates of quantities of costs, to enable him to decide on the most suitable alternative or alternatives. The survey should also help in determining basic geometric standards to be adopted for the highway facility.

3.2.1 Survey Method

The reconnaissance survey may be conducted in the following sequence

- Study of topographical survey sheets, agricultural, soil, geological, and meteorological maps, and aerial photographs, if available.
- Aerial reconnaissance (where necessary and feasible)
- Ground reconnaissance

3.2.1.1 Study of Topographical Survey Sheets

Reconnaissance begins with a study of all the available maps. The types of useful map information which are currently available in the country are topographical map, land use map, hydrological map, and geological map.

After the study of the topographical features on the maps, several alignments feasible in a general way are selected keeping in view the following points:

- The alignment should take into account all the control points and should be the shortest and most economical compatible with the requirements of grade and curvature.
- The shape ofthe alignments.
- Avoidance, as far as possible, of marshy ground, steep terrain, unstable hill features, and areassubject to severe climatic conditions, flooding, and inundation.
- Land use pattern, Soil type, village, settlements, etc.
- The need of connecting important villages and towns.
- Bridging cross-drainage and drainage problems.
- Need to preserve the environment and maintain ecological balance.
- Geology, geomorphology and groundwater prospecting and
- Environmental factors, e.g., vegetation, soil condition, land use, etc.

3.2.1.2 Aerial Reconnaissance

An aerial reconnaissance will provide a bird's eye view of the alignments under consideration along with the surrounding area. It will help to identify factors that call for rejection or modification of any of the alignment. The final decision about the alignments to be studied in detail on the ground could be taken based on the aerial reconnaissance.

3.2.1.3 Ground Reconnaissance Survey/ Road Inventory Survey

The various alternative routes located as a result of the map study are further examined in the field by ground reconnaissance. As such, this part of the survey is an important link in the chain of activities leading to the selection of the final route. General reconnaissance consists of a general examination of the ground walking or riding along the probable route and collecting all available information necessary for evaluating the same. In the case of hill sections, it may sometimes be advantageous to start the reconnaissance from the obligatory point situated close to the top. If an area is inaccessible for the purposes of ground reconnaissance, recourse may be had to aerial reconnaissance to clear the doubts.

While carrying out ground reconnaissance, it is advisable to leave reference pegs to facilitate further survey operations.

The methodology used for preparation of Road Condition is called Road Condition Survey.Instruments generally used during ground reconnaissance include GPS, compass, Abney level/Altimeter, Pedometer, Aneroid barometer, Clinometer, Ghat tracer, etc. Walkie-talkie sets, mobile phonesare useful for communication, particularly in difficult terrain. Use ofthe instruments

mentioned above to obtain ground slopes, maximum gradients, the elevation ofcritical summits or stream crossings, and location ofobligatory points, serve as a check on the maps being used.

Points and Formats on which data may be collected during ground reconnaissance and road condition survey are listed in**Appendix II.**

3.2.1.4 Reconnaissance Report

Based on the information collected during the reconnaissance survey, a report should be prepared. The report should include all relevant information collected during the survey, a plan to the scale of 1:50,000 or larger as available showing the alternative alignments studied along with their general profile and rough cost estimates. It should discuss the merits and demerits ofthe different alternatives to help the selection of one or more alignments for detailed survey and investigation.

3.3 Topographical Survey for Road Works

3.3.1 Objectives

A topographic survey is an Engineering survey to understand and analyze the ground features along the proposed alignment. By applying mathematical principles to the Survey data, existing or future horizontal and vertical position will be determined. The main objective of a topographic survey for a road is to create a digital terrain model (DTM) by acquiring terrain data. Survey activities include road alignment, fixing the centerline of the road, providing permanent grid lines and benchmarks as per the applicable standards.

The topographic survey helps the engineers to:

- prepare alignment drawings
- prepare cross-sectional profiles
- identify existing structures in the proposed road alignment
- Finalize requirement of bridges, culverts, diversions, etc.
- plan land acquisition requirements
- establish control of locations
- establish an elevation difference between fixed points
- Identify the presence of underground utilities like pipelines, electrical cables, etc.

The objectives of this chapter are to provide guidelinesto carryout a topographical survey and prepare topographical maps of the project alignments for the preparation of DPR of Road and Bridge Works. While conducting survey works, the Survey work must consider the following works but not limited to;

- Establishment of Control Point
- Monuments of the major control points.
- Prepare Description Cards
- DGPS control
- Control traverse.
- Detailed topographical survey project alignments.
- Prepare a topographical map of contour interval 1m from the survey data.
- Submit a detailed survey report.

3.3.2 Control Station

All survey for road projects shall be adequately referenced to the nationwide coordinate system directly derived from or indirectly connected to GPS satellite observations. The position

coordinate coordinates shall be based on the national horizontal geodetic control points unless other otherwise authorised.

Levels shall be preferred to the mean sea level and related to a vertical network of national geodetically heighted primary, secondary and tertiary benchmarks unless otherwise authorised.

3.3.2.1 Establishment

The first step of the topographical survey is the establishment of control points. The process of establishment of control points depends on instrument used DGPS or Total Stations or combination of both.Survey monuments are used to provide horizontal and vertical control for survey works. These project control monuments provide the basis for all survey works. Their stability and positional accuracy are crucial as they are the only references for the detail survey as well as construction survey.

3.3.2.2 Location

The permanent station should be placed within the right of way. They should be placed in areas that minimize the possibility of disturbance due to construction activities. Each location should also be chosen to avoid potential conflicts with underground utilities. When possible, adjacent project control monuments should be placed on opposite sides of the roadway. The permanent station should be placed so as to avoid nearby and overhead obstruction (i.e. clear horizon).

3.3.2.3 Spacing

The control points shall be installed at maximum interval of 200 m within ROW and on both sides of the riverbanks in case of bridges for traverse survey of alignment. The control points shall be connected to the Trig Points established by the Government of Nepal. The entire project and its components shall be connected to the National Coordinate System. Closed traverse loops shall be carried out between control points to check the accuracy of the survey. A topographic survey shall be carried out to high precision.

3.3.2.4 Monuments and D-cards

Control Points have to be established either on a concrete pillar (0.15x 0.15x 0.60m)LxBxH size of 1:2:4 or cross chiselled on a boulder or concrete nail on permanent features. Every control point has to be marked with suitable colour

paint on the site. A separate BM reference sheet, together with a BM card has to be prepared and submit which will be useful during the further survey and construction stage of the project. All the surveyed data and topographic map thus prepared shall be handed over to the client in (Dwg/Dxf) formatalong with the report.

Description cards of all the major control points shall be prepared and the description cards of the control points / BMs shall depict the following information:

- The ID of the control point.
- Method of the establishment.
- Location description of the point.
- Monuments type.
- Dimension to the references of the points.
- Coordinates of the point (E, N, and Z) of the point
- Photographs

The survey code to be used during survey is in **Appendix-III**and sample of the D-card is presented **IV.**

- **Establishment of Control Point by DGPS**

Differential global positioning system (DGPS) is an enhancement to the global positioning system that provides improved location accuracy, from the 15- meter nominal GPS accuracy to about 10cm in case of the best implementations. DGPS uses one or several (network) fixed ground-based reference stations in known locations. DGPS components are the base receiver, rover receiver.

A modification of the relative positioning method is the differential GPS (DGPS) technique, where one of the two receivers observing simultaneously is equipped with a transmitter and the other receiver(s) can receive the messages given by this transmitter. The transmitting receiver (Base Station) is kept fixed on a point whose location is known to a high degree of accuracy. Based upon this position, the receiver (Rover) computes corrections to the range/phase observations from a GPS satellite and transmits them to the other receiver, which can apply these corrections to improve the accuracy of its own position computed from GPS observations.

- **Establishment of Base station (Control Points with DSPS)**
    - Base Stations to be fixed by Multi/Dual-frequency DGPS receivers with Trig Control Point of Government of Nepal as reference (to be supplied by Department of Survey).
    - The minimum observation time for the base station shall be 3 hours.
    - Required number of Control Points shall be established in such a way that the distance between the DGPS base station & rover shall be less than 5 km.
    - The panoramic view surrounding the Base Station as well as antenna location showing the terrain nearby should be digitally photographed (should be taken in three or four different directions) and documented.
    - **Rovers** shall be of **Dual/Multiple frequency DGPS receivers within a radius of 50 km from the base**. In case **Single frequency DGPS receivers** are used they should be used **within a 10 km radius only**. Readings of the BMs shall be taken with a minimum observation period of 1 hour.

- **Total Station Traverse**

In every stretch traversing in loop has to be completed prior to detailed survey. Traverse shall be done from GPS to GPS. Maximum length of each loop shall not be more than 5 km. While traversing, stations will be established 200 to 300 m apart and all reference/BM pillars shall be connected. These points would be further used for detailed survey. The minimum accuracy of this survey will be 1:10000. Traverse line diagrams for each closed loop traverse shall be submitted. Surveyor shall keep hand written survey notes for all the observations of traverse and the same shall be submitted with traverse data. Traverse loops shall be submitted in XLS format. Distance & included angle observations format shall be used in traversing. Traverse lines shall also be run along the selected realignments and proposed bypasses along the project corridor, if any in same manner as described above.

All the existing traverse (control) stations shall be connected while doing the traverse and accuracy of existing horizontal control needs to be verified.
The detailed topographical survey shall cover a strip of right of way on the proposed alignments. As well as in the contest of curves or turnings, the survey shall be extended up to 100m or requirement of designers.

The detailed survey shall carry out to prepare a topographical map of contour interval 1m and generate longitudinal - sections and cross-sections of the transmission alignments, distribution alignments, and sub-distribution alignments of the proposed and existing water supply pipeline.

3.3.3 Detailed Survey

The detailed survey shall depictthe following information on the ground:

- Existing road details,Tress, forests, water bodies, existing infrastructures, and other features
- Details of existing cross drainage structures such as length, width, and height of culverts, bridges, High Flood Level, Water Level, River Center, River Bank, etc.,details about bridge span, river training works, riverbank structures, and Gully or Streams, etc. if any
- Existing power line details such as high-tension poles, low tension poles, transformers, sub-stations, street lighting poles, underground electrical supply if any
- Existing telecommunication details such as telephone lines,poles, tower, and underground lines if any
- Existing water supply line details such as trunk sewers, branches, manholes, location/position of septic tanks and soak pits of the adjacent building on both sides of the road within ROW.
- Existing building details such as Temples, Church, Gumba, Mosque, Government/Residential Buildings, Boundary Walls, City Boundary, etc.,
- Existing Irrigation canal structures if any,

3.3.4 Longitudinal Sections Survey

Collection of Longitudinal centerline Points would be 10m for hill and 20m for plain terrain (Except in Curve Locations). On the vertical and horizontal curves, it has to be 3m to 5m apart depending on the nature of curve i.e. degree of sharpness of the curve. For very sharp curves, if any, the distance may be 2 to 3 m apart. Apart from this, in case of vertical curves the points should be captured in such a fashion by which the crest and bottom most points of the curve should not be missed.

3.3.5 Cross-Sections Survey

The cross section data must be taken at the interval of 5 m in straight section and at 2 m interval in sharp curve locations. Besides, cross-sections should be taken at points of beginning and end ofspiral transition curves, at the beginning, middle,and end ofcircular curves, and at other critical locations. All cross-sections survey must cover whole ROW.

3.3.6 Trees

Location of individual tree having girth of equal or more than 0.3m coming within the proposed right of way on either side has to be collected along with their broad categorization and girth as mentioned below;

- Girth from 300 mm to 600 mm
- Girth from 600 mm to 900 mm
- Girth from 900 mm to 1800 mm
- Girth from 1800 to 2500 mm
- Girth above 2500 mm

The template for data collection is given hereunder:

SN	CH	Location	Left/Right	Type of tree	Girth cms	Ownership	Remarks (Road/RoW)

3.3.7 Digital Terrain Model (DTM) Preparation

After completion of survey, the DTM model have to be prepared by survey and designer team, and DTM data should be verified and approved by client for further process. To prepare DTM, survey data are imported to AutoCAD by using SW DTM and then a three-dimensional base plan with contour and all the features has to be prepared by connecting all the collected points with 3D poly lines. This data should be sufficient enough to support base plan prepared and the plan must be verified and approved by client for design process. During verification if the data is found insufficient then again data must be collected of missing section and if data is completely mismatching with field topography then resurvey must be conducted.

3.3.8 Topographical Mapping

The Topographic Survey and Mapping Report shall be preparedto describe the activities undertaken including all necessary basic data and records relating to the topographic surveys. The topographical map shall be prepared showing all the above-mentioned information in Auto CAD. All the features such as houses, rivers, roads, tracks, etc.shall be drawn and appropriate symbols are used to show the detailed features like trees, poles, transmission lines, temples, hospitals, schools, etc. The final map of the road corridorshall be prepared with a contour interval of 1m on the scale of 1:500.DTM (Digital Terrain Model) shall be prepared. The Digital Terrain Module of the surveyed area shall be prepared by using AUTOCAD / AUTOCAD Land Development Software. The produced digital map shall be compatible with computer-aided design and GIS system.

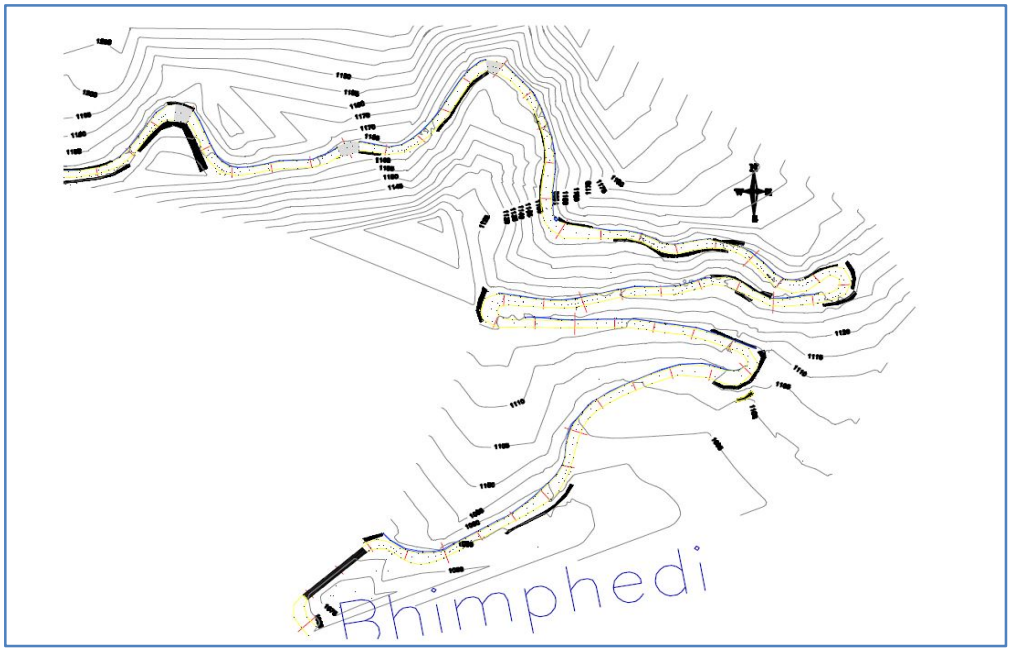


Figure 3.1: Sample of Topographic Map

3.3.9 Topographical Survey Reports

The topographical reports must contain following data, drawings and information;

- Traverse Calculation Sheet
- Levelling Sheet
- D-Cards
- Field sketches
- Points Data (Serial No., Easting, Northing, Reduced Level, Description)
- Complete topographic survey drawings in Autocad format

3.4 Topographical Survey for Bridge Works

While conducting the topographical survey for bridge design, the survey area shall cover a minimum distance of 500 m upstream, 500m downstream, and 200m from the river banks on either side of the river at the proposed bridge site. In the case of the topographical survey of the bridge site, the topographical survey of the bridge site, the topographic map should show the following:

- Contours at 0.20 m interval
- Flood lines on either side of the river in the entire area surveyed
- Both banks of the river
- River cross-section at 25 m interval
- Details of government and /or public establishment on the river banks, details of existing river training works (if any)
- Traverse lines benchmark reference lines and /or points concerning which the present topomap is prepared.
- The angle and direction of skew, if the bridge is proposed to be aligned skew.
- The foundation type and zone of influence of the existing foundation of the bridges or any other structures adjacent to the proposed bridge site.
- Other information relevant to the design, construction, and /or maintenance of the bridge.

3.5 Drone Survey

A drone survey refers to the use of a drone, or unmanned aerial vehicle (UAV), to capture aerial data with downward-facing sensors, such as RGB or multispectral cameras, and LIDAR payloads. During a drone survey with an RGB camera, the ground is photographed several times from different angles, and each image is tagged with coordinates.

With a drone, it is possible to carry out topographic surveys of the same quality as the highly accurate measurements collected by traditional methods, but in a fraction of the time. This substantially reduces the cost of a site survey and the workload of specialists in the field.

The primary outputs of the survey are:

- High-resolution aerial images
- A detailed map of the entire road section: high-resolution orthophoto, contour maps of 1m contour intervals, and a complete top map.
- Profile and cross-section maps at each chainage.
- A web-based road inventory to store images and different outputs of the project

3.5.1 Benefits of Drone Survey

❖ **Reduce Field Time and Survey Costs**

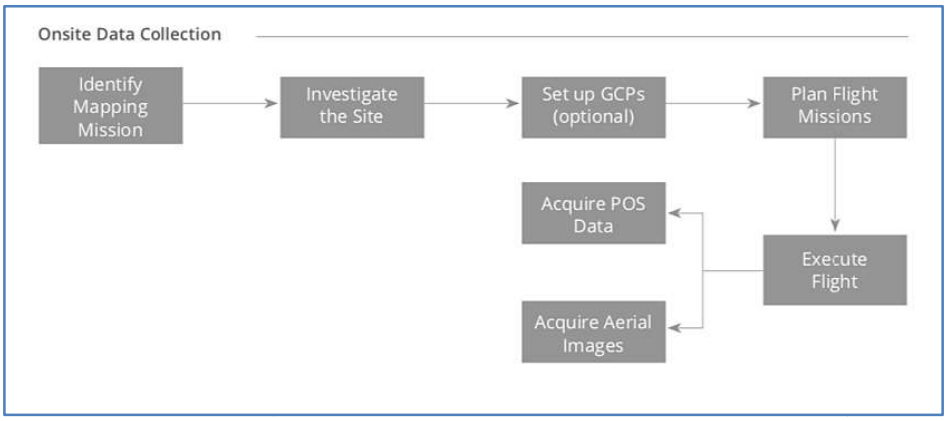
Capturing topographic data with a drone is up to five times faster than with land-based methods and requires less manpower. This survey ultimately delivers your survey results faster and at a lower cost.

❖ **Provide Accurate and Exhaustive Data**

Total stations only measure individual points. One drone flight produces thousands of measurements, which can be represented in different formats (orthomosaic, point cloud, DTM, DSM, contour lines, etc). Each pixel of the produced map or point of the 3D model contains 3D geo-data.

3.5.2 Benefits for Drone Survey

Surveying drone solutions can produce surveys with different degrees of accuracy, depending on the requirements of the project.In an independent study by Drone Deploy, the DJI Phantom 4 RTK achieved 2 cm relative vertical accuracy and 1.20 cm relative horizontal accuracy. The flow diagram mentioned below represents how drones are typically integrated into surveying workflows:



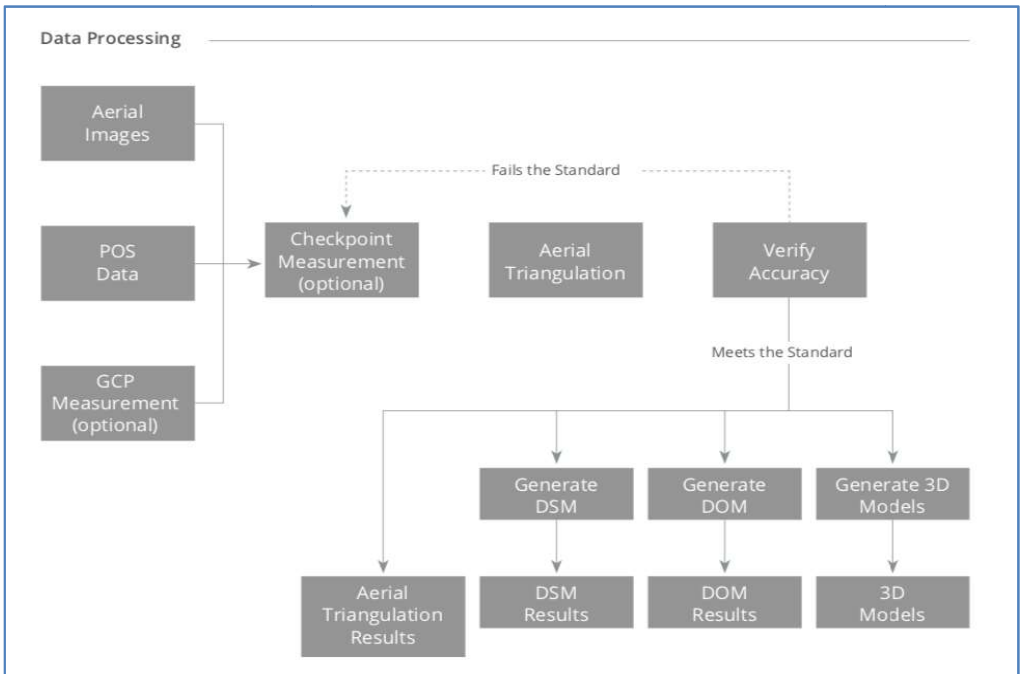


Figure 3.2:Flow Chart for Data Collection and Processing

3.6 Hydrographical Survey

The detailed hydrological surveyshall be carried out based on the analysis of the rainfall and flood records, supplemented by engineering field investigations necessary for detailed design of bridges, culverts, longitudinal drainage and protection works including river training works for drainage structures and bridges.

The objective of the hydrological study will be to determine the different hydrological parameters of the river/steams/gullies, which are to be crossed by the road. This will help in selecting, identifying, and determining the type of river crossing structures, different design data for the design of longitudinal and cross-drainage works, requirement of erosion protection and river training works, the capacities of side drain as well as cross drainage works, catch and subsurface drains, etc. For these tasks, all relevant data and meteorological records shall be assembled to enable the necessary hydrological calculations (design discharge, required span/openings, scour depth, high flood levels, etc) and assessments of drainage requirements along the proposed roads and bridges.

3.7 Geological and Geotechnical Survey

3.7.1.1 Engineering Geological Survey

In hilly and mountainous terrain, engineering geological investigations need thorough detailed study. The main objectives of the study are to identify those geological and geo-morphological conditions present in the region, as well as site-specific issues, which may have a direct bearing on the location, design, and operational aspects of the roads and the road allied structures. Engineering geological studies shall be carried out using simple hand-held instruments, eg: Brunton compasses, altimeters, geological hammers, measuring tapes, Abney levels, etc.

Engineering geologic field survey shall include mapping on the topographic base map of the different parameters of the State of Nature and of the Danger. These will include the followings:

- rock types, including weathering state
- soil type (Generic and Unified Soil Classification) and soil thickness
- rock structures (bedding plane, joint, foliation, cleavage, fault, fold, sheer faces)
- Hydro-geologic conditions (drainage pattern and drainage characteristics, springs and seepage, and their discharge). Dry seed holes will also be mapped.
- Slope characteristics inclination, irregularities, breaks, hummocky topography, cliffs, escarpments, etc.
- Landslide (classification and geometry)
- Erosion (type and extent) and debris flow areas etc.

All the field observations will be recorded in a standard format using the MRE prescribed form with necessary improvements. The format of data collection for Geological and Soil Stability is in **Annex V.**

3.7.1.2 Geo-technical Survey

Geo-technical investigations and sub-surface explorations for the proposed road and bridges shall be carriedout for the proper design of the works and conduct all relevant laboratory and field tests on soil and rock samples.The investigation and testing works will comprise mainly of investigation of sub-grade and the main objective will be to determine the general and strength properties of sub-grade soil and to decide the sub-grade characteristics for pavement design.

The sub-grade investigation works will involve:

(i) **Trial Pit Survey:** Auger Holes and Trail Pits for evaluation of subgrade materials shall be dug in required interval. Representative samples shall be collected for laboratory testing e.g. for Soil Classification, Atterberg's Limits, Shrinkage Limits, Compaction Tests and Socked and unsoacked CBR Tests.

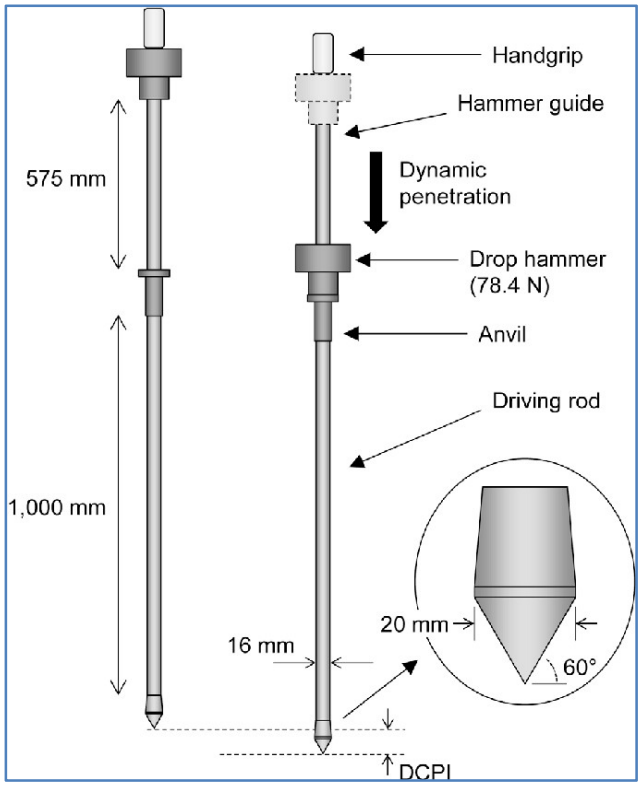
(ii) **Dynamic Cone Penetrometer (DCP) Tests:** Dynamic Cone Penetrometer tests shall be undertaken for the entire road length sections in order to establish the strength of the subgrade. The DCP tests will be undertaken normally at an interval of approximately 500m or as required.Test shall bestarted from subgrade level and it will be continued to 1 m depth from the test level. An 8 kg hammer and 10 mm cone will be used and rate of penetration against each blow shall be measured.The results shall be analysedin order to calculate the Field CBR of the subgrade at each test location.

Principles of DCP

- DCP is an instrument designed for the rapid in situ measurement of the structural properties of existing sub grade condition.
- Continuous measurement can be made to a depth of 800 mm. Measurement is possible to a depth of 1200 mm if an extension is fitted.
- The underlying principle of the DCP is the rate of penetration of the cone, when driven by a standard force, is inversely related to the strength of material as measured.
- The basic principle involved in the operation of this apparatus is the measuring of the resistance offered by the pavement layers to the penetration of a standard cone with a diameter of 20 mm (with 600 apex angle) driven by an 8 kg hammer freely falling through a height of 575 mm. the amount of penetration (in mm) of the cone is generally reported in terms of the average penetration per blow, (mm/blow).

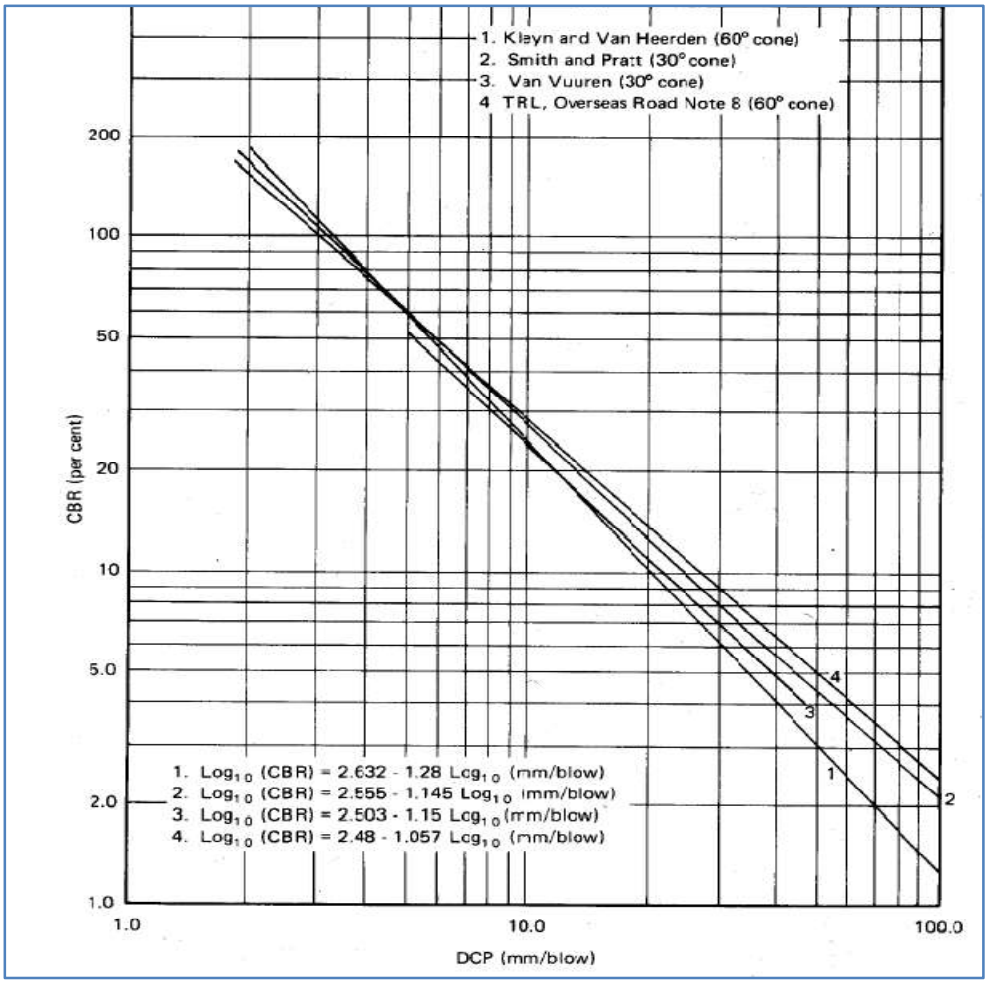
Apparatus/ Equipment

A complete set of TRL DCP instrument and its accessories.



Procedure

- Three operators are required for carrying out this test. One to hold instrument, one to raise and drop the weight and a technician to record the results.
- Hold the instrument vertically and raised the weight carefully to handle.
- Care should be taken to ensure that the weight touches the handle, but does not lift the instrument.
- Before it is allowed to drop the operators should let weight fall freely without lowering it with his hands.
- Record the initial reading on the dynamic cone penetrometer scale.
- Calculate the value of penetration (in mm) for each blow by subtracting the previous recorded reading (i.e. reading on scale) from the current reading.
- Calculate the cumulative depth of penetration (in mm) for each blow by adding all the previous individual depth of penetrations.
- Use the following equation and determine the corresponding CBR value of each layer by using TRL, Overseas Road Note 8.
- **log10CBR = 2.48 – 1.057 log10 (mm/blow)**



3.8 Cadastral Survey

The cadastral survey shall be carried out of the land parcels to verify and finalize those areas that need to be acquired. Cadastral maps (ammonia prints) of the road alignment corridor of concern shall be collected from the district office of the Department of Land Survey. The Surveyor shall mark the road centerline and existing road width on the cadastral maps. In coordination with the topographic survey team, the additional land needed according to the final

designed width and alignment of the road for upgrading works shall be marked on the site with pegs, as well as on the cadastral map. This activity shall lead to the initial finalization of land parcels from which the area needs to be acquired. The Surveyor, in the presence of the landowners and his immediate neighboring landowners,shall then confirm the area. Any house, structure, tree, and standing crops falling within the area will also be documented. The format for house hold survey for cadastral survey is in Annex IV.

3.9 Assessment of Bioengineering Works

Bio-engineering is the application of vegetative and vegetation structures to replace or strengthen the minor engineering structures for soil stabilization and slope protection works.It is cost-effective and environmentally friendly. In many places, bio-engineering can be applied for the beautification of the roadside development. There are different planting configurations, the choice of which will depend on different factors. Choice of species of vegetation should adequately address engineering, physical, biological, and social factors.

The sites for the application of bio-engineering methodsshall be analyzed by a process of prioritization, appraisal, and characterization. Possible danger to the road, to its associated drainage and other structures as well as the danger to neighboring land and environmental degradation,shall also be assessed thoroughly. Hence, for the design of the most suitable and appropriate bio-engineering measures, first shall prepare a Bio-engineering Map of the road corridor by undertaking field surveys and by using information from the Engineering Geologist/Geotechnical Engineer, Highway Design Engineer, and the Structural Engineer.

This map shall be a schematic diagram in which the features of the road corridor will be shown such as attitude, topographical features, slope angle, and slope type, soil type, site moisture (wet, moist, dry, seasonality), drainage characteristics, groundwater, causing increased pore pressure, surface erosion (sheet erosion, gully erosion, piping, and slide, etc.) land river bank cuttings, cultivation practice, type and characteristics of indigenous quick-growing local pants and species, indigenous method and practice of vegetation, possibilities of planting fuel and fodder trees, etc. Nurseries developed in the vicinity of the project area, if any, will be inspected; the type, characteristics, available stock of plants and species will be noted.

Using all the above information and field findings, the sites for bio-engineering application shall be finalized in conjunction with Engineering Geological/Geotechnical Engineer, Structural and Highway Engineer. Different possible alternatives and their combination shall also be identified for each site and reflected into the Bio-engineering map.

3.10 Traffic Count and Axle Load Survey

3.10.1.1 Traffic Count and Projection

The main objective of the traffic survey is to determine the traffic volume with vehicle classifications suitable for pavement design. It requires an estimate of the annual average daily traffic (with vehicle classification), which shall be based on manual classified volume counts and historical traffic data. The classified counts shall be done for seven days and a full 24 hours at important locations and one day period ranging from 16 hours to 24 hours at other locations. The daily and hourly variations shall be analyzed and used from the 24 hours;seven days counts locations. Standard count forms will be used and the results screened to ensure accuracy. Using the classified volume count information, together with historic traffic data such as the daily and seasonal variations, derived from the survey and previous studies, the current level of traffic will be determined for each section of the project roads. Future traffic levels shall then be determined from the information on growth rates for the normal traffic, generated traffic, and diverted traffic.

The format of manual traffic count survey is given in **Annex VII**.

3.10.1.2 Axle Load Survey

The objective of the axle load survey is to quantify the damage that any vehicle type will cause to the road. It requires an estimate to be made of the average equivalence factor per each type of commercial vehicle using the road, which shall be based on 24 hours axle load surveys of commercial following the procedure set out in IRC guidelines. This survey will record not only the axle loads of vehicles but also; loaded or empty state; origin-destination; and cargo type. The axle load data will be analyzed to calculate the equivalency factor (number of standard 10.2 t axles) for each class of commercial vehicle, thus providing the current level of axle loading on the project road. The equivalency factors used in or derived from other studies will be reviewed and analyzed. Care shall be taken to finalize the equivalency factor of each.

In the absence of axle survey work,the survey data together with axle load information from previous studiescan be used if available.The Government has adopted a legal axle load limit of 10.2 tons per standard axle type of commercial vehicle because it will affect to great extent in the design thickness of the pavement.

The format of Axle load survey is given in **Annex VIII.**

3.11 Material Availability Survey

The material availability survey and study shall be carried out. It shall determine the quantity and quality of the materials required for construction. The availability of the necessary materials shall be surveyed to determine the following:

- Information for the manufactured materials such as cement, steel, fuel, timber, bitumen, etc. will be collected from the potential and prospective importers and suppliers in terms of quality, quantity, and costs.
- Natural occurring material sources such as stone quarries, sand, aggregates, and fill material borrow areas, and water sources will be identified and investigated for quality and quantity.
- All potential quarry sites/borrow areas to evaluate the composition of deposition and quantities. Bulk samples of the materials encountered shall be collected for laboratory testing (natural moisture content, gradation, water absorption, unit weight, CBR, Los Angeles, flakiness index, Aggregate Crushing Value, 10% fines)
- The lead distances of the source from road alignment, base price, and royalties, etc. at the source will also be enquired and recorded for use in cost estimations.
- Possible environmental impacts due to the extraction of construction materials and their mitigation measures will also be assessed.

The format for collection of information on quarry sites near the road alignment is in **Annex IX.**

4 DESIGN

Based on survey and investigation works, the extent and type of new alignment design, road improvement, rehabilitation, and up-gradation work throughout the road length is determined. The Detailed Engineering Design is prepared that shall include improvement of road geometrics, drainage structures, retaining and protection structures, slope stabilization, and bioengineering work, road pavement works, road safety works, and miscellaneous ancillary works. All the design work must follow the requirement and standard acceptable to Bagmati Province road standard or DOR and should be based on current proven and acceptable practices.

4.1 Design Standard

The standards and criteria adopted shall be as per**BagmatiProvincial Road standard** and DOR Standards road-specific, and following the end goal. They will also be following the proven method and technology and commensurate with benefits.

4.2 Engineering Design

4.2.1 Interactive Design Environment

All the design works shall be carried out using an Interactive Design Environment such that the changes in the plan, profile, and cross-sections are instantly updated.Initially the Centreline alignment will be created from the corridor mapping to match the existing road widths.The cross-sections at required intervals and profile will be generated from the Triangulated Irregular Network (TIN) model. The interactive environment provides a lot of benefits which include trial design, selection of appropriate structures and continuity check, placement of the cross-drainage structures, checking off the drain invert levels epically at the hairpin bends. Road alignment designed on Digital Terrain Model (DTM) shall be set out at the site with staking the central line and taking levels with verification of the design.

4.2.2 Geometric and Cross-section Design

The detailed design of geometric elements shall cover mainly the major aspects of horizontal alignment, longitudinal profile, cross-sectional elements, junctions, and intersections.These road geometric elements shall be designed following project road design standards. Design of the road geometrics shall be carried out by using acceptable software such as ‘SOFTWELL’. This is windows based software and the output can be exported to AutoCAD and Microsoft Excel.All the design works shall be done by extensive utilization of Computer-Aided Design software for the highest accuracy and quality of work, as well as to complete the work in the specified limited time.

4.2.3 Design of Widening, Extra Widening, and Super Elevation

All the extra-widening works will be included in the plan and cross-section itself rather than leaving it for the construction stage. The extra-widening placement i.e. inner or outer or mixed will be decided for each of the curves and the rate of extra widening willbe according to agreed design criteria.Precise super-elevation design including the chainage-wise values will be prepared.The complex nature of the hill road will be carefully incorporated in the super-elevation design works.

4.2.4 Retaining Structure

Various types of retaining structures shall be designed and included in the cross-section.All the

retaining structures shall not only be shown in the cross-section but also be shown in the plan and profile.A three-dimensional view of the structure shall also be generated and the quantity extracted accordingly rather than from the cross-section. This method provides a more accurate method of retaining quantity estimation which takes into account of the total volume rather than the areas in each cross-section.The retaining structures upto 10 m height can be designed from the Standard Drawing for Road Elements Published by DOR.

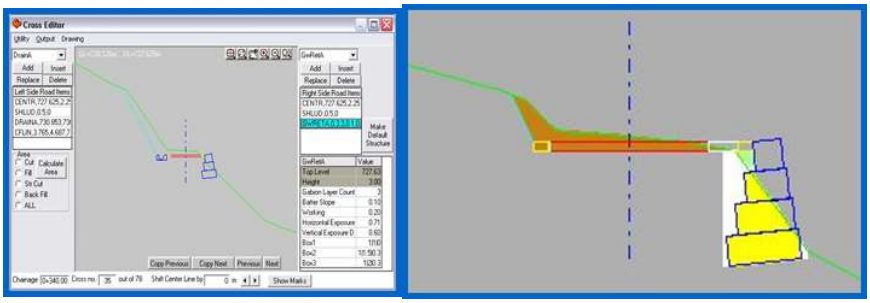


Figure4.1:Example of Cross-Section Editing with Structures and Drains

4.2.5 Design of Pavements

The design of pavement shall be done using DOR Pavement Design Guidelines, 2014 for a periodof 15-20 years. Results from various design methods shall be compared before recommending the final composition for adopting in the Project. The design alternatives in some selected reaches, mostly in the urban area, shall be investigated both for rigid and flexible pavement design options to avoid the deterioration of pavement due to drainage problems. The Consultant is aware of such conditions during the site visit also.

For the design of the new pavement / paved shoulder, each set of design input will be decided based on rigorous testing and evaluation of its suitability and relevance in respect of the in-service performance of the pavement. Values of various design inputs criteria will be carefully chosen taking into consideration to the local practice and conditions. The pavement design task will also cover working out the maintenance and strengthening requirements and periodicity and timing of such treatments.

4.2.6 Design of Drainage and Cross Drainage System

The requirement of a roadside drainage system and the integration of the same with the proposed cross-drainage system shall be worked out for the entire length of the project roads. In addition to the roadside drainage system, the special drainage provisions for sections with super-elevated carriageways, high embankments, and road segments passing through cuts shall be designed.Adequate drainage provisions shall be worked out for road segments passing through urban areas. Following are the important factors which are required to be kept in mind before designing a drainage system for a road:

- Expected traffic, importance and configuration of the road (single lane, intermediate lane, double lane)
- Sources of water which may reach the road from above, side and below
- Drainage catchment areas and existing drainage system.
- Geometric characteristic of the road (alignment, profile and cross section)
- Presence of extreme gradients and cross slope, areas of excavation and land fill, probably of frost formation
- Any limitation in and around the road which may affect the design of drainage system.

For the better results in hydrological analysis, following stepwise procedures are followed:

- Rainfall analysis (Construction of IDF Curves)
- Review of previous studies/reports
- Delineation of catchment boundary of cross drains and determination of their catchment areas using digital topographical map
- Verification of cross and side drains during field visit and with survey data
- Estimation of design floods by rational formula for cross and side drains based on available rainfall data.

The data required for hydrological design include intensity of rainfall of the area concerned, the catchment area characteristic viz. soil type, vegetation cover, and land use pattern.

4.2.6.1 Rainfall

The rainfall data from the nearest rainfall stations along the road alignment shall be established by Department of Hydrology and Meteorology shall be collected.

4.2.6.2 Return Period

The return period is an average interval of time within which an event (rain fall/flood) of given magnitude will be equaled or exceeded at least once. The return period (design frequency) for various types of cross drainage structures such as road side drain, pipe culvert, slab culvert and major-minor bridges etc., has been adopted referring the "IRC: SP guidelines and Nepal bridge standard" as followed;

	Return Period	
i	Road side drain	5 years.
ii	Culverts	25 Years
ii	Bridges and major culverts	100 years

4.2.6.3 Time of Concentration

Time of concentration is the time taken to flow storm water from far most point of the catchment area to the outlet point. It is the sum of Inlet time and flow time. The inlet time has been estimated using IRC:SP:12 formula as follow;

$$tc = (0.84*L^3/H)^{0.385}$$

where,

t_c = Time of concentration in hr,

L = Stream length in km (the distance from the remote point to the outlet)

h = Difference of the maximum and minimum elevations in m. (the fall in level from the most remote point to the outlet in m)

If the time of concentration is less than 15 minutes then it is assumed to be 15 minutes as recommended by ASCE (American Society of Civil Engineers).

4.2.6.4 Rainfall Analysis

Yearly maximum daily rainfalls for representative stations shall be collected from DHM and frequency analysisshall be carried out. Values obtained by frequency analysis shall be adopted for determination of design intensities for the design of cross and side drains.

The extreme rainfall data of available years from rainfall station shall be considered for rainfall analysis of the catchment. The frequency analysis using Gumbel (1941) method shall be used to determine the rainfall intensity in mm/day for the required return period. The following formula has been used in the calculation.

$$X_T = \bar{X} + K\sigma_x$$

Where,

K is the frequency factor and is given as

$$K = -[0.45 + 0.78ln\left(ln\frac{T}{T-1}\right)]$$

Where, T= return period

Similarly, the rainfall intensity in mm/hrs shall be calculated using Mononobe's equation.

$$I= (R/24)*(24/t_c)^{(2/3)}$$

Where,

R= return period rainfall event in mm/day

t_c= time of concentration in hrs.

4.2.6.5 Runoff Coefficient

The runoff coefficient depends on catchment characteristics such as slope, vegetation, shape and size of the catchment. These characteristics are different even in a single watershed. It is very difficult to define the accurate value of runoff coefficient. However standard tables are available to select this coefficient roughly for different cases.

In present study it is impossible to establish this coefficient for individual catchments as they are in plenty. However, it is very clear from topographical maps and field visit that the catchments are more or less catchments in the project area homogeneous. Hence the single value of runoff coefficient may be used for all.

Runoff Coefficient

Runoff Coefficient	Paved surface – 0.9
	Unpaved surface – 0.3
	Green area (loamy) – 0.3
	Green area (sandy) – 0.2
	Lawns and parks – 0.15
	Moderately steep built up area – 0.8

4.2.6.6 Design Flood Estimation

Rational formula is well applicable to small catchments. Hence it is used to calculate the design floods for cross and side drains using maximum hourly

$$Q_P = \frac{C * I * A}{3.6} \qquad (3)$$

Where,

Q_p= Maximum flood discharge in m^3/s

I= Rainfall intensity within the time of concentration in mm/hr

A= Catchment area in km^2

C= Dimensionless run-off coefficient

4.2.6.7 Velocities

The minimum & maximum velocities adopted for the cross drainage and side drain are based on the "table 3.11, CPHEEO manual 2013". The minimum and maximum velocity adopted is as follows:

- Minimum – 0.6 m/sec
- Maximum – 5 m/sec

The minimum limiting velocity has been considered to prevent siltation in channel bed, whereas, the maximum limiting velocity has been limited to prevent excessive scouring in channel wetted surface by flow water.

4.2.6.8 Capacities of Cross Drain and Side Drains

The capacities of the cross drainage and side drains shall be calculated/checked by using the manning's formula as below;

$$Q = \frac{1}{n} AR^{\frac{2}{3}}S^{\frac{1}{2}}$$

Where,

A= Wetted area (m^2)

P= Wetted perimeter (m)

R= Hydraulic radius (A/P) in m

S= Bed slope

N= Manning's roughness coefficient

4.2.6.9 Cross Drains

Cross drains are mainly designed to pass the stream flows. However, in some cases the cross drains are provided to divert the flows coming from side drains. Following steps are followed for locating cross drains:

- Identifying stream points and valley curves in topographical map
- Verifying these locations during field visit and survey
- Locating finally after study of designed plan and profile of the road

The design discharge for a cross drain is a high flow corresponding to the selected return period. In order to economize on construction costs, frequency of flood is selected for return periods, depending upon the importance of the structure. It is recommended to design the cross drains pipe culverts for 25 years return period flood. The drain size varies based on the design discharge. The design discharge for each drain is different. Pipe culvert shall be proposed for crossing the small streams as rivulet and springs do not carry debris. Pipe culverts of pipe diameter 0.60, 0.90 and 1.20 m are considered for crossing the drains.

4.2.6.10 Side Drains

Side drains are recommended for catching the flows from road surface and upside adjoining areas. In some stretches side drains exist but most of them occupied by new design width of the road and new side drains are proposed along the full length of this road. The design discharge for a side drain is a high flow corresponding to the selected return period. In order to economize on

construction costs, frequency of flood is selected for return periods, depending upon the importance of the structure. It is recommended to design the longitudinal side drains for 5 years return period flood.

4.2.7 Design of Traffic Safety Features, Road Furniture, Road Markings, and Road Safety Audit if required

Traffic safety features and road furniture including traffic signals in urban areas, if required, traffic signs, markings, overhead signboards, crash barriers, street lighting in urban and semi-urban areas shall be designed, etc.

Data on accident statistics will be compiled, showing accident type and frequency so that, black spots are identified along the project road. Possible causes (such as substandard geometric features, poor intersection layout, pavement condition, etc.) of accidents will be investigated and suitable cost-effective remedial measures will be suggested.

The alignment design will be verified for available sight distances as per the approved design criteria for the Project. The provision of appropriate markings and signs will be made wherever the existing site conditions do not permit the adherence to the sight distance requirements as per the standard norms. The purpose of carrying out a Road Safety Audit (RSA) will be to:

- Minimize the risk and severity of accidents on roads
- Minimize the risk of accidents occurring on adjacent roads as a result of operation and maintenance of the main roads
- Recognize the importance of safety in highway design needs and perception of all type of road users, and to achieve a balanced safety solution thereto; and
- Reduce the long term cost schemes, bearing in mind the overall cost-effective safe solutions.

4.2.8 Design of Bio-Engineering Measures

Bioengineering is the use of living plants for engineering purpose. Vegetation is carefully selected for the functions it can serve in stabilizing road side slope and for its suitability to the site. It is usually used in combination with civil engineering structures. The basis for the design of bio-engineering measures shall be the detailed analysis of the results of field investigation and the information and knowledge of bio-engineering works in other road projects. The selection of plant species for a specific site will be done taking into consideration functional requirements, physical and biological factors, the possibility of grazing by cattle and/or human intervention, local availability of plants and species, etc. The main engineering functions of structures are; Catch, Armour, Reinforce, Anchor, Support and Drain.

The steps for design and implementation of bioengineering techniques are:

➢ Step 1 Make the Initial Plan and Priorities the Work
➢ Step 2 Divide the Site into Segments
➢ Step 3 Assess the Site
➢ Step 4 Choose the right bio-engineering works
➢ Step 5 Selected the Species to Use
➢ Step6Calculate the required quantities and rates

1. STEP 1 MAKE THE INITIAL PLAN AND PRIORITSE THE WORKS

The first step is making an initial plan and schedule for design and construction of bioengineering works. The whole alignment must be inspected and make a list of sites that require treatment. Priorities them according to the importance of stabilization. Weighting of seriousness of the existing or potential failure against the damage it could cause helps to priorities and schedule works.

Expected Consequence if the Site in not Treated	Priority Rating
Slope movement threatens houses	Priority 1 (i.e Very High Priority
Slope movement threatens complete loss of road	Priority 2
Slope movement threatens partial loss of road	Priority 3
Slope movement threatens complete road blockage	Priority 3
Debris may fall on top of pedestrians or vehicles and cause injury	Priority 3
Slope movement threatens loss of productive farmland	Priority 4
Slope movement threatens blockage of drains	Priority 4

2. STEP 2 DIVIDE THE SITE INTO SEGMENTS

It is very important to have a good knowledge of the site. A slope segment can be defined as a length of slope with a uniform angle and homogenous material that is likely to erode or fail in uniform manner.

The mechanical, hydrological and biological process at work in a slope are many and complex. Nevertheless, before any remedial work can begin, it is necessary to identify the major factors contributing to instability in order to decide on appropriate action.

The assessment and treatment of each site is based on the use of one or more techniques for each segment. So, it is necessary to divide the slope into its component segments. Each segment of slope must be considered a separate entity for treatment: both civil engineering and bio-engineering techniques should be planned for each segment rather than for an entire state.While carrying out this step on site, it is useful to sketch the site on the format in **Annex IV.**

3. STEP 3 ASSESS THE SITES

This is the most important step, and the one of which you must spend the most time. You must make a site visit and you will need:

- Format for data collection
- Tape
- A clinometer or an Abney level
- A GPSor maps or site drawings of the road line that show the altitude

The study of detailed factors contributing to instability within each slope segment. In order to achieve this, it is very essential to look carefully at each segment of the site and note down following factors;

Erosion and Failure List and Process: Each site has a different variety of erosion processes at work, which must be identified before remedial work can be started; often, there will be more than one process affecting each slope. The common types of erosion and slope failure are erosion on the surface, gully erosion, debris fall, and debris flow

Slope Angles: Record the slope angles and assign each segment to one of three classes; $<30^0$, $30\text{-}45^0$, or $>45^0$. Slopes of less than 300 will need only mild treatment, those falling in the other

two classes will require more substantial stabilization.

Slope Length: Record the length of each segment of the site as <15 m or > 15 m. A slope length of 15 meter represents a practical dividing line between 'big' and 'small' site segment.

Material Drainage: This related to internal porosity of soils and the likelihood of their reaching saturation, losing cohesion and starting to flow. Materials with internal poor drainage tend to have more clay than sand. They are prone to slumping at a shallow depth if they accumulate too much moisture. In such a case, a stabilization required some kind of drainage in addition to other functions.

Segment Moisture: The moisture regime of the entire site must be considered although, in the field, this can only be estimated. In assessing sites, it is necessary to determine into which of four categories each segment falls.

Wet	:	permanently dam sites
Moist	:	sites that are reasonably well shaded or moist for some other reasons
Dry	:	generally dry sites
Very dry	:	sites that are very dry, these are usually quite hot as well.

Altitude: Altitude is the main determinant of temperature in Nepal and therefor regulated the local climate to a large extent. It is necessary to know the altitude to a reasonable f=degree of accuracy when the actual species are selected for bio-engineering works.

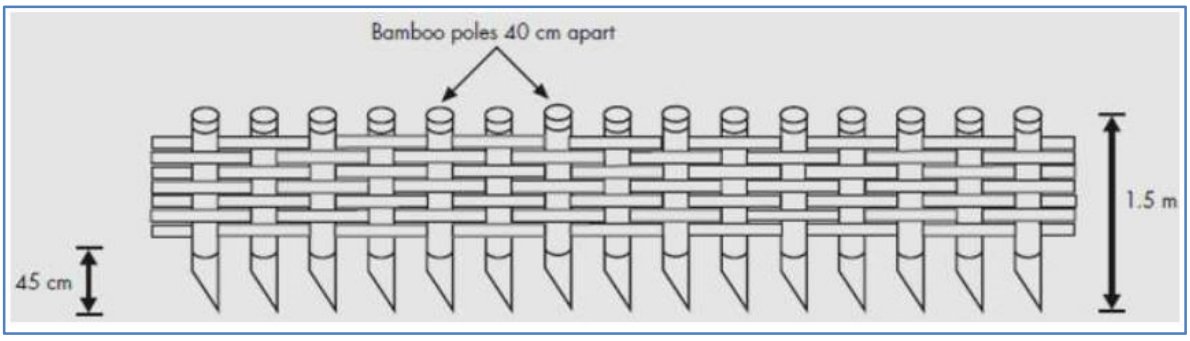
4. STEP 4 CHOOSE THE RIGHT BIO-ENGINEERING TECHNIQUES

This step gives detail of bioengineering and other related techniques for protecting surface, stabilizing and improving surface drainage and enhancing and protecting large civil engineering structures.

The bioengineering techniques that are adopted in Nepal are:

A. Bamboo Fencing

Bamboo fencing can be used to prevent soil creep or surface erosion on a slope, to hinder gully extension, particularly in seasonal water channels, and to control flood waves along a river bank. Live bamboo pegs can be used for the main posts so that the wholestructure becomes rooted.



The growing bamboo can be further interleaved between the posts (as in a wattle fence) to increase the strength of the fence. Shrubs and grasses are planted on the upper side of the fence to hold small soil particles. The main purpose is to trap loose sediments on the slope, to improve the conditions for growing vegetation, and to reduce the surface runoff rate.

Bamboos fencing on a slope – the posts (pegs) are live bamboo that will sprout to provide foliage (left); detail showing live bamboo peg with sprouting leaves (right).

Materials

- Live bamboo pegs or strong bamboo poles about 1.5 m long and 10–15 cm in diameter
- Digging tools
- Seeds or plants of grasses or shrubs

Installation

- Starting from the base of the slope, mark the line for the fence with string.
- Dig a long pit about 45–50 cm deep along the contour of the slope for each line of fencing.
- Insert a row of bamboo poles or pegs 40 cm apart into the pit and back fill the pit to stabilize the poles.
- Weave split bamboo or branches in and out between the poles to form a semi-solid face.
- Plant small grasses and/or shrubs along the upper side of the fence.
- Regular maintenance is important to ensure longevity of the fence. Any broken sections should be replaced immediately.

B. Brush Layering

In brush layering, live cut branches are interspersed between layers of soil to stabilize a slope against shallow sliding or erosion. Fresh green cuttings are layered in lines across the slope. As the roots grow, they anchor and reinforce the upper soil layers (up to 2 m depth), and the foliage helps to catch debris. Some toe protection structures such as wattle fencing, fiberschine, or rock riprap may be required to support brush layering.

Materials

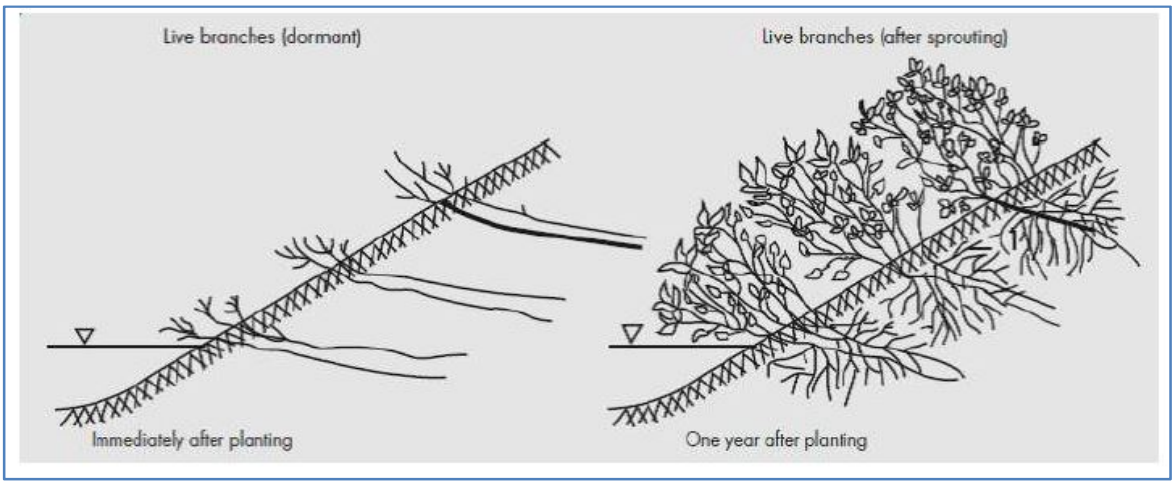
- Branches of different age and diameter cut from rooting woody plants of different species (e.g., willow, alder, populus spp., garuga spp., Malabar nut [Justicia adhatoda], mulberry, five leaved chaste trees [Vitex negundo]). Branches should be at least 1 m long and 4 cm in diameter.
- Mixed plants of different easily growing species, both rooted and freshly cut
- Shovels or other digging tools
- Measuring tape and string line to calculate and mark the surface

Installation

- Mark lines across the slope to be planted at intervals of 0.5–1.0 m upwards from the

base. The slope should have an inclination of at least of 10–20%. Dig a small channel along the line by hand or machine.

- Cut fresh branches with a right angle at the top and 45° angle at the bottom. If possible, cut the branches on the same day that they are to be planted. Ensure branches are at least 1 m long with a mixture of different species. This will allow the root system to penetrate deeper into the soil, giving greater chances of survival and producing mixed vegetation.
- Place branches in the dug terrace, with only ¼–⅕ of their length overhang.
- Place rooted and unrooted plants of species that grow easily 0.5–1.0 m apart among the layers of branches.Regular supervision and care are needed until the branches are fully rooted.The pre-monsoon season is good for installing brush layering. If the site is moist, installation can be done in any season.



C. Brush Mattress

A brush mattress is a layer of interlaced live branches placed on a bank face or slope, often with a live fascine and/or rock at the base. The aim is to provide a living protective covering to an eroding bank to hinder erosion, to reduce the river velocity along the bank, and to accumulate sediment. The mattress is generally constructed from live stakes, fascines, and branches from species that root easily, but can be made from any brushy and woody branches to provide immediate and effective protection. A layer of biodegradable material such as loosely woven jute can be placed under the mat on steep slopes to increase stability if the soil is very loose. The mattress that is formed protects the surface of the bank until the branches can root and native vegetation becomes established.

Materials

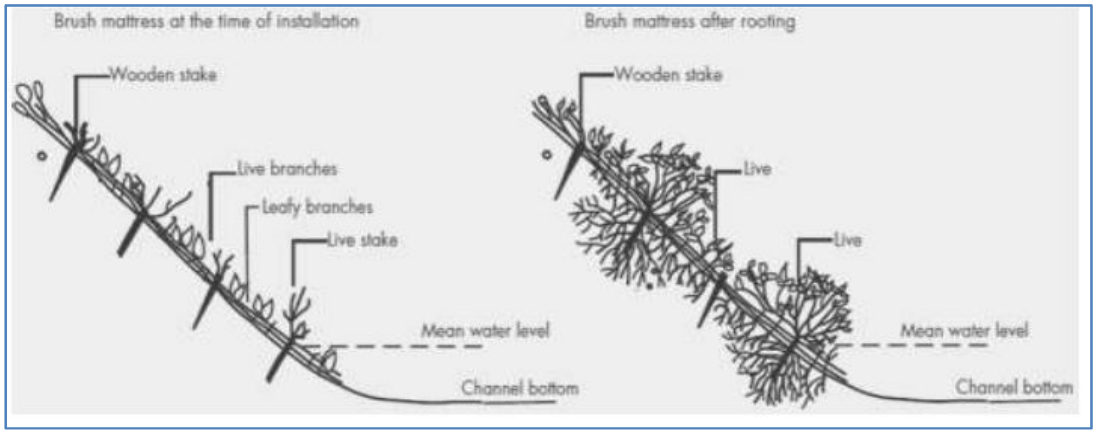
- Live branches 2–3 m long and approximately 2.5 cm in diameter
- Fascine bundles
- Live and/or dead wooden stakes
- Digging tools (shovel)

Installation

- Prepare the site by clearing away large debris and other materials
- If desired, cover the slope with a layer of biodegradable material, e.g., jute netting, to provide extra stability
- Dig a horizontal trench 20–30 cm deep at the toe of the bank or slope.
- Lie the cuttings flat on the graded slope in an overlapping crisscross pattern with the root ends pushed into the soil in the trench to below the water leveland the growing tips

placed at a slight angle in the direction of the stream flow (if on a stream bank) or parallel to the slope.

- Branches should be placed at a density of approximately 4 branches every 15 cm.
- Pound wooden stakes between the branches into the soil to half their length and about 1 m apart.
- Wrap wire around the stakes and over the branches as tightly as possible.
- Pound the wooden stakes further in to tighten the wire and press the branches down onto the slope.
- Push live stakes into the ground between the wooden stakes.
- Place bundles of fascines along the trench at the base of the slope over the bottom of the branches and cover with soil, leaving the tops slightly exposed.
- Fill any voids around and in between the branches with loose soil (from the trench) to promote rooting.
- Periodic maintenance is required to ensure the mattress is securely tied to the slope.



D. Fiberschine

Fiberschine is a roll of material made from coconut fiber used to form a toe protection structure on a slope and to trap any sediment derived from erosion. The most common use is to stabilize the base of a stream bank or shoreline, but it can also be used in slope stabilization to support other measures such as brush layering. Live cuttings from herbaceous plants are planted together with the fiberschine; by the time the fiberschine decomposes, the vegetation will have stabilized the stream bank or slope. Fiberschine can usually be installed throughout the year, but the high water season should be avoided along streams. The following describes installation along a stream bank. The method can be adapted for use on a slope.

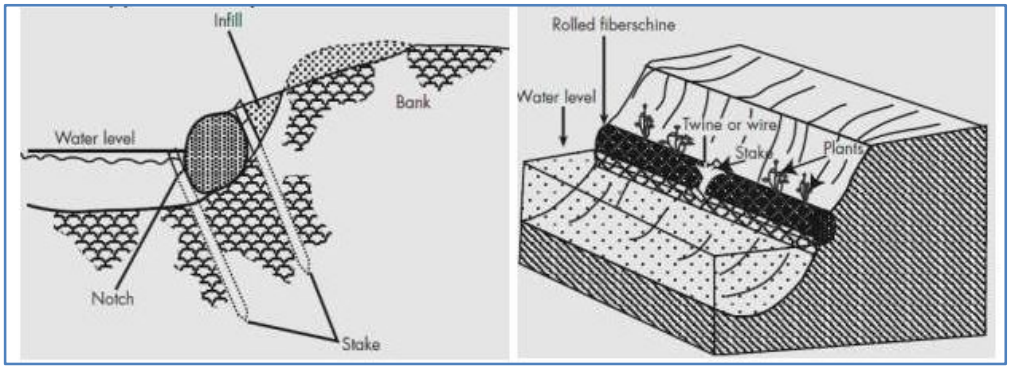
Materials

- Fiberschine roll
- Wedge-shaped wooden stakes 60–90 cm long Twine or wire
- Herbaceous wetland plants or willow twigs

Installation

- Determine the length of the treatment area and obtain the necessary amount of fiberschine.
- Place a roll of fiberschine along the toe of the stream bank at the level of the low flow line with approximately half the roll below the water line and half above. Place additional rolls of fiberschine along the bank for the extent of the treatment area. Tie the ends of adjacent fiberschine rolls together with strong twine.
- Secure the fiberschine on both sides with wedge-shaped wooden stakes 60–90 cm) long at 1.5 m intervals. Cut a 7.5–10 cm deep notch in each stake about 12.5 cm from the top. Secure each pair of stakes together by binding around the notches. Drive the stakes in so that the twine is secured against the top of the fiberschine.

- Key the ends of the fiberschine into the bank to prevent the flow from entering behind it and protect the ends with something hard such as rock to prevent scouring.
- Backfill behind the fiberschine by knocking down the top of the stream bank onto the fiberschine.
- Plant herbaceous wetland plants or willows into and behind the fiberschine at approximately 15–30 cm intervals.



E. Jute Netting

Jute netting is a useful way of stabilizing steep slopes of 35–80° where it is difficult to establish vegetation. Locally available woven jute net is used as a form of armor on the slope and low growing grass is planted through the holes. The technique is often used in South Asia to reduce landslides along roads. The aim is to protect the bare slope from rain splash erosion, to improve the condition of the site, and to enable vegetation to become established by retaining soil moisture and increasing infiltration.

Materials

- Woven jute net
- Digging tools
- Sledgehammer
- Live wood pegs
- Grass seed or small-rooted tufts of grass

Installation

- Trim the slope so that it is even and clear away any hanging masses or depressions.
- Spread fertile soil on the bare slope.
- Mulch with straw or other soft vegetation.
- Start laying netting along a line above the slope to be covered, secure by hammering wooden pegs through the net at 0.3 m intervals.
- Unroll the net down the slope and fix by hammering live wood pegs through it at intervals of 0.5–1.0 m.Continue until the whole slope is covered by netting.Sow grass seed or plant small grass clumps through the netting diagonally at a spacing of 10cm by 10cm over the entire area.
- Regular supervision and care are needed until the grass is fully grown

F. Live Crib Wall

A crib wall is a box structure made of interlocking struts (either logs or precast structures made of concrete, recycled polymers, or other material) and back-filled with boulders, soil, or similar. They are mainly used to stabilize steep banks and protect them against undercutting, for example a stream bank or the side of a cutting made for a road, and are also a useful method for stabilizing the toe of a slope. However, they are only effective where the volume of soil to be stabilized is relatively small. In a live crib wall, live branches and well-rooted plants are placed between interlocking logs where they can grow and develop a root network that further strengthens the wall. If needed, the anchor and cross logs can be held together with nails or bolts. Vegetated crib walls provide immediate protection, and their effectiveness increases over time as the vegetation grows. Once the plants become established, the vegetation gradually takes over the structural functions of the wooden supports. Crib walls should be installed at an angle of 10–15° towards the slope to increase stability. Green willow branches can be used to ensure a quick outcome.

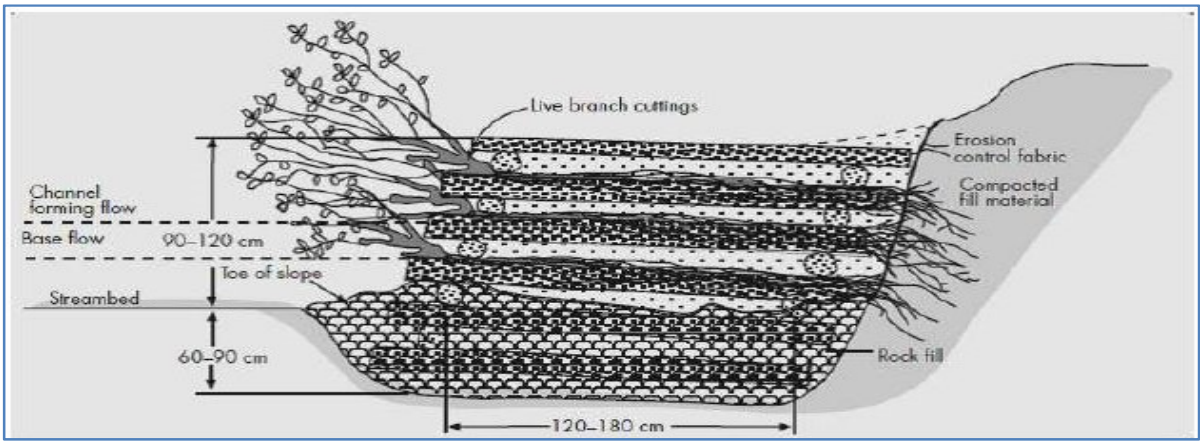
Materials

- Live branches 1–6 cm in diameter and long enough to reach from the front to the back of the structure with an overhang at both ends.
- Logs, timber, or bamboo 1–2 m long
- Steel reinforcing bars
- Excavator or digging tools (shovels), rakes, sledgehammers, knife, measuring tape, level instruments
- Rock and soil

Installation

- Excavate an area 1–2 m wide along the toe of the bank (stream bank or toe of a landslide) to a level around 1 m below the surface and fill with rock.
- Place a series of large logs on the rock end to end along two lines marking the front and back of the wall.Place a series of large logs on the rock end to end along two lines marking the front and back of the wall.
- Place a layer of live willow (or other) cuttings from front to back of the wall between the logs, and protruding over the front logs and extending into the slope behind the back logs.
- Cover the branches with a layer of rock and soil and press down to fill the box.(Steps 4 and 5 can also be carried out in reverse order.)

- Continue for as many layers as needed to reach the desired height, alternating layers of soil and cuttings and logs and ending with soil. Each successive course of logs parallel to the bank should be set back by 15–20 cm from the log beneath.
- To ensure success, the upstream and downstream sections should be well-secured to the bank to prevent undercutting.



G. Live fascines

A fascine is a bundle of sticks or brushwood used in construction, generally to strengthen an earthen structure, fill ditches, or make a path across uneven or wet terrain. Live fascines are bundles of live branches intended to grow and produce roots. They can be placed in shallow trenches on a stream bank to reduce erosion across the bank and increase soil stability. The rooted branches protect the toe of the stream bank from erosion and improve infiltration. Properly placed, the bundles can also trap debris and sediment. Live fascines can also be used to reinforce slopes and increase drainage and infiltration. They are installed perpendicular to the slope in dug trenches or in existing gullies and rills. The optimum spacing depends on the steepness of the slope, usually 4 m intervals for slopes of less than 30° and 2 m intervals for slopes of 30–45°. They are most effective on soft cut slopes or slopes with consolidated debris. Draining effects can be seen as soon as the fascines are established.

Materials

- Live branches of rooting plants of different species 3–5 cm in diameter and 50–100 cm or more long.
- Live wooden stakes ready to sprout 3–6 cm in diameter and 50–100 cm long.
- Dead wooden stakes 3–6 cm in diameter and 50–75 cm long
- Digging tools
- Jute or coir string or wire to bind the fascines.

Installation

- Prepare the site by clearing away loose material and protrusions and firmly infill any depressions.
- Mark the lines along which fascines are to be installed. The lines should follow the contours, or be at a desired angle or along rills and at intervals of 2–4 m up the slope (2 m for slopes of 30°–45°; 4 m for slopes of less than 30°).
- Excavate trenches approximately 10 cm deep and 20–40 cm wide along the marked lines starting from the bottom of the slope and working upwards.
- Bind 4–8 live branches into bundles (fascines) using string or wire.
- Place the fascines lengthwise in the trenches.
- Drive alive or dead stakes directly through the fascines every meter or so flush with the top of the fascines, and where the bundles connect.
- Drive live stakes into the soil immediately below the fascines, protruding about 7 cm above the fascine.Backfill the trench with moist soil to the side of the fascine, but allow the top of the fascine to show.Riprap can be used to stabilize the toe of the slope and prevent scouring.
- Backfill the trench with moist soil to the side of the fascine, but allow the top of the fascine to show.
- Riprap can be used to stabilize the toe of the slope and prevent scouring.

H. Palisades

A palisade is a fence or wall made from wooden stakes or tree trunks. Palisades were used historically as a defensive structure. In slope protection, palisades are barriers made from live wood cuttings or bamboo installed across a slope following the contour in order to trap debris moving down the slope, to armour and reinforce the slope, and to increase the infiltration rate. Palisades are used to prevent the extension of deep, narrow gullies and the erosion of V-shaped rills by forming a strong barrier which stabilizes the gully floor and traps material moving downwards (Lammeranner et al. 2005). They are also effective on steep landslide or debris slopes. Palisades can be used on a wide range of sites with slopes of up to about 60°.

Materials

- Stakes made from cuttings of rooting plants of different species 3–5 cm in diameter and 30–50 cm long
- Cross beam
- Gabion wire
- Digging tools such as crowbars and shovels

Installation

- Installation should start from the top of the slope and work down
- Clean or trim the site, remove unnecessary irregularities of slope and loose material.
- Mark the places to be planted. Palisades should be spaced at intervals of about 2 m down a slope of less than 30° and 1 m down a slope of 30-600.
- Make holes with the help of a pointed bar or crowbar for planting the cuttings.
- Trim the top of the cuttings at a right angle to the stem and the bottom at an angle of 45°.
- Place at least two-thirds of the length of the cutting into the hole and pack the soil around it.
- Tie the stakes with pieces of gabion wire to a cross beam which is anchored in the sides of the gully and protected by pegs at either end.
- On steep gullies and rills, support the palisade by placing a layer of stone and soil in front of and below the structure.
- Regular inspection is necessary throughout the year. Broken stakes should be repaired and strengthened to encourage vegetation to develop.
- Thinning might be required after a few years.

Major Problems and their Remedies

Phenomenon	Erosion Problem and Condition	Suitable Bioengineering Techniques
Landslide	Deep-rooted landslide (>3m depth	○ Smoothing to a suitable slope gradient ○ Diversion canals, channel lining, catch drains, waterways Stone pitching and planting of trees, shrubs and grass slip Bamboo fencing with live poles, planting and seeding grass ○ Terracing and planting with bamboo, trees, shrubs, grass Live peg fence, wild shrubs, live check dams ○ Contour strips planted with grass, shrubs, and pegs Fascines, brush layering, and palisades ○ Planting bamboo with or without a structure ○ Check dams planted with deep-rooted species (e.g., bamboo, trees)
	Slumping	
	Planar Sliding	
	Shear Failure	
	Cut and fill area at deep and shallow rooted landslide (< 3 m depth)	
	Bare and Steep slope or newly exposed surface	
	Cracking Zone	○ Bamboo fencing above zone; zone covered with polythene sheet ○ Catch drain with vegetation ○ Fascines, brush layering, and palisades
	Head scarp of landslide or slope failure	○ Slope excavated to an appropriate gradient and rounded (when high and steep) and ○ planted with deep-rooted plants (e.g., bamboo, trees) Bamboo fencing, planting grass, seeding, and mulching Fascines, brush layering, and palisades ○ Jute netting or straw mat covering soil, seeds, and compost mixture; turfing ○ Stone pitching; planting of trees, shrubs, and grass slip Planting grass slip and seeding grass
Debris flow	Sediment production zone	○ As for landslides
	Sediment transportation zone	○ Series of gabion check dams, retaining wall, and side wall planted with deep-rooted ○ species (e.g., bamboo, trees) ○ Bamboo fencing; grass planting, seeding, and mulching
	Sediment deposition zone	○ Diversion canal, channel lining, retaining wall, and side wall planted with trees, shrubs, ○ and grasses ○ Plantation of deep-rooted species (e.g., bamboo, trees)
Soil Erosion	Sheet and rill erosion	○ Planting of bamboo, trees, shrubs, and grass with or

Phenomenon	Erosion Problem and Condition	Suitable Bioengineering Techniques
		without terracing o Live peg fence, wild shrubs, and live check dams Contour strips planted with grass, shrubs, trees, and pegs Fascines, brush layering, and palisades with wild and thorny shrub species.
	Gully erosion	o Diversion canals, channel lining, catch drains, waterways, cascade retaining wall, and o side wall, planted with trees, shrubs, and grasses Bamboo fencing with live pegs o Planting of bamboo, trees, with or without check dams Series of retaining walls and plantation o Vegetated stone pitching in small gullies and rill beds
	Erosion on bare land, degraded steep sloped land, dry and burnt area	o Planting of deep-rooted species (e.g., bamboo, trees) Bamboo and live peg fencing and live check dams Vegetated stone pitching in small sheets and rill beds Stone pitching and planting of trees, shrubs, and grass slip.
	Planting of deep-rooted species (e.g., bamboo, trees) Bamboo and live peg fencing and live check dams Vegetated stone pitching in small sheets and rill beds Stone pitching and planting of trees, shrubs, and grass slip.	o Bamboo fencing with live poles, planting and seeding grass o Planting of bamboo, trees, shrubs, and grass with or without terracing and structure o Live peg fencing and live check dams o Vegetated stone pitching in small gullies and rill beds Contour strips planted with grass, shrubs, trees, and pegs Planting fascines, brush layering, and palisades.
	Water induced degraded land (spring, water source damaged area, canal command area)	o Planting of bamboo, trees, shrubs, and grass with or without terracing and structure o Stone pitching and planting of trees, shrubs, and grass slip o Planting of deep-rooted species (e.g., bamboo, trees) Live peg fences and live check dams o Vegetated stone pitching and loose stone masonry walls or check dams
	Cut and filled area or newly exposed area on slope	o Jute netting and straw mats covering soil, seeds, and compost o Live peg fences and stone masonry walls o Plantation, seeding, and planting grass o Live wattling with terracing and seeding

5. STEP 5 SELECT THE SPECIECES TO USE

It is important to select the right species for use in each bio-engineering technique. To do this there are three factors to consider: function/technique, propagation and site suitability.

The ability of a particular plant to grow in a certain site is determined by the suitability of the species to that site. Plants should become well-established in the season of planting so that they are able to survive the dry months until the next rainy season.

Many bio- engineering sites have extremely poor and stony soils, which drain rapidly. The species should be robust enough to fulfill the bio-engineering function. Vegetation growth depends upon the temperature and moisture conditions for which the species is adapted. Species used for bio-engineering have a tolerance for site conditions and grow on almost any site, depending on specific characteristics. Water is the main factor for plant growth in the warmer months. The use of pioneer species for bioengineering on bare roadside slopes helps to allow a vegetation community to establish through the development of shade and better soil. The factors contributing to the final choice of species are:

- The species that will address the specific problems for bio-engineering techniques.
- Types of appropriate propagation techniques.
- Suitable species for the environmental conditions on site.
- Performance of the required functions on site and also usefulness to local farmers.
- Availability of species at the right place, at the right time, and in the right quantities

Local species are generally better suited to local conditions than species introduced from another area. This means that the choice should normally be a species found in the area where the bioengineering is being implemented. Many of the recommended bio-engineering plants are pioneer species, which means that they are naturally adapted to grow and survive on poor sites with extremes of sunlight, heat, drought and low nutrition levels. The main points related to the establishment of stable natural vegetation are:

- Use of fast-growing species for rapid establishment.
- Establishment of a stable, easily maintained plant community.
- Development of a vegetation cover that will reduce erosion.
- Development of a canopy which shades the soil and improves rooting conditions.

Many bio-engineering sites in the sub-projects are in inhabited areas. Local farmers may be able to make use of the plants grown on the sites. Wherever possible, the choice of species should be made with the consideration that products are of potential use to local people

6. STEP 6 CALCULATE THE REQUIRED QUANTITIES AND RATES

The quantity for bioengineering works is calculated based on site conditions and adopted bioengineering techniques. The quantity of work is estimated by measuring area (length and width) proposed for bioengineering works.The rate analysis for bioengineering is adopted from Department of Roads and rates are taken from district rates. Calculate the quantities and rates required for the work.

4.2.9 Design of Ancillary Works

The design of Ancillary Works shall include treatment of local instabilities, gully, and torrent control works, and road signs and safety markings. Detail designs will also be prepared for facilities such as the construction of tracks, trails, footpaths, pedestrian bridges, bus stations/stops, and market centers as per DOR Standards. The location of such facilities will be determined in close consultation with the local community to ensure that their social needs are

met. Typical designs shall be prepared for these facilities. The design shall ensure that the facilities to be constructed are simple and yet functional. As far as possible, local materials will be specified. The design shall ensure that the facilities can be constructed with locally available labor.

4.3 Preparation of Engineering Design and Cost Estimates

4.3.1 Preparation of Engineering Drawings

All the engineering drawings shall be prepared with appropriate details and scales suitable for bidding and construction, and in the format acceptable to the Client. The drawings and details shall, among others, include

- Locality map (sometimes called a “key map”) showing the location of the works in relation to the region/district/municipality/ Rural Municipalities commonly at a scale of 1:2,500,000.
- Site plan (sometimes called "index map") showing the project and its immediateneighborhood including the important physical features such as hills, rivers, tracks, etc. It may be to a scale of 1:50,000. The locality map and site plan are commonly drawn on a single sheet.
- Map showing complete alignment with Kilometer, names of area, land use, Rural Municipalities, municipalities, name of natural drainage etc.
- Location Map showing linkage of the road with surrounding road network.Map showing survey and design status of the complete road, intersection points,Benchmarks and other references points.Plan with Topographical Map, Profile (Longitudinal Section) and Cross-Section in the following Scale:
  - Plan - 1:1000
  - Horizontal Profile - 1:1000
  - Vertical Profile - 1:200
  - Cross Section - 1:200
- Plans and profile of the road shall contain contour along with details of geometry viz. horizontal alignment with coordinates of IP, deflection angle, IP to IP distances, Chainage of IP, curve data etc. names of Rural Municipalities or municipalities, forest, land use pattern, cross drainage structure, retaining and protection structure required or as directed by Engineer in charge.
- Standard charts of mentioned cross drainage structures, retaining/Brest wall andprotection works, side drain, typical cross section of the road according to types of soil, passing zone(if provided), hairpin bend (If provided)
- D-card, Topo-Map (all coloured), legend of drawings, KMZ files etc. directed by Engineer in charge.

The standard template for drawing of plan and profile and cross section is given in **APPENDIX X.**

4.3.2 Preparation of Cost Estimates

Based on the detailed design/drawings (plan, profile and cross section) quantities of civil work shall be computed for each item of works. The capital cost estimate shall include the initial cost of construction, engineering supervision, environmental management cost, acquisition of land and properties, and contingencies. The rate analysis for the civil engineering items will be made following the DoR norms and market prices of construction materials, labor and equipment hiring rates. The rates for civil engineering items shall be based on approved district rates of respective district.

The template of quantity and cost estimates is given in **APPENDIX XI**

4.3.3 Preparation of Bill of Quantities (BOQ)

Each item shall be clearly described and corresponding clauses of the standard and special specifications shall be referenced to allow the contractor to easily find the corresponding specification. The BOQ may be broken down into different types of works and shall clearly provide for VAT and contingencies.

The template of BOQ is given in **APPENDIX XII.**

4.3.4 Preparation of Bid Documents

Suitable Bid Documents for the procurement of works ICB/NCB contracts shall be prepared in Standard Bidding Documents.The bid documents shall be prepared by incorporating the mandatory requirements of the GON's prevailing Public Procurement Actand Regulations. It shall be ensured that the environmental and social requirements identified are incorporated in the Bill of Quantities, specifications, and contract clauses. Department's Standard Specification will be used along with modifications/additions/deletions and/or amendments, which shall be included in the Special Specifications. The specifications shall also incorporate the findings of the IEE, EMP, RP, IPP, etc.

The bidding documents shall include

- Notice of invitation of Bids
- Letter of invitation of bids
- Form of bid
- Form of agreement
- Condition of Contract, both general and particular specification and drawings
- Bill of Quantities and schedule of Prices
- Bidding data sheet or Appendix
- Bid security form
- Performance security form
- Bank guarantee form for advance payment
- List of additional information required from bidders

The specification shall comply with the standards adopted in Nepal as well as realistically achievable by the classes of contractors who are being invited to bid.

5 ECONOMIC ANALYSIS

5.1 Introduction

The basic objective of the economic analysis is to enable the client or the stakeholder to determine whether the project is an economically worthwhile investment proposal and whether it should be taken up at all. This is done by identification of the potential benefits expected to accrue to the community and comparison with the economic costs of the project. But, for a project to be economically viable, it must be financially sustainable, as well as economically efficient. If a project is not financially sustainable, economic benefits will not be realized. Here, the concept of financial profit is not the same as economic profit. The financial analysis of a project estimates the profit accruing to the project operating entity or to the project participants, whereas economic analysis measures the effect of the project on the national economy.

The economic analysis of projects includes an assessment of the sustainability of project effects to ensure that

- The project provides sufficient incentives for investors
- Sufficient funds are available to maintain project operations
- The least cost means of providing the project benefits is used
- The distribution of project benefits and costs is consistent with project objectives
- Environment effects are included in the analysis

5.2 General Approach

The approach used for the evaluation of the project follows conventional appraisal methodology of considering two stages i: e, **without project situation and with project situation.** The **"with project situation"** is the situation after the implementation of the proposed project, whereas, **"without project situation"** is the situation of not implementing the proposed or similar project in that area. But, the without project situation is not the same as the before project situation. It can be represented by the present levels of productivity of the relevant resources. However, present levels of productivity can frequently change without the project.

Generally, following four basic steps can be used to analyze the economic viability of a project.

- Identify the economic costs and benefits
- Quantify the costs and benefits as much as possible
- Value the costs and benefits
- Compare the benefits with the costs.

5.3 Economic Evaluation

Economic evaluation is done in terms of comparison of Economic cost and benefits.

Economic benefits of the project were estimated in terms of savings in vehicle operating cost (VOC) and savings in travel time for passenger and goods vehicles. The estimates of VOCs and time costs of each vehicle type in with and without project scenario have been used.

The economic cost includes construction cost and maintenance cost. The construction cost includes the cost of widening of road where track opened and opening of track & widening at new section, construction of drainage structures & stabilizing structures, Tunnel (if any) pavement finishing, physical contingencies, costs of environmental mitigations and cost of resettlement etc.

The maintenance cost includes Routine maintenance cost, Emergency Maintenance Cost & Periodic maintenance cost.

Basically, following three indicators of economic indicators are ascertained and compare to test project viability.

- Economic Net Present Value (ENPV)
- Benefit Cost Ratio (BCR) and
- Economic Internal Rate of Return (EIRR)

These are calculated using discounted cash flow methods since costs are incurred and benefits accrue at different dates. The feasibility of the project is determined by comparing the EIRR with the current (considered) accounting rate of 12%. The project is further subjected to sensitivity analysis by varying the project costs and benefits by different percentage and the effect on the EIRR reviewed. This helps to gauge the economic strength of the project to withstand future risks and uncertainties.

6 ENVIRONMENTAL ASSESSMENT

Environment impact assessment of the Project shall be undertaken as per provisions of applicable Lawson environment protection of the Government of Nepal and identify a package of measures to reduce/eliminate the adverse impact identified during the assessment.

It is necessary to address the issues of environmental aspects for environmentally-friendly sound and sustainable planning, designing, and construction of road structures. The environmental issues are, but not limited to, preservation of natural landscape, forest, and existing monuments, the arrangement of construction materials and techniques, construction of cross drainage structures, management of mucks and by-product waste, bio-engineering for slope protection, conservation of the aquatic and terrestrial community, environmental pollution, health and safety of construction workers and the road users, etc.

Different environmental interventions shall be proposed for the entire project cycle of the project road e.g. landslide and slope protection, cross drainage and flood control structures, minimal removal of trees and vegetation, use of eco-friendly construction materials and techniques, health and safety precautions for the construction and operation phases. The intervening measures are either preventive or corrective or compensatory depending upon the nature of the impact and its gravity. These interventions have to be kept in mind during the entire project cycle of the project.

Moreover, an environmental assessment shall includethe mitigation measures for the potential impacts of road construction, criteria of monitoring of the mitigation measures employed in the subproject, Environmental Management Plan (EMP), and the budgetary arrangements for implementing the EMP.

7 SOCIAL ASSESSMENT

The social assessment shall be carried out especially the persons affected due to the Project and requiring resettlement and rehabilitation. GoN rehabilitation and resettlement guidelines shall be the basis for undertaking the assessment. Plan for resettlement and land acquisition shall be prepared, which shall include the following:

- Draft Resettlement and Land Acquisition Plan;
- The social assessments should include gender and local aspects;
- Scope and magnitude of likely resettlement and land acquisition effects, likely losses of households, lands, business, and income opportunities, as well as affected community assets and public buildings;
- Development of an entitlement matrix i) in consultation with local stakeholders, government and the Authority, ii) socio-economic surveys, and iii) inventories of losses that will determine the amount of compensation following the guidelines and policies of the Government;

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APPENDIX-I: Guiding Principles of Route Selection and Alignment Improvement

General

- The highway should be as direct as possible between the cities or towns to be linked, thereby, satisfyingthe major desired links. A direct highway link results in the economy in construction, maintenance, and operation.
- The location should result in minimum interference to agriculture and industry.
- The location should, as far as possible, facilitate easy grades and curvature.
- The location should steer clear of obstruction, such as cemeteries, burning ghats, places of worship,archaeological and historical monuments, and as far as possible, from public facilities, like hospitals, schools, playgrounds, etc.
- Where the proposed location interferes with utility, services, like, overhead transmission lines. Watersupply lines, etc., a decision between changing the highway alignment or shifting the utility services should be based onthe study of the relative economics and feasibility.
- An important obligatory point in the selection of the route is the location of river crossings. Whilecrossings of major rivers (waterway exceeding 200 m.) may have to be as normal to the river flow if possible, withhighway alignment sub-ordinated to considerations of the bridge sitting. Crossings of medium/minor streams should begenerally governed by the requirements of the highway proper. If necessary, such structures could be made skew/located on curves.
- The location should be such that the highway is fully integrated with the surrounding landscape of thearea. In this connection, it would be necessary to study the environmental impact of the highway and ensure that theadverse effects of it are kept to the minimum.
- The highway should, as far as possible, be located along edges of properties rather than through theirmiddle to cause the least interference to cultivation and other activities and to avoid the need for the frequent crossing ofthe highway by the local people.
- The location should be, such as, to avoid unnecessary and expensive destruction of wooded areas.Where intrusion into such areas is unavoidable.
- The highway should be aligned on a curve if possible to preservean unbroken background.
- The location should, as far as possible, be close to sources of embankment axil pavement materials sothat haulage of these over long distances is avoided and the cost minimized.
- A preferred location is one which passes through areas having the better type ofsoil and permits a balancingof the cost of the cut and fills for the formation.
- Marshy and low-lying land and areas having poor drainage and very poor embankment material shouldbe avoided, as far as possible. Also, areas susceptible to subsidence due to mining operations should be by-passed.
- Areas liable to flooding should be avoided, as far as possible.
- Highways through villages and towns increase traffic hazards and cause delays and congestion. Wherevera serious problem ofthis nature is encountered it may be advisable to by-pass the built-up area playing well clear of thelimits upto which the town or village is anticipated to grow in the future.
- As far as possible, areas likely to be unstable due to toe-erosion by rivers shall be avoided.

Special Problems of Locating in Hilly Areas

- The route should enable the ruling gradient to be attained in most of the length.
- Steep terrain and other inaccessible areas should be avoided, as far as possible.
- Unstable hilly features, areas having frequent landslide or settlement problems, and upslope benched agricultural field with potential for standing water may be avoided as far as possible.
- Locations, along a river valley, have the inherent advantage of comparatively gentle gradients, proximity of inhabited villages, and easy supply of water for construction purposes. However, this solution is be-set with disadvantages, such as the need for a large number of cross-drainage structures and protective works against erosion. It would, therefore, be necessary to take the various aspects into account before making the final selection.
- The alignment should involve the least number of hairpin bends. Where unavoidable, the bends should belocated on stable and gentle hill slopes.
- In certain cases, it may be expedient to negotiate high mountain ranges through tunnels. For such cases,the decision should be based on relative economics or strategic considerations.
- In crossing mountain ridges, the location should be such that the highway preferably crosses the ridge attheir lowest elevation.
- An alignment likely to receive plenty ofsunlight should receive due to preference over the one which will bein shade.
- Areas liable to snowdrift should be avoided.

- As far as possible, needless rise and fall must be avoided, especially where the general purpose of theroute is to gain elevation from a lower point to a higher point.
- Areas of valuable natural resources and wildlife sanctuaries shall be avoided.

APPENDIX II: Data to be collected during Reconnaissance Survey

- Details of route vis-à-vis topography of the area, whether plain, rolling, or hilly.
- Length of the road along withthe various alternative.
- Bridging requirements number, length.
- Geometrics Features:
    - The gradient that is feasible, specifying the extent of deviations called for
    - Curves hair-pin bends, etc.
    - Railway crossings.
    - Ground constraints.
- Existing means of surface travel-mule path, jeep track, earthen cart tracks, railway lines, waterway, etc.
- Right-of-way available, bringing out constraints on account of built-up-area, monuments, and other structures.
- Terrain and soil conditions:
- Geology of the area
- Nature of soil, drainage conditions, and nature of hill slopes
- Road length passing through
- Geology of the area
    - Steep terrain
    - Rocky stretches with the indication of the length in loose rock stretches
    - Areas subject to avalanches and snowdrift
    - Areas subjected to inundation and flooding
    - Areas subjected to sand dunes including the location of dunes
    - Areas of poor soils and drainage conditions
    - Areas with very poor sub-soil strength, e.g. marshes
    - Areas of high salinity or wet saline soil.
    - Cliffs and gorges
- Drainage characteristics of the area including susceptibility to flooding
- General elevation of the road indicating maximum and minimum heights negotiated by main ascents and descents in hill sections
- Total number of ascents and descents in hill sections
- Disposition and location of sand dunes
- Vegetation – extent and type
- Climatic Conditions
    - Temperature – monthly maximum and minimum readings
    - Rainfall data – average annual, peak intensities, monthly distribution (to the
    - extent available)
    - Snowfall data – a average annual, peak intensities, monthly distribution (to the
    - extent available)
    - Wind direction and velocities
    - Visibility
    - Exposure to sun
    - Water Table and its variation between maximum and minimum
    - History of unusual weather, like, cloudbursts, etc.
- Facility Resources
    - Landing ground in case of hilly stretches
    - Dropping zones in case of hilly stretches
    - Foodstuffs
    - Labour – local availability and need for import
    - Construction material timber, bamboo, sand, stones, shingle, etc. with the extent of
    - their availability leads involved and availability of easy access
    - Availability of water, especially in arid zones
    - Availability of local contractors
- Value of land-agriculture land, irrigated land, built-up land, forest land, etc.
- The approximate construction cost of various alternatives.

- Access points indicating the possibility of induction of equipment.
- The period required for construction.
- Strategic considerations.
- Recreational potential.
- Important villages, towns, and marketing centers connected.
- Economic factors:
    - Population served by the alignment
    - The agricultural and economic potential of the area
    - Marketing centers
- Other major developmental projects being taken up in the area, e.g., railway project
- hydro-electric projects, railway projects, dams, reservoirs, mining/agricultural projects,etc.
- Crossings with Railway Lines and other existing highways.
- Location of existing or proposed utilities along the alignment.
- The necessity of by-passes for towns and villages.
- Position of ancient monuments, burial grounds, cremation grounds, religious structures, hospitals, and schools.
- Ecology and environmental factors.
- Aspects of needing coordination with other administrative authorities.
- Traffic counts from existing records.

ROAD INVENTORY DATA SHEET													Sheet No:	
Road Name: Badkhola-Nayabazar-Rayalae-Masarka-Mohoria												Road no.:		
												Road Classification:		
Section (From):					(To):							Date of Survey:		
From (km)	To	Terrain (Plain/ Rolling /Hilly)	Landuse(Builtup/ agrt/forest/Industry/Barren)	Name of village/town	Formation width	Carriage way			Shoulder+			Detail of cross roads		Remarks
						Type(BT/CC/ER/GR/Ottaseal)	Width (m)	Condition(G/F/P/VP)	Type(BT/CC/GR/ER)	Width (m)	Condition (G/F/P/VP)	Location (Km)	Carriage way width (m)	

APPENDIX III: Survey Codes and Markings

List of Survey to be used as follows: Survey Coding Method

Example

MW/T/E-Top ofMasonrywall end

NS/MiII/C-Natural surface at mill corner

Main Code	Description	Main Code	Description
CL	Road Center line	BL	Baseline Point
RE	Right Road Edge	ST	Traverse Station
LE	Left Road Edge	FS	Fly Stations
SRE	Right Road Shoulder Edge	BM	Benchmark
SLE	Left Road Shoulder Edge	TBM	Temporary Benchmark
PRE	Right Road Pavement Edge	TK	TrackRoadCentre
PLE	Left Road Pavement Edge	TR	Tree
JNC	Road Junction	WL	WaterLevel
DR	Drain	BDG	Bridge
EP	ElectricPole	F	Fill
PC	Pipe Culvert	CU	Cut
SC	Slab Culvert	CA	Canal
BOC	BoxCulvert	TEL	Telephone Pole
HW	CulvertHead wall	RO	RockyOutcrop
NS	Natural Surface	BO	Boulder
PW	ParapetWall	W	Wall
CH	Chainage	FE	Fence
HC	House Corner	TOL	Toilet
GW	GabionWall	HP	Hand Pump
MW	Cement Masonrywall	PW	ParapetWall
DW	DryWall	CP	CatchPit
HFL	High Flood Level	FL	Normal Flood Level
KI	Stream/Gully	Others	AsinstructedbyField Engineer

Description Codes	Description	Description Codes	Description
C	Corner	R	Right
T	Top	IL	InvertLevel
B	Bottom	DS	Downstream
S	Start	US	Upstream
CL	Centre	Temple	Temple
E	End	Pipal	Pipal
L	Left	Wing	WingWall/ Guide Wall
BRL	BreakLine		

APPENDIX IV: Sample of D-CARD

Provincial Government
Ministry of Physical Infrastructure Development
Transport Infrastructure Directorate
Bagmati Province
Hetauda, Makawanpur

Name of Project……..

Description card of BASELINE/BENCHMARK STATIONS page…..of…..

Name of Road:

District: - **Municipality/Rural Municipality: -** **Ward No:-**

Station Type	**Description**	**Monumentation Mark (Photographs)**
	Chainage:	
	Easting:	
	Northing:	
	Elevation:	

Location Sketch Showing the Station and Reference Points

Sketch	**Photographs of BM with Reference Points**

Ref. No.	**Distance**	**Bearing**	**Remarks**
R1	m	DMS	
R2	m	DMS	
R3	m	DMS	

APPENDIX V: Data Collection for Geological and Soil Stability

Checklist for Road Instability Survey

Road Instability Survey										
Road:		**Chainage with landslide No:**					**Date:**			
1 LOCATION Of INSTABILITY AREA (Natural Hill slope (DD/DA):										**)**
Along the road		Above road - any distance				Below road - any distance				
Type of instability: Rock/Soil		Slide/Erosion/fall/debris flow								
Deep seated / shallow slide: River undercutting/ drainage blocked										
2 MATERIAL FORMING ORIGINAL (FAILED) SLOPE:										
Colluvium	Alluvium	Residual Soil	Glacier till	Fill material			Rock			
Thickness of the soil on the bed rock:				**Color:**						
3 ROCK WEATHERING GRADE:										
Completely	Highly	Moderately	Slightly	Fresh						
Discontinuities (DD/DA)		**Continuity**	**Spacing**	**Waviness**	**Opening**		**Filling materials**			
Bedding/Foliation:										
Joint 1										
Joint 11										
Joint 111										
4 HYDROLOGICAL CONDITIONS AND LANDUSE PATTERN:										
Spring /Seepage flow/Active seepage flow				Monsoon saturation/well drained. Dry/ wet						
Forest	Barren	Wet cultivated	Dry cultivated	Sparsely dense forest	Grassland					
5 DIMENSION OF THE FAILURE (m):										
Length		Breadth				Depth				
6 TYPE OF SLOPE AFFECTED:										
Road cutting but not hill slope		Hill slope but not road cutting		Road cuting plus hill slope						
7 SlOPE CONDITIONS ABOVE THE SLIDE (above road, if road is at top of slide):										
Gentle slope (less than 35)		Stable, undisturbed hill slope								
Unstable hill slope. Cracked ground, another landslide or topography that collects water										
8 SLOPE CONDITIONS BELOW SLIDE (or below road, if road is at base):										
Stable, undisturbed hill slope		Stream								
Unstable hill slope. Cracks, landslide or topography collecting water.										
9 GENERAL TYPE OF FAILURE:										
Rock/soil; Fall/topple; Rotational/translational										
10 FAILURE MECHANISM:										
Erosion (sheet, rill, pipe)		Shear failure (slide, slump, flow)								
Plane failure	Wedge failures in rock									
11 CAUSE OF FAILURE:										
Surface water. Erosion, or soaking of surface: shallow slide/flow										
Ground water, causing increased pore water pressure at depth				Weathering						
Undercutting of slope by strem or road cutting Active/passive				Addition of spoil or landslide debris			Other:			
12 HISTORY OF SLIDE:										
Moved this year for the first time, if possible mention year:				Moves every year by initial mechanism - diminishing						
Moves every year by initial mechanism - constant or getting worse										
Reactivated	Brief history if possible:									
13 LIFE PROGRESSION OF SLIDE:										
Stable slope formed, or will stabilise naturally				Further movement expected, by less serious mechanism						
Repeated movement expected, by initial mechanism or another equally serious										

Engineering geological log of the road alignment

ENGINEERING GEOLOGICAL LOG OF ROAD ALIGNMENT												
	Road Name:											
	Starting from CH. to											
	Chainage (km)	+000	+200	+400	+600	+800	+000	+200	+400	+600	+800	+000
LEFT SIDE	Rock (W)/Soil (D)											
	Hill slope/Height CS											
	Attitudes											
	Landuse											
	Hydrology											
	Instability Type											
	Terrain Type											
	Causes											
	Recommendations											
	ROAD											
RIGHT SIDE	Rock (W)/Soil (D)											
	Hill slope/Height CS											
	Attitudes											
	Landuse											
	Hydrology											
	Instability Type											
	Terrain Type											
	Causes											
	Recommendations											
W-Weathering; F-Fresh; SW-Slightly weathered; MW-Moderately weathered; HW-Highly weathered; CW-Completely weathered; BE-Bioengineering; CKD-Check Dam												
CSF-Cut slope failure, TR-Trimming; D-depth; F-Foliation, J-Joints, DR-Drain; CS-Cut Slope; Dry Cultivated (DCL); Wet cultivated (WCL); Forest (F); Bush (B);												
G-Grassland; Set-Settlement; GE-Gully erosion; SE-Soil erosion; LSD-Landslide												
LEGEND												

APPENDIX VI: Formats for Household Survey (Cadastral Survey)

आयोजनाको नाम :	सि. नं. :..... घरधुरी नं.: .....

आयोजनाप्रभावित घरधुरी सर्वेक्षण फारम

१. अन्तरवार्ता लिनेको नाम:	२. अन्तरवार्ता मिति: .....

१. परिचयात्मक र साधारण जानकारी

१.१उत्तरदाताको नाम:	१.२ जिल्ला: .....
१.३ गा.पा./ न.पा. :	१.४वार्ड नं.: .....
१.५ गाउँ / टोल :	१.६ जग्गाधनीको नाम: .....
१.७नागरिकता नं. :	
१.८ जग्गाधनीको बाबु/आमा वा पति/पत्निको नाम:	
१.९ जग्गाधनीको ससुरा/बाजेको नाम:	
१.१० जात/जाति:	

अन्तरवार्ताकार र सुपरिवेक्षकको बिचारमा आयोजनामा पर्नेव्यक्तिलाई के कस्तो पुनर्वास सहयोग आवश्यक पर्ने हो सो बारेमा आफ्नो धारणा उल्लेख गर्नुहोस् ।

.....

.....

.....

.....

.....

द्रष्टव्य: *आयोजनामा पर्ने सबै घरधुरीमा सर्वेक्षण गर्दा उपयुक्तता हेरी यहाँदिईएकासबै प्रश्नहरु सोध्नु पर्नेछ ।*

२. पारिवारीक विवरण

२.१ जम्मा परिवार संख्या .....

क्र. सं.	परिवारका सदस्यको नाम	लिङ्ग	उमेर	शिक्षा (६ वर्ष माथिको)	आर्थिक गतिबिधी	गत १वर्ष भित्र एक महिनाभन्दा बढि समय घर छोडी बाहिर गएको भए		घरमुलीको नाता	कैफियत
						घर छोडी जानुको उदेश्य	घर छोडि गएको ठाउँ		
१									
२									
३									
४									
५									
६									
७									
८									
९									
१०									
११									
१२									
१३									
१४									
१५									

संकेत:

लिङ्ग: १=पुरूष, २= महिला

शिक्षा: १= साक्षर मात्र र प्राथमिकशिक्षा पुरा नगरेको, २= प्राथमिकशिक्षा (कक्षा १-५ सम्म) पुरा गरेको, ३= निम्नमाद्यमिक (६-८ सम्म)शिक्षा पुरा गरेको, ४ = माद्यमिकशिक्षा (९-१० सम्म) पुरा गरेको, ५= उच्चमाद्यमिकशिक्षा (प्रमाण पत्रतहवा सो सरह) पुरा गरेका, ६= स्नातकवामाथि । ७= निरक्षर (पढ्न, लेख्ननसक्ने ।

आर्थिक गतिबिधी: १= खेती (आफ्नै जमिनमा), २= खेती (आफ्नै जमिनमा र अधिया" समेत), ३= खेतीअधिया"मात्र, ४= कृषिमजदुरी, ५= सरकारी जागिर, ६= निजीजागिर, ७= उमेर नपुगेको, ८= व्यापार/व्यवसाय, ९= पशुपालन, १०= वनजङ्गलको उत्पादन सङ्कलन, ११= बिद्यार्थी, १२= केहि पनि छैन, १३= बैदेशिक रोजगार, १४= बेरोजगार, १५≠अन्यभएउल्लेख गर्ने,

घर छोडि जानुको उद्धेश्य : १=कामको खोजीमा, २=अन्यत्रजागिरे, ३=. व्यापार/व्यवसाय, ४= औषधीउपचार, ५= शिक्षा, ६= नातेदार/साथी भेटन, ७=तिर्थ/भ्रमण

घर छोडि गएको ठाउँ : १=जिल्लाभित्र २= जिल्लाबाहिर ५= भारत, ६= अन्यमुलुक

घरमुलीको नाता: १= घरमुली २= श्रीमति, ३= श्रीमान, ४= छोरा, ५= छोरी, ६= दाजुभाई, ७= दिदीबहिनी, ८= नातीनातिनी,

९= छोराबुहारी, १०=भाउजु/बुहारी, ११= भतिजा/भतिजी, १२= बुबाआमा, १३= अन्य (कोहि भए)

३. जीविकोपार्जनको स्थिति

३.१ तपाईको वा परिवारका अन्य सदस्यको नाममाकतिजग्गा छ र कतिमा खेति गर्नुहुन्छ ? सबै ल्पट र उपभोगको बारेमा उल्लेख गर्नुहोस् ।

क्र. सं.	धनीको नाम	लिङ्ग	ल्पटको नामवा स्थान	क्षेत्रफल/ ईकाई	जग्गाको प्रकार	सिचाई सुविधा	जग्गाको उपयोग	उपभोगको तरीका	कैफियत
१									
२									
३									
४									
५									
६									
७									
जम्माक्षेत्रफल (प्रचलित ईकाईमा)					जम्माक्षेत्रफल (ब.मी.)				

संकेत:

जग्गाको प्रकार: १=अब्बल, २= दोयम, ३= सीम, ४= चाहार ५=अन्यभए।

सिचाई सुविधा: १= छ, २= छैन ।

जग्गाको उपयोग:१= घरवारी, २= खेत, ३= बारी, ४= व्यापारीक क्षेत्र, ५=खरवारी/बुट्टयान, ६= बा"झो/चरिचरन, ७= निजीवन, ८= अन्यभएउल्लेख गर्ने,

उपभोगको तरीका: १= आफ्नो जग्गाआ"फैले कमाएको, २= आफ्नो जग्गाअरूलाई अधिया"मादिएको, ३= बन्दकीदिएको,४= मोही, ५= ठेक्कावा भाडामा दिएको ।

३.२ तपाईको परिवारले कसैको जग्गाअधियाँ/ठेक्कामाकमाएको भएसोको विवरण दिनुहोस् ।

क्र. सं.	धनीको नाम	लिङ्ग	ल्पटको नामवा स्थान	क्षेत्रफल/ ईकाई	जग्गाको प्रकार	सिचाई सुविधा	जग्गाको उपयोग	उपभोगको तरीका	कैफियत
१									
२									
३									
४									
५									
६									
७									
जम्माक्षेत्रफल (प्रचलित ईकाईमा)					जम्माक्षेत्रफल (ब.मी.)				

संकेत:

जग्गाको प्रकार: १=अब्बल, २= दोयम, ३= सीम, ४= चाहार ५=अन्यभए।

सिचाई सुविधा: १= छ, २= छैन ।

जग्गाको उपयोग:१= घरवारी, २= खेत, ३= बारी, ४= व्यापारीक क्षेत्र, ५=खरवारी/बुट्टयान, ६= बा"झो/चरिचरन, ७= निजीवन, ८= अन्यभएउल्लेख गर्ने,

उपभोगको तरीका: १= अरूको जग्गाआफुलेअधिया"माकमाएको, २= बन्दकीलिएको, ३= ठेक्कावा भाडामा लिएको ।

३.३ तपाईको आफ्नो तथाअधियाँमाकमाएको जग्गाबाट हुने कृषिउत्पादनको विवरण दिनुहोस ।

क.स.	वालीहरु	क्षेत्रफल (रोपनी)		उत्पादन (के.जी.मा)	विक्री परिमाण (गतवर्षको)	
		खेत	पाखो		परिमाण (के.जी.)	जम्माआम्दानी(रु.मा)
१	धान					
२	मकै					
३	गहुं					
४	कोदो					
५	दाल /गेडागुडी					
६	तेलवाली					
७	आलु/तरकारी					
८	जडिबुटी					
९	अन्य (खुलाउने)					
					जम्मा	

३.४ तपाईको आफ्नो जग्गाको उत्पादनले वर्षको कतिमहिनाखान पुग्दछ ?

(१) उत्पादननभएको (२) ३ महिनाभन्दाकम

(३) ३-६ महिना (४) ६-९ महिना

(५) ९-१२महिना (६) वचत हुन्छ

३.५ यदितपाईको परिवारलाई आफ्नो जमिनमाउत्पादितखाद्यान्ननभएको समयमाकिनेर खानुपर्दा मासिककति रूपैयाँखर्च गर्नुपर्दछ ? .....रूपैयाँ ।

३.६ खाद्यान्ननभएको समयमातपाईले कुन स्रोतवाटखाद्यान्नको लागिआवश्यकव्यवस्था गर्नुहुन्छ?[वहुउत्तर]

संकेत:

१ = नोकरी , २ = व्यापार, ३ = कृषिश्रम, ४ = गैर कृषिश्रम, ५ = बैदेशिक रोजगारीवाट प्राप्तहुने कमाइ,

६ = सापट, ७ =संपत्ति बेचेर, ८ = अन्यभएउल्लेख गर्ने,.....

४. परिवारीक आम्दानीतथाखर्चको विवरण

४.१ परिवारीक आम्दानीकाश्रोतहरु

श्रोतहरु					
क.स.	कृषि क्षेत्र	बार्षिक आम्दानी (रू.)	क.स.	गैर कृषि क्षेत्र	बार्षिक आम्दानी (रू.)
१	अन्नबाली बिक्रीबाट		१	कृषिमजदुरीबाट	
२	नगदेबाली बिक्रीबाट(हरियो तरकारी तथाफलफुल, विउविजनतथाबागबानी समेत)		२	ज्यालामजदुरीबाट	
३	जडिबुटी बिक्रीबाट		३	नोकरीबाट	
४	पशु/पंक्षि बिक्रीबाट		४	लघुउद्यमबाट	
५	दुग्धउत्पादनबाट		५	व्यापार / व्यवसायबाट	
६	मौरी पालन		६	पेन्सन/विदेशबाट पठाएको	
७	माछा पालन		७	भाडा/व्याज	
८	अन्य(खुलाउने)		८	सम्पति बेचबिखनबाट	
९	अन्य		९	अन्य	
१०	अन्य		१०	अन्य	
जम्मा			जम्मा		
कूलजम्मा (कृषि क्षेत्र र गैर कृषि क्षेत्रवाट भएको कूलबार्षिक आम्दानी)					

४.२ परिवारीक खर्च को विवरण

क.स.	खर्चको किसिम	जम्मावार्षिक खर्च (रू.)
१	खानेकुरा	
२	लत्ताकपडा	
३	स्कुलशुल्क, किताबकापीआदि	
४	औषधी, डाक्टर अस्पतालआदि	
५	बत्तिबाल्ने, पकाउने इन्धनआदि	
६	सुनचाँदी, गरगहनाआदि	
७	वस्तुभाउ / मलखादआदि	
८	यातायात/ सञ्चार आदि	
९	सामाजिक, चाडपर्व, पुजाआदि	
१०	सामाजिककार्यमा चन्दा /दानदिन	
११	जाँड, रक्सी, जुवा, तास आदिमा	
१२	आयआर्जन सम्बन्धीकार्यमालगानी	
१३	ऋण/व्याज तिर्न	
१४	कर/विभिन्नशुल्क/जरिवानाआदि	
१५	अन्य	
	जम्माबार्षिक खर्च:	

४.३ यदिआम्दानीभन्दाखर्च अमिल्दो रुपले बढी आएमात्यसो हुनाको कारणहरु उल्लेख गर्नुहोस्?

५. सीप र तालिम

५.१ तपाईको परिवारका सदस्यहरूमाकूनैसीप र घरेलु उद्योगको अनुभव छ ?(पुरुषवामहिलामा प्र. नं. २.को पारिवारीक विवरण वाट पारिवार नं. राख्नुहोस्)

सीपहरु	पुरुष	महिला	दुबै	कैफियत
१.बेत/बाँसको काम				
२. ताम्र बुन्ने				
३. काठको काम				
४. गाह्रो लगाउने				
५. घर बनाउने				
६. ज्यामीकाम				
७. खाद्यप्रशोधन				
८. अन्य				

५.२ तपाईको परिवारको कुनै सदस्यकुनै पनिप्रकारको सीपमूलकवाअन्यकिसिमको तालिममा सहभागीहुनुभएको छ ? छ भने,पुरुषवामहिलामा प्र. नं. २.को पारिवारीक विवरण वाट पारिवार नं. राख्नुहोस्)

क.स.	सीप / तालिम	अवधि	आयोजक संस्था(संकेत)	सहभागी संख्या	
				पुरुष	महिला

संकेत

१. घरेलु तथा सानाउद्योग कार्यालय २. जिल्ला स्तरीय कार्यालय ३. गा.वि.स. कार्यालय
४. गैह्रसरकारी संस्था ५. अन्तराष्ट्रिय गैह्र सरकारी संस्था ६. निजीतालिमप्रदान गर्ने संस्था
७. अन्यभएखुलाउने

५.३ उनीहरूले प्राप्त गरेको सीपलाई आयआर्जन गर्ने कार्यमा प्रयोग गरेका छन् ?

१,[ ] छन् । २, [ ] छैनन् ।

यदि छन् भने, कस्तो किसिमले

.....

.....

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.....

छैनन् भने, किन

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.....

६. पुर्वाधार सम्बन्धी योजनामाकामको अनुभव

६.१ तपाईको परिवारका सदस्यहरुमापूर्वाधार निर्माण सम्बन्धीकुनै प्रकारको सीप/ज्ञान छ ?

१,[ ] छ । २, [ ] छैन ।

यदि छ भने, कस्तो प्रकारको सीप/ज्ञान छ कृपया ठिक चिनो लगाउनुहोस् ।[बहुउत्तर]

१,[ ] सडक २, [ ]पुल ३, [ ]खानेपानी४,[ ]गोरेटो ५, [ ] वृक्षारोपण ६,[ ]अन्य ।

६.२ के तपाई वातपाईको परिवारका अन्य सदस्यहरु सडक निर्माण सम्बन्धी योजनामाकाम गर्न चाहन्छन् ?

१,[ ] चाहन्छन् । २,[ ]चाहदैनन् ।

६.३ यदि चाहन्छन् भने, निम्नविवरण दिनुहोस् । (नाममा प्र. नं. २.को पारिवारीक विवरण वाट पारिवार नं. राख्नुहोस्)

क्र.सं.	नाम	लिङ्ग	दक्ष	अदक्ष
१.				
२.				
३.				

संकेत:**bIfM** !=ufx|f] nufpg], @=9'·f sf6\g], #=808L afWg] $=hfnLa'Gg], %=kfO{k hf]8\g], ^=emf]n'·]k'n ;DaGwLsfd ug]{, &=l;d]G6sf] sfd ug]{, *=jfof]O{lGhlgol/·sf] sfd ug]{, (=;fwf/0f d]l;grnfpghfGg], !)≠ cGoePpNn]v ug]{ .

cbIfM!=9'·fdf6f] vGg]÷af]Sg], @=9'·f km'6fpg], #=HofdL÷x]Nk/, $=cGoePpNn]v ug]{ .

६.४ तपाईको घरबाट सडक निर्माण स्थलसम्मपुग्नकति समय लाग्दछ ?

पुग्नलाग्ने समय.....

७. आयोजनामा पर्ने घर परिवारको जग्गातथाअन्य सम्पत्तीको बिबरण ।

७.१ आयोजनाबाट प्रभावित ल्पटमा सञ्चालितगतिबिधी र खेतिपातीको बिबरण दिनुहोस् (निम्न संकेत प्रयोग गर्नुहोस्) ।

चेनेज		नक्सा / सिट नं.	कित्ता नं.	लालपुर्जाको मोठ नं. र पाना नं. उल्लेख गर्नुहोस)	ठेगाना	क्षेत्रफल / ईकाई		क्षतिको प्रकार [बहुउत्तर]				तरीका	जग्गाको उपयोग	जग्गाको किसिम	कैफियत
देखि	सम्म					प्रभावित क्षेत्रफल	जम्माक्षेत्रफल	जग्गा	खेति	रूखबिरूवा	संरचनाहरू				

संकेत

उपभोगको तरीका: १= आफ्नो जग्गा आँफैले कमाएको, २= आफ्नो जग्गा अरूलाई अधिँयामा दिएको, ३= अरूको जग्गा अधिँयामा आफुले कमाएको, ४= बन्दकी दिएको, ५= बन्दकी लिएको, ६= मोही, ७= ठेक्का वा भाडामा दिएको ८ = अन्य भए उल्लेख गर्ने,।

जग्गाको उपयोग: १= घर, २= खेत, ३= बारी, ४= व्यापारीक क्षेत्र, ५=खरवारी / बुट्यान, ६= बाँझो / चरिचरन, ७= निजी वन, ८= अन्य भए उल्लेख गर्ने,

जग्गाको किसिम: १= अब्बल, २= दोयम, ३= सीम, ४= चाहार, ५= अन्य भए उल्लेख गर्ने

७.२ ,लालपुर्जा कसका नाममा जारी भएको छ ?

१, नाम: ..... २. लिङ्ग: **[ ]** पुरुष **[ ]** महिला

७.३ आयोजनामा पर्ने जग्गामा अरु कुनै परिवारले काम गरिरहेकोछ भने, सो सम्बन्धी विबरण दिनुहोस ।

क्र. सं.	जग्गाउपभोग गर्नेकोनाम	ठेगाना	परिवार संख्या	कहिले देखि उपभोग गरेको	उपभोगको तरीका	कित्ता नं.	कैफियत
उपभोगको तरीका: १= मोही,, २= बन्दकी ३= ठेक्कावा भाडा ३ = अन्य ।							

(नोट : प्रभावितजग्गामाकुनै व्यक्ति, संस्थावा परिवारले काम गरिरहेकोछ भने, सो सम्बन्धमाविशेष ध्यानदिनुहोस् । मोहीवाअन्यकुनै श्रमिक छन् भने पत्तालगाउनुहोस् । जग्गाकमाएको प्रकार र उपभोगको तरिकाकाबारेमा पूर्ण बिबरण दिनुहोस् । जस्तै उपभोग गरेको अबधी, अधिँया/बन्दकिवा ठेक्का के हो उल्लेख गर्ने ।)

७.४ आयोजनामा पर्ने जग्गाधनीको हालबासोवास गरिरहेको ठेगानादिनुहोस ?

१.जग्गाधनीको नाम: ..... २. पुरा सम्पर्क ठेगाना र फोन नं.: .....

३. कहिले देखि बाहिर बसोबास गर्दै आएको: ..... ४. वारिसेको नाम:.....

८. कृपया, बिगत एक बर्षको अबधिमाआयोजनामा पर्ने ल्पटमा भएको अन्नतथानगदेबालीको उत्पादन र बिक्रीको बिबरण दिनुहोस् ।

क्र.सं.	प्रभावित प्लटको		बाली	उत्पादनक्षेत्रफल	जम्माउत्पादन (के. जी.)	गतवर्षको औषतबिक्री		प्रभावितभागमाहुने उत्पादन (के.जी.)	प्रभावित ल्पटको बालीचक्र
	सिट नं.	कित्ता नं.				परिमाण (के.जी.)	आम्दानी (रू.)		

९. आयोजनामा पर्ने घर/संरचनाको पूर्ण विवरण दिनुहोस् ।

क्र. सं.	भवन/ संरचना नं.	गाविस	वार्ड नं.	बस्ती	चेनेज	केन्द्र बाटको दुरी (मि.)	सिट नं. / किता नं.	धनीको नाम	संरचनाको प्रकार	निर्माणमा प्रयोग भएको सामाग्री	जम्माक्षेत्र फल ब.मि.	तला संख्या	प्रभावितक्षेत्रफल ब.मि.	% प्रभावित	निर्माण वर्ष वि.सं.	उपयोग
१																
२																
३																
४																
५																

संरचनाको प्रकार: १= बस्ने घर, २= व्यापारीक भवन, ३= सामुदायिकभवन, ४= गोठ, ५= शौचालय, ६= पर्खाल, ७= अन्यभएमाउल्लेख गर्नुहोस् ।

हालको उपयोग: १= आँफै बसोबास गरिरहेको, २= व्यापार/व्यवसायमाउपयोग भएको, ३= बसोबास वाव्यापार व्यवसायदुवैमा प्रयोग भएको, ४= अन्य कसैलाई भाडामा दिएको ।

(भवनवा संरचनाको जम्मा क्षेत्रफलवाप्रभावित क्षेत्रफलनिकाल्दातलाको क्षेत्रफल (लम्बाई **X** *चौडाई) लाई तला संख्याले गुणन गरिनिकाल्नुपर्नेछ ।)*

९.१ यदि घर/संरचना हटाउनु पर्ने छ भने, के यो संरचनातपाईको आफ्नै जमिनमा बनेको हो?

१,[ ]हो २, [ ]होईन

यदिहोईन भने, यो जमिनकस्को हो नाम ठेगानाबताईदिनुहोस् ।

.....

९.२ यदिबसोबास गरिरहेको घर हटाउनु पर्ने भएमा, तपाई बसोबास गर्नको लागि यो बाहेक कुनै अर्को घर छ?

१,[ ] छ २, [ ] छैन ।

९.३ यदि छ भने कहाँ छ?

१,[ ]यहि ल्पटको अर्को स्थानमा २, [ ] दोस्रो कुनै ल्पटमा ।

९.४ यदि यो घर आयोजनाका कारणले भत्काउनु पर्ने भएमाअर्को घरमा तपाईको परिवार वस्न सक्ने ठाउँ उपलब्ध छ?

१,[ ] छ २, [ ] छैन ।

९.५ यदिहाल बसिरहेको ल्पटदेखि फरक ल्पटमा जानुपर्ने भएमा, सो ल्पट कति टाढा छ? ..... कि.मि. ।

९.६ हालको ल्पटबाट नयाँ ल्पटसम्म सामान लैजानकस्तोप्रकारको साधनप्रयोग गर्नुपर्दछ ?

१,[ ] पैदल २, [ ] बस ३, [ ] रिक्सा

४, [ ] ट्र्याक्टर ५, [ ]निजीकुनै सवारी साधन ६, [ ]अन्यकुनै .....

९.७ नयाँ ल्पटसम्म सामान लैजानअनुमानितकतिजतिखर्च लाग्दछ? ..... रूपैयाँ ।

९.८ यदिअर्को घर छैन भने, बसोबासको व्यवस्था कसरी गर्नुहुन्छ?

१,[ ]नयाँ घर बनाएर २, [ ]बसाई सरी नयाँ ठाउँमा गएर

३,[ ] भाडामा घर लिएर ४, [ ]अन्यकुनै सोच भएमा .....

९.९ यदितपाईले यो घर सडक आयोजनामा परेपछि नयाँ घर किन्ने वावनाउने योजनाबनाउनु भएको छ भने, यस्तै प्रकारको घर बनाउनकतिजति रकमखर्च होला?

..... रूपैयाँ।

९.१० सडक आयोजनामा पर्ने यो घरमा तपाईको बाहेक अन्यकुनै परिवारका सदस्यपनिबसोबास गर्दछन्?

१,**[ ]** छन् २, **[ ]** छैनन् ।

९.११ यदि छन् भने, पूर्ण विवरण दिनुहोस् ।

घर नं.	परिवारमुलीको नाम	ठेगाना	जात/ जाति	जम्मा परिवार संख्या	मूख्यपेशा	कति समयदेखि बसोबास गरिरहेको	उपभोग गरेको कोठा संख्या	भाडा प्रतिमहिना	वस्ने विकल्प

१०. आयोजनामा पर्ने ल्पटबाट कुनै रुखविरुवा हटाउनु पर्दछ ।

१,**[ ]** पर्छ । २, **[ ]** पर्दैन ।

१०.१ आयोजनामा पर्ने ल्पटवाट कुनै रूखविरूवा हटाउनु पर्ने भएमानिम्नानुसारको विवरण दिनुहोस् ।

चेनेज		नाम/जात	प्रकार	गोलाई (सेमी)	उचाई (मि.)	संख्या	कैफियत
देखि	सम्म						
संकेत:प्रकार: १= काठका लागिप्रयोग हुने रूख, २ =दाउराको लागिप्रयोग हुने रूख, ३ =बहु प्रयोगको रूख, , ४= गैह्व काष्ठ वन पैदावर, ५= अन्यभएउल्लेख गर्ने							

१०.२ आयोजनामा पर्ने ल्पटबाट कुनै फलफुलकाविरूवा/लहरा हटाउनु पर्ने भएमानिम्नानुसारको विवरण दिनुहोस् ।

चेनेज		फलफुलकाविरूवा/लहरा को नाम	प्रकार	फललागेको		फलनलागेको		बार्षिक उत्पादन (कि.ग्रा.)	यदिगतवर्ष बिक्री गरेको भए		तपाईले रोप्नु भएको हो	रोप्नुको उद्देश्य के थियो
देखि	सम्म			संख्या	उमेर	संख्या	उमेर		(कि.ग्रा.)	(रूपैयाँ)		
संकेत:प्रकार: १= फलफूलको रूख, २ = गैह्र काष्ठ वन पैदावर, ३ =बाँस /निगालो, , ४= अन्यभएउल्लेख गर्ने												

१०.३ आयोजनामा पर्ने ल्पटवाट कुनै घाँस/जडिबुटीको रूख/विरुवा हटाउनु पर्ने भएमा, निम्नानुसारको विवरण दिनुहोस् ।

चेनेज		नाम/जात	संख्या	गोलाई (से.मी.)	उचाई (मीटर)	वार्षिक उत्पादन	तपाईले रोप्नु भएको हो?	रोप्नुको उद्देश्य के थियो ?	यदिउत्पादनबेच्ने हो भने, प्रति ईकाइकति पर्दछ ?
देखि	सम्म								

१०.४ आयोजनामा पर्ने ल्पटबाट तपाईको बसोबास भएको घरसम्म रुखविरुवा ढुवानी गर्न कति समय लाग्छ/दुरी छ ?

समय ..... मिनेट, दुरी ..... मिटर

११. स्वामीत्वहस्तान्तरण र यसकालागिप्रभावित परिवारको प्राथमिकता ।

११.१ यदितपाई बसोबास गरिरहेको घर आयोजनाले लिएमा, कस्तो प्रकारको क्षतिमहशुस गर्नुहुन्छ?

१,[ ] दैनिकआम्दानीको क्षति २, [ ] घर/जग्गाको क्षति

३,[ ]अन्यभएमा (उल्लेख गर्ने).....

११.२ यसआयोजनामा पर्ने जमिनक्षतिपुर्ती बिनादिन ईच्छुक हुनुहुन्छ?

१,[ ] दिन्छु २, [ ]दिन सक्दिन

११.३ योजनामा पर्ने परिवारका हैसियतले योजनावाट कस्तो प्रकारको अवसर/सहयोगको अपेक्षा राख्नुहुन्छ?[वहुउत्तर]

१,[ ] रोजगारीको अवसर २, [ ] सीप विकास तालिम

३,[ ] बचत तथा ऋण कार्यक्रम ४, [ ]अन्यभए .....

APPENDIX VII: Traffic Count Survey

Traffic Count Survey

Data Source: Manual
Data Collection Date
From Date
To Date

Location:

Surveyed and Supervised By:

Note:
a = Direction of the movement of vehicle from A to B
b = Direction of the movement of vehicle from B to A

Date	Day	End Time	Volume of Vehicle																													
			Truck						Bus						Car/Taxi		MC		Utillity Vehicles		Tractor		Motorised three Wheeler		Four Wheel Drive/Jeep		Power Tiller		Rickshaws		Bullock Cart/Tanga		Total	
			Multi-axle Truck		Heavy		Light		Big		Mini		Micro																				
			a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
	Day 1	6:00 AM - 6:00 AM																															-	-
	Total of Day 1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Day 2	6:00 AM - 6:00 AM																															-	-
	Total of Day 2		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Day 3	6:00 AM - 6:00 AM																															-	-
	Total of Day 3		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Day 4	6:00 AM - 6:00 AM																															-	-
	Total of Day 4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Day 5	6:00 AM - 6:00 AM																															-	-
	Total of Day 5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Day 6	6:00 AM - 6:00 AM																															-	-
	Total of Day 6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Day 7	6:00 AM - 6:00 AM																															-	-
	Total of Day 7		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total (a+b)				-		-		-		-		-		-		-		-		-		-		-		-		-		-		-		-
Average Daily Traffic (ADT)																																		
Composition (%)																																		
Total ADT excl. MC & Rickshaws																																		
Composition excl. MC & Rickshaws																																		
Average Annual Daily Traffic (AADT)																																		
AADT excl. MC & Rickshaws																																		
PCU Factors																																		
AADT in PCUs																																		
AADT in PCUs excl. MC & Rickshaws																																		

APPENDIX VIII: Axle Load Survey

Axle Load Survey

Station:		District:			Day & Date:										
Road Name:		Surveyed by:													
Pavement Type:		Direction:							Supervisor:						

Time	Veh.Type	Load Type	Origin	Destin.	Front Wheel Load (Kg)		Rear Wheel 1 Load (kg)		Rear Wheel 2 Load (kg)		Gross Weight (kg)	Axle-load (kg)			Equivalent Std. Axle-load			
					L/S	R/S	L/S	R/S	L/S	R/S		Front	Rear 1	Rear 2	Front	Rear 1	Rear 2	Veh. ESAL
1	2	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

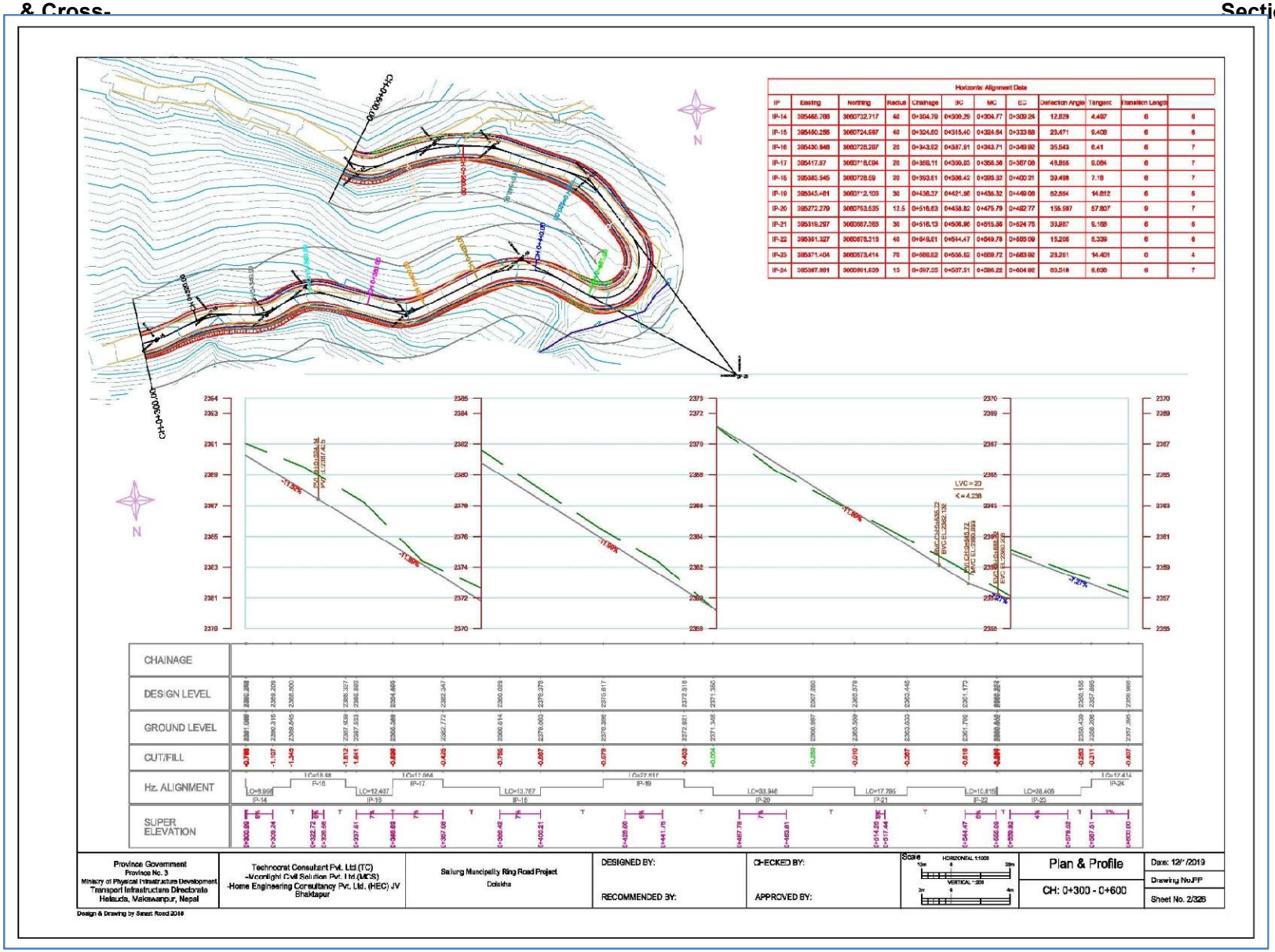
SUMMARY ANALYSIS OF THE AXLE DATA				
Vehicle	A to B		B to A	
	ESA/unit	No. of Samples	ESA/unit	No. of Samples
MaT				
LT				
B				
MB				
MiB				
4WD				
UV				
TRA				
Total				

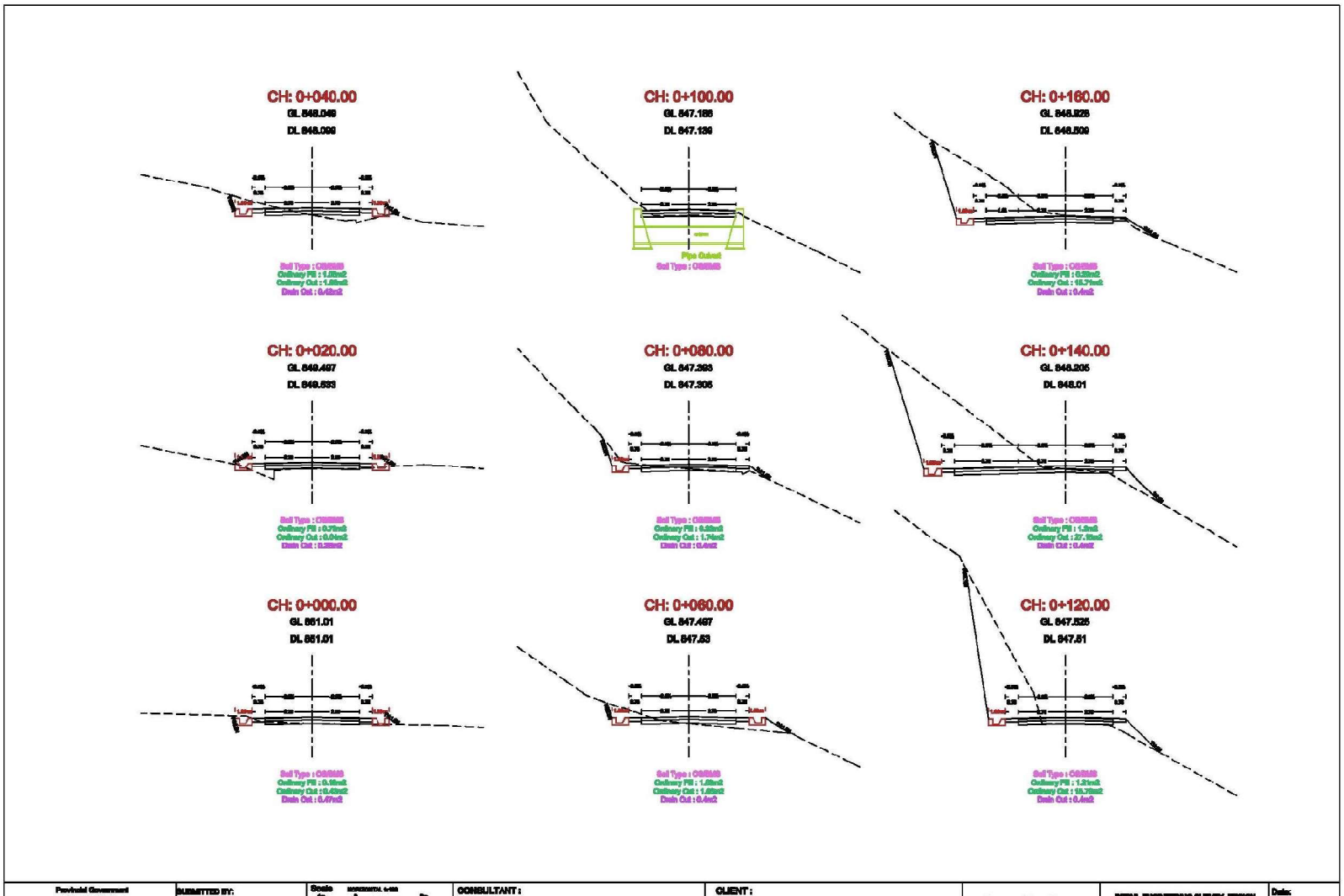
APPENDIX IX: Material Availability Survey

The format for collection of information on quarry sites near the road alignment

Location/ Chainage	Distance from the Road	Side of the Road (Left/Right.)	Type of material available in the quarry (Sand/Gravel/Stones)	Status of the access road	Approximate quantity of material available

APPENDIX X: Template for Plan Profile & Cross-Section




CH: 0+040.00
GL 848.049
DL 848.099
CH: 0+100.00
GL 847.188
DL 847.139
Pipe Culvert
CH: 0+160.00
GL 848.825
DL 848.509
CH: 0+020.00
GL 849.497
DL 849.533
CH: 0+080.00
GL 847.393
DL 847.505
CH: 0+140.00
GL 848.205
DL 848.01
CH: 0+000.00
GL 851.01
DL 851.01
CH: 0+060.00
GL 847.497
DL 847.53
CH: 0+120.00
GL 847.525
DL 847.51

APPENDIX XI: Templates for Quantity and Cost Estimates

Provincial Government
Ministry of Physical Infrastructure Development
Transport Infrastructure Directorate
Bagmati Province

Hetauda, Makwanpur, Nepal

SUMMARY OF QUANTITY SHEET

Name of Project:
Contract No:
Location:
Section:

S N.	Description	Unit	Road way/Shoulder	Side Drain	Stone Masonry Wall	Gabion Wall	Pipe Culvert	Causeway	Slab Culvert	Road Safety Works/ Bio-engineering Works	Total
1	**Site Clearance**										
1.1	Clearing of grass, removing roots, breaking sods, leveling the surface and disposal as per specification with all complete. ***(Norms S. No. 2.3 and Ref to SS clause No 201)***	Sqm									
2	**Earthwork**										
2.1	Road way Excavation in all types of soil as per Drawing and technical specifications including removal of stumps and other deleterious matter, all lifts and lead as per Drawing and instruction of the Engineer by Mechanical means ***(Norms S. No 9.1 I (B) and Ref. to SS 905***	Cum									

APPENDIX XII : Templates for BoQ

Provincial Government
Ministry of Physical Infrastructure Development
Transport Infrastructure Directorate
Bagmati Province

Hetauda, Makwanpur, Nepal

ABSTRACT OF COST

Name of Project:
Contract No:
Location:
Section:

S.N.	Description of works	Unit	Quantity	Rate in Figure, (NRs)	Rate in Words (NRs)
Section II. Site Clearance					
2.1	Clearing Grass and Removal of Rubbish and Dressing and levelling the construction surface Clearing grass/ top soil and removal up to a distance of 50 meters outside the periphery of the area, including cutting and filling of small undulation. ***(Norms S. No. 2.3 and Ref to SS Clause No201)***	Sqm.			