Mandavi Rural Municipality

Office of Municipal Executive

Jaspur, Pyuthan

MAIN REPORT

On

Preparation of Report on Disaster Risk Reduction Plan, Site Visit, Risk Analysis, Risk Evaluation and Preparation of Treatment Plan with Cost Estimation

Submitted By:

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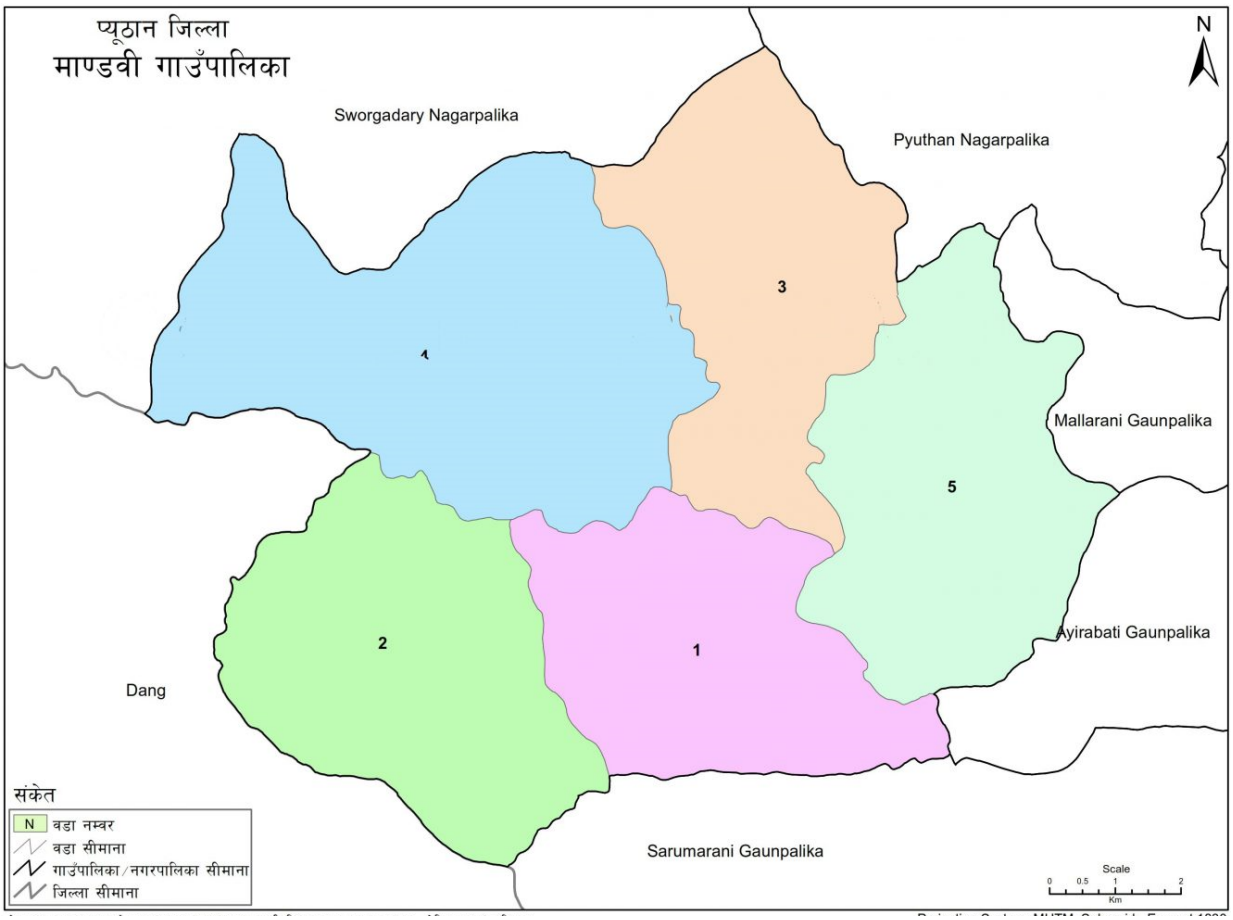
Contents

Introduction

1.1. Background

Nepal is Himalayan and land locked country where mountainous region that constitutes 70% of the total area of the country comprises a geologically active zone where instability due to tectonic activity and steep slope erosion is predominant throughout the country. Almost 80% of the rainfall occurs during the monsoon period from June to September and during this period bank erosion, land slide and debris flow lead the river aggrading and inundating the nearby agricultural lands and settlements and thereby damaging numerous lives and properties each year. It is becoming natural phenomenon, further infrastructural development activities and increasing population has triggered further destabilization of the land surface.

Mandavi is a Rural Municipality, which is located in Pyuthan district, Lumbini Province of Nepal. Mandavi has total 5 wards, which are scattered across 113 square kilometers of geographical area. According to 2011 Census conducted by Central Bureau of Statistics (CBS), Mandavi Rural Municipality had total population of 15,058. Most of land inside the Rural Municipality are Mountainous in terrain and most of the settlements are on sloped land on mountains. Households situated on mountains are prone to landslide disaster especially during monsoon.



1.2. Scope and Objective of Study

Scope of the study area is to prepare the disaster risk management plan inside the area of Rural Municipality. The study area mainly covers the disaster caused due to landslide and flood. For preparation of project report, the expert team needs to visit the risk areas, the households which are on risk of landslide and flood, accumulate the data and prepare the plan for mitigation of risk.

The main objectives of the this study is to find

- What might happen?
- How likely is it?
- What can be done to reduce the risk?

Who are the beneficiaries?

Historical Background

2.1. Historical Background

2.2. Topography and Geology

The topography and geology of Nepal can be divided into the following zones

(1) Inner Himalayan valleys
(2) Higher Himalayan zone
(3) Lesser Himalayan zone
- Midland range
- Mahabharat range

(4) Siwalik (Churia) hills
(5) Dun valleys
(6) Terai plain

Principal features of these zones are presented below.

Siwalik (Churia) Hills

The Siwalik (Churia) hills are the lowest hills bordering the Indo-Gangetic plain in the north. Mostly it consists of rocks of alternating beds of clay, sandstone, sand and pebble. The rocks generally dip northwards. Alternately loose and hard rock beds have produced the escarpment feature. In many places rugged land with numerous gullies and mound of talus are found. the topographic slope varies from 200 to 400m/km on the average. The Siwalik hills are divided into three layers, i.e., upper, middle and lower Siwaliks.

Upper Siwalik

The upper Siwalik is mainly conglomerate with pebbles and boulders of pale schistose quartizite, purple and white quartizitem dark phyllites; purple and dark pebbly quartizite and silt brown sandstone. The depth of upper Siwalik is about 2000 to 3000 meters.

Middle Siwalik

The layer of middle Siwalik is found in the form of thick deposits of sandstone. These are characterized by their feldspar and mica content. Apparently the sandstone has been derived from granite rocks. Calcareous concretions and seams of coal are foun in the basal part. In many sections, the sandstone forms vertical cliffs. The depth of middle Siwalik is about 2000 to 2500 meters.

Lower Siwalik

The lower Siwalik is alteration of brown, weathered sandstone and chocolate colored clays. The alternation of beds is not thick as the sandstone. Beds of impure limestone also occur within the lower Siwalik. The depth of lower Siwalik is about 1200 to 1500 meters. All pebbles except those found in the brown sandstone are derived from rocks of Pre-tertiary age.

Terai Plain

The Terai plain is the continuation of Indo-Gangetic plain having an elevation from 50 to 300 m, MSL. Its width varies between 10 to 30 km with one exception at Koilabash, and extends from east to west Nepal for about 900km.

The Terai slopes toward south with steeper slope at the foot hill region and nearly flat at the southern end.

In the Terai plain the changes of river stream are often seen in places by the lateral erosion incorporated by much sediment from the mountainous area. On such rivers artifical structure works such as bridge, roads and irrigation facilities have to be given careful consideration.
The Terai plain is divided into three zones, i.e., (1) Bhabhar zone (foot of hill), (2) Marshy area (spring line), and (3) Southern Terai (Indian border).

Bhabhar Zone

The Bhabhar zone lies at the foot of Siwalik hills and is about 10 to 12km wide. It is composed of boulder, pebble, cobble and sand of Siwalik hills or Mahabharat range deposited by the present rivers. In most cases the rocks are sandstone, quartz or charty dolomite. The foot of hills is covered with evergreen forest.

Soils are mainly alluvium consisting of sand, silt, clay looms and silty clay. In the dry season almost all rivers in this zone have no flow on the surface and water flow underground only.

Marshy Area

The marshy area is found in the south of Bhabhar zone where two lighological units having different porosity and permeability meet or inter finger along with the change of elevation mainly resulting in spring lines, ponds, lakes, etc. The lighology is mostly composed of pebbles and sandy bed with a few clay partings. The lighology of the pebbles is similar to the boulder zone and sand beds are loose, brownish to greenish with black and red shale fragments. The clay is mostly blackish gray where a thick sequence is found, but yellow one is also observed at some places where there was a temporary hiatus in its deposition or because of a flood at that time. This is particularly true in Lumbini zone.

Southern Terai

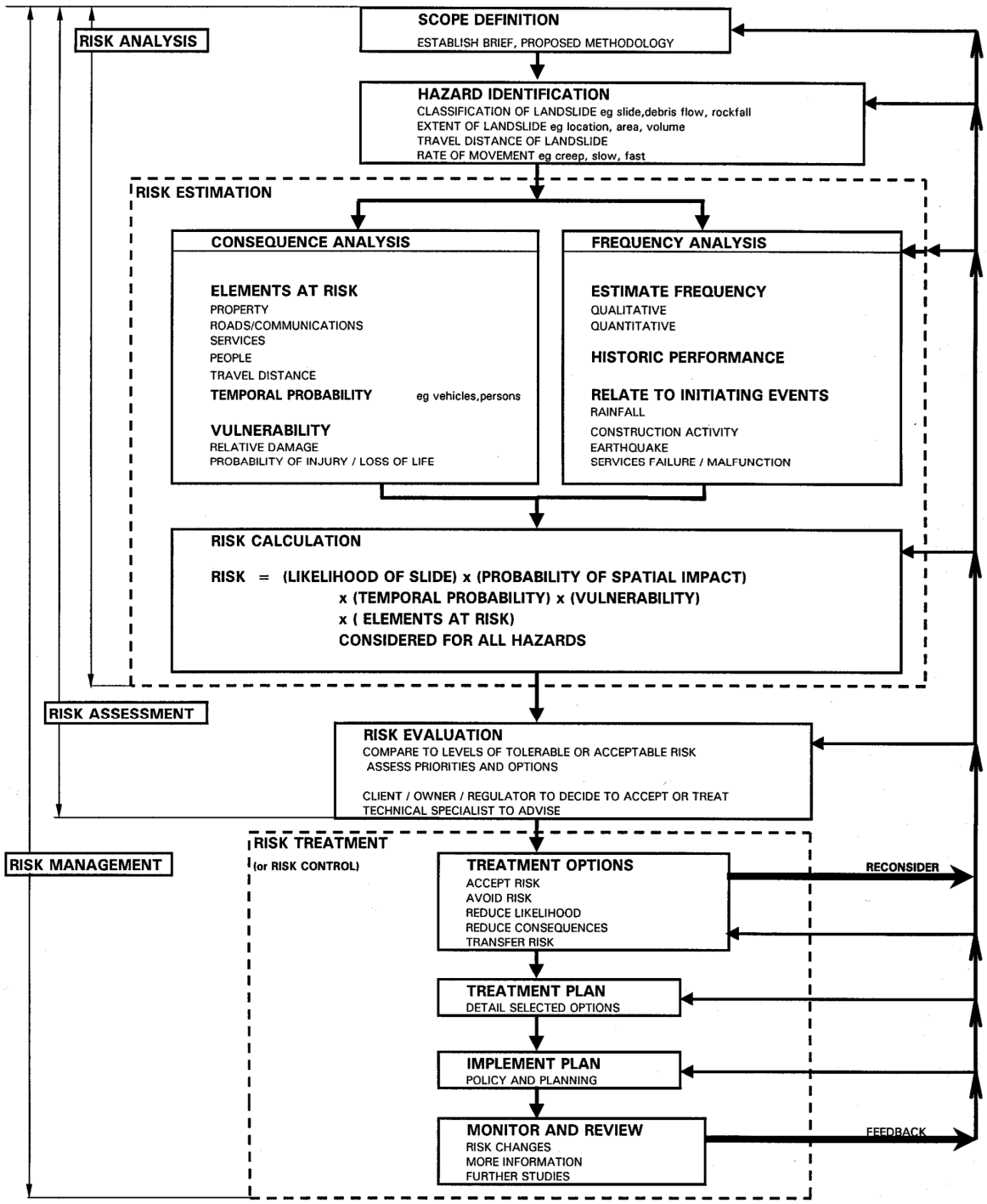
This nearly flat and not well-drained area is found between middle Terai and the Indo-Nepal border. The area is composed of sand, clay and silt with less pebble.

Methodology

The risk management process comprises the following components

- Risk Analysis
- Risk Evaluation and
- Risk Treatment

Flow chart for Risk Management



3.1. Risk Analysis

To ensure that the analysis addresses the relevant issues, and to qualify the limits or limitations of the analysis, it is important to define:

- The site, being the primary area of interest
- Geographic limits that may be involved in the processes that affect the site
- Whether the analysis will be limited to addressing only property loss or damage, or will also include injury to persons and loss of life
- The extent and nature of investigations that will be completed
- The type of analysis that will be carried out
- The basis for assessment of acceptable and tolerable risks

Hazard Identification

Hazard identification requires an understanding of the slope processes and the relationship of those processes to geomorphology, geology, hydrogeology, climate and vegetation. From this understanding it will be possible to:

- Classify the types of potential landsliding
- Assess the physical extent of each potential landslide being considered, including the location, areal extent and volume involved.
- Assess the likely initiating event(s), the physical characteristics of the materials involved, and the slide mechanics.
- Address the possibility of fast acting processes, such as flows and falls, from which it is more difficult to escape

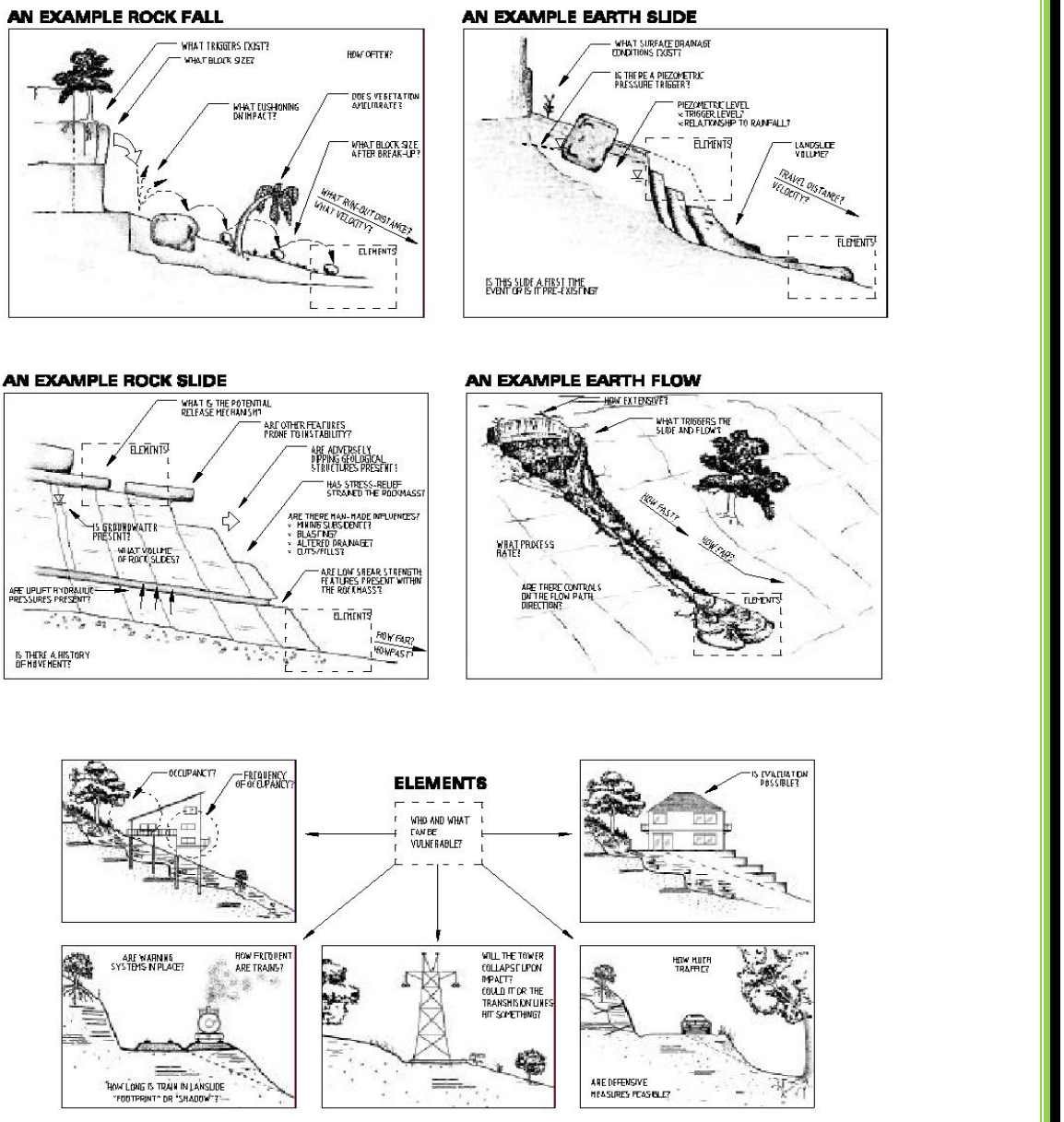


FIGURE 1: SOME EXAMPLE OF LANDSLIDES

The team with well-educated and experienced in landsliding and slope processes are involved in this stage of the identification and analysis which certain that there is no omission or under/over estimation of the effects of different hazards.

The team visits to the ward offices, conduct meetings with ward representatives, ward officials, community personals etc. Team discusses about the potential hazards inside the respective wards, their locations, historical background of the hazard and many more.

The team collects the finding and measurements of every potential sites which are at risk. During field visit team collects probable type of landslide, existing condition, and slope, extent of landslide, probable frequency, what triggers the landslide (i.e. initiating event), Type of soil and how likely the slide happens.

Data collection form has been attached on Annexure I Section of this report.

Consequence Analysis

The consequence of the hazard injury/loss of life, damage of property. Property could be individual household, property land, public property, public services such as road, electricity etc.

The consequences may not be limited to property damage and injury/loss of life. Other consequences may include;

- public outrage
- political effects
- loss of business confidence
- effect of reputation
- social upheaval and many more

The elements at risk will include:

- Households, which includes the peoples either live, work or may spend some time as well as domestic animals/pets.
- Property, which includes the agricultural land, playground, historical places and many more
- Services, which includes Road connection, Telephone Supplies, Electricity Lines, Water Supply lines etc.

Risk Estimation

The quantitative risk estimation is the product of hazard and their consequences.

The risk can be calculated from

$R=P \times L \times E$

where,
R= is the risk
P=Probability of hazard due to geological /environmental conditions
L=How likely hazard may happen
E= Elements at Risk
The criteria for assessing values of P, L and E has been attached in Annexure II.

3.2. Risk Evaluation

Risk analysis alone has limited benefits and it is normal to carry the process to the next stages of risk evaluation and risk treatment.

The main objectives of risk evaluation are usually to decide whether to accept or treat the risks and to set priorities. The decision is usually the responsibility of the owner/client/regulator. Involvement of those indirectly affected is desirable. Non- technical clients may seek guidance from the risk assessor on whether to accept the risk. In these situations, risk comparisons, discussion of treatment options and explanation of the risk management process can help the client make their decision.

In risk estimation, all P, L and E will be given by a numerical values which gives risk as a numerical value. The risk will be evaluate in three categories which are high risk, moderate risk and low risk.

When R is

- more than or equal to 27, then very high risk
- more than or equal to 12 and less than 27, then high risk
- more than 6 and less than 12, then moderate risk
- less than or equal to 6, then low risk

	Hazard (PxL)						
Consequences (E)	**Value**	**1**	**2**	**3**	**4**	**6**	**9**
	1	1	2	3	4	6	9
	2	2	4	6	8	12	18
	3	3	6	9	12	18	27

Legends

	Very High Risk
	High Risk
	Moderate Risk
	Low Risk

3.3. Risk Treatment

At the end of the evaluation procedure, it is up to the client or policy maker to decide whether to accept the risk or not or to decide that more detailed study is required. The risk analyst can provide background data or normally acceptable limits as guidance to the decision maker, but as discussed above, should not be making decision.

Treatment options:

Typical options may include:

- **Accept the risk;** this would usually require the risk to be considered to be within the acceptable or tolerable range.
- **Avoid the risk:** this would require abandonment of the project, seeking an alternative site or form of development such that the revised risk would be acceptable or tolerable.
- **Reduce the likelihood:** this would require stabilization measures to control the initiating circumstances, such as reprofiling the surface geometry, groundwater drainage, anchors, stabilizing structures or protective structures etc. After implementation, the risk should be acceptable or tolerable, consistent with the ALARA principle.
- **Reduce the consequences:** This would require provision of defensive stabilization measures, amelioration of the behavior of the hazard or relocation of the development to a more favourable location to achieve an acceptable or tolerable risk.
- **Transfer the risk:** by requiring another authority to accept the risk or to compensate for the risk such as by insurance.
- **Postpone the decision:** If there is sufficient uncertainty, it may not be appropriate to make a decision on the data available. Further investigation or monitoring would be required to provide data for better evaluation of the risk and treatment options.

Treatment Plan

Treatment for reduce likelihood and to reduce the consequences, the some construction work as well as bio-engineering work has to be implemented.

For landslide, the following works may need to be implemented as a risk treatment,

- Retaining structures such as gabion wall, stone masonry wall with C/S mortar, dry wall etc.
- Road side drain, for channelizing the surface water.
- Cross drainage structures, for channelizing the surface water.
- Fall structure, for reducing erosion of loose soil which may cause large landslide.
- bio-engineering works, for stabilization of slope

For flood, the following works may need to be implemented as risk treatment,

- River training works
- Gabion wall protection works with spurs for guidance of flow.
- Canal, for channelizing of water reducing flooding on households

Typical drawings

Typical drawing has been attached to the Annexure V.

Unless specified to the specific sites, typical drawing will be adopted for risk treatment plan.

Findings, Risk evaluation, Treatment

The team has been visited to each ward with respective ward officials and other stakeholder as well as related personals. In close coordination of the related personals, team has collected data related to risk. The team collected existing conditions of each site as and possible consequences.

Team collects the data by filling the Annexure I form with close coordination with the stakeholders. Team reaches each site and fills the data collection form attached on Annexure I.

The risk evaluation of each site has been attached in Annexure III.

Site wise finding is follows

I. Ward No. 1.

Site No 1. Water Tank at Mathillo Simalchaur

In Madavi Rural Municipality, Ward no 1, Mathillo Simalchaur, the water tank and public tap which serves 22 households is at risk of land slide. A kholsi which passes through just below of water tank makes the risk of sliding of foundation of water tank and tap due to flash flood on kholsi during monsoon.

- The team analyses the hazard for this site and also its consequences, and it evaluated as moderate risk getting R value as 8.
- To reduce, 2 layer of gabion works has been proposed for length of 8 meter. The total cost for civil works is 91,634.05 (including VAT).

Site No 2. Rom Bahadur Nepali at Mahillo Simalchaur

In Mandavi Rural Municipality, ward no 1, there is risk of landslide just under the courtyard (Aagan) of the Mr. Rom Bahadur Nepali's house. Because of this, the house in which 7 people's lives, becomes vulnerable. The landslide is likely to occur during monsoon.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***high risk*** getting R value as 18.
- To reduce, 3 layer of gabion works has been proposed for length of 8 meter. The total cost for civil works is 183,122.06 (including VAT).

Site No 3. Gokarna Bahadur Rahu Magar, Indra, Chandraman and Karna Bahadur at Mathillo simalchaur

In Mandavi Rural Municipality, ward no 1, there is risk of landslide just under of the Mr. Gokarna Bahadur Rahu Magar's, Indra's, Chandraman's and Karna Bahadur's houses. Because of this, these house along with their families, are comes under risk. The landslide is likely to occur during monsoon.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***high risk*** getting R value as 18.
- To reduce risk, gabion works has been proposed for length of 15 meter and 3 layer in center and right part, and 15 meter and 2 layer in left part. The total cost for civil works is Nrs. 858,521.56 (including VAT).

Site No 4. Tej Bahadur Gharti Magar at Ratapani

In ward no 1, Ratapani there is risk of landslide just above the Mr. Tej Bahadur Gharti Magar's houses. Because of this risk, these house along with their 6 person's families, comes under risk. The landslide is likely to occur during monsoon.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***high risk*** getting R value as 12.
- To reduce risk, 2 layer of gabion works has been proposed for length of 14 meter. The total cost for civil works is Nrs. 164, 460.13 (including VAT).

II. Ward No 2

Site No 5. Dil Bahadur Khatri at Ratapani

In ward no 2, Ratapani there is risk of landslide just under of the Mr. Dil Bahadur Khatri's house. There is also bank of kholsi is continuously erosion during monsoon which increases the risk.. Because of this risk, these house along with their 7 person's families, comes under risk. The landslide is likely to occur during monsoon.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***high risk*** getting R value as 18.
- To reduce risk, canal and hume pipe as cross drainage structure for proper guidance of surface water has been proposed. The total cost for civil works is Nrs. 638,361.10 (including VAT).

Site No 6. Bam Bahadur Bhandari at Markabang

In ward no 2, Ratapani there is risk of landslide just under of the Mr. Bom Bahadur Bhadaru at Markabang's house. Because of this risk, these house along with their 10 person's families, comes under risk. The landslide is likely to occur during monsoon.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***high risk*** getting R value as 18.

- To reduce risk, four layer of gabion work for length of 120 m in length. The total cost for civil works is Nrs. 35,71,3,48.05 (including VAT).

Site No 7. Bhim Kali BK at Ratapani (Khala)

In ward no 2, Ratapani (Khala) there is risk of landslide just under of the Mr. Bhim Kali BK's house. Due to construction of road there is vertical cutting without proper soil stabilization mechanism, which increases the chance of landslide. Because of this risk, these house along with their 11 person's families, comes under risk. The landslide is likely to occur during monsoon.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***high risk*** getting R value as 18.
- To reduce risk, four layer of gabion work for length of 120 m in length. The total cost for civil works is Nrs. 14,75,553.44(including VAT).
- Except engineering structures plantation of grass such as dhayero, Ketuke (acts as checkdam) and brooming grass as Amriso, Napier for surface erosion control.

Ward No 3

Site No 8. Nine Household village at Aapchaur, Dharapani

In ward no 3, Aapchaur, Dharapani, there is risk of landslide just under of the settlement of 9 household. Due to construction of road there is vertical cutting without proper soil stabilization mechanism, which increases the chance of landslide. Because of this risk, these house along with their 11 person's families, comes under risk. The landslide is likely to occur during monsoon.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***high risk*** getting R value as 18.
- To reduce risk, five layer of gabion work for length of 330 m in length, canal above the landslide risk portion is proposed to divert surface water flow from the landslide risk zone. Fall and cross drainage structure (Hume pipe) and road side drain is proposed to reduce soil erosion as well as proper management of surface water along road. The total cost for civil works is Nrs. 1,65,34,610.85 (including VAT).
- Except engineering structures plantation of grass such as dhayero, Ketuke (acts as check dam) and brooming grass as Amriso, Napier for surface erosion control.

Site No 9. Irrigation canal (Diyo Kulo) at Jhylang Khola

The irrigation canal which serves the cultivable land of almost 300 household which expands from Darimchaur to Sahutola/Pokhara. Near the aqueduct at Jhyalangkhola, the foundation of canal is continuous draining off, which causes the risk of collapse of canal section of length almost 22m. To reduce the risk, the gabion wall of 6 layer for length of 22m is proposed.

On same canal almost 50m along upstream, there is also the risk of collapse of canal due to erosion of soil of foundation of canal, so stone masonry of 1.5m height is proposed.

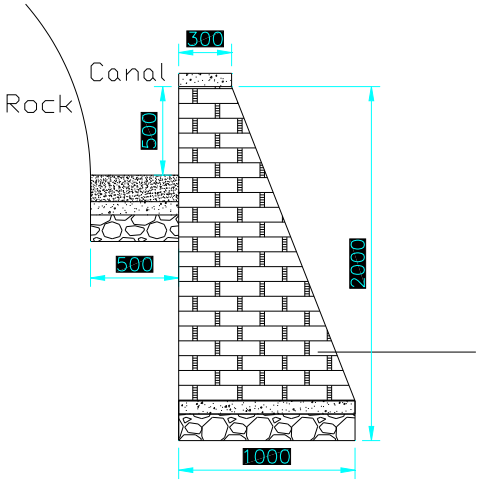
At intake of this canal, Jugekhola which flows along perpendicularly to this canal, damages the canal every monsoon, so RCC canal for length of 15m is proposed in which 3m section will be covered with RCC slab. Gabion wall of 2 layer is proposed to guide the flow of Jugekhola.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***moderate risk*** getting R value as 9.
- The total cost for civil works is NRs. 16,19,566.33 (including VAT).

Site No 10. Irrigation canal intake of Tallo Kulo on Jhanglyang khola under the motorable bridge

During monsoon, the intake of Tallo kulo is always drain off by flood in Jhanglyang Khola every year. Currently the intake and canal is earthen. So as the permanent solution, stone masonry wall of height 2.2m with foundation on river is proposed with lined canal.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***low risk*** getting R value as 6.
- The total cost for civil works is NRs. 9,43,559.21 (including VAT).



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Site No 11. Flood risk and Bank erosion of Mandavi River at Newarni

Cultivable land at Newarni has been eroded and flooded at every year. Likewise there is the risk of flooding for 12 household and water tank also. To reduce the risk there should be divert the river toward left bank. For diversion, proper river training works with spurs has to be implemented. For precise protection works detailed design of river training works with study of hydrology and metrology of catchment area is recommended.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***low risk*** getting R value as 6.
- The total cost for civil works is NRs. 14,079,361.53 (including VAT).

Site No 12. Flood risk and Bank erosion of Mandavi River at Jaspur Bazar

Jaspur Bazar is the central market of rural municipality. 25 households market center is located in right bank of Mandavi River. There is the risk of flooding during monsoon. To reduce the risk river should be divert and guide properly. For diversion, proper river training works with spurs has to be implemented. For precise protection works detailed design of river training works with study of hydrology and metrology of catchment area is recommended.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***High risk*** getting R value as 12.
- The total cost for civil works is NRs. 20,812,969.23 (including VAT).

Site No 13. Flood risk at Up and down of Arangkhola

Cultivable land at U/S side of Arangkhola Bridge has been eroded and flooded at every year. Likewise there is the risk of flooding for almost 10 households. To reduce the risk there should be divert the river toward right bank. For diversion, river training works having 4m in height, and gabion in river side and embankment on next side is proposed.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Low risk*** getting R value as 6.
- The total cost for civil works is NRs. 12,432,873.48 (including VAT).

Site No 14. Man Bahadur Roka, Chorpani

At Chorpani, ward no 4, Mr. Man Bahadur Roka is constructing a 3 room building with load bearing masonry structure with mud mortar. There is no any courtyard (Aagan) space in front of building. So the foundation of the building is very weak, and the any sliding of mud or erosion can trigger the further disaster while the building itself is very weak.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Very High risk*** getting R value as 27.
- To reduce the risk, 3 layer of gabion of wall for length of 40m is proposed. The total cost for civil works is NRs. 921,832.38 (including VAT).

Site No 15. Chitra Bahadur Sunar at Jukepani, Dadakateri

Chitra Bahadur Sunar's house is located at steep sloped terrain in which 5 peoples family lives. The house is load bearing structure, walls made of stone masonry with mud mortar. Which may causes the settlement of foundation due to erosion of soil under the building.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***High risk*** getting R value as 12.
- To reduce the risk, stone masonry wall of height 2.5 with foundation for length of 65m is proposed. The total cost for civil works is NRs. 1,348,917.04 (including VAT).

Site No 16. Khadka Bahadur Bishowkarma at Jukepani Dadakateri

Khadka Bahadur Bishowkarma's house is located at steep sloped terrain in which 5 persons family lives. The house is load bearing structure, walls made of stone masonry with mud mortar. Which may causes the settlement of foundation due to erosion of soil under the building.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***High risk*** getting R value as 12.
- To reduce the risk, stone masonry wall of height 2.5 with foundation for length of 28m is proposed. The total cost for civil works is NRs. 492,950.80 (including VAT).

Site No 17. Shiv Bahadur Sunar's at Jukepani, Dadakateri

Shiv Bahadur Sunar's house is located at steep sloped terrain in which 4 person's family lives and at lower part another house of Min Bahadur Sunar located in which 7 persons lives. The houses is load bearing structure, walls made of stone masonry with mud mortar. The steep slope may slide and erode the foundation of Shiv Bahadur's house and damages the lower house of Min Bahadur.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***High risk*** getting R value as 12.
- To reduce the risk, stone masonry wall of height 2.5 with foundation for length of 11m is proposed. The total cost for civil works is NRs. 262,658.22 (including VAT).

Site No 18. Tanka Bahadur Sunar at dadakateri

Tanka Bahadur's house is located at steep sloped terrain in which 3 person's family lives. Road is excavated in upper side of house while another side is also very steep and is at risk of slide. The house is load bearing structure, walls made of stone masonry with mud mortar. The steep slope may slide and erode the foundation of house which led to disaster.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Very High risk*** getting R value as 27.

- To reduce the risk, stone masonry wall of height 4m with foundation for length of 22m is proposed. The total cost for civil works is NRs. 971,807.67 (including VAT).

Site No 19. Dor Bahadur Pun at Narsu, Ward no 4.

Dor Bahadur Pun's house is located at steep sloped terrain where 10 person's family lives. Continuous mud flow with stone from upside of house creates. The house is load bearing structure, walls made of stone masonry with mud mortar. The steep slope may slide and erode the foundation of house which led to disaster.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***High risk*** getting R value as 12.
- To reduce the risk, stone masonry wall of height 3m with foundation for length of 19m is proposed. The total cost for civil works is NRs. 642,087.35 (including VAT).

Site No 20. Yug Bahadur Pun at Narsu, Ward no 4

Yug Bahadur Pun's house is located at steep sloped terrain where 4 person's family lives. Continuous mud flow with stone from upside of house creates. The house is load bearing structure, walls made of stone masonry with mud mortar. The steep slope may slide and erode the foundation of house which led to disaster.

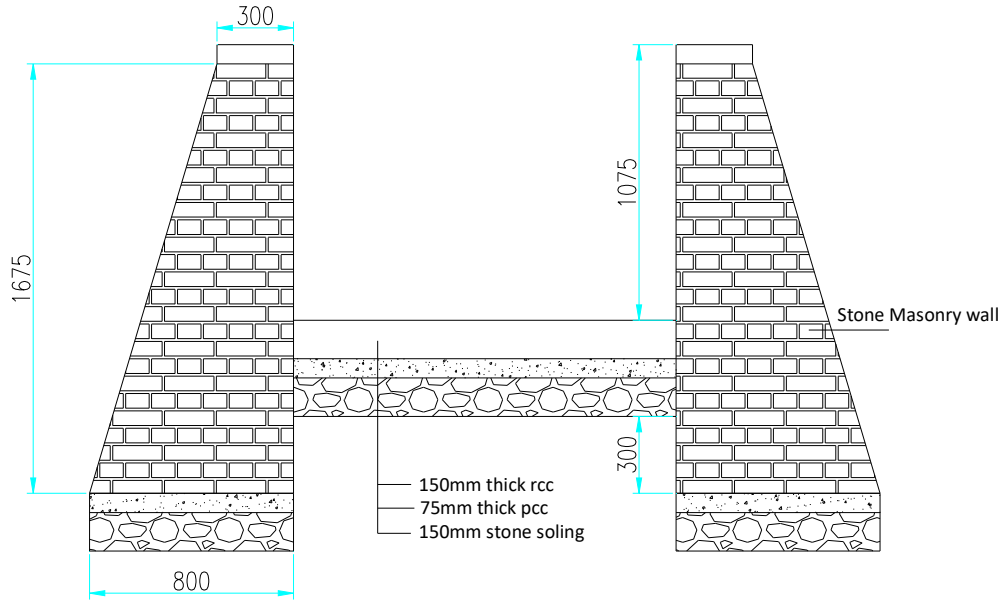
- The team analyses the hazard for this site and also its consequences, and it evaluated as ***High risk*** getting R value as 18.
- To reduce the risk, stone masonry wall of height 3m with foundation for length of 11m is proposed. The total cost for civil works is NRs. 371,567.41 (including VAT).

Ward no 5

Site No 21. Jyoti Prabidhik Bidhayala and Khetulal Gaha's House

In chakchake, every year during monsoon, Dondre Khola's flood inundates Shree Jyoti Pra. Vi School and and there is risk of flooding to Khetulal Gaha's House. There is road in front of gate of school, so cross drainage structure is proposed to drain the water flows from that canal, to Mandavi River.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Low risk*** getting R value as 6.
- To reduce the risk, canal of 116 m in length, and one 90cm dia Hume pipe is proposed. The total cost for civil works is NRs. 3,685,844.34 (including VAT).



Site No 22. Mum Bahadur Khanal's House at Chakchake, Kolot Tole

Mum Bahadur's house is located at ward no 5, Kolot tole, Chakchake at right bank of Daderi Khola. During monsoon, flash flood comes in Daderi Khola which creates risk to inundation of house.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Low risk*** getting R value as 6.

- To reduce the risk, 2 number of 90 cm dia Hume pipe as cross drainage structures and 2 layer of gabion work for 9m length on both sides for protection of house is proposed. The total cost for civil works is NRs. 1,687,071.02 (including VAT).

Site No 23. Yug Bahadur Thapa at Bharamtole, Chakchake

Yub Bahadur Thapa's house is located at right bank of Kukurkhani Khola. During flooding on this Khola makes risk to swipe foundation of house.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***High risk*** getting R value as 12.
- To reduce the risk, stone masonry wall having height 2.2m including foundation is proposed for length of 13m . The total cost for civil works is NRs. 252,821.60 (including VAT).

Site No 24. Santa Bahadur KC at Bharamtole, Chakchake

There is vertical cliff below the road in front of Santa Bahadur's house. House is at almost 8-10m offset from the cliff. There is the same road at lowest point of cliff. The risk is the sliding of road which may effects to the house and the service of road.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Low risk*** getting R value as 6.
- To reduce the risk, 3 layer of gabion works for length of 20m is proposed. The total cost for civil works is NRs. 458,962.81 (including VAT).

Site No 25. Lal Bahadur Thapa at Dungdunge

Lal Bahadur Thapa's house is located at steep sloped terrain where 8 person's family lives. Already there is a landslides a year ago and 2 layer of gabion wall has been already laid. The house is load bearing structure, walls made of stone masonry with mud mortar. The steep slope may slide and erode the foundation of house which led to disaster.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Very High risk*** getting R value as 27.
- To reduce the risk, 2 layer of gabion works for length of 13 m is proposed. The total cost for civil works is NRs. 151,920.15 (including VAT).

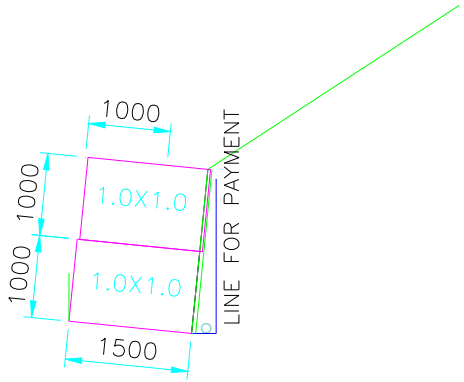
Site No 26. Santa Bahadur KC at Khadka tole

During road construction of 9m wide, there is 10m vertical cliff. Cutting for road construction is just offset of building foundation. There is already the stone masonry retaining wall of height 3.5m including foundation.

The house is load bearing structure, walls made of stone masonry with mud mortar. The steep slope may slide and erode the foundation of house which led to disaster.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Very High risk*** getting R value as 27.

- To reduce the risk, 2 layer of gabion works above stone masonry wall for length of 30 m is proposed. In which both layer of gabion is 1x1 m in size. The total cost for civil works is NRs. 276,465.35 (including VAT).



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Site No 27. Indra Bahadur Khadka at Khadka tole

During road construction of 10m wide, there is almost 9-10m vertical cliff. Cutting for road construction is just offset of building foundation. There is already the stone masonry retaining wall of height 3.5m including foundation.

The house is load bearing structure, walls made of stone masonry with mud mortar. The steep slope may slide and erode the foundation of house which led to disaster.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Very High risk*** getting R value as 27.
- To reduce the risk, 2 layer of gabion works above stone masonry wall for length of 19 m is proposed. In which both layer of gabion is 1x1 m in size. The total cost for civil works is NRs. 175,094.72 (including VAT).

Site No 28. Sarshwota Basnet at Khadka tole

During road construction of 10m wide, there is almost 22 m vertical cliff. Cutting for road construction is just offset of building foundation.

The house is load bearing structure, walls made of stone masonry with mud mortar. The steep slope may slide and erode the foundation of house which led to disaster.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Very High risk*** getting R value as 27.
- To reduce the risk, stone masonry wall with c/s mortar having height of 6m including foundation is proposed. The total cost for civil works is NRs. 3,883,751.49 (including VAT).

Site No 29. Public toilet at Cherneta

Public toilet has been constructed on sloped terrain after excavation. Toilet covers all excavated flat portion. Apron of toilet is just off the excavated materials. There is the risk of sliding of excavated mud which makes the risk of settlement of apron and later some damages to the septic tank and toilet building.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Low risk*** getting R value as 6.
- To reduce the risk, one layer of gabion work for the length of 10m has been proposed. The total cost for civil works is NRs. 46,077.56 (including VAT).

Site No 30. Tigra River at Tigra Village

Tigra khola has changed its previous route continuously so that there is the risk of flood in 35 household in Tigra Village. To protect Tigra village, we need to guide the Tigra Khola in proper way after guiding the river.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Moderate High risk*** getting R value as 8.
- To reduce the risk, 2 layer of gabion wall with spurs has been proposed. The total cost for civil works is NRs. 1,970,293.76 (including VAT).

Site No 31. Suntali Devi Thapa and Chinta Bahadur Thapa at Upper Sikhre

The houses are located in very steep terrain. There is no flat space after apron. During monsoon, the soil under the apron is on continuous erosion. Currently the kept *Tripal* to protect soil erosion.

- The team analyses the hazard for this site and also its consequences, and it evaluated as ***Very High risk*** getting R value as 27.
- To reduce the risk, 3 layer of gabion wall for length of 23 m for Suntali Devi's house and 4 layer of gabion wall for length of 15m for Chinta Bahadur's house has been proposed. Stone masonry having height of 3.5m and 4.5 m for length of 58m has been proposed. The total cost for civil works is NRs. 4,067,340.26 (including VAT).

Quantity and Cost Estimation

Detailed quantity estimation, cost estimation and rate analysis for each site has been prepared separately.

Quantity estimation, cost estimation and rate analysis have been attached on Annexure IV.

Conclusion

In general, natural disasters like floods, landslides, river bank erosion, debris flow, soil erosion, etc have become common phenomena that occur every year in Nepal. Among these disasters, landslides arised due to natural as well as human activities, and floods due to uncontrolled rivers, create great threats to Nepal's economy causing considerable loss to most of the agricultural land, food production, private properties and lives. There is no costs compares to the lives of people. Hence it has been an essential task to measure the proper mitigation to reduce the risk before it becomes disaster. The initiation for the preparation of this type of study is the good start for reducing threats of landslide, floods and inundation.

Annexure I: Disaster Assessment form

Annexure II: Criteria for Assessing Values of P, L and E

Annexure III: Risk Evaluation Sheet

SN	Elements at risk	Ward no	Village/tole	P	L	E	R	Risk Evaluation
1	Water Tank	1	Mathillo Simalchaur	2	2	2	8	Moderate Risk
2	Rom Bdr Nepali	1	Mathillo Simalchaur	3	2	3	18	High risk
3	Gokarna Bdr, Indra	1	Mathillo Simalchaur	2	3	3	18	High risk
4	Tej Bdr Gharti Magar	1	Ratapani	2	2	3	12	High risk
5	Dil Bdr Khatri	2	Ratapani	2	3	3	18	High risk
6	Bom Bdr Bhandari	2	Markabang	2	3	3	18	High risk
7	Bhim Kali BK	2	Ratapani	2	3	3	18	High risk
8	9 House hold	3	Aapchaur, Dharapani	2	3	3	18	High risk
9	Irrigation Canal	3	Cultivable land from Darimchaur to Sahutola	3	3	1	9	Moderate Risk
10	Irrigation Canal	3	Cultivable land	2	3	1	6	Low Risk
11	12 House and Cultivable land	3	Newarni	1	2	3	6	Low Risk
12	25 Household	3	Jaspur Bazar	2	2	3	12	High risk
13	Arung Khola Bazar	3	Arung Khola Bazar	1	2	3	6	Low Risk
14	Man Bdr Roka	4	Chorpani	3	3	3	27	Very High Risk
15	Chitra Bdr Sunar	4	Jukepani, Dadakateri	2	2	3	12	High risk
16	Khadka Bdr Bishowkarma	4	Jukepani, Dadakateri	2	2	3	12	High risk
17	Shiv Bdr Sunar and Min Bdr Sunar	4	Jukepani, Dadakateri	2	2	3	12	High risk
18	Tanka Bdr Sunar	4	Dadakateri	3	3	3	27	Very High Risk
19	Dor Bdr Pun	4	Narsu	2	2	3	12	High risk
20	Yug Bdr Pun	4	Narsu	2	3	3	18	High risk
21	Jyoti Pra. Vi. And Khetulal Gaha	5	Chakchake	1	2	3	6	Low Risk
22	Mum Bdr KM	5	Kolwot tole, Chakchake	1	2	3	6	Low Risk
23	Yug bdr Thapa	5	Bharamtole, Chakchake	2	2	3	12	High risk
24	Santa Bdr KC	5	Bharamtole, Chakchake	1	2	3	6	Low Risk
25	Lal Bdr Thapa	5	Dungdunge	3	3	3	27	Very High Risk
26	Santa Bdr KC	5	Khadka Tole	3	3	3	27	Very High Risk
27	Indra Bdr Khadka	5	Khadka Tole	3	3	3	27	Very High Risk
28	Sarshwota Basnet	5	Khadka Tole	3	3	3	27	Very High Risk
29	Public Toilet	5	Cherneta	3	2	1	6	Low Risk
30	Tigra village	5	Tigra	2	2	2	8	Moderate Risk
31	Suntali Devi Thapa and Chinta Bdr Thapa	5	Mathillo Sikhre	3	3	3	27	Very High Risk

Annexure IV: Quantity and Cost Estimation

Annexure V: Typical Drawing

Annexure VI: Meeting Minutes