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INSTITUTE OF ENGINEERING

PASHCHIMANCHAL CAMPUS

A Report on

"Field Survey"

(**Field Survey II:** 3 WEEKS)

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We want to express our sincere thanks to the Geomatics Engineering Department at Paschimanchal Campus for giving us the amazing opportunity to be a part of the survey camp. It was a real-world experience that helped us learn a lot practically and theoretically. We believe this experience will be beneficial for our future surveying work.

This report was put together with the guidance of our teachers and various study materials. The main goal of this project was to familiarize bachelor-level students like us with the challenges involved in GPS surveying, Cadastral surveying, Hydropower surveying, Drone, and DGPS surveying. This experience is essential for developing our knowledge and skills for fieldwork.

The success of "Survey Camp 2080" wouldn't have been possible without the exceptional guidance and support from our respected teachers: Er. Umesh Bhurtel, Er. Pradip Aryal, Er. Saurav Gautam, Dr. Niraj KC, and Er. Netra Katuwal. We also extend our gratitude to Sandhya Dhakal, the survey officer from District Survey Office, Kaski, for helping us during the cadastral survey and map preparation.

Despite our best efforts, there may still be some mistakes in our work. Therefore, we request our teachers and all readers to assist us in identifying these issues so that we can improve our report-writing skills and complete future projects more effectively. Lastly, a big thank you to everyone who directly or indirectly supported us during the survey camp and the preparation of this report.

ABSTRACT

This report provides a detailed exploration of the BGE077 Group '8' activities during the BGE SURVEY CAMP II - 2080, highlighting various survey methodologies and tools employed.

GPS Survey:

During the GPS Survey, the six-member team utilized the KOBO Collect toolbox for collecting attribute data that supports us in preparing different thematic maps. Furthermore, GIS was used for mapping which encouraged the students to be familiar with the advanced mapping technologies.

Cadastral Survey:

In the Cadastre Survey at Armala, Kaski, Total Station (TS) was employed to delineate parcel boundaries and calculate areas. The report provides insights into the specific techniques used for cadastral surveying, emphasizing the importance of accurate mapping for land management and property rights..

Hydropower Survey:

The Hydropower Survey focused on outlining different positions of the hydropower plant, including forebay, canal, tailrace, etc. The report delves into the strategic application of surveying methods to gather crucial data for the hydropower project at Armala, Kaski. This section provides insights into the practical application of survey instruments, showcasing the team's ability to map out intricate details of hydropower infrastructure.

Drone and DGPS Survey:

The final sections delve into modern technologies—Drone and DGPS surveys. The Drone Survey outlines use of drone technology for aerial surveying, covering flight planning, data acquisition, and image processing. Simultaneously, Differential Global Positioning System (DGPS) technology was employed to achieve highly accurate and reliable coordinate measurements of control points within the Traverse area of Hydropower.

This report also addresses challenges encountered during the camp, providing concise solutions. Survey results, including a comprehensive topographic map and attribute data for the surveyed area, are thoroughly. presented within the report.

ABBREVIATIONS

BM	Benchmark
CP	Control Point
DGPS	Differential Global Positioning System
DoS	Department of Survey
DTM	Digital Terrain Model
DSM	Digital Surface Model
GIS	Geographic Information System
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
OSM	Open Street Map
RADAR	RAdio Detection And Ranging
TS	Total Station

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CHAPTER 1: GPS SURVEY

1.1 INTRODUCTION

1.1.1 BACKGROUND

Global Positioning Systems, commonly known as GPS, are networks of satellites designed for satellite-based navigation, offering precise time and location information to GPS receivers anywhere on Earth. The origins of GPS date back to the early 1960s when the United States initiated satellite navigation experiments to monitor submarines carrying military missiles. The success of these experiments led to the deployment of a more advanced navigation system in 1978, featuring a network of 24 satellites.

Initially, GPS was exclusively accessible to the military due to a program called Selective Availability, allowing the U.S. to control access for national security reasons. However, in May 2000, President Bill Clinton directed the discontinuation of Selective Availability, making GPS available for civil and commercial users globally. While GPS remains a national resource owned and operated by the U.S. government, it is open to the public for tracking and data purposes.

GPS satellites, each weighing approximately 2,000 pounds, are powered by solar energy and equipped with backup batteries to sustain operations during solar eclipses. Small rocket boosters on each satellite ensure they stay on the correct trajectory. With a lifespan of around ten years, these satellites play a crucial role in providing accurate location and timing information for both military and civilian applications (Stephens, 2022).

1.1.2 GPS

Global Positioning System (GPS) is a satellite-based navigation system that provides accurate positioning and timing information to users anywhere on Earth. Developed and maintained by the United States Department of Defense, GPS originally had military applications but is now widely used in civilian, commercial, and scientific fields. The system comprises a network of satellites in orbit, ground control stations, and GPS receivers.

1.1.3 Parts of GPS

Typically, the working of a global positioning system can be divided into three main parts, namely a ground station, a network of satellites, and a receiver.

i. Ground Stations

The ground stations of a global positioning system typically make use of multiple RADARs to monitor the position and the condition of the satellites present in outer space. The satellites tend to move in a fixed circular path around the earth and are susceptible to frequent wear and tear. The ground stations help to keep a check on the health of the satellites. The working of a global positioning system to detect the location of a particular object or place primarily depends on the position of the satellites, which is why the information regarding the position, distance, location, and health of a satellite is required to be processed and maintained by the RADARs available at the ground stations at every instant of time.

ii. Satellites

A global positioning system typically comprises a network of 32 satellites orbiting the earth. 24 out of the 32 satellites are the core satellites; whereas, the remaining 8 are known as the emergency satellites. The emergency satellites are reserved to be used in case a malfunction or failure occurs in any of the core satellites. The average life span of a satellite is about 10 years. The satellites receive the signal broadcasted by the ground stations and transmit it back to the earth after processing.

iii. Receiver

The receiver element of a global positioning system is nothing but the GPS chip that is present within the gadgets that we use in our daily life. This means that the mobile phones that we use, the smartwatches that we wear, and the navigation system installed in our vehicles serve to be the receiver and an integral part of the global positioning system. The receiver devices continuously receive signals from the satellites and help calculate the distance between the receiver devices and the network of satellites. The distance estimated with the help of four or more satellites present in outer space helps locate the exact position of an object, a device, or a person.

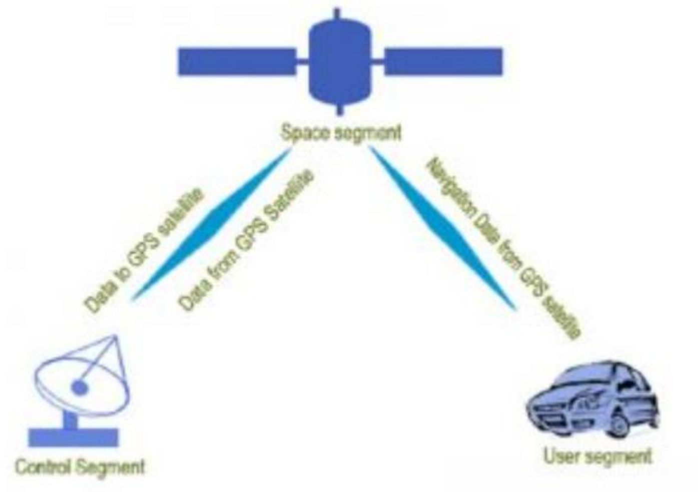


Fig 1.1: Parts of GPS

Source: www.StudiousGuy.com

1.1.4 Working Procedure of GPS:

The Global Positioning System (GPS) works through a complex but highly effective process that involves satellites, ground control stations, and GPS receivers. Here's a detailed breakdown of the working procedure of GPS:

i. **Satellite Constellation**: The GPS system consists of a constellation of at least 24 satellites orbiting the Earth. These satellites are spread across six orbital planes to ensure global coverage. Each satellite continually broadcasts signals containing information about its location and the current time.

ii. **GPS Receivers**: Users on the ground utilize GPS receivers to access signals from multiple satellites simultaneously. The GPS receiver calculates the distance between itself and each satellite by measuring the time it takes for the signals to travel.

iii. **Trilateration**: Once the distances to at least four satellites are known, the GPS receiver uses a process called trilateration to determine the user's precise location. Trilateration involves intersecting spheres (or, in this case, spheres in three-dimensional space) to pinpoint the receiver's position.

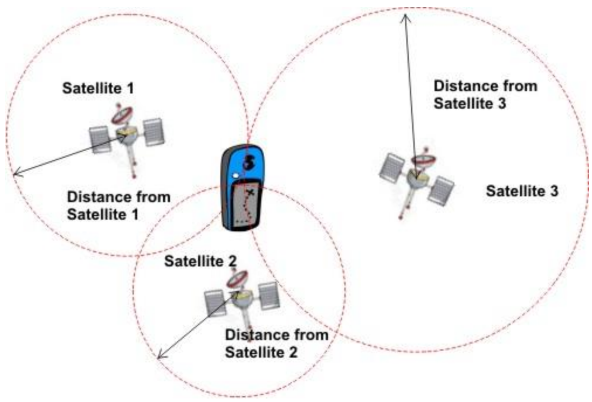


Fig 1.2:Triliteration principle of GPS

Source: www.scienceline.org

iv. **Correctional Signals**: To enhance accuracy, correctional signals may be used. Differential GPS (DGPS) involves a fixed ground-based station that compares its known location with the GPS-calculated location. Any discrepancies are transmitted to GPS receivers in the vicinity to improve accuracy.

1.1.5 Errors in GPS:

GPS receivers may encounter various sources of potential position errors, influencing the accuracy of location information. These errors arise from diverse factors:

i. **Satellite Clock** Errors: Satellite clocks can experience slight inaccuracies, leading to timing errors. The discrepancy in the satellite clock time can result in positional errors for GPS users.It is caused mainy due to two reasons:

- slight inaccuracies in time keeping by the satellites can cause errors in calculating positions
- satellites drift slightly from their predicted orbits which contributes to errors.

ii. **Atmospheric Interference**: The Earth's atmosphere can delay GPS signals as they travel, causing errors in the calculated distances. This is more pronounced during adverse weather conditions, impacting signal accuracy.

While radio signals travel with the velocity of light in the outer space, their propagation in the ionosphere and troposphere is slower. In the ionosphere (consisting of layers) in a height of 80 – 400 km a large number of electrons and positive charged ions are formed by the ionizing force of the sun. The layers refract the electromagnetic waves from the satellites, resulting in an elongated runtime of the signals. Since the Electromagnetic waves emit in form of a sphere, therefore, Inverse square law is employed and the waves are slowed down inversely proportional to the square of their frequency (1/f2) while passing the ionosphere. The reasons for the refraction in troposphere are different concentrations of water vapors, caused by different weather conditions. The error caused that way is smaller than the ionosphere error, but cannot be eliminated by calculation. It can only be approximated by a general calculation model.

iii. **Multipath Interference**: GPS signals may reflect off surfaces such as buildings or bodies of water before reaching the receiver. This multipath interference can introduce errors as the receiver may calculate the wrong distance.
The multipath effect is caused by reflection of satellite signals (radio waves) on objects. For GPS signals this effect mainly appears in the neighborhood of large buildings or other elevations. The reflected signal takes more time to reach the receiver than the direct signal. The resulting error typically lies in the range of a few meters.

iv. **Selective Availability (SA) (Historical**): The intentional degradation of GPS accuracy, known as Selective Availability, was a source of significant errors until its discontinuation in 2000. SA was implemented for national security reasons but was later terminated to provide more accurate GPS data for civilian and commercial use.

v. **Receiver Error**: Since the receivers are also not perfect, they can introduce their own errors which usually occur from their clocks or internal noise. Despite the synchronization of the receiver clock with the satellite time during the position determination, the remaining inaccuracy of the time still leads to an error of about 2 m in the position determination. Rounding and calculation errors of the receiver sum up approximately to 1 m.

1.2 THEMATIC MAPPING

Thematic maps are special maps that focus on one specific topic or idea, like where people live, how much rain falls, where plants grow, or areas with poverty. Unlike regular maps that show many things like roads and borders, thematic maps help us understand patterns in a particular theme. They are great for studying how information is spread out in space and finding connections between different places.

Thematic maps have three main parts: the main theme (primary content), a basic map showing the area (secondary content), and extra information on the sides (supportive content). There are various types of thematic maps, such as maps with colors to show levels (chorochromatic and choropleth), line maps for showing lines or shapes (isoline and isopleth), and others like dot maps and flowline maps

Our project focused on gathering information about public toilets along the main highways in Pokhara Valley. We collected various details to support our theme, such as the precise locations of these toilets, whether they are free to use or require payment, and if they are accessible for people with disabilities. By compiling data on these attributes, we aimed to create a comprehensive understanding of the public toilet facilities available along the major highways in Pokhara Valley. The collected data on public toilets benefits travelers, locals, and individuals with specific needs, as it provides valuable information about the locations, accessibility, and cost of these facilities, enhancing overall awareness and convenience for the community.

1.3 OBJECTIVES

1.3.1 PRIMARY OBJECTIVE:

- To conduct GPS Survey on public toilets along main highways of Pokhara Valley for addressing the problem of toilets at public places .
- To collect spatial and attributes of existing public toilets.

1.3.2 SECONDARY OBJECTIVES:

- To prepare the thematic maps on obtained spatial and non-spatial data.
- To help local government for data acquisition of public toilets and its conditions.
- To visualize the different attributes on the map.

1.4 INSTRUMENT AND SOFTWARE USED

- Handheld GPS and mobile application KOBO Collect were used for obtaining data.
- KOBO Toolbox was used for downloading data obtained from KOBO Collect.
- ArcMap, Google Earth Pro were used for preparing maps.

1.5 STUDY AREA

Our study area is different wards of Pokhara Metropolitan City. Our area mainly covers main highway of Pokhara leading from Lamachaur to Prithvichowk , Birauta –Halanchowk to Zero km and area nearer to them.

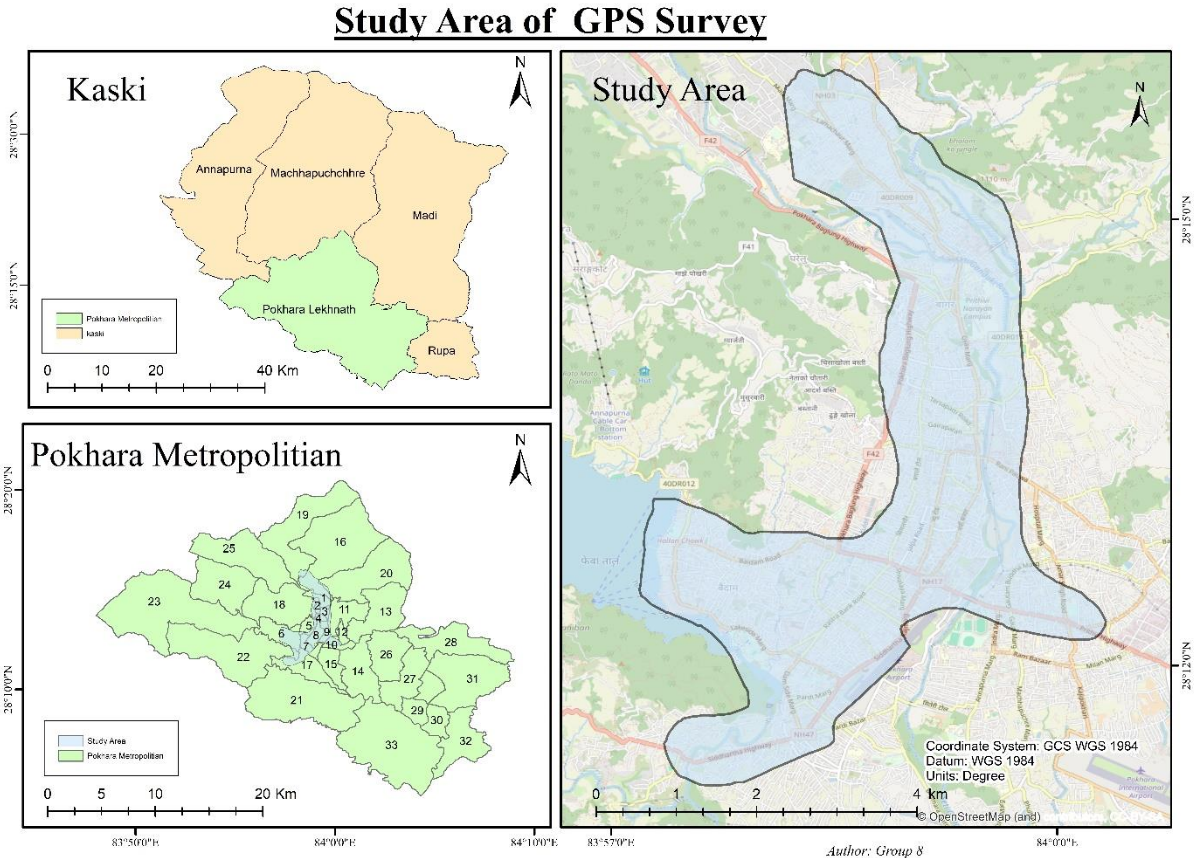


Fig 1.3: Study Area Map of GPS survey

1.6 METHODOLOGY

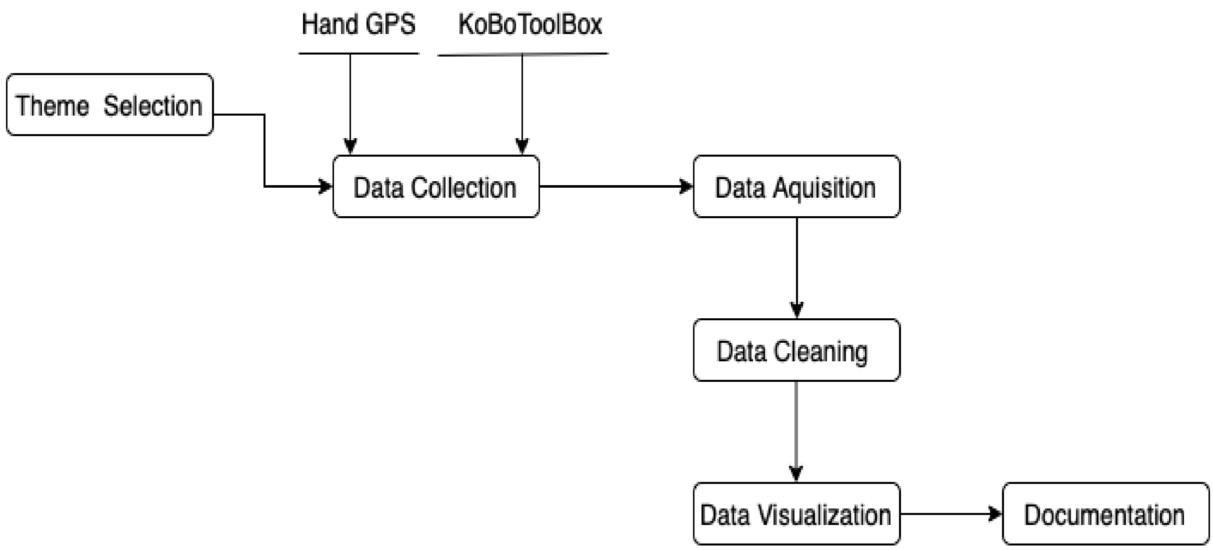


Fig 1.4: Methodology of GPS Survey

1.6.1 THEME SELECTION

The theme to carry out the GPS survey on was selected on the basis of relevance, economy and need, with approval from teachers. The theme selected was "Public Toilets Near main Highways of Pokhara valley."

1.6.2 DATA COLLECTION

i. GPS POINT DATA COLLECTION

The locations coordinate of public toilets were collected using Kobo Collect application.

ii. ATTRIBUTE DATA COLLECTION

The required attribute data were collected using the Kobo Collect application with the help of questionnaires form that was prepared beforehand using Kobo Toolbox.

In the section of attribute data, we had made questionnaires which includes Location Name, Average number of people using that toilet, Accessibility for disabled people, Paying or Free and Operating time of toilet.

1.6.3 DATA ACQUISITION

- The attribute and location data from Kobo Collect were downloaded from Kobo Toolbox website in CSV format.

1.6.4 DATA CLEANING

The obtained raw data were cleaned by organizing the data into tables and adding the missing data from the manually noted information as well as incorporating them into the table in added columns.

Table 1.1: Sample Data from GPS Survey

Place name	Male or female	Disabled Friendly	operating time	Average no of people using per day	paying or Free	Latitude	Longitude
Prithivichowk	both	No	Daytime	75	Paying	28.20835	83.98887
Prithivichowk	both	Yes	Daytime	550	Paying	28.20911	83.98742
Amarshing cho	both	Yes	Daytime	200	Paying	28.20462	84.00251
Shahid chowk p	both	No	Daytime	30	Free	28.20095	83.97029
kedareshwar m	both	No	Daytime	30	Free	28.20054	83.96611
kedareshwar m	both	No	Daytime	30	Free	28.19992	83.96658
kedareshwar m	Female	No	Daytime	5	Free	28.20098	83.96565
Basundhara pa	both	No	Daytime	50	Paying	28.20371	83.96308
Barahichowk(la	both	No	Daytime	150	Paying	28.20813	83.95586
Hallanchowk	both	No	24 hours	250	Paying	28.21468	83.95632
Hallanchowk	both	No	Daytime	200	Paying	28.21446	83.95688
Chhorepatan(D	both	Yes	24 hours	50	Paying	28.18908	83.95865
Chorepatan	both	Yes	Daytime	50	Paying	28.18747	83.95921

1.6.5 DATA VISUALIZATION

i. **Static thematic map** was created using ArcMap where OpenStreetMap was used as a basemap. The boundary for the wards were obtained and downloaded from National Geoportal SDI webapp, in Everest coordinate system which was later transformed into WGS 84 system.

1.7 RESULT AND DISCUSSION

Using the data collected in the field, thematic maps representing existing public Toilets of Pokhara Metropolitan City has been prepared. The map is intended to provide information of public toilets to general people regarding its location and accessibility to disabled people . The maps are based on daily average users represented by Proportional symbol map and Disabled Friendly represented by respective symbols. The map can be utilized by metropolitan , locals, travelers and so on.

1.8 CONCLUSION AND RECOMMENDATION

In conclusion, the GPS survey conducted for Public toilets found that there are some toilets designed for people with disabilities in the city, which is good. However, the problem is that these special toilets are not in enough places, especially in busy parts of the city .This survey also reveals a shortage of toilets in tourist areas. This shortfall poses a challenge to visitor convenience and satisfaction. To enhance the overall experience for general public , it is crucial for authorities to address this deficiency by strategically increasing the number of toilets in popular destinations.

CHAPTER 2:DIGITAL CADASTRAL SURVEY AND MAPPING

2.1 INTRODUCTION

Cadastral surveying is a specialized field within surveying that focuses on precisely measuring and marking out land parcels. The primary goal is to establish clear boundaries for individual pieces of land to facilitate proper documentation in land registries. In this process, Total Stations, which are advanced surveying instruments, are commonly employed to record the coordinates of each corner of a land parcel.

The collected data, including both graphical representations and attribute information, is then stored, processed, and managed in a digital format. This digital environment enables efficient handling of cadastral information. The ultimate objective of cadastral surveying is twofold: first, to create accurate cadastral maps that clearly depict the boundaries of land parcels, and second, to gather attribute data essential for maintaining comprehensive cadastral records. These records play a crucial role in land management, property ownership, and legal documentation.

2.1.1 Components of Cadastre

The main cadastre components are described below briefly:

- **Field Book:**
  The field books identify the landowners of each parcel, which is based on the evidence produced during registration of the parcel. It includes the description of landownership or 17 tenants (full name, address, age or date of birth), father's name, description of legal information of land registration, land classification, land type, soil type, crops, area of the land parcel etc.

- **Land Ownership Certificate:**

  Two copies of land ownership certificate are prepared, the official copy is termed as Jagga Dhani Sresta and the second copy is termed as Jagga Dhani purja and is distributed to the concerned owner. The details are copied from the field book.

- **File Maps:**

  During the process of land transaction when the parcel is too small and if it is not possible to plot the map after fragmentation of the parcel, a file map of this parcel will be prepared in a separate sheet in larger scale.

- **Plot Register:**

  Plot register is an information of each parcel which has been fragmented. The main information in the plot register are the newly established parcel numbers along with the 14 mother parcel number, the area of each fragmented parcels and how the parcels has been fragmented in the cadastral system.

2.1.2 CADASTRAL SURVEY PROCEDURE AND WORKFLOW

1. Area selection

The selection of areas for cadastral survey is determined by factors such as the condition of existing maps and land records, the need for updated documents in cases of deterioration, the transition from free sheet island maps to national control points, and the urbanization level of an area.

2. Notice published in gazette

The intention of publishing government decision in gazette is to make those decision legal and official. After the decision is published in gazette, the respective organizations and people would cooperate to carry out cadastral survey successfully.

3. Planning

The planning phase for the project involves the establishment of a survey office and on-site survey team. A meeting is conducted with local stakeholders to discuss.

4. Notification and awareness/Interaction with local community

The notification and awareness phase for the cadastral survey begin with the publication of a 15-day notice, informing local communities and government units about the upcoming survey and mapping activities. This initiative aims to create awareness about the purpose and importance of cadastral mapping within the community.

5. Establishment of control points

The geodetic survey branch of Survey Department design the sheets(of scale 1:500, 1:1250, 1:2500) for a area of which cadastral surveying is intended. The sheet generally contains 3-4 control points. The control points which are plotted on sheet is found out in the actual field with the help of D-card details.

6. Adjudication

In adjudication process, the landowner, tenants, notary, adjacent parcel owners, representative from local government unit and aged and experienced people and the survey team formalized the ownership over the property land based on their mutual understanding. The agreement between adjoining parcel neighbours with their signature is recorded on paper, termed as muchulka.

7. Boundary demarcation, monumentation, and Surveying

In this process, the defining corners of parcel boundary are identified and those corners are monumented using wooden peg, iron pipe etc. And then parcel boundary is surveyed using PT or TS.

8. Preparation of records: (cadastral maps, field books)

The plotting work is done in field in case of plane table survey i.e the map is prepared in the field. Along with plotting, the preliminary Terij and sketch is prepared in the field.

9. 7 days notification and Registration

After completion of cadastral map and field book preparation 7 days notice is published. Within this 7 days, If there are any corrections to be made on land records as shown in INDEX-2 published by survey team or survey office, respective parcel owner can file complaints. The corrections should be done within next 7 days after the 7days notification deadline.

10. Descriptive document preparation(terij/shresta/purja)

Two copies of landowner certificate is prepared. One copy is official copy termed as Jagga Dhani Darta Shresta and another copy is given to landowner termed as Jagga Dhani Darta Purja. Land owner certificate (Jagga Dhani Darta Purja) Distribution Hand over map and records to District Survey Office and District Land Revenue Office

2.2 OBJECTIVES

2.2.1 PRIMARY OBJECTIVES:

- The primary objective of our project is to produce the Cadastral map of Armala village within Pokhara metropolitan city ward 16.

2.2.2 SECONDARY OBJECTIVES:

- To become familiar with all the GIS tools necessary for making cadastral maps.
- To become able to present an attribute data with maps.
- To collect information about land use and land type.
- To take details of the area like trees, buildings, roads, etc.
- To calculate area of some parcels using total station.

2.3 METHODOLOGY

The methodology applied for cadastral surveying includes the following :

- **Site Selection:**

For the Cadastral survey, Armala in Pokhara-16, located in the north-west part of the Pokhara valley, was chosen as the study area

- **Reconnaissance:**

The initial step involved inspecting the survey area to identify suitable locations for control stations, ensuring intervisibility between them.

- **Marking Control Points and Making Closed Traverse:**

Control stations were marked, and pegs were fixed. Total Station was then set up at each station for angular measurements, creating a closed traverse. Description Cards (D-Cards) were prepared for major and minor stations to aid control point reconstruction if needed.

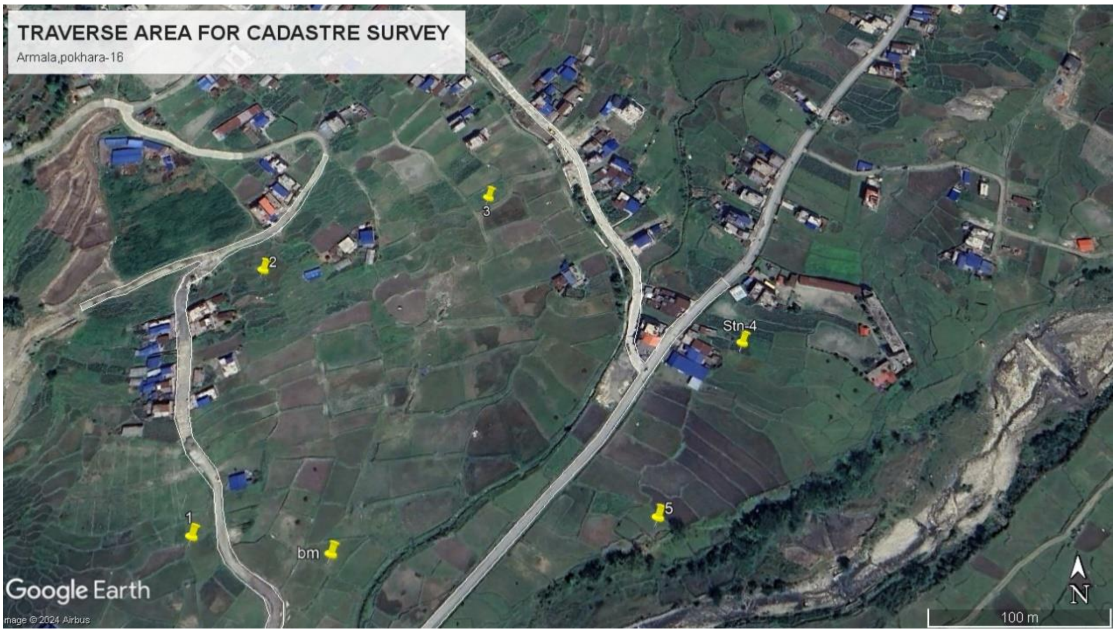


Fig 2.1: Traverse area showing major control points

- **Calculation of Coordinate:**

Coordinates for each station were calculated using Bowditch's Rule, and closing errors were adjusted.

- **Determining the Coordinate of Parcel:**

Total Station was used to observe and note the coordinates of each corner of the parcel at successive stations.

- **Data Extraction and Digitizing:**

Data recorded in Total Station were extracted and processed in ArcMap for further manipulation and analysis.

- **Database and Cadastral Map Preparation:**

Using the Editor tool in ArcGIS 10.4.1, a database was created, and spatial data attributes were added. This process led to the preparation of the cadastral map for the proposed location, along with various reports.

- **Documentation:**

The final step involved documenting the cadastral maps, attaching them to other essential documents and reports, ensuring a comprehensive record for future reference.

Sample Dataset:

Table 2.1: Sample Data from Cadastral Survey

Sn	Northing	Easting	Elevation	code
0	3131995	793005.9	937.73	BM
1	3132004	-792924	940.0682	STN-1
2	3132003	792923.3	940.1538	HS
3	3132002	793190.9	942.019	STN-5
4	3132004	792923.6	940.1558	STN-1
5	3132060	792903.5	946.6936	HC
6	3132070	792919.8	946.6236	HC
7	3132079	792916.6	946.9709	P
8	3132092	793188.5	945.3748	P
9	3132085	793212.2	945.4714	P
10	3132083	793185.4	944.5907	P

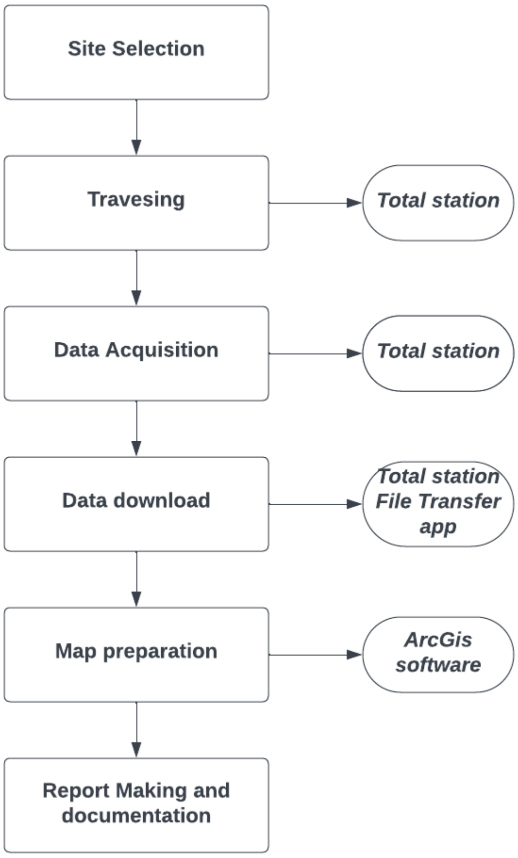


Fig 2.2: Flowchart for methodology of cadastre survey

2.4 STUDY AREA

The cadastral survey took place in Armala Village, which is in Ward No. 16 of Pokhara Metropolitan City. The main traverse covered a significant portion of the survey area, ensuring that most of the targeted region was thoroughly examined and documented .

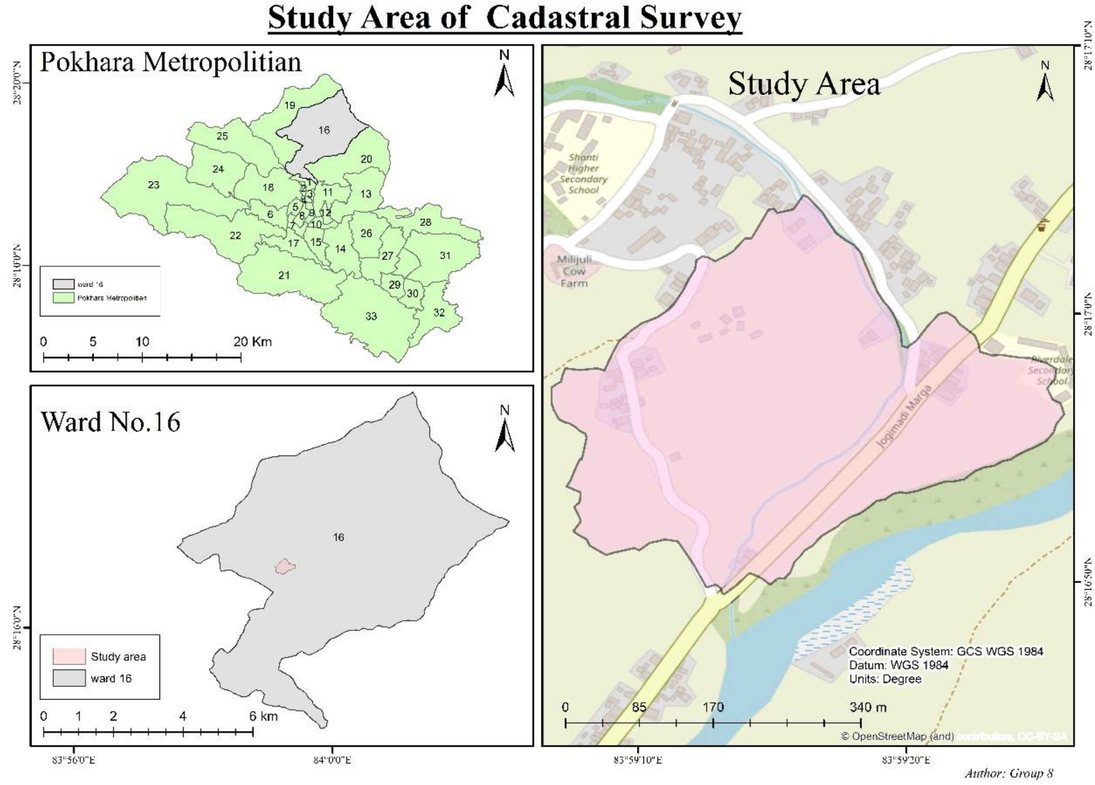


Fig 2.3: Study area map of cadastre survey

2.5 RESULT

Hence we were able to create cadastral map of Armala at scale of 1:2500 using Arc-GIS software and also calculated area of some parcels .The created maps are provided at the Appendix.

2.6 CONCLUSION AND DISCUSSION

Our survey on digital cadastral surveying and mapping revealed that using digital methods is a quick and precise way to collect data for mapping land and keeping records of landowners. This approach not only delivers excellent service in a digital setting but also ensures the accuracy and reliability of land information. It enhances security, accessibility, and efficiency in land management and administration.

After completing this project, we strongly recommend adopting digital cadastral surveying as the most suitable, precise, and practical method for mapping land in Nepal. The digital approach proves to be more effective than traditional methods, especially in handling spatial data.

Looking ahead, to create a more advanced cadastral system for our nation, we should continue to embrace digital methods. They make the process more manageable and provide a foundation for a robust and efficient land management system in the future.

CHAPTER 3: HYDROPOWER SURVEY

3.1 INTRODUCTION

3.1.1 BACKGROUND

Hydropower is an attractive alternative to fossil fuels as it does not directly produce carbon dioxide or other atmospheric pollutants and it provides a relatively consistent source of power. Nonetheless, it has economic, sociological, and environmental downsides and requires a sufficiently energetic source of water, such as a river or elevated lake. International institutions such as the World Bank view hydropower as a low-carbon means for economic development. Hydropower, one of the oldest and most reliable sources of renewable energy, plays a significant role in the global energy landscape. Harnessing the power of flowing water, hydropower has been utilized for centuries to generate electricity, drive machinery, and support various industrial and domestic activities. This is achieved by converting the gravitational potential or kinetic energy of a water source to produce power. Hydropower is a method of sustainable energy production. Hydropower is now used principally for hydroelectric power generation and is also applied as one- half of an energy storage system known as pumped-storage hydroelectricity.

This survey aims to delve into the multifaceted aspects of hydropower, including its historical significance, technological advancements, environmental impacts, and future prospects. By examining these facets, we can gain a comprehensive understanding of the role hydropower plays in meeting energy needs while addressing sustainability challenges.

3.1.2 Parts of Hydro Power

The working of a Hydro power consists of the following parts:

1.Resorvoir/Dam

A reservoir is an area to collect the flowing water and store it. A dam is constructed in the suitable area to stop the flow of water and accumulate large amount of water within it. It is generally constructed in an area with larger portion of wide base available so as not to destroy more natural habitat around it.

2. Settling Basin

A settling basin, also known as a settling pond or sedimentation basin, is a structure commonly used in water treatment and environmental engineering. Its primary purpose is to remove suspended solids and particles from water by allowing them to settle out due to gravity. Settling basins are typically constructed with large surface areas and shallow depths to maximize contact between the water and settling particles.

3. Canal

A canal refers to a water channel or conduit that is part of a hydropower system. Canals play a crucial role in conveying water from its source, such as a reservoir or river, to the hydropower plant where it is utilized to generate electricity. It is generally used to transport water from dam to settling basin and settling basin to the forebay.

4. Forebay

The forebay, an essential component of hydropower systems, acts as a reservoir positioned upstream of the power plant. Its primary function is to regulate the flow of water entering the intake structure or penstock, ensuring a steady supply to the turbines for electricity generation.

5. Penstock

The penstock, a fundamental component of hydropower infrastructure, serves as the lifeline that delivers water from its source to the turbines of a hydropower plant. Crafted from durable materials like steel or concrete, the penstock is engineered to withstand immense pressures while efficiently transporting water over significant distances. Its primary role is to regulate the flow of water, ensuring a consistent supply to the turbines for electricity generation.

6. Powerhouse

The powerhouse of a hydropower plant stands as the nucleus of energy transformation, where the kinetic energy of flowing water undergoes a remarkable metamorphosis into electrical power. As water courses through the turbines, it propels the generator rotors, generating electricity through electromagnetic induction. Complemented by sophisticated control systems, transformers, and auxiliary equipment, the powerhouse orchestrates a symphony of energy conversion, ensuring optimal performance and reliability.

7. Tailrace

The tailrace, a critical component of hydropower infrastructure, serves as the conduit through which water exits the turbines of a hydropower plant and is returned to the natural watercourse downstream. Functioning as the endpoint of the energy conversion process, the tailrace ensures the safe and controlled discharge of water, maintaining ecological balance in the surrounding environment. Its design incorporates features to dissipate residual kinetic energy, minimizing downstream turbulence and erosion while preserving aquatic habitats.

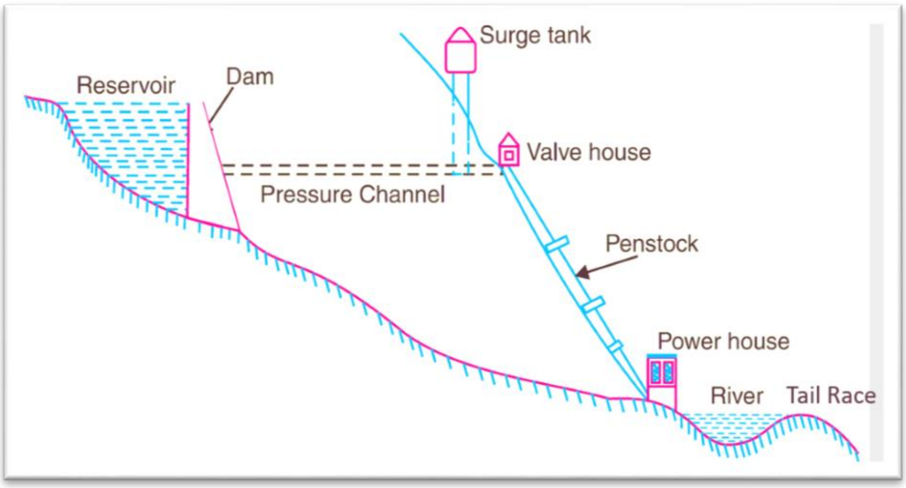


Fig 3.1: Components of Hydropower Plant

Source: https://www.kavaken.com

3.2 OBJECTIVES

3.2.1 PRIMARY OBJECTIVE:

- To make detailed study of Hydropower site through surveying

3.2.2 SECONDARY OBJECTIVES:

- To prepare a contour map and a topographic map of the surveyed area.
- To allocate each of hydropower components.
- To measure discharge of the source.

3.3 INSTRUMENTS AND SOFTWARES USED

3.3.1 INSTRUMENTS USED

- Total Station
- Reflector
- Hammer
- Pegs
- Marker
- Measuring Tapes

3.3.2 SOFTWARES USED

- MS-Excel
- Google Earth Pro
- ArcGIS

3.3 STUDY AREA

Our study area was Armala which is located near to the Mahendra cave of Pokhara-19. It's a place with vast open land and river area to do the survey for study purpose.

Study Area of Hydropower Survey

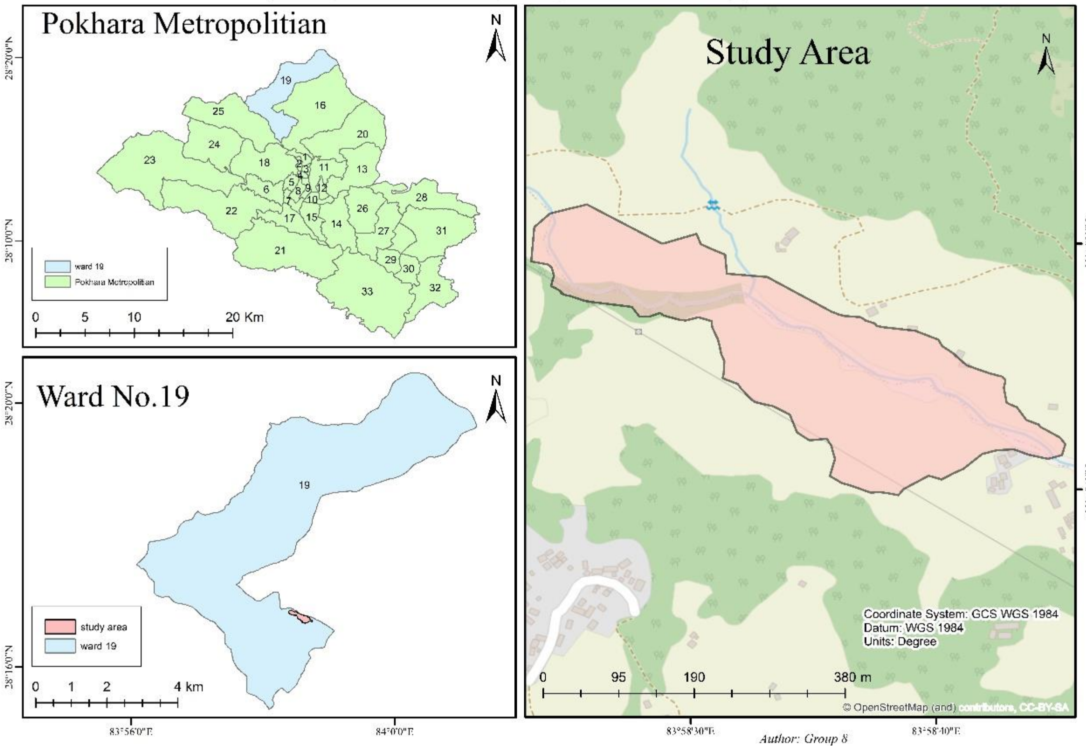


Fig 3.2: Study area map of Hydropower survey

3.4 METHODOLOGY

We performed the following methodologies to carry out detailed survey of hydropower site :

- **Site Selection and Planning:**

We start by surveying the area to make sure the site is visible from all viewpoints. This step helps us choose the best location for our hydropower project.

- **Reconnaissance:**

After a thorough examination of the site's topography, we analysed the details to get a clear picture of the area to be covered. It involves looking closely at the land features.

- **Major Traverse and Coordinate Calculation:**

Building on the reconnaissance, we analyzed the topographical structure in more detail. This involves calculating specific coordinates to understand the area better.

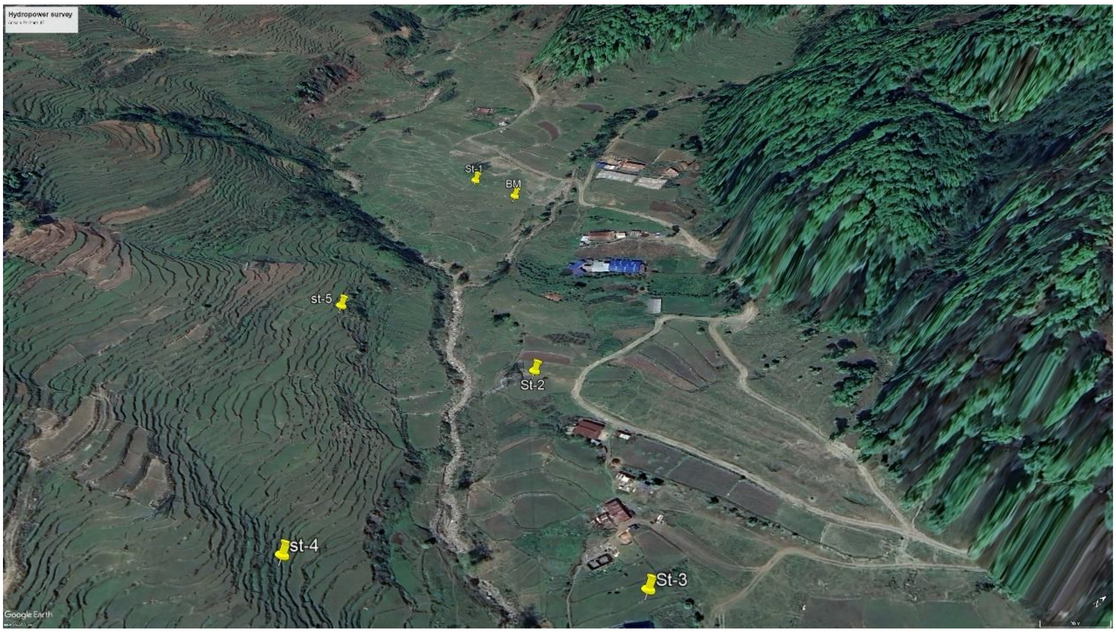


Fig 3.3: Traverse area showing major control points

- **Topographic Surveying using TS:**

Using Total Station (TS), we gather detailed information about the land, including structures like trees, houses, water bodies, dams, forebays, canals, and reservoirs observed during the field survey.

1. **Canal:**

Maintaining the equal gradient, canal alignment was fixed where the survey was performed for the area of 30m at chainage of about 10m and 15m left and right from centre line.

2. **Fore Bay:**

Detailing of 50m*50m was performed at a chainage of about 10m.

3. **Penstock:**

Detailing was performed from centre line of 15m left and right at a chainage of about 10m.

4. **Powerhouse and Tailrace:**

Detailed survey was done for powerhouse in an area of about 50m * 50m and for the tailrace, it is surveyed at an interval of 10m.

- **Data Download and Cleaning:**

We collect field data using Total Station survey equipment, then download and clean this data using Microsoft Excel to prepare it for further analysis.

- **Preparing Topo Map:**

The cleaned data is used to create a topographical map using ArcGis software. This map provides a detailed representation of the land, crucial for project planning.

Sample dataset:

Table 3.1: Sample Data from Hydropower Survey

Points	Northing	Easting	Elevation	Code
0	3131995	793005.9	937.73	BM
1	3132004	792923.6	940.0682	STN-1
2	3132003	792923.3	940.1538	H
2	3132022	792783.4	953.6586	OFS-2
2	3132004	792923.5	939.6704	P
3	3132052	792806.2	955.057	P
4	3132049	792810.5	954.107	P
5	3132011	792896.1	942.8315	OFS-1
5	3132002	793190.9	942.019	STN-5
6	3132040	792821.7	952.1668	H
7	3132018	792843.7	946.4039	H
8	3132041	792832.3	952.4131	H
9	3132060	792903.5	946.6936	H
9	3132025	792841.9	949.2202	P
10	3132070	792919.8	946.6236	H

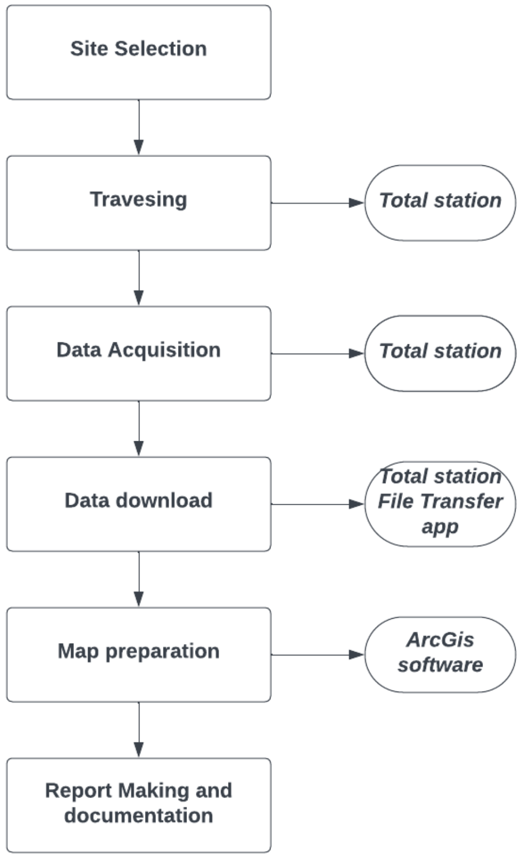


Fig 3.3: Flowchart for methodology of Hydropower survey

3.8 RESULT AND DISCUSSION

Thus we created a topographic map for hydropower site and its components; dam, penstock, powerhouse, settling basin, tailrace, forebay at contour interval of 1m . The created maps are attached here after.

3.9 CONCLUSION AND RECOMMENDATION

Hydropower survey for the proposed area was conducted and thus a map was prepared to show proper location for the prominent structure of hydropower showing the river, dam, settling basin, powerhouse, canal, forebay etc. Hence a hydropower system was designed in the required area .The existing features such as canal and penstock falls on electric tower ; thus the tower should be managed properly. Buildings and farms should be properly kept without damaging the hydropower structure.

CHAPTER 4: DRONE AND DGPS SURVEY

4.1 DRONE SURVEY

4.1.1 INTRODUCTION

Drones, also known as Unmanned Aerial Vehicles (UAVs), have revolutionized data collection in various fields. Their ability to capture aerial imagery from unique perspectives makes them valuable tools for tasks like mapping, surveying, inspection, and photography. However, to extract the most value from drone data, effective image processing and meticulous flight planning are crucial.

4.1.2 FLIGHT PLANNING

Drone flight planning involves the systematic process of preparing and organizing all aspects of a drone operation to ensure safe, efficient, and successful flights. Whether used for recreational, commercial, or professional purposes, proper flight planning is essential for maximizing the effectiveness of drone missions and minimizing risks to people, property, and airspace

Part of the planning process involves defining a number of specifications for the desired end-product before going into the field. Some basic considerations include:

- **Image resolution**: A smaller ground sample distance (GSD or pixel resolution) will have a higher resolution compared to a larger one. The flying height and focal length of a cameras sensor determine the pixel resolution.
- **Image overlap and sidelap**: Image overlap and sidelap are essential for the establishment of tie points that orient the images and create the 3D model. Traditional standards call for 60% overlap and 30% sidelap, however, UAS acquisition usually requires higher variations of both.
- **Sun angle and weather**: Reducing the amount of shadows is very important when capturing aerial imagery. Having the sun at it's peak height in the sky minimizes shadows and allows the sensor to receive as much light as possible.

4.1.2 OBJECTIVES

4.1.2.1 PRIMARY OBJECTIVE:

- To create DTM, DSM and Orthomosaics photos.

4.1.2.2 SECONDARY OBJECTIVES:

- ❖ To learn about flight planning and handling drone.

4.1.3 INSTRUMENTS AND SOFTWARES USED

4.1.3.1 INSTRUMENTS USED

- ❖ Drone
- ❖ I-Pad
- ❖ Cardboard
- ❖ Marker

4.1.3.2 SOFTWARES USED

- ❖ Pix4Dmapper
- ❖ Google Earth Pro
- ❖ ArcGIS

4.1.3 METHODOLOGY

The methodology followed for processing the captured Drone images are discussed below:

I. **Drone Operation**: Trained in drone handling and flight planning outside campus.

II. **Image Capture**: Obtained high-resolution aerial imagery of IOE Pashchimanchal campus.

III. **Data Processing**: Used Pix4Dmapper to generate DTM, DSM, and orthomosaics.

IV. **Analysis**: Visualized and analyzed DTM and DSM in ArcMap for terrain insights.

V. **Reporting**: Compiled findings into a comprehensive report for assessment and planning.

4.1.4 RESULT AND CONCLUSION

The drone survey was carefully planned and executed. It has provided essential data for analysis. It has produced detailed Digital Terrain Models (DTMs), Digital Surface Models (DSMs), and orthophotos of Pashmimanchal Campus. These outputs generated are provided at Appendix section.

4.1.5 CONCLUSION AND RECOMMENDATION

The drone survey, guided by thorough flight planning, has effectively generated Digital Terrain Models (DTMs), Digital Surface Models (DSMs) and orthophotos, providing invaluable spatial data for analysis. These outputs are instrumental in diverse applications, including land planning, environmental assessment, and infrastructure development.Additionally, ongoing improvements in drone technology and data processing techniques should be embraced to enhance the efficiency and accuracy of future surveys. This survey fieldwork also provides the importance of integrating drones into geospatial data collection practices and underscores their potential to revolutionize how we understand and manage our environment.

4.2 DGPS SURVEY

4.2.1 INTRODUCTION

A Differential Global Positioning System (DGPS) is an enhancement to the Global Positioning System (GPS) which provides improved location accuracy, in the range of operations of each system, from the 15-meter nominal GPS accuracy to about 1-3 cm in case of the best implementations.

Each DGPS uses a network of fixed ground-based reference stations to broadcast the difference between the positions indicated by the GPS satellite system and known fixed positions. These stations broadcast the difference between the measured satellite pseudo ranges and actual (internally computed) pseudo ranges, and receiver stations may correct their pseudo ranges by the same amount. The digital correction signal is typically broadcast locally over ground-based transmitters of shorter range.

4.2.2 DGPS Working Principle

The DGPS is an enhanced version of the Global Positioning System (GPS) used for more accurate and precise positioning and navigation. While GPS provides reasonably accurate location information, DGPS improves this accuracy by taking into account and correcting for various sources of errors and inaccuracies in the GPS signals. Let us understand how DGPS works with its various components.

➡Reference Station: It is set up at known and precisely surveyed location on Earth's surface. This reference station receives signals from GPS satellites just like a regular GPS receiver.

➡Error Calculation: The reference station calculates the difference between its known location and the location calculated by the GPS receiver using the received satellite signals.

➡Correction Data: The reference station then broadcasts this error correction data to nearby DGPS receivers, typically using radio waves or a cellular communication network.

➡GPS Receiver Correction: DGPS receivers, which can be mobile devices (aircraft, truck etc.) or other equipment, receive the correction data from the reference station. They use this data to adjust their own GPS position calculations in real-time

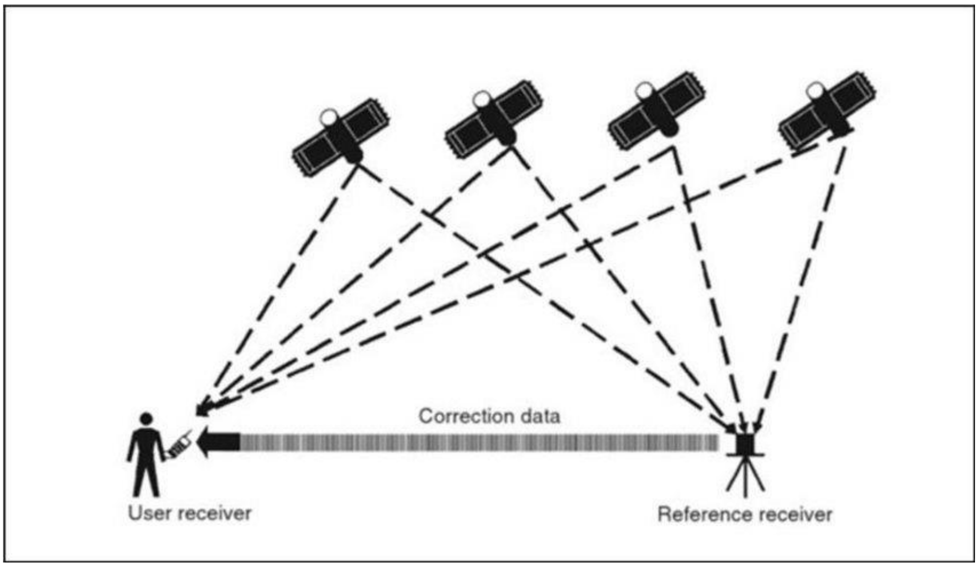


Fig 4.1 : Working Principle of DGPS

4.2.3 OBJECTIVES

4.2.3.1 PRIMARY OBJECTIVE:

- To measure accurate three dimensional coordinates using DGPS.

4.2.3.2 SECONDARY OBJECTIVES:

- To learn about DGPS and its working principle .
- To set-up DGPS components
- Using app Emlid Flow.

4.2.4 INSTRUMENTS AND SOFTWARES USED

4.1.3.1 INSTRUMENTS USED

- DGPS

4.1.3.2 SOFTWARES USED

- Emlid Flow

4.2.5 METHODOLOGY

The methodology and process followed during the DGPS survey are briefly discussed below:

- **Planning Phase:**

During the planning phase, we assess environmental factors such as terrain, vegetation, and potential sources of interference like electric poles, tin roofs ,clear water etc that may affect DGPS performance.

- **Equipment Setup:**

In this section, we selected DGPS receivers capable of receiving correction signals from reference stations and compatible with the survey requirements and also ensured that the DGPS receivers are properly calibrated and configured according to manufacturer specifications.

- **Reference Station Setup:**

We installed and activate reference stations at known locations within or near the survey area and configure the reference stations to continuously receive GPS signals, calculate correction factors, and transmit correction data to the field receivers

- **Field Survey Execution:**

- We then deployed DGPS receivers in the field at desired survey points, ensuring adequate satellite signal reception.
- Power on the DGPS receivers and allow them to acquire satellite signals and correction data from the reference stations.
- Collect positioning data at each survey point, maintaining sufficient observation time at least 10 minutes at each control points to ensure accuracy and reliability.

- **Data Post-Processing:**

We then transferred the raw data collected by the DGPS receivers to a mobile device using Emlid Flow for post-processing and we applied correction factors received from the reference stations to the raw GPS data to improve accuracy. Finally we generated final output files containing corrected positioning data in the desired coordinate system and format for analysis and visualization.

4.2.6 RESULT AND DISCUSSION

Thus, DGPS survey was carried out to measure a precise coordinates of control points inside our Hydropower survey site. Each control points were measured at least 10 minutes to ensure accuracy . Then coordinates file was obtained from DGPS .

4.2.7 CONCLUSION AND RECOMMENDATION

In conclusion, the DGPS survey demonstrated its effectiveness in providing accurate positioning data essential for mapping and boundary identification. Moving forward, it is recommended to optimize reference station placement and minimize interference to further enhance survey accuracy. Additionally, we should also maintain meticulous planning and quality checks to ensure ongoing survey success and usefulness across various applications.

CHAPTER 5: MISCELLANEOUS TOPICS

5.1 MISSING LINE MEASUREMENT (MLM)

Missing line measurement is used to measure the slope distance, horizontal distance, and horizontal angle to a target from the target which is the reference (starting point) without moving the instrument.

- It is possible to change the last measured point to the next starting position.
- Measurement result can be displayed as the gradient between two points.

5.2 PRINCIPLE

The missing line measurement on a total station works based on the principle of trigonometry and distance measurement. The total station calculates the missing line by measuring angles and distances from known points to the endpoints of the missing line. Using trigonometric calculations, it then determines the coordinates and length of the missing line relative to those known points. This process relies on accurate angle and distance measurements, along with the principles of geometric triangulation, to determine the position and dimensions of the missing line.

5.3 METHODOLOGICAL FLOWCHART

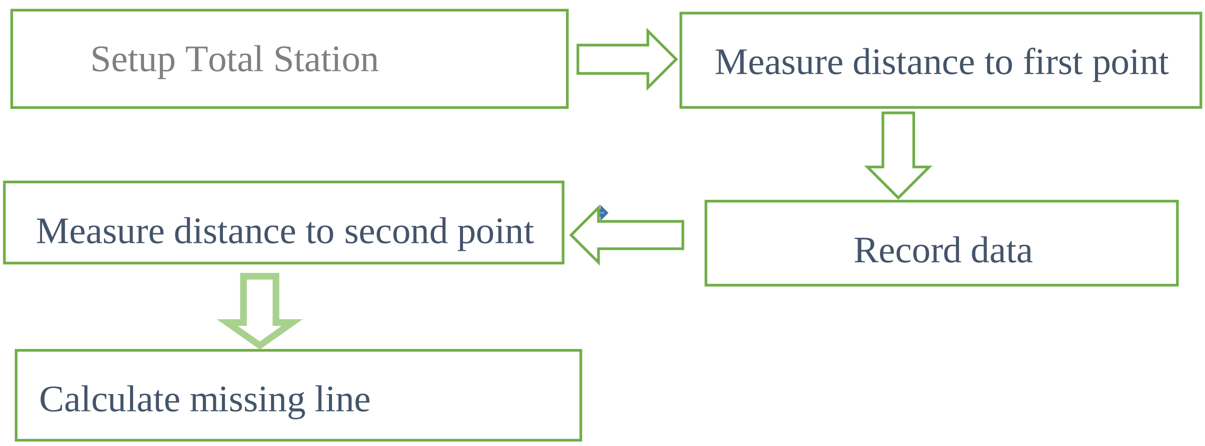
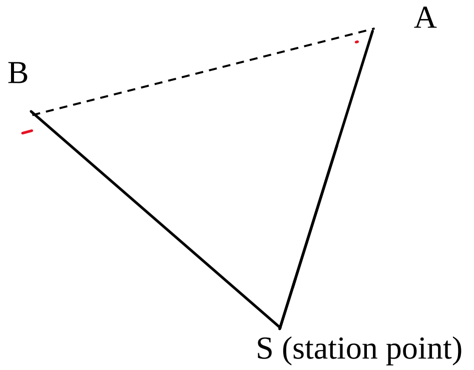


Figure 3 Methodological Flowchart

5.4 SAMPLE FIGURE



AB= Missing line

BS and AS=Measured line using TS

5.5 RESULT

The obtained outcomes are given below:

No. of Observation	SA	SB	AB	AB’	Error
1	27.326	31.534	43.699	43.60	0.099
2	26.124	27.374	41.963	41.895	0.068
3	11.647	12.472	18.131	18.142	-0.011
4	11.647	19.098	16.536	16.462	0.074
5	25.184	24.736	13.246	13.159	0.087
6	31.534	27.326	43.717	43.696	0.021

5.6 CONCLUSION

In conclusion, using the total station method, we accurately measured a missing line by calculating angles and distances from known points. This data gives us valuable insights into the surveyed area, demonstrating the effectiveness of total station technology in mapping features. These results will guide future decisions in engineering, construction, and land surveying.

5.2 TOWER HEIGHT MEASUREMNT

5.2.1 BACKGROUND

Measuring the height of a tower using a total station involves setting up the instrument at a known location with a clear view of the tower. By aiming the total station at both the top and bottom of the tower and taking distance and angle measurements, trigonometric calculations can determine the tower's height. These calculations utilize the differences in vertical angles and measured distances to compute the tower's height accurately. Repeat measurements and checks ensure precision, accounting for factors like atmospheric conditions and instrument calibration. Once confirmed, the final height measurement is recorded, providing valuable data for surveying and construction projects.

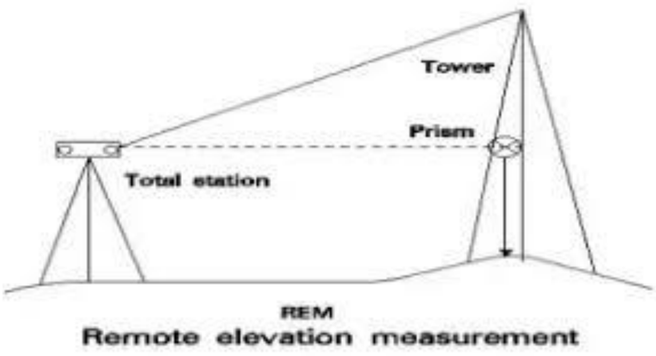


Fig 5.2: Tower Height Mesurement

5.2.2 STUDY AREA

The study area that we took for determining the height of tower is in ward 16 of Pokhara in Kaski District. We measured the height of 5 different tower by the different member of group.

5.2.3 INSTRUMENTS USED

- Total Station
- Prism Pole
- Tripod
- Reflective Prism

5.2.4 METHODOLOGY

- Set up the total station at a known point with a clear view of the tower.
- Mark control points around the tower with known coordinates.
- Measure vertical angles from control points to the top and bottom of the tower.
- Measure horizontal distances from control points to the tower's base.
- Use trigonometry to calculate the tower's height based on angles and distances.
- Double-check measurements for accuracy.
- Record all data accurately.
- Analyze data and prepare a report.

5.2.5 RESULT

The obtained heights are as follows:

S.N.	O1	O2	O3	O4	O5	06	Average height(m)
H1	26.2566	26.2019	26.1284	26.1322	26.1419	26.1485	26.1998
H2	29.2923	29.357	29.3205	29.2749	29.2236	29.2779	29.2910
H3	29.9122	29.9820	29.9668	29.9956	29.9931	29.9589	29.9731
H4	37.1408	37.50	37.0416	37.0340	37.634	37.0259	37.2294
H5	34.4745	34.4988	34.4769	34.5011	34.5264	34.5158	34.4689

5.2.6 CONCLUSION

In conclusion, we used total station technology to accurately measure the height of the tower. By calculating angles and distances from known points, we got reliable data. This shows how well total stations work for vertical measurements. The information we gathered will be important for planning and designing engineering and construction projects.

5.3 PARCEL AREA CALCULATION

5.3.1 BACKGROUND

Some modern surveying software that integrates with Total Stations offers automatic area calculation features. These programs can take the collected data points and apply the triangle method or other area calculation algorithms to provide the final area.

5.3.2 METHODOLOGY

1. Fieldwork with Total Station:

- Set up the Total Station at a convenient location with a clear view of the parcel.
- Measure the horizontal distances (sides) between at least three corner points of the parcel.

  Record these distances electronically and perform following steps:

- ➢ First go to Menu option
- ➢ Go to option 2 Cogo
- ➢ Then option 3 Area and Perimeter
- ➢ Then select MSR1 and sight the required first corner of parcel
- ➢ Press enter and continue process to another corner of parcel
- ➢ After finshing all corners of parcel select CALC to caculate required area of parcel.

Using Triangle Method:

In the triangle method, we used engineering tape to measure all sides of parcels and formed numbers of triangles .

There are two main scenarios depending on our data:

- **Right-angled triangle:** If you have a perpendicular distance (height) measured in the field, you can use the Shoelace Theorem:

  Area = (Base Length) * (Height) / 2

- **Non-right-angled triangle:** If you only have side lengths, use Heron's Formula:

  Area = √(s * (s - a) * (s - b) * (s - c))

  Where:

  s = semi-perimeter (total of all sides divided by 2)

  a, b, c = lengths of the three sides

5.3.3 RESULT AND CONCLUSION

In summary, calculating the area of a plot using a total station is important in land surveying. We calculated area of some parcels using Tape and verified it using Total Station. In conclusion, utilizing a Total Station in conjunction with the triangle method provides a reliable approach for calculating the area of a surveyed parcel. While the Total Station itself focuses on precise distance and angle measurements, the collected data serves as the foundation for area calculations using well-established formulas

6. FINAL CONCLUSION OF SURVEY CAMP

In conclusion, our 18-day survey camp was a valuable experience where we got opportunity to transform our theoretical knowledge in engineering practice dealing with real field experiences. During our time, we learned about GPS surveying, Cadastral surveying, Parcel area calculation and studying hydropower sites with its components. We worked hard to create detailed maps using softwares accordingly.

Despite facing tough weather and rough land, our team worked together and succeeded. We tackled challenges by working together and valuable guidance from our teachers .

As we say goodbye to this camp, we take away unforgettable memories and important lessons. Our teamwork, perseverance, and hands-on learning will help us in the future.

Even though the camp is ending, its impact will stay with us. We leave as stronger professionals, ready to face whatever comes next. Our experience shows the power of teamwork, determination, and striving for excellence.

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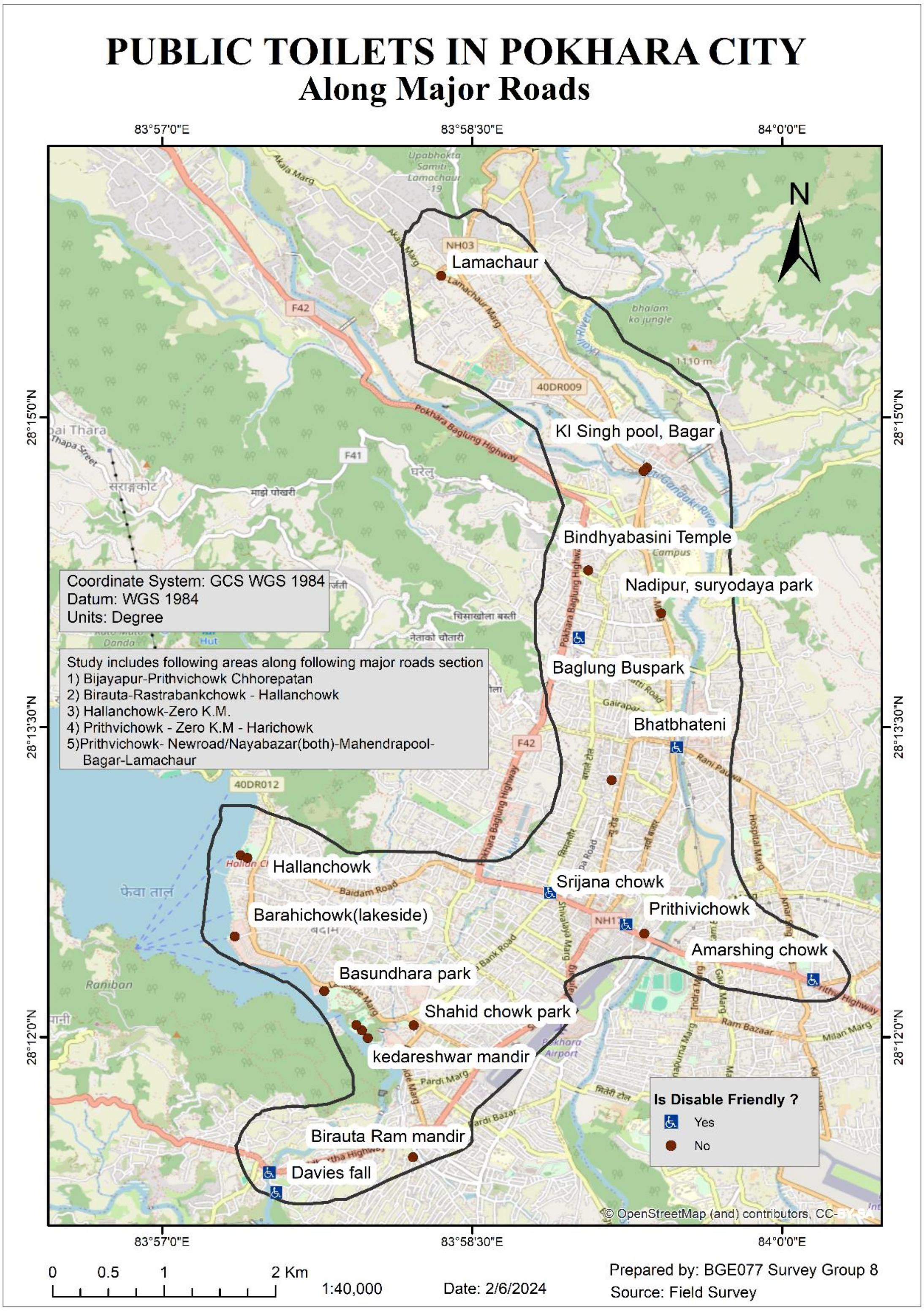
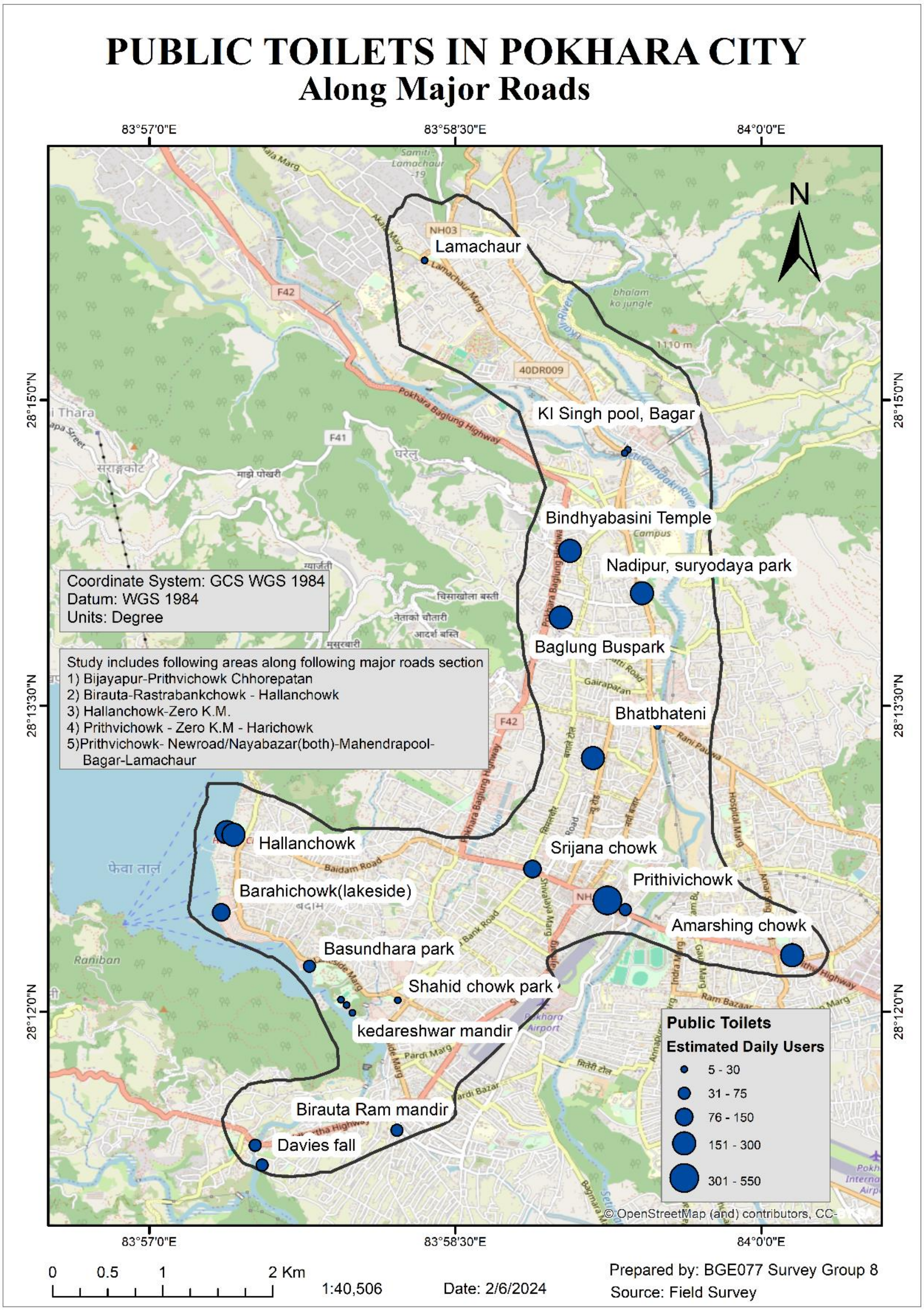
APPENDEX

1.GPS SURVEY





PUBLIC TOILETS IN POKHARA CITY
Along Major Roads
83°57'0"E
83°58'30"E
84°0'0"E
28°15'0"N
28°13'30"N
28°12'0"N
N
Lamachaur
Kl Singh pool, Bagar
Bindhyabasini Temple
Nadipur, suryodaya park
Baglung Buspark
Bhatbhateni
Srijana chowk
Prithivichowk
Amarshing chowk
Hallanchowk
Barahichowk(lakeside)
Basundhara park
Shahid chowk park
kedareshwar mandir
Birauta Ram mandir
Davies fall
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
Study includes following areas along following major roads section
1) Bijayapur-Prithvichowk Chhorepatan
2) Birauta-Rastrabankchowk - Hallanchowk
3) Hallanchowk-Zero K.M.
4) Prithvichowk - Zero K.M - Harichowk
5)Prithvichowk- Newroad/Nayabazar(both)-Mahendrapool-Bagar-Lamachaur
Public Toilets
Estimated Daily Users
5 - 30
31 - 75
76 - 150
151 - 300
301 - 550
© OpenStreetMap (and) contributors, CC-
0 0.5 1 2 Km
1:40,506
Date: 2/6/2024
Prepared by: BGE077 Survey Group 8
Source: Field Survey

Horizontal Angle Observation Sheet By Total Station In Cadastral Survey Site

Station/Object		Face	Horizontal Readings/Angles				Mean	Distance(m)	Mean Distance	Remarks
			SET l	HA	SET ll	HA				
From	To		d-m-s	d-m-s	d-m-s	d-m-s	d-m-s			
1	2	L	0°0'0"	85°6'30"	"0°0'0"	85°6'31"	85°7'29.5"	171.4445	171.442	
		R	180°0'0"		180°0'0"			171.44		
	5	L	85°6'30"	85°6'28"	85°6'31"	85°6'29"		267.324	267.32	
		R	265°6'28"		265°6'29"			267.32		
5	1	L	0°0'0"	113°27'38"	0°0'0	113°27'39"	113°28'37"	267.3645	267.364	
		R	180°0'0"		179°59'58"			267.3643		
	4	L	113°27'38"	113°27'35"	113°27'39"	113°27'36"		144.078	144.176	
		R	293°27'35"		293°27'34"			144.075		
4	5	L	0°0'0"	98°04'41"	0°0'0"	98°04'54"	98°05'34.75"	144.1494	144.149	
		R	180°0'04"		180°0'16"			144.1493		
	3	L	98°04'4"	"98°04'23"	98°04'54"	98°04'21"		196.523	196.522	
		R	278°04'27"		278°04'37"			196.5218		
3	4	L	0°0'0"	124°8'25"	0°0'0"	124°8'50"	124°9'38"	196.578	196.579	
		R	179°59'56"		180°0'05"			196.5806		
	2	L	124°8'31"	124°8'29"	124°8'50"	124°8'48"		156.5509	156.5509	
		R	304°08'25"		304°08'25"			156.551		
2	3	L	0°0'0"	119°07'13"	0°0'0"	119°07'13"	119°8'14.25"	156.582	156.581	
		R	180°0'02"		180°0'02"			156.58		
	1	L	119°07'13"	119°07'16"	119°07'13"	119°07'15"		171.472	171.472	
		R	299°07'18"		299°07'15"			171.472		

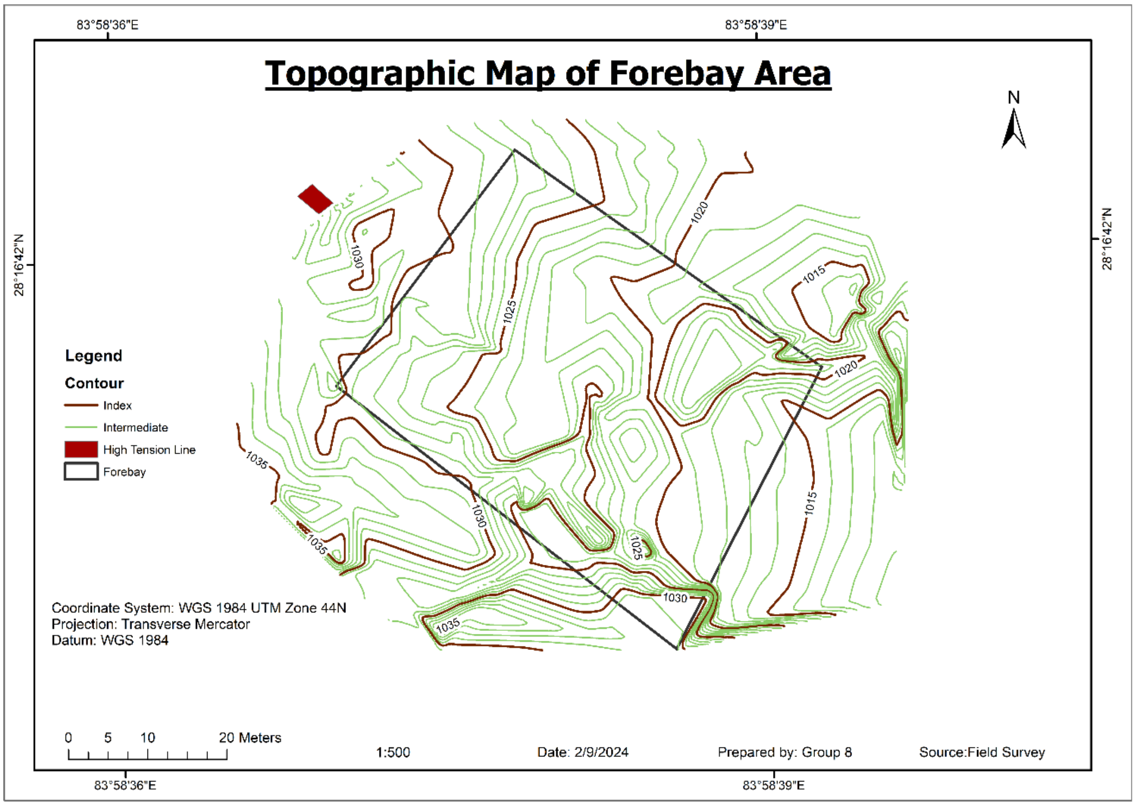
Horizontal Angle Observation Sheet By Total Station In Hydropower Site

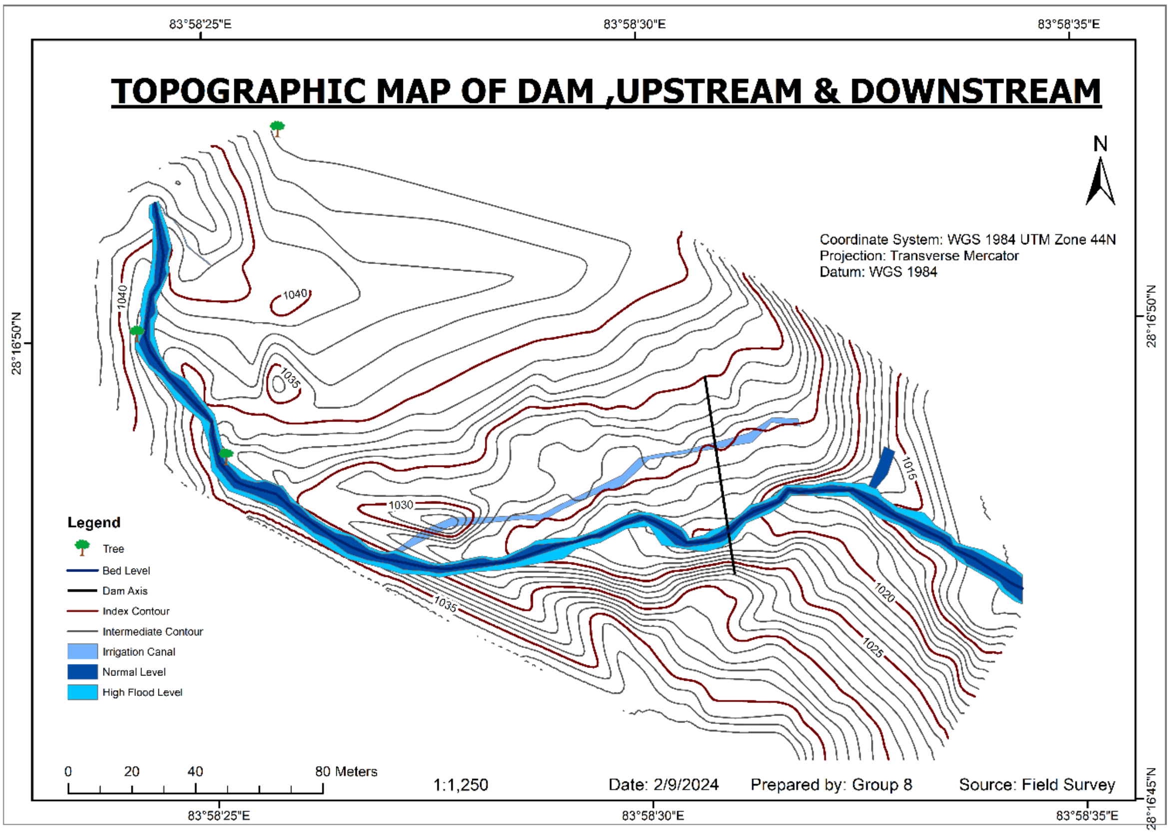
Station/Object		Face	Horizontal Readings/Angles				Mean	Distance(m)	Mean Distance	Remarks
			SET l	HA	SET ll	HA				
From	To		d-m-s	d-m-s	d-m-s	d-m-s	d-m-s			
1	2	L	0°0'0"	33°39'03"	0°0'0"	33°38'46"	33°39'6.25"	191.8164	191.81495	
		R	180°0'06"		180°0'04"			191.8135		
	5	L	33°39'03"	33°39'57"	33°38'46"	33°39'4"		159.3458	159.34475	
		R	213°39'03"		213°39'08"			159.3437		
5	1	L	0°0'0"	155°19'13"	0°0'0"	155°19'14"	155°19'15.25"	159.3252	159.3255	
		R	179°59'58"		180°0'01"			159.3258		
	4	L	155°19'13"	155°19'19"	155°19'14"	155°19'15"		166.1694	166.1702	
		R	335°19'17"		335°19'16"			166.171		
4	5	L	0°0'0"	95°26'17"	0°0'0"	95°26'08"	95°26'08.75"	166.1636	166.16255	
		R	180°0'04"		180°0'02"			166.1615		
	3	L	95°26'17"	95°26'4"	95°26'08"	95°26'6"		133.3796	133.38195	
		R	275°26'08"		275°26'08"			133.3843		
3	4	L	0°0'0"	69°22'01"	0°0'0"	69°22'17"	69°22'27.75"	133.3622	133.3598	
		R	179°59'01"		179°59'36"			133.3574		
	2	L	69°22'01"	69°22'51"	69°22'17"	69°22'42"		138.9417	138.94015	
		R	249°21'52"		249°22'18"			138.9386		
2	3	L	0°0'0"	186°13'20"	0°0'0"	186°13'12"	186°13'8.75"	138.9382	138.925	
		R	179°59'55"		180°0'17"			138.91		
	1	L	186°13'20"	186°13'7"	186°13'12"	186°12'56"		191.88	191.8815	
		R	6°13'02"		6°13'13"			191.883		

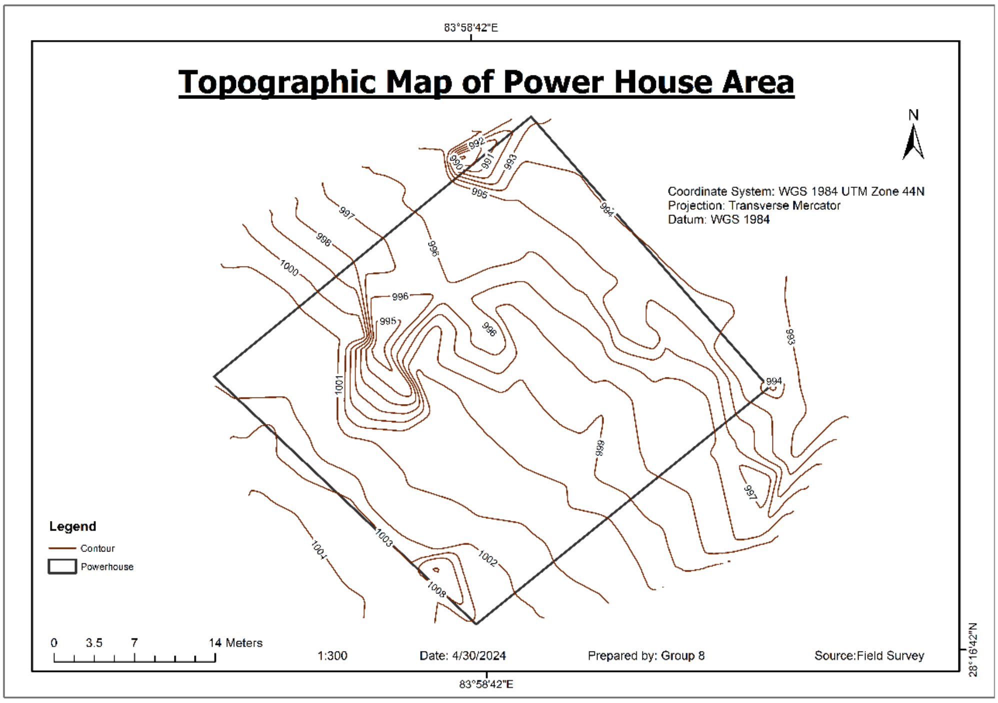
Traverse Control Point Of Hydropower Survey Site				
S.N	Easting	Northing	Elevation	Remarks
1	791838.747	3131879.536	1033.728	BM
2	791804.761	3131872.857	1035.079	STN-1
3	791980.085	3131794.972	1013.6214	STN-2
4	792112.413	3131752.656	1003.534	STN-3
5	792029.647	3131648.055	1029.11	STN-4
6	791890.15	3131738.343	1031.297	STN-5

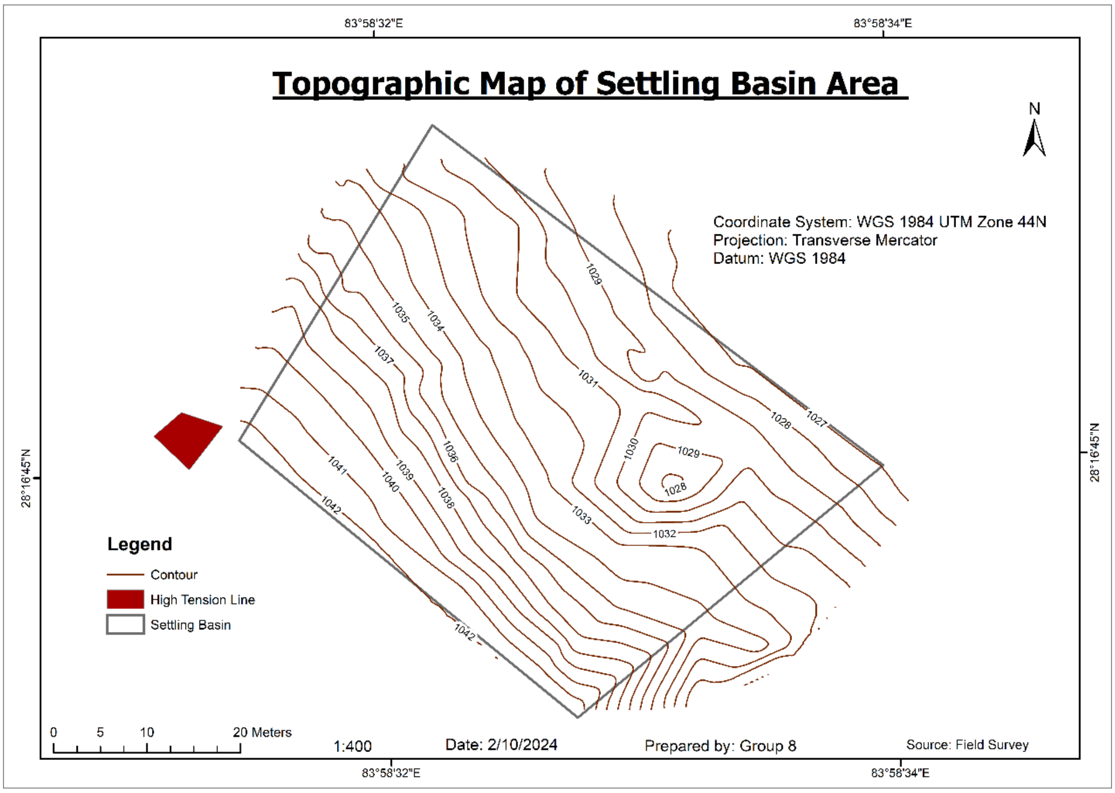
Traverse Control Points Of Cadastral Site				
S.N	Easting	Northing	Height	Control Points
1	793005.8396	3131995.366	937.7448	BM
2	792923.5564	3132003.756	940.0682	STN-1
3	792939.5964	3132174.453	945.0078	STN-2
4	793082.8824	3132237.558	944.7456	STN-3
5	793249.4504	3132133.202	943.7689	STN-4
6	792923.3264	3132002.467	942.019	STN-5

2.HYDROPOWER SURVEY

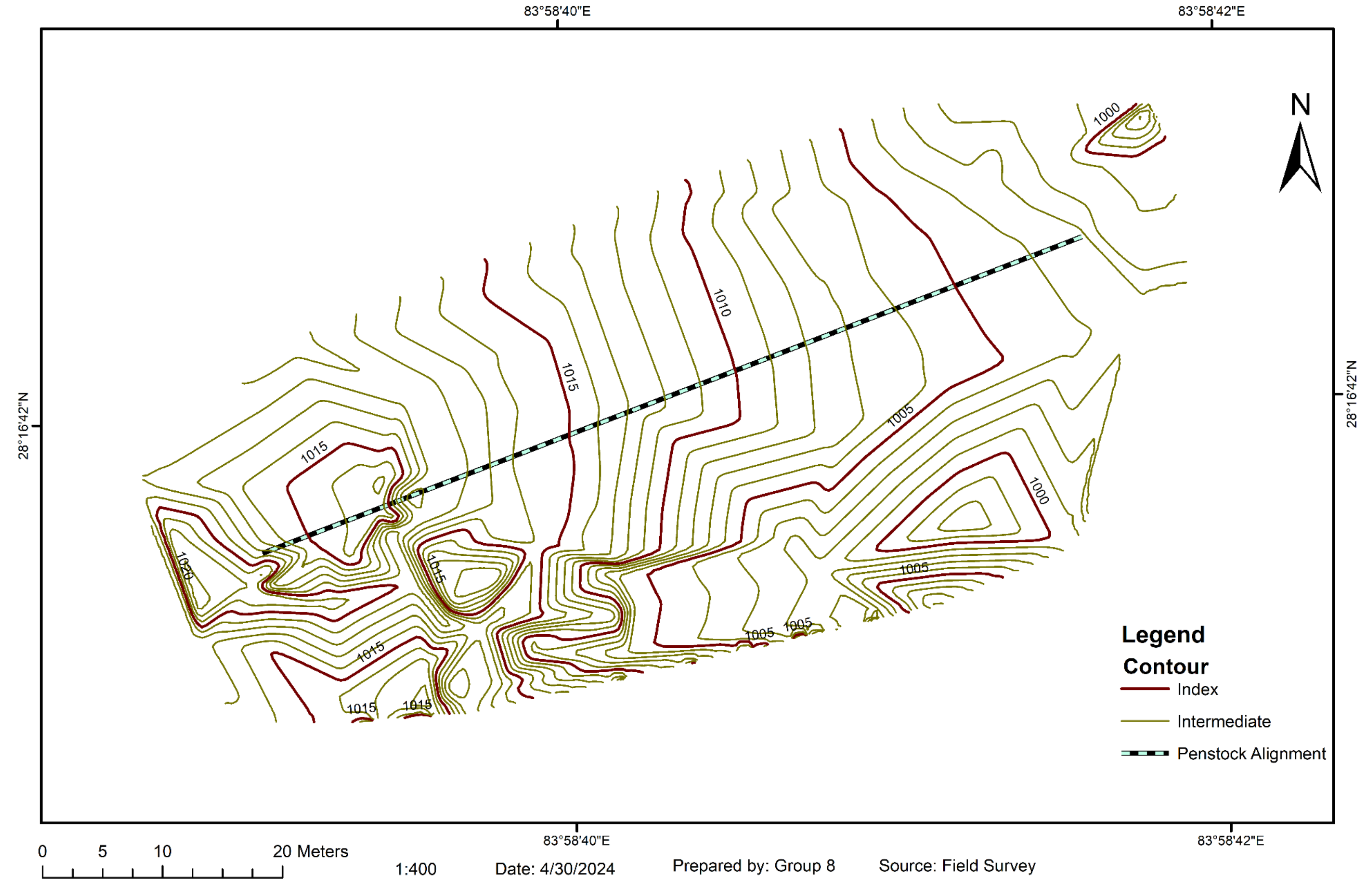





83°58'42"E
Topographic Map of Power House Area
N
Coordinate System: WGS 1984 UTM Zone 44N
Projection: Transverse Mercator
Datum: WGS 1984
Legend
Contour
Powerhouse
0 3.5 7 14 Meters
1:300
Date: 4/30/2024
Prepared by: Group 8
Source:Field Survey
28°16'42"N
83°58'42"E


83°58'32"E
83°58'34"E
Topographic Map of Settling Basin Area
N
Coordinate System: WGS 1984 UTM Zone 44N
Projection: Transverse Mercator
Datum: WGS 1984
28°16'45"N
Legend
Contour
High Tension Line
Settling Basin
0 5 10 20 Meters
1:400
Date: 2/10/2024
Prepared by: Group 8
Source: Field Survey
83°58'32"E
83°58'34"E

Topographic Map of Penstock Alignment



3. DRONE SURVEY