Instrumentation Laboratory and Field Practices in geoinformatics CE673

Report

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1. Introduction

The study and practice of civil engineering require a combination of theoretical knowledge and practical experience. My time at the survey camp in Chitrakoot provided me with both, allowing me to apply and expand upon the concepts learned in the classroom. Chitrakoot, known for its natural beauty and spiritual significance, was an ideal setting for this experience. Located in the hilly terrains of Chitrakoot, the Aarogyadham campus is a serene and tranquil location that encompasses a variety of ayurvedic facilities, including a Medicine Laboratory, Gaushala, and Hospitals. The campus also features a resort and residential areas for the staff and their families. During the survey camp, I had the privilege of working alongside an incredible team of peers who provided invaluable support and collaboration throughout the process. Group 5 members were instrumental in our shared success, and their dedication to the project was evident in the quality of our work. I am extremely grateful for the guidance and affection of Professor Onkar Dixit, Shitla sir, Hari Babu sir, and Maurya sir, as well as the other supporting staffs, teaching assistants Rashmi ma'am and Ratnesh sir. Their vast knowledge and expertise were instrumental in shaping our learning experience and helping us gain practical skills. I will always be indebted to them for their mentorship. This report presents the findings and experiences gained during the survey camp, encompassing road profiling, calibration for Electronic Distance Measurement Instruments (EDMI), distance measurement using chain and tape, and compass and total station surveying. The knowledge and practical skills acquired during this camp will serve as a strong foundation for my future endeavours in civil engineering and geoinformatics, particularly in the fields of infrastructure development and spatial data analysis. The combination of advanced software and hardware tools facilitated efficient data collection, analysis, and interpretation, contributing to a comprehensive understanding of the surveyed area, and supporting the successful completion of the survey camp.

Figure 1: Utilizing total station at the Aarogyadham survey site

2. Objectives

- Create a Topographic Map: Develop a detailed topographic map of the Aarogyadham area to capture its natural and man-made features.
- Utilize GIS Software: Employ Geographic Information Systems (GIS) software to process data efficiently and generate high-quality maps.
- Conduct Road Profiling: Perform road profiling and create longitudinal and cross-sectional profiles for better understanding of the terrain and infrastructure.
- Develop Navigational Maps: Create navigational maps for improved wayfinding and accessibility within the Aarogyadham area.
- Chain and Compass Surveying: Utilize traditional chain and compass surveying methods for precise measurements and map creation.
- Calibrate Electronic Distance Measurement Instruments (EDMI): Ensure the accuracy of distance measurement tools by conducting necessary calibrations.
- Adjust Traverses with Total Station: Use total station surveying to perform traverse adjustments and ensure high precision in measurements.

3. Methodology

Survey Outline:

Duration: November 28th, 2023, to Dec 3rd, 2023
Location: Arogyadham, Chitrakoot (M.P)

Day 1: November 28th, 2023

- **Activity: Reconnaissance**
- **Details:** Identified suitable locations for control points (CPs) based on predefined criteria. Marked 7 CPs ensuring maximum coverage and efficiency.

Day 2: November 29th, 2023

- **Activity:** GNSS Traversing
- **Details:** Used R10 receivers for GNSS traversing in static mode. Obtained precise coordinates of the CPs to establish geodetic control.

Day 3: November 30th, 2023

- **Activity:** Auto Level Levelling
- **Details:** Conducted Auto Level Levelling to determine orthometric heights. Obtained accurate elevation data for subsequent mapping tasks.

Day 4-5: December 1st-2nd, 2023

- **Activity:** Feature Mapping with Total Station
- **Details:** Employed Total Station for detailed feature mapping. Collected data on terrain, buildings, vegetation, etc., for topographic map creation.

Day 6: December 3rd, 2023

- **Activity:** Data Collection with Juno Receiver
- **Details:** Utilized Juno receivers for data collection. Gathered area generic, line generic, and point generic data to create navigational maps.

Additional Labs: IIT Kanpur Campus (April-2024)

- TS traversing

- EDM
- Chain and Compass Surveying

Basic Surveying Principles Followed:

The following basic surveying principles were adhered to during the survey camp to ensure accuracy, efficiency, and reliability in the data collection process:

- Work from Whole to Part: Begin with a broad overview of the survey area to establish a general understanding of the landscape. This approach helps to identify major control points and guide detailed measurements.
- Adequate Provisions for Checks: Implementing redundancy and verification methods ensures the accuracy of measurements and data collected. Cross-checking results minimizes errors and increases confidence in the final survey data.
- Choice of Appropriate Survey Method: Selecting the most suitable survey method based on the project's requirements and the area to be surveyed ensures the highest level of accuracy and efficiency. Consider factors such as terrain, access, and project objectives when making this decision.
- Careful Recording of Field Data: Accurate and detailed documentation of field data is essential for successful surveying. Proper record-keeping allows for easier data analysis, interpretation, and application in subsequent stages of the project.
- Safety and Environmental Considerations: Always prioritize safety for surveyors and the environment when planning and conducting surveys. This includes assessing potential risks and taking necessary precautions to minimize them.

3.1 Reconnaissance

Reconnaissance is an indispensable initial step in the surveying process, involving a meticulous study of the area to be surveyed. It serves as the foundation for making informed decisions regarding survey methods, instrumentation, and control point placement to ensure accuracy and efficiency within given time constraints. Conduct a detailed walk around specific locations, identifying potential station locations and noting features to be collected.

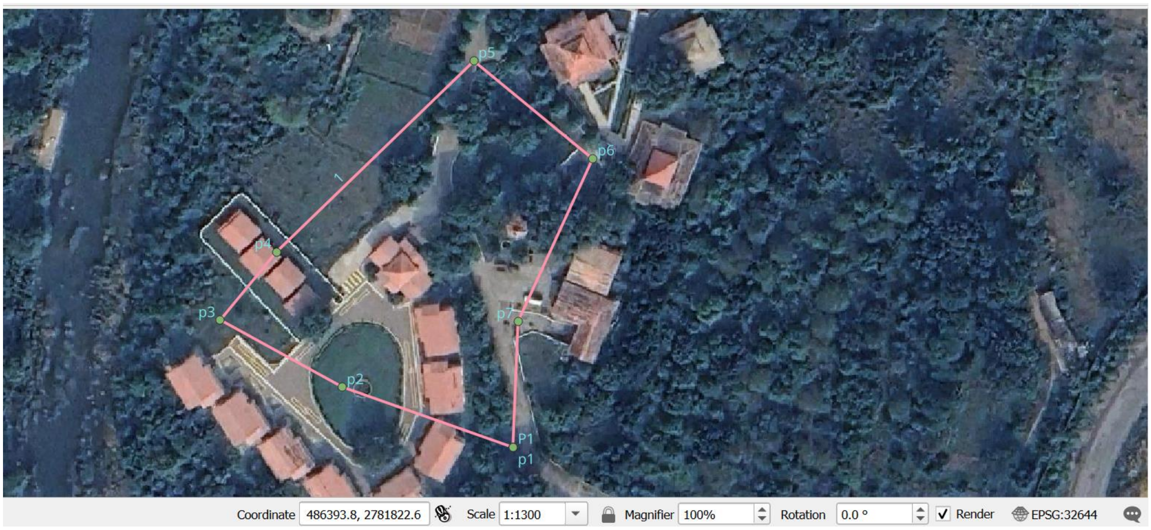

Figure 2: Using QGIS, the closed loop traverse connects the seven control points displayed.

Control point marking is a crucial aspect of reconnaissance, involving several considerations:

- The number of control points should be minimized while ensuring adequate coverage.
- Intervisibility between consecutive control points is necessary for survey continuity.
- Control points should be open to the sky and clear lines of sight.
- They should cover the maximum area possible.
- Gain an understanding of the area by visiting and walking around it.

3.2 Trimble R10 Receiver

The Trimble R10 is a high-precision GNSS receiver used in a wide range of surveying applications, including land surveying, construction, and GIS. It is a durable and portable receiver that may be utilized in several settings. The R10 supports a variety of GNSS constellations, including GPS, GLONASS, Galileo, and BeiDou. This allows it to provide accurate positioning even in challenging environments, such as under tree cover or in urban canyons.

Figure 3: Front and back panel of R10 Receiver

To measure the coordinates at the Control Points (CP) using R10 receiver (static mode):
Following are the various exercises that are being performed in this survey
Exercise 1: Setting up of R10 GNSS Receiver
Step 1: Marking the Control Point, before setting up our R10 Receiver, proceed to the specified site. Clearly show the exact point (Ground Control Point, GCP) with a visible marker, such as a bright paint dot. This marker will be used as a reference for both the GNSS receiver and any future total station surveys.
Step 2: Placing the Receiver, Screw the R10 receiver onto the tripod head, Extend the tripod legs and place instrument height approximately 2 meters above the GCP.
Step 3: Levelling the Tripod, aim for the bubble to be centred within the circle, indicating a perfectly levelled instrument with the help of tripod leg adjustment.
Step 4: Power on and Initialize, Switch on the R10 receiver respectively once the instrument has been set.

3.2.1 Trimble TSC7 Controller

The Trimble TSC7 is a robust field controller, designed to collaborate seamlessly with GNSS receivers like the R10. With a powerful processor, it efficiently handles complex calculations for large projects. The device features a large touchscreen, optional keyboard, and a rugged design, making it suitable for challenging field conditions. Offering Wi-Fi, Bluetooth, cellular, and USB connectivity, it supports effortless data transfer. Compatible with Trimble surveying and GIS software, including Trimble Access, Trimble Land Works, and Trimble eSurvey, the TSC7 serves diverse applications. Paired with the Trimble R10, it excels in static GNSS surveys, real-time surveys, GIS data collection, and machine control applications, ensuring precision in various field operations.

Exercise 1: Connecting your R10 to the TSC7 and Performing Static Surveys: A Practical Guide
Step1: Initializing Trimble Access & Job Setup, Open Trimble Access: Launch the software on your TSC7 controller. Generate a new project group. Give it a meaningful name, the same as your job title.
Step 2: Configure Coordinates: In the job settings, select the "World Wide UTM" coordinate system with zone "44N" and local datum "WGS-1984 (7p)" indicating 7 parameters. Set the project height to 0m, distinct from your antenna height.
Step 3: Defining Survey Style & Rover Configuration: Static Mode, Open the "Settings" menu and navigate to "Survey Style." Select "Static" for precise static positioning. Rover Options, within "Static," choose "Rover" as our receiver role.
Step 4: Survey Type & Antenna Data: Select "FastStatic" as the survey type. Enter your R10 receiver's code or number under "Antenna Type." Specify the measured height to the bottom of the quick release as well as the total antenna height of 2 meters. Set the logging interval to 15 seconds, elevation mask to 10 degrees, and PDOP mask to the default 6. Choose all available GNSS signals like GPS and GLONASS for tracking. Save these settings.
Step 5: Instrument Settings & Rover Connection: Open "Instrument Settings" and activate the "GNSS" function. Set the "Rover Mode" to allow customizable observation times, unlike the fixed-time setting for base mode. Connecting Controller & Rover: Once our instrument settings are saved, navigate to "Measure," and select "Static." Click on "Measure Points" to initialize the survey.
Step 6: Point Measurements & Observation Duration: Assign names and codes to our measured points, like "CP1," "CP2," etc., using the "CP" code for control points. Based on our location and satellite visibility, set appropriate observation times for each control point, typically between 15 and 25 minutes.
Step 7: Capture one temporary point each for every four control points. These points should be visible from the corresponding control points and will aid in both total station surveying and data collection.

3.3.2 TBC software used for post-processing

Trimble Business Centre (TBC) is used in analysing our R10 Static Data. It is a powerful surveying and engineering software solution specifically designed to process and analyse data collected by Trimble field instruments like your R10 GNSS receiver. TBC seamlessly imports raw R10 data files, allowing us to organize and manage multiple projects and datasets effortlessly. It easily converts our data between various coordinate systems and datums, ensuring compatibility with other projects and maps.TBC utilizes sophisticated algorithms to process our static observations, resolving ambiguities and generating precise coordinates for each control point. TBC accurately calculates baselines between our R10 receiver and any established reference stations, providing crucial information for network adjustments and coordinate accuracy assessment. It helps generate professional reports detailing your survey project, including baseline solutions, error statistics, project diagrams, and point coordinates. These reports serve as valuable documentation and verification of your field work. Post-Processing the R10 data using TBC software was carried out.

Applying transit rule for corrections:

In this method, the coordinate error is distributed in proportion to the amount that various coordinates change between points.

- Northing adjustment = Change in Northing for traverse line to point / Sum of absolute values of all changes in northing for all traverse lines × Northing closure error

- Easting adjustment = Change in Northing for traverse line to point / Sum of absolute values of all changes in northing for all traverse lines × Easting closure error

Readings are taken in static mode by GNSS R10 receiver:

Table 1 Table generated in our TBC baseline processing report:

ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Horizontal Precision (Meters)	Vertical Precision (Meters)
base02 29112023	486196.668	2781803.081	86.516	0.007	0.023
IITK	423495.479	2933660.080	70.242	-	-
p1	**486247.495**	**2781780.715**	**90.214**	0.004	0.008
p2	486194.414	2781799.487	86.332	0.002	0.004
p3	486156.410	2781820.361	85.100	0.003	0.005
p4	486173.896	2781841.542	87.198	0.002	0.004
p5	486235.354	2781900.992	84.555	0.005	0.012
p6	486272.301	2781870.551	89.658	0.004	0.008
p7	486249.084	2781819.863	89.999	0.002	0.006
P1	**486247.492**	**2781780.702**	**90.211**	0.005	0.010

Traverse misclosure:

$$\Delta N= 486247.495-486247.492=0.003m$$

$$\Delta E=2781780.715-2781780.702=0.013m$$

$$\Delta elev=90.214-90.211=0.003m$$

The table below displays the Aposteriori covariance matrix for each point from the base line processing:

Table 2: Covariance matrices

For point P_1:	**X**	**Y**	**Z**
X	0.0000033395		
Y	0.0000028819	0.0000143831	
Z	0.0000019061	0.0000058374	0.0000043408

For point P_2:	**X**	**Y**	**Z**
X	0.0000009106		
Y	0.0000004302	0.0000040431	
Z	0.0000002798	0.0000015764	0.0000012293

For point P_3:	**X**	**Y**	**Z**
X	0.0000013662		
Y	0.0000003264	0.0000057905	
Z	0.0000002532	0.0000027491	0.0000024929

For point P_4:	**X**	**Y**	**Z**
X	0.0000007506		
Y	0.0000001691	0.0000030093	
Z	0.0000001779	0.0000013100	0.0000013062

For point P_5:	**X**	**Y**	**Z**
X	0.0000042703		
Y	0.0000030480	0.0000295595	
Z	0.0000024125	0.0000155626	0.0000139574

For point P_6:	**X**	**Y**	**Z**
X	0.0000021908		
Y	0.0000005567	0.0000143782	
Z	0.0000008435	0.0000058199	0.0000046602

For point P_7:	**X**	**Y**	**Z**
X	0.0000008756		
Y	0.0000003343	0.0000070004	
Z	0.0000002669	0.0000027123	0.0000020560

Calculating the change in northings and eastings for each traverse line to point:

From Point	to Point	ΔE (m)	ΔN (m)
base02	p1	486247.495 - 486196.668 = 50.827	2781780.715 - 2781803.081 = -22.366
p1	p2	486194.414 - 486247.495 = -53.081	2781799.487 - 2781780.715 = 18.772
p2	p3	486156.410 - 486194.414 = -38.004	2781820.361 - 2781799.487 = 20.874
p3	p4	486173.896 - 486156.410 = 17.486	2781841.542 - 2781820.361 = 21.181
p4	p5	486235.354 - 486173.896 = 61.458	2781900.992 - 2781841.542 = 59.450
p5	p6	486272.301 - 486235.354 = 36.947	2781870.551 - 2781900.992 = -30.441
p6	p7	486249.084 - 486272.301 = -23.217	2781819.863 - 2781870.551 = -50.688
p7	P1	486247.492 - 486249.084 = -1.592	2781780.702 - 2781819.863 = -39.161
P1	base02	486196.668 - 486247.492 = -50.824	2781803.081 - 2781780.702 = 22.379

Correction for Misclosure:

The sum of absolute values of all changes in Northing and Easting for all traverse lines:

∑ΔE = |-50.827| + |-53.081| + |-38.004| + |17.486| + |61.458| + |36.947| + |-23.217| + |-1.592| + |-50.824| = 332.446m

∑ΔN = |-22.366| + |18.772| + |20.874| + |21.181| + |59.450| + |-30.441| + |-50.688| + |-39.161| + |22.379| = 100.252m

Calculate the Northing and Easting adjustments for each point using the Transit Rule:

Northing adjustment for each point = (ΔN for traverse line to point / ∑ΔN) * Northing closure error

Easting adjustment for each point = (ΔE for traverse line to point / ∑ΔE) * Easting closure error

Calculating the adjustments:

Point	Northing Adjustment (m)	Easting Adjustment (m)
p1	(-22.366 / 100.252) * 0.003 = -0.000671m	(-50.827 / 332.446) * 0.013 = -0.001986m
p2	(18.772 / 100.252) * 0.003 = 0.000564m	(-53.081 / 332.446) * 0.013 = -0.002073m
p3	(20.874 / 100.252) * 0.003 = 0.000626m	(-38.004 / 332.446) * 0.013 = -0.001488m
p4	(21.181 / 100.252) * 0.003 = 0.000634m	(17.486 / 332.446) * 0.013 = 0.000687m
p5	(59.450 / 100.252) * 0.003 = 0.001783m	(61.458 / 332.446) * 0.013 = 0.002389m
p6	(-30.441 / 100.252) * 0.003 = -0.000912m	(36.947 / 332.446) * 0.013 = 0.001446m
p7	(-50.688 / 100.252) * 0.003 = -0.001520m	(-23.217 / 332.446) * 0.013 = -0.000909m
P1	(-39.161 / 100.252) * 0.003 = -0.001488m	(-1.592 / 332.446) * 0.013 = -0.000062m

Adjusting the coordinates:

Point	Original Easting (m)	Original Northing (m)	Original Elevation (m)	Northing Adjustment (m)	Easting Adjustment (m)	Corrected Easting (m)	Corrected Northing (m)	Corrected Elevation (m)
base02	486196.7	2781803	86.516	-	-	486196.7	2781803	86.516
p1	486247.5	2781781	90.214	-0.00067	-0.00199	486246.8	2781781	90.214
p2	486194.4	2781799	86.332	0.000564	-0.00207	486195	2781799	86.332
p3	486156.4	2781820	85.1	0.000626	-0.00149	486157	2781820	85.1
p4	486173.9	2781842	87.198	0.000634	0.000687	486174.5	2781842	87.198
p5	486235.4	2781901	84.555	0.001783	0.002389	486237.1	2781901	84.555
p6	486272.3	2781871	89.658	-0.00091	0.001446	486271.4	2781871	89.658
p7	486249.1	2781820	89.999	-0.00152	-0.00091	486247.6	2781820	89.999
P1	486247.5	2781781	90.211	-0.00149	-6.2E-05	486246	2781781	90.211

The adjusted Eastings (E) and Northings (N) obtained from the R10 receiver using the transit rule for corrections will serve as the reference coordinates for conducting feature mapping in the designated study area using a Total Station. These corrected coordinates provide precise positioning information that ensures accuracy and reliability in mapping the features of interest. By integrating these corrected coordinates into the Total Station surveying process, we can effectively capture and document the spatial data required for detailed feature mapping within the study area.

Quality assessment:

- ΔN = 0.003m
- ΔE = 0.013m
- Traverse perimeter (p) = Sum of the lengths of all traverse lines

First, we need to calculate the traverse perimeter (p). Since the traverse lines are not explicitly provided, we can approximate the perimeter by summing the distances between consecutive points:

$$p=\sum\sqrt{(\Delta Ei)^2+(\Delta Ni)^2}$$

Let's calculate the perimeter and closing error:

$$e=\sqrt{(\Delta E)^2+(\Delta N)^2}$$

e/*p*: ratio

Assuming a linear approximation between points, we can calculate the distances between consecutive points:

$$P = (\sqrt{(\Delta E1)^2+(\Delta N1)^2}) + \sqrt{(\Delta E2)^2+(\Delta N2)^2} + \ldots + \sqrt{(\Delta E\text{n})^2+(\Delta Nn)^2}$$

$$e = (0.013)^2+(0.003)^2=0.000169+0.000009\approx 0.000178\approx 0.013m$$

$$e/p=0.013/\text{p}$$

Given the changes in Easting (ΔE) and Northing (ΔN) for each traverse line to point

$p \approx 2646.822m$

$e/p \approx 4.911 \times 10-6$ = (1:203563)

Quality	Permissible limit of closing error
First order	1: 25000
Second order	1: 10000
Third order	1: 5000

The ratio falls in first order surveying. First-order surveying is often used for projects where precise measurements are required, and meeting these standards means that the survey data adheres to high accuracy and precision specifications. It implies that our survey work was well-executed, and the data collected with the R10 receiver is trustworthy and precise for its intended uses.

3.3 Auto-Level

Auto level, also known as an automatic level or dumpy level, is a surveying tool used to estimate height differences efficiently and effectively between various sites in a survey region.

Figure 4: Auto-Level instrument

- Auto levels are equipped with a compensator that automatically levels the instrument. This feature ensures that the line of sight remains horizontal, eliminating the need for manual adjustments.
- The instrument is fitted with a telescope with crosshairs, allowing surveyors to precisely target specific points or benchmarks.
- Auto levels typically have three levelling screws that allow for fine adjustments to achieve accurate horizontal levelling.
- A bubble level is integrated on the instrument to give a visual indication of whether it is level.
- Auto levels are primarily used for determining the difference in height between different points on the ground. This is crucial for various applications, such as construction, engineering, and topographic mapping.
- Surveyors use auto levels to establish benchmarks, which serve as reference points with known elevations. These benchmarks are essential for creating a reliable vertical control network.

Auto levels are known for their precision in determining elevation differences, often within a few millimeters over a distance of a kilometer (e.g., ±1 to ±3 mm per km of leveling).

Exercise 3.3.1: Setting up of Auto – Level

Step 1: Set up the tripod on a stable and level surface near the control point or benchmark. Adjust the tripod legs to ensure stability. Use the built-in level bubble on the tripod to level it approximately.

Step 2: Mount the auto level instrument onto the tripod securely. Utilize the three bottom screws on the auto level to level the bubble within the instrument accurately.

Step 3: Place the levelling staff at the control point or benchmark with a known Reduced Level (RL), such as 128.061 or assume100 if not given.

Step 4: Set up the auto level in a way that allows clear visibility to the next point of interest. Use the top large screw for zooming and the adjacent small screw for horizontal movement to align the instrument.

Exercise 3.3.2: Taking Readings by Height of Instrument Method or Height of collimation method

Back Sight (BS):

- Focus the auto level on the levelling staff at the control point (Point 13).
- Adjust the instrument's position using the screws for optimal visibility.
- Take the reading from the eyepiece, recording the Back Sight (BS) reading.

Height of Instrument (HI) Calculation:

- Calculate the Height of Instrument (HI) using the formula

HI = BS + RL

HI = Height of Instrument

BS = Back Sight

RL = Reduced Level

Fore Sight (FS):

- Shift the auto level's focus to the next point as the Fore Sight (FS).
- Adjust the instrument as needed and record the Fore Sight (FS) reading.

Next RL Calculation:

- Calculate the Reduced Level (RL) for the next point using the formula

RL = HI – FS

- Repeat for Loop Closure:
- Continue the process, moving from one point to the next, until you close the loop (e.g., from Point 13 to 8 to 10 and back to 13).
- Ensure readings are recorded for both control points and temporary points**.**

Data Recording:

- Record all readings systematically, including Back Sight (BS), Fore Sight (FS), and calculated Reduced Levels (RL) for each point.
- Keep track of the loop closure to validate the accuracy of the levelling survey.

Calculations: Height of instrument (HI) method

Table 3: HI by taking RL as 100

BS	FS	HI	RL	Remark
0.975		100.975	100	BM
0.54	1.335	100.18	99.64	CP1
0.76	2.875	98.065	97.305	
1.22	2.16	97.125	95.905	CP2
0.81	1.39	96.545	95.735	
2.83	1.65	97.725	94.895	CP3
1.71	1.085	98.35	96.64	CP4
3.765	4.38	97.735	93.97	CP5
2.665	0.955	99.445	96.78	
1.325	0.365	100.405	99.08	CP6
1.285	1.385	100.305	99.02	CP7
1.305	0.88	100.73	99.45	
	0.725		100.005	

Arithmetic Checks:

$$\boldsymbol{\Sigma BS - \Sigma FS = Last\ RL - First\ RL}$$

$$\sum BS - \sum FS = 19.19 - 19.185 = 0.005\text{m}$$

$$Last\ RL - First\ RL = 100.005 - 100 = 0.005\text{m}$$

Accuracy standards/error tolerance for levelling:

Error in mm is related to distance traversed in levelling operation

E = C$\sqrt{K}$, Where E is error in mm, K distance in km C is constant as below

Table 4: Accuracy Standards

Work	Purpose	C
Highest quality	Geodetic levelling and surveys for special purpose	1
Precise levelling	Geodetic levelling and benchmarks of widely distributed points	4 (5)
Accurate	Principal benchmarks and extensive surveys	12 (10)
Ordinary	Location and construction survey	24 (25)
Rough	Reconnaissance and preliminary surveys	100 (100)

Classification of work:

By $E = C\sqrt{K}$
E= 5 mm

K= 0.5278
C = 2.639

Therefore, from table 3 we know that our levelling is classified as precision levelling, so now we go for Error distribution or loop closure.

Distribution of error in levelling observations
Closing error or loop closure (or misclosure) is the amount by which a level circuit fails to close. It is difference of elevation of the measured or computed elevation and known or established elevation of the same point.

Correction:
Loop closure: as function of distance

$$C = -e\,\frac{l}{L}$$

Correction = -(total error)x [(distance of given level segment / total distance of all level segments)]

Example for few station:

$$Correction@1 = \frac{0.005}{527.8}(50) = 0.000474$$

$$Correction@2 = \frac{0.005}{527.8}(29.2) = 0.000277$$

Station	RL	Cumulative distance	correction	Corrected RL
BM	100	50	0.000474	100.0005
CP1	99.64	29.2	0.000277	99.64028
	97.305	25.2	0.000239	97.30524
CP2	95.905	59.5	0.000564	95.90556
	95.735	47.9	0.000454	95.73545
CP3	94.895	51	0.000483	94.89548
CP4	96.64	58	0.000549	96.64055
CP5	93.97	76	0.00072	93.97072
	96.78	28.5	0.00027	96.78027
CP6	99.08	48	0.000455	99.08045
CP7	99.02	25.5	0.000242	99.02024
	99.45	20.5	0.000194	99.45019
	100.005	8.5	8.05E-05	100.0051

Once we obtained these corrected reduced levels (RL), these values will serve as reference points in total station surveying. By using these corrected RL values as control points, we can establish an accurate network of data points across the survey area. Using total station (TS) equipment, we typically obtain ellipsoidal heights, which are relative to a mathematical reference ellipsoid. However, by using corrected reduced levels (RL) from auto level measurements, which provide orthometric heights, we can bypass the need to convert ellipsoidal heights to orthometric heights. The auto level's RL measurements offer precise heights above mean sea level, which can directly inform our surveying and mapping work. Thus, incorporating these corrected RL values allows us to work with reliable and accurate elevation data without needing to perform further conversions between different height measurement systems. The corrected RL values will be directly utilized to compute contours, providing a clear representation of the terrain's shape and elevation changes. This approach ensures the reliability and precision of the total station measurements and the accuracy of the resulting maps and models.

3.4 Total Station

We utilized Total Station for field surveys and QGIS/ArcGIS Pro for spatial analysis and mapping in this survey. Various exercises demonstrate their combined functionality. To perform feature mapping using Total Station, auto-level and generate topographic map. A total station is a precision surveying instrument widely used in the fields of civil engineering, construction, land surveying, and mapping. It combines the functionality of a theodolite for measuring angles and a distance meter (EDM) for measuring distances electronically. Total stations are essential tools for capturing precise measurements of angles, distances, and elevations, allowing surveyors to accurately map out and analyse land features, construct buildings and infrastructure, and perform various surveying tasks with high levels of accuracy and efficiency. These instruments are equipped with electronic displays, keypads, and onboard software for data collection, calculation, and storage, making them indispensable tools for modern surveying professionals. Total stations typically offer high angular accuracy, often within a few seconds of arc (e.g., 1" to 5"). Depending on the model, total stations can measure distances with a high degree of accuracy, usually around a few millimeters plus a small part-per-million of the measured distance (e.g., ±2 mm + 2 ppm).

Setting Up the Total Station:

1. **Set Up the Tripod**: Place the tripod firmly on stable ground, ensuring that the legs are spread evenly and securely locked in place.
2. **Level the Tripod**: Adjust the tripod legs to ensure that the tripod is level using a bubble level attached to the tripod head.
3. **Position Above Control Point**: Position the tripod directly above the control point by aligning it visually or using a plumb bob.
4. **Attach the Total Station**: Mount the total station securely on the tripod head and tighten the locking screws to ensure stability.
5. **Electronic Levelling**: Use the built-in electronic level of the total station to ensure it is accurately levelled. Adjust the levelling screws until the bubble level is cantered, ensuring the error is less than 9 seconds.
6. **Verify Crosshair Alignment**: Verify that the crosshair of the total station aligns precisely with the control point's coordinates obtained from an auto level or other surveying equipment.

Taking Readings:

1. **Create a New Job File**: Initialize the total station by creating a new job file and saving it with a descriptive name for the survey area.

2. **Station Setup**: Input the control point's name, instrument height (typically 1.27m), and its coordinates (Northing, Easting, and Elevation) obtained from previous GNSS receiver measurements.
3. **Set Temporary Point as Backsight**: Designate a temporary point near the control point as the backsight reference for the total station.
4. **Measure Topography**: Using the total station's vertical and horizontal angle measurement capabilities, use VX and S series mode, start measuring the topographic features of the survey area.
5. **Set Backsight Height**: Set the backsight height to 1.5m, which typically corresponds to the height of the prism fixed on the bipod.
6. **Take Backsight Reading**: Begin by taking a backsight reading to establish a reference point for subsequent measurements.
7. **Feature Mapping**: Proceed with mapping various features by recording their readings (horizontal angles, distances, and vertical angles) as observed through the total station giving various code names.

After gathering detailed data from the total station, including Easting, Northing, and Height (H), we will use this information to create a feature map. This process involves plotting the coordinates and elevations to accurately represent the topography and features of the surveyed area. By using the total station data to create the feature map, we can visualize the terrain's contours and other natural and man-made features, providing valuable insights for future planning, design, and management of the area.

3.5 JUNO B3

The Trimble Juno 3B is a rugged, handheld GPS device designed for field data collection. It features a high-sensitivity GPS receiver, a 5-megapixel autofocus camera with flash, and a long-life battery suitable for all-day use. With its compact and lightweight design, the Juno 3B is well-suited for various outdoor applications, including mapping, scouting, soil sampling, and field record keeping. Key features of the Trimble Juno 3B include Rugged Design, it has The Juno 3B has an IP54 rating, making it resistant to dust, water, and shock, ensuring durability in tough outdoor conditions. Windows Embedded Handheld Operating System, Equipped with the Windows Embedded Handheld 6.5 Professional operating system, the Juno 3B offers an intuitive interface for easy navigation. Wireless Connectivity
Accuracy: The Juno 3B offers GPS accuracy within the range of 2 to 5 meters after differential correction.
Field Applications: The Juno 3B is commonly used for collecting points, lines, and polygons for generating navigational maps in various environments. It is particularly useful for applications requiring spatial data collection in remote or challenging terrain.

To set up and use the Trimble Juno 3B:

1. **Power**: Ensure the device is charged using the included AC power supply or USB data cable. Insert the fully charged battery into the device.
2. **Initialization and setting CRS**: Power on the Juno 3B and allow it to initialize. Follow the on-screen prompts to set up the device and configure initial settings and set the respective CRS to WGS 84 Zone 44N.
3. **GPS Reception**: Wait for the device to acquire GPS signals. Position the device in an open area with a clear view of the sky to facilitate satellite reception.
4. **Data Collection**: Launch the data collection software (e.g., Trimble TerraSync) installed on the Juno 3B. Configure the software settings for the desired data collection parameters, such as point interval and accuracy requirements.

5. **Fieldwork**: Begin collecting data by navigating to the desired location and selecting the appropriate data collection method (e.g., point, line, polygon). Follow the on-screen instructions to capture spatial data accurately.
6. **Post-Processing and Data Transfer**: After completing data collection and post-processing, transfer the collected data from the Juno 3B to a computer or other storage device using the USB data cable or wireless connectivity options.

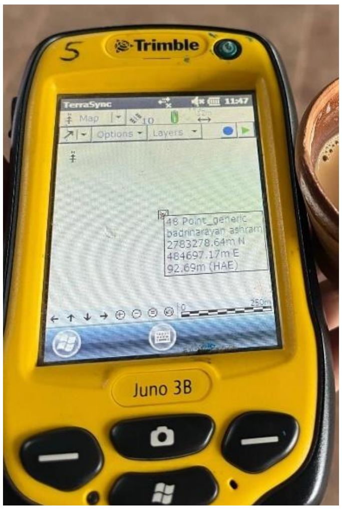

Figure 5: JUNO 3B

3.5.1 QGIS (Used to create navigational map using JUNO 3B data)

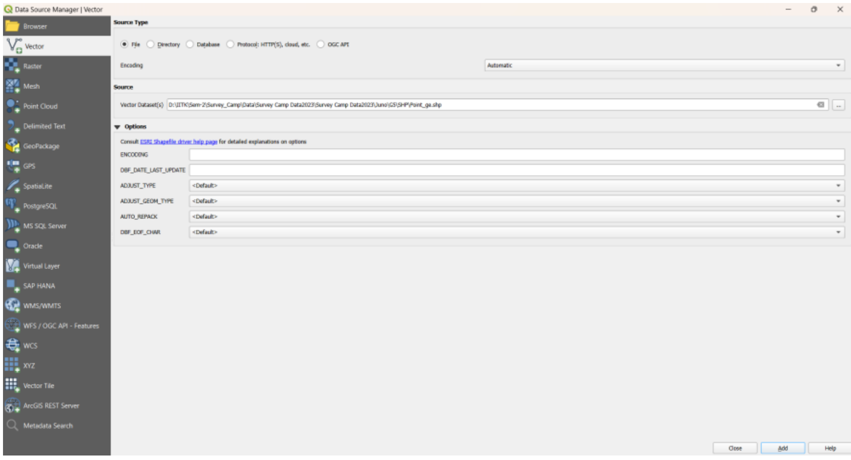

Figure 6: Adding shape file in QGIS

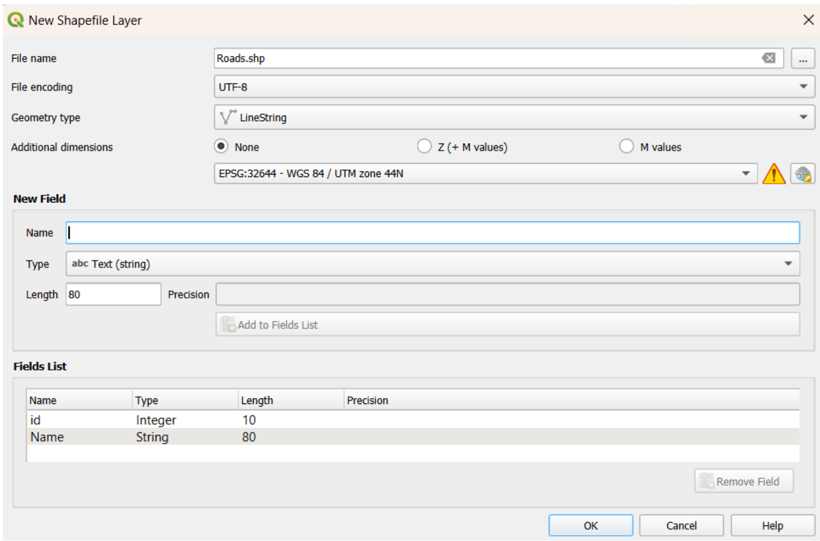

Figure 7: Creating New file for Line string for Road.

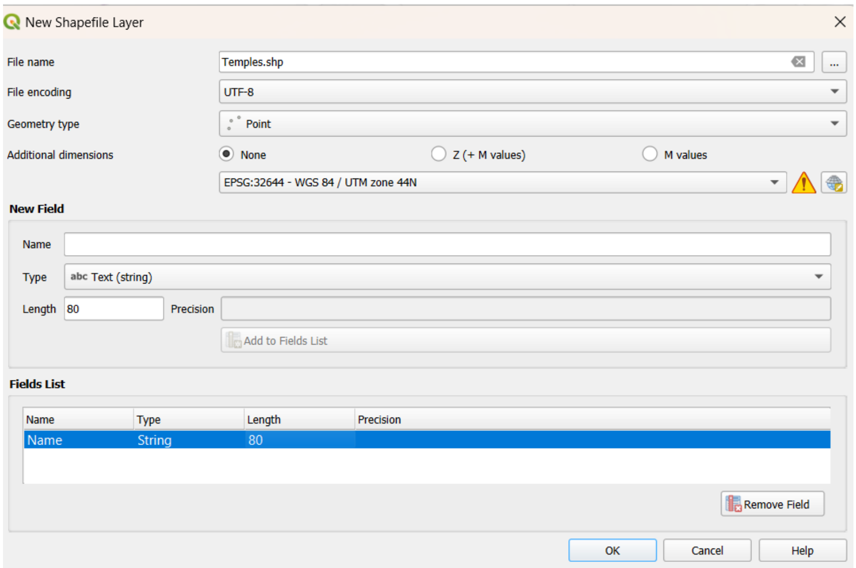

Figure 8: Creating new shape file for Point geometry type.

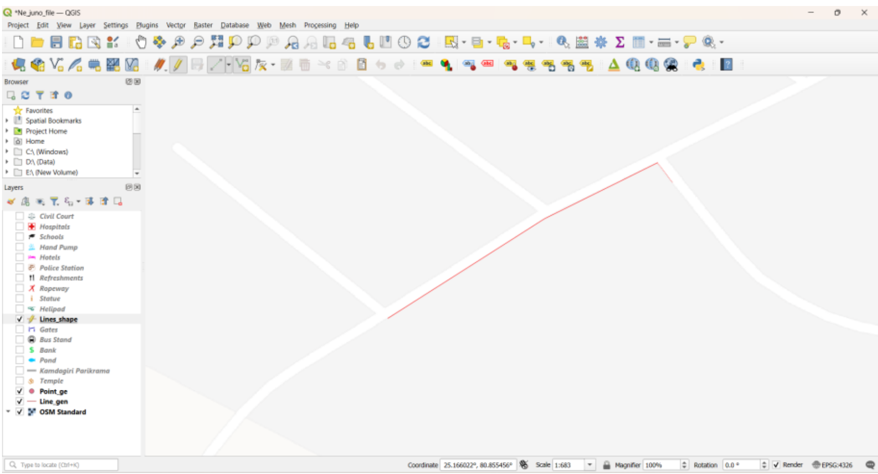

Figure 9: Creating vector Line as road feature

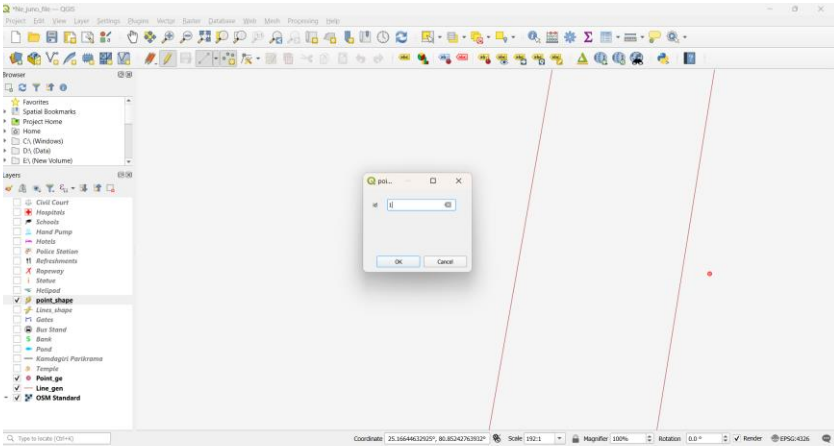

Figure 10: Creating pint data feature as shape file

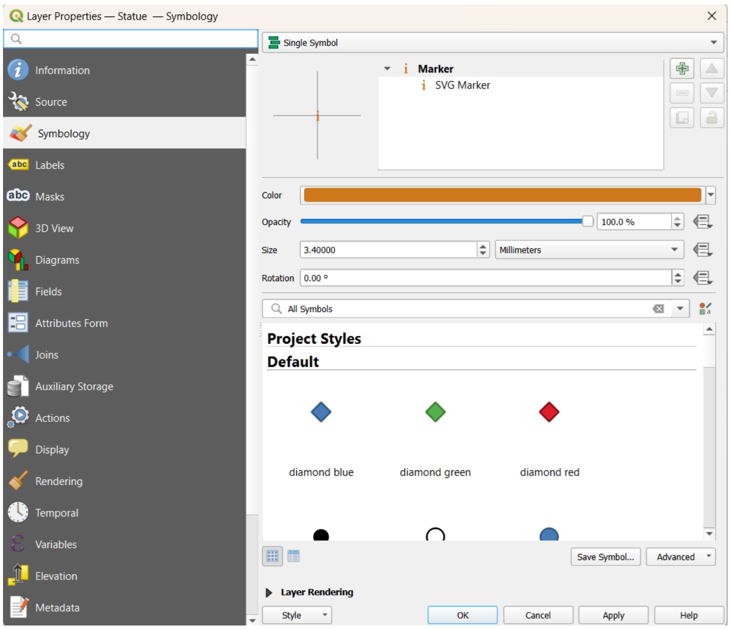

Figure 11: Opening Layer properties.

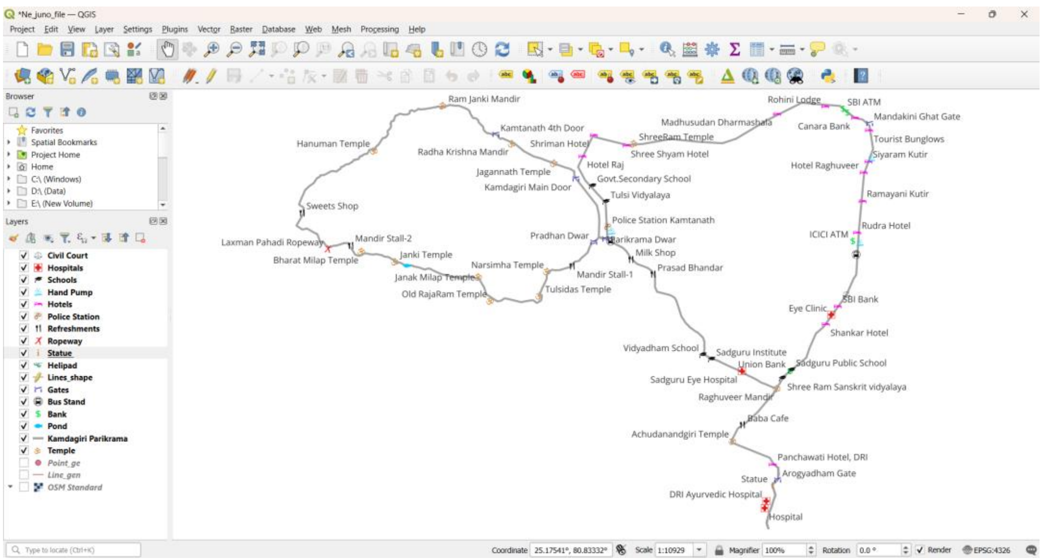

Figure 12: Digitized Line and Point features.

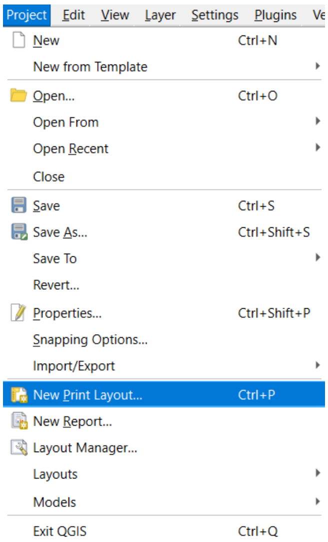

Figure 13: Opening Print Layout for creating a published map.

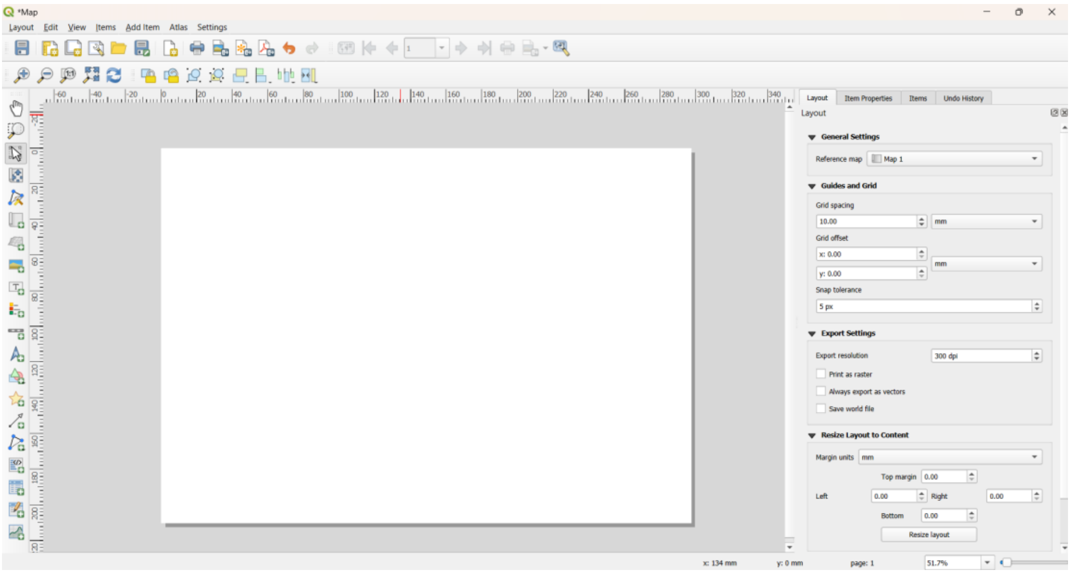

Figure 14: New Print layout.

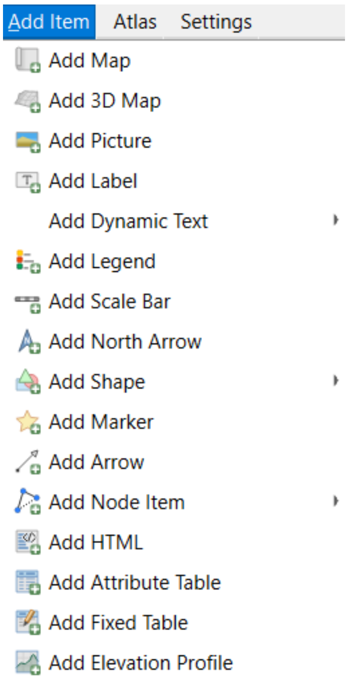

Figure 15: Add item Menu for adding features to the map.

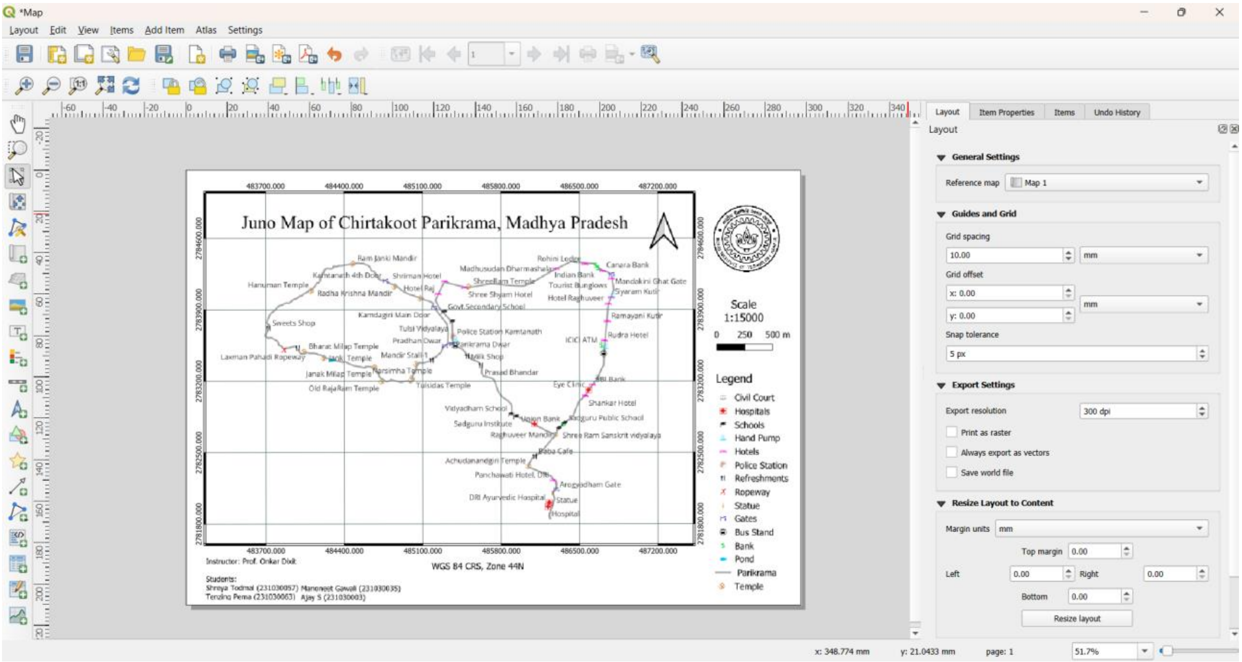

Figure 16: Created Map in Print layout

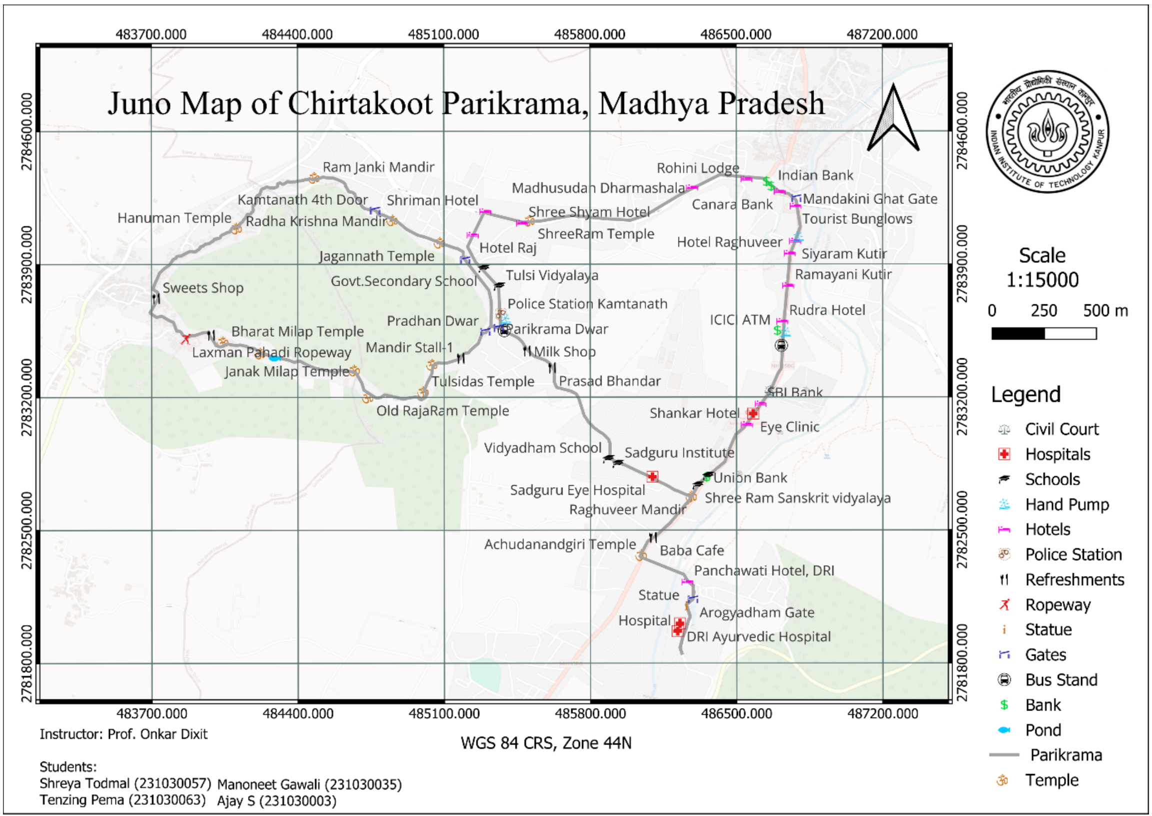

Figure 17: Navigational map created using JUNO 3B and QGIS

3.6 ArcGIS (Used to generate topographic map)

Generating Contour and map Feature using ArcGIS.
Scale of the map: 1: 1500 (Large scale map)
Plottable Error: Plottable error refers to the smallest measurable distance on the map.

$$0.25*1500 = 375mm = 37.5cm$$

A plottable error of 37.5 cm means that anything smaller than 37.5 cm might not be accurately represented on the map. In other words, features, or details smaller than 37.5 cm may not be visible or distinguishable at the given scale. So, in your map, the smallest feature that can be accurately represented is 37.5 cm. Anything smaller than that might not be visible or might not accurately reflect its true size or position on the map.
Contour interval as 1m, as we have large scale map and ground type is rolling.

3.6.1 Contour Map: Digitization of point data to features

Digitizing point data in QGIS is a fundamental GIS task with diverse applications ranging from data visualization and analysis to field data collection and historical research. It is a powerful tool for understanding and exploring spatial relationships within a geographic context.
Add coordinate system

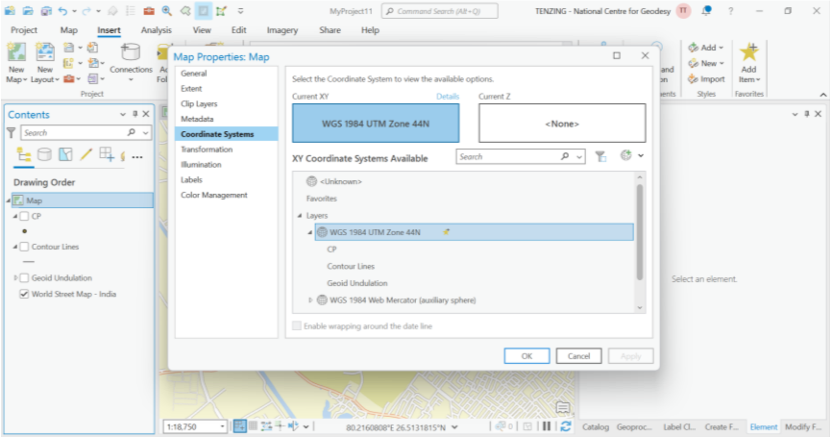

Figure 18: Adding the coordinate system

Add Delimited text file

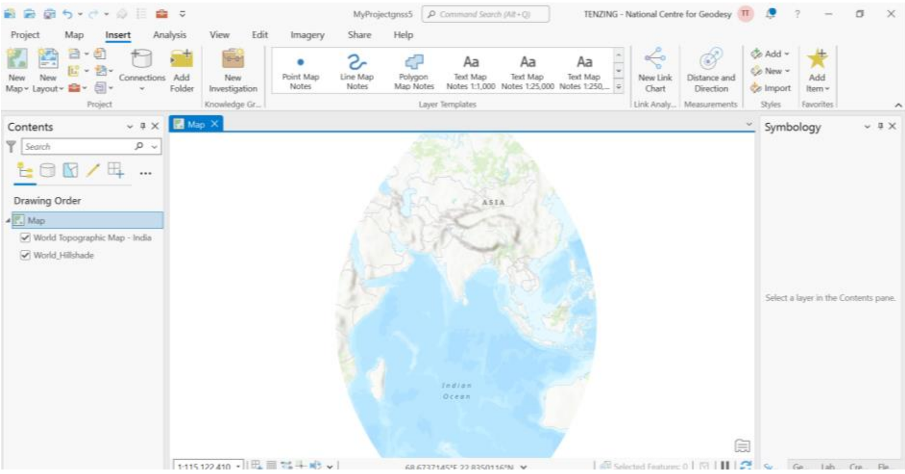

Figure 19: ArcGIS interface left side showing delimited text layer

Add the.CSV file

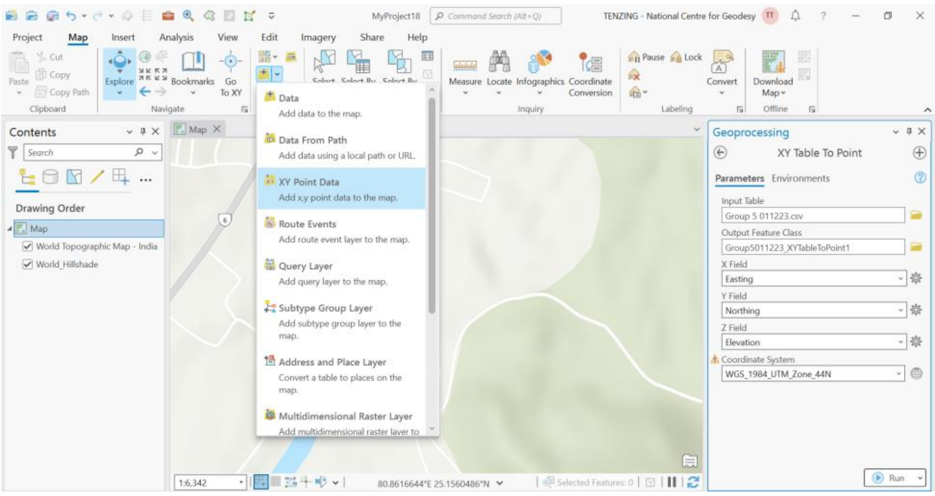

Figure 20: Adding XY point data

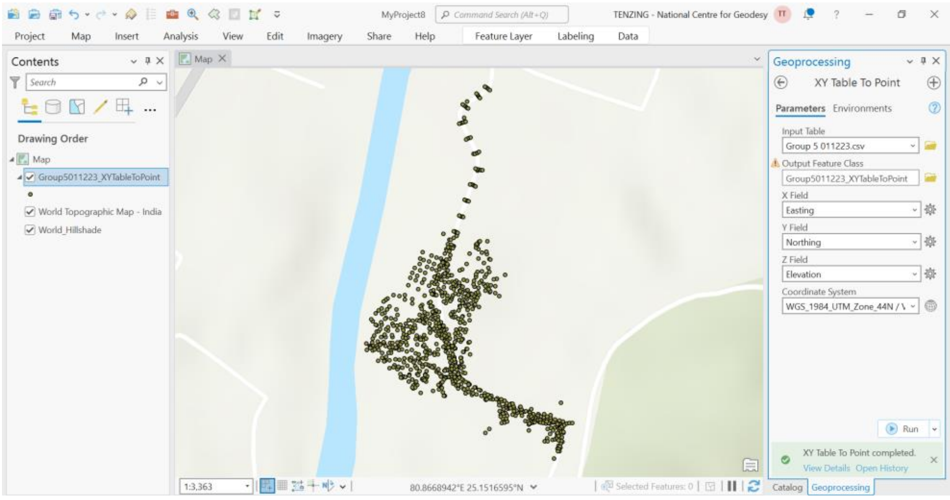

Figure 21: point data generated

Add Base Map "Quick map services"

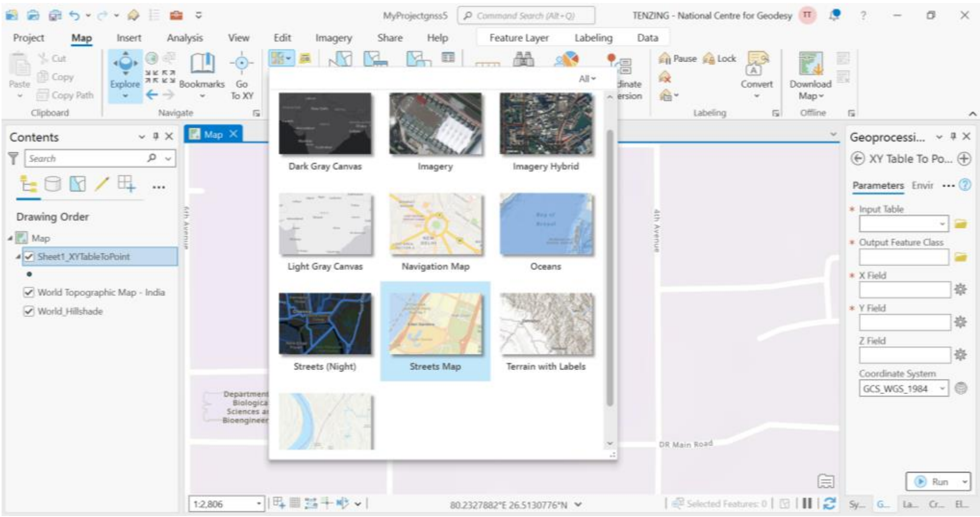

Figure 22: Adding Base Map satellite imagery

Check for correct geographical location

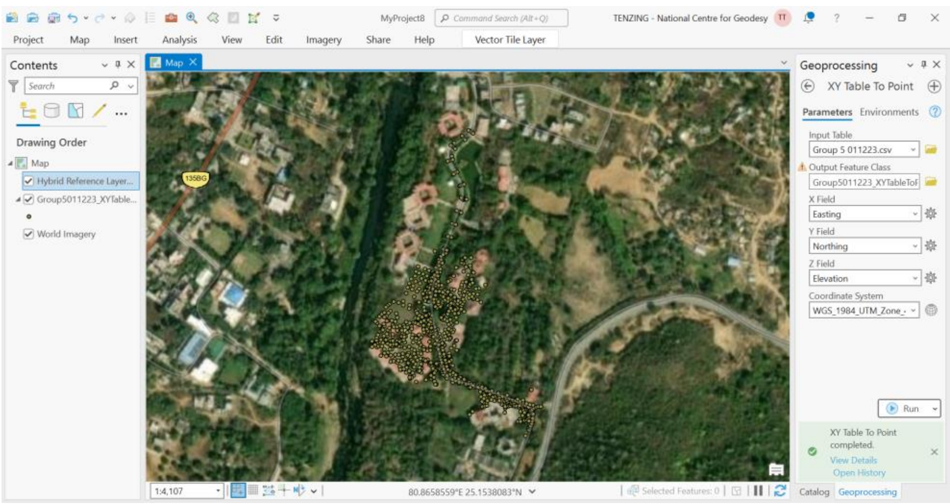

Figure 23: displaying the georeferenced points on base map

Interpolating topo to raster to generate DEM:

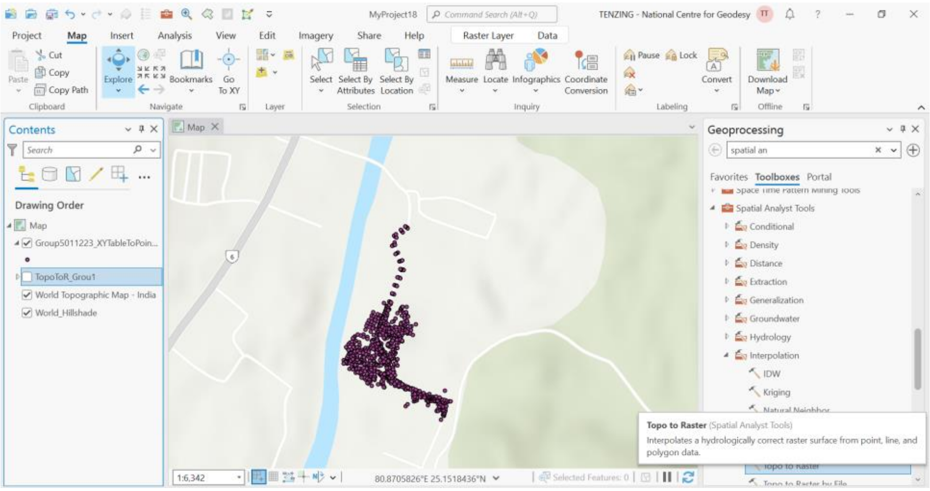

Figure 24: Topo to raster interpolation

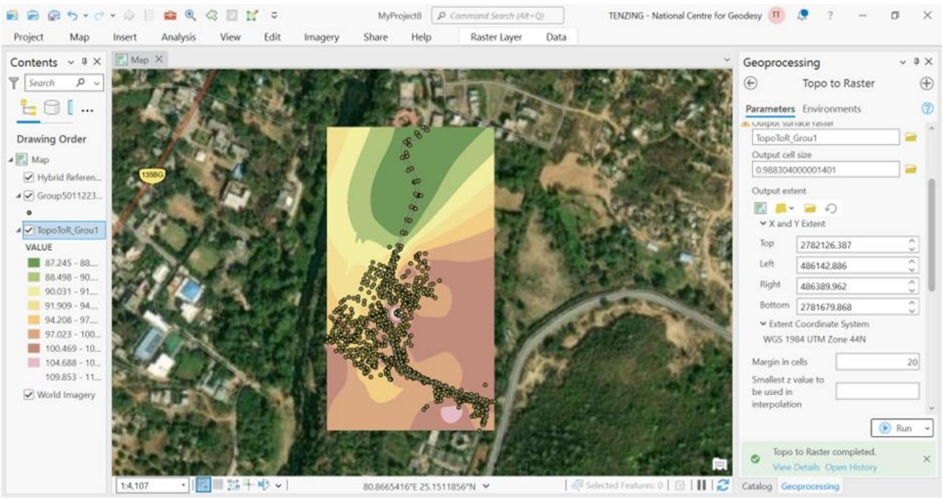

Figure 25: Displaying DEM generated

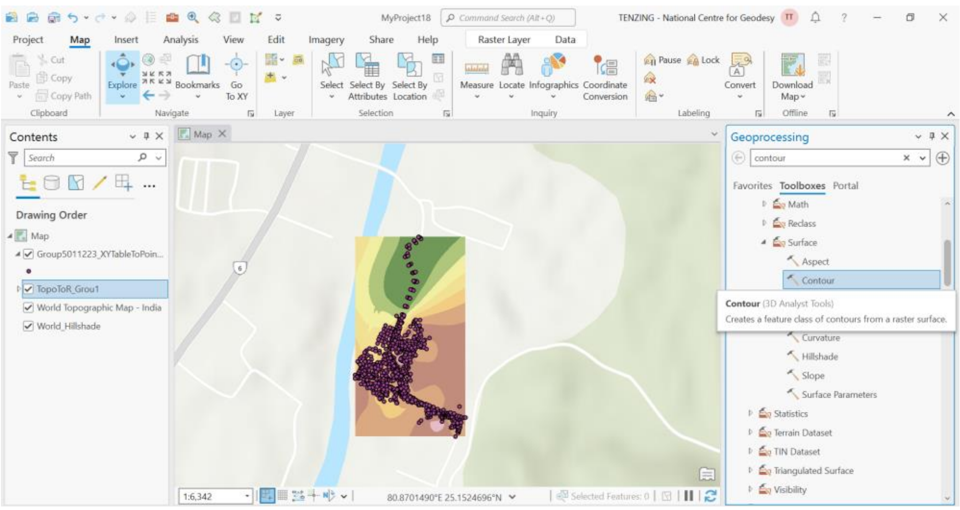

Figure 26: Interface showing toolboxes for contour

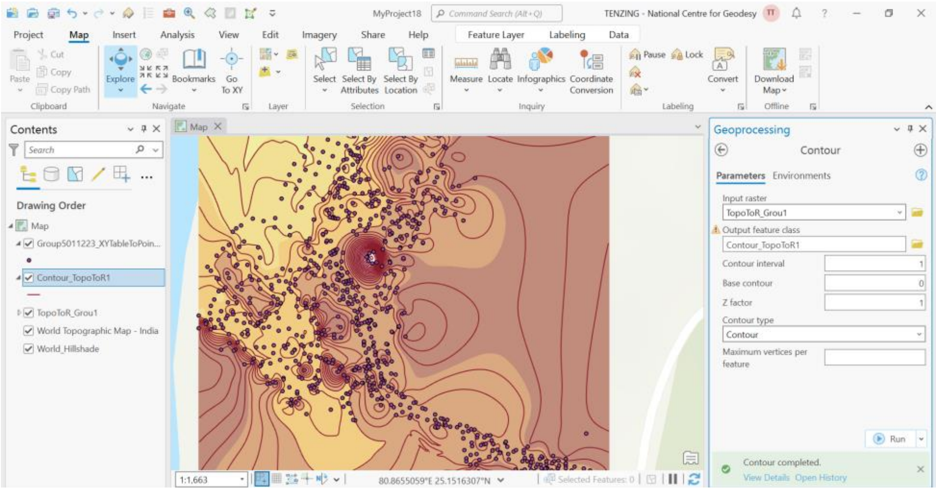

Figure 27: Contour Map generated at an interval of 1m

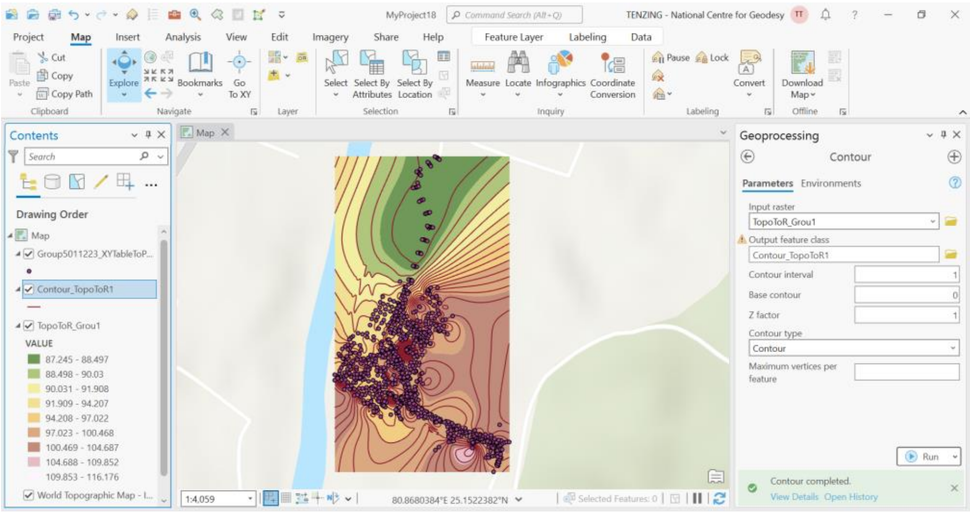

Figure 28: Contour generated

Use Symbology for displaying various colours, width etc.

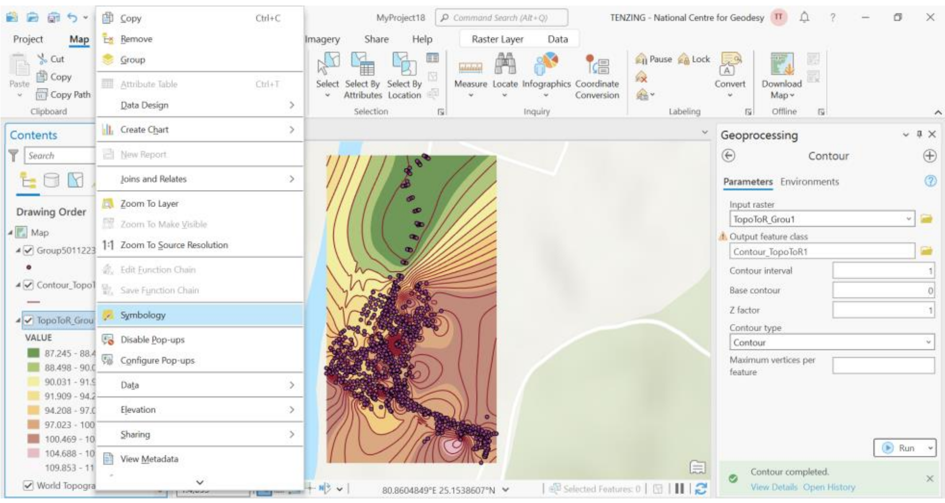

Figure 29: Symbology

Attributes table Showing various datas

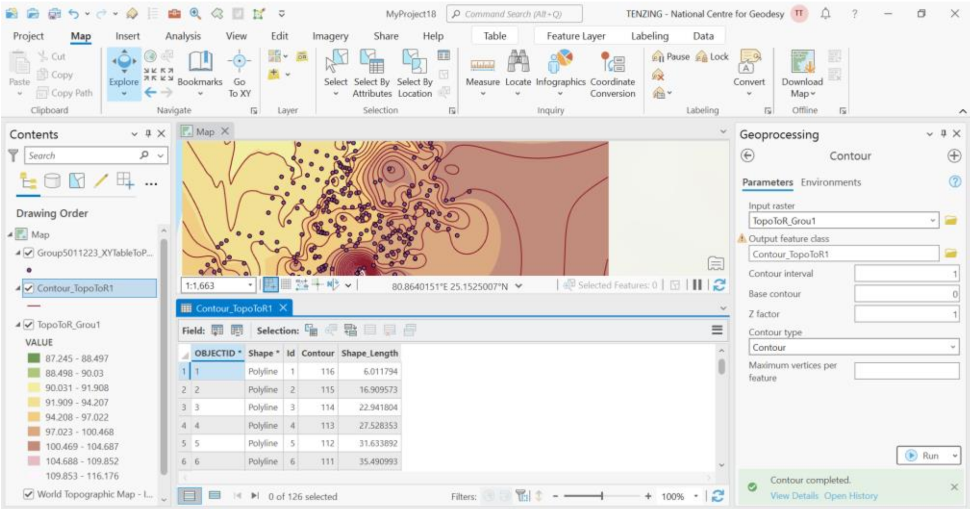

Figure 30: Attributes table

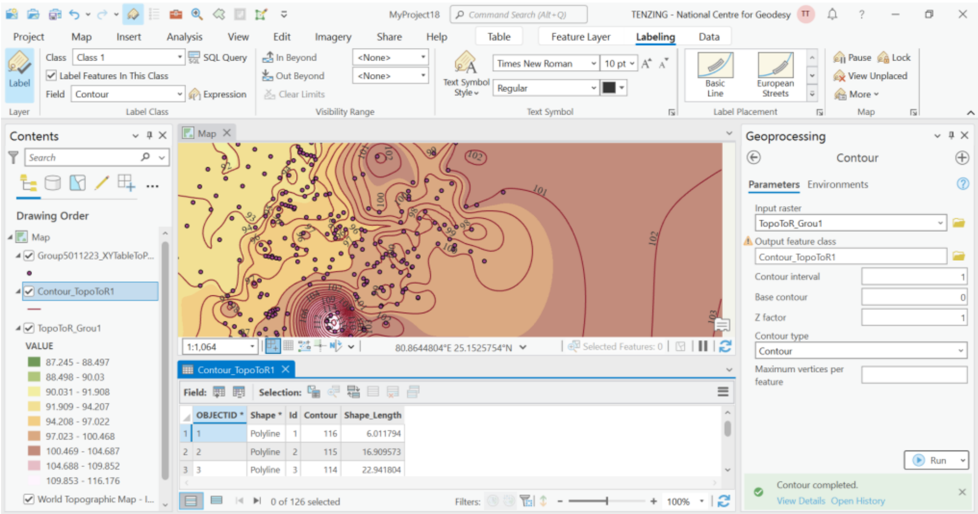

Figure 31: Labelling the generated Contour

3.7.2 Feature Map

Creating various feature class like lines, polygons and point .shp files

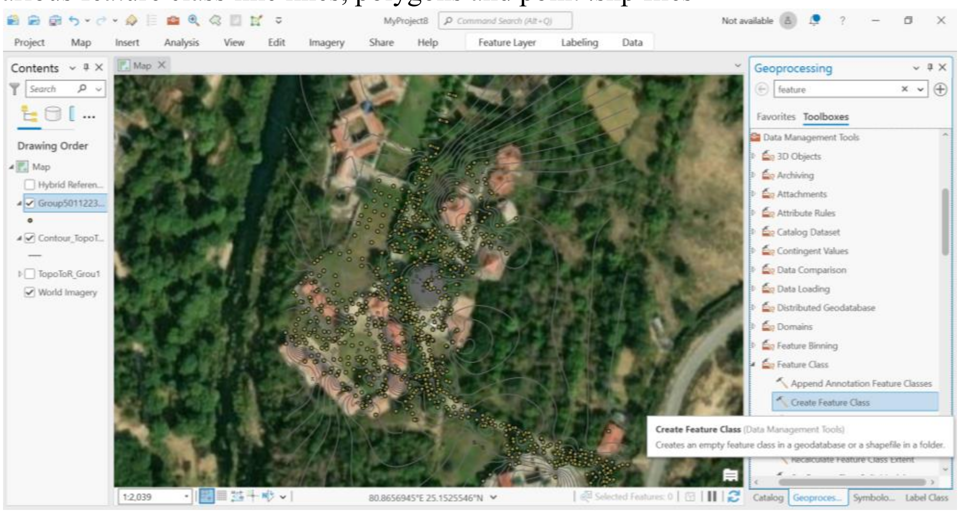

Figure 16: Use the code/name property to view different features individually

Digitization, is the process of converting features into a digital format, it is one way to create data in GIS environment.

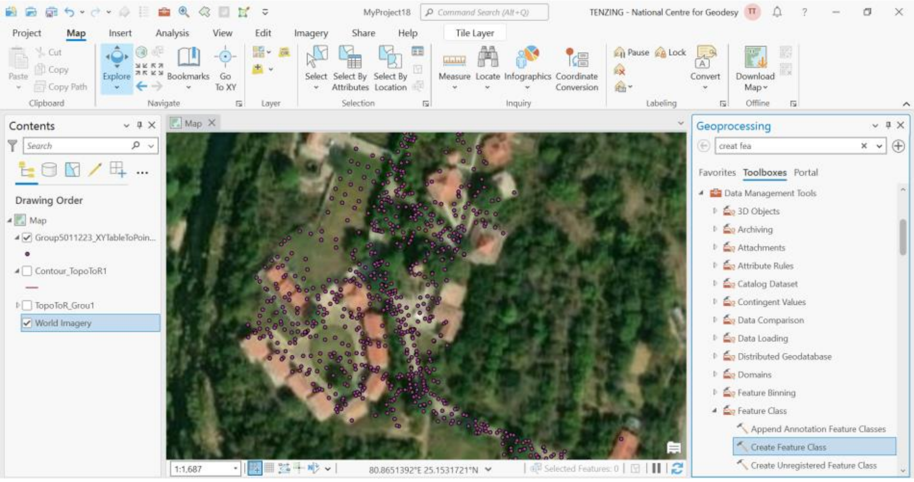

Figure 32: Digitizing toolbar

Once various points, lines, polygon **.shp file.** Start plotting the map.

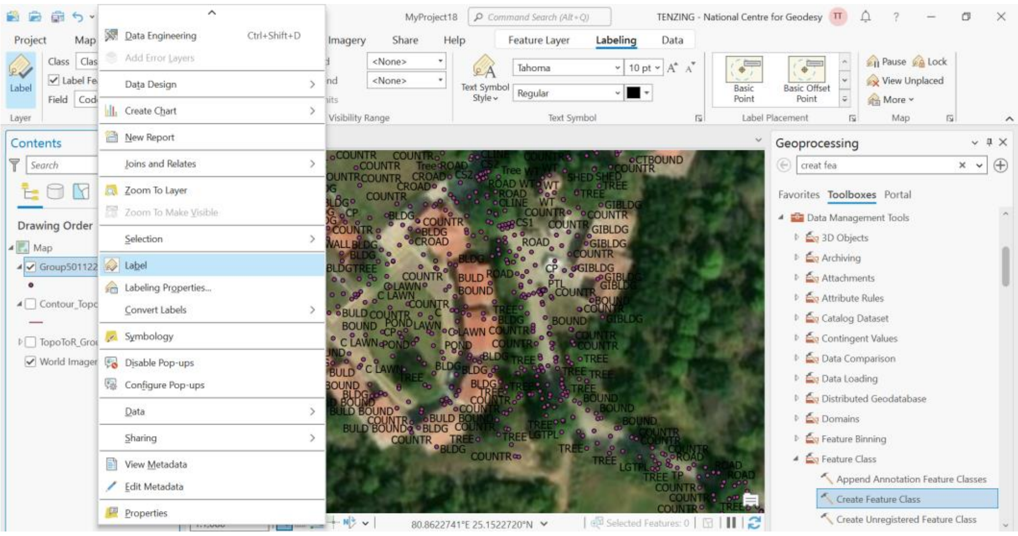

Figure 33: Labels showing various feature codes

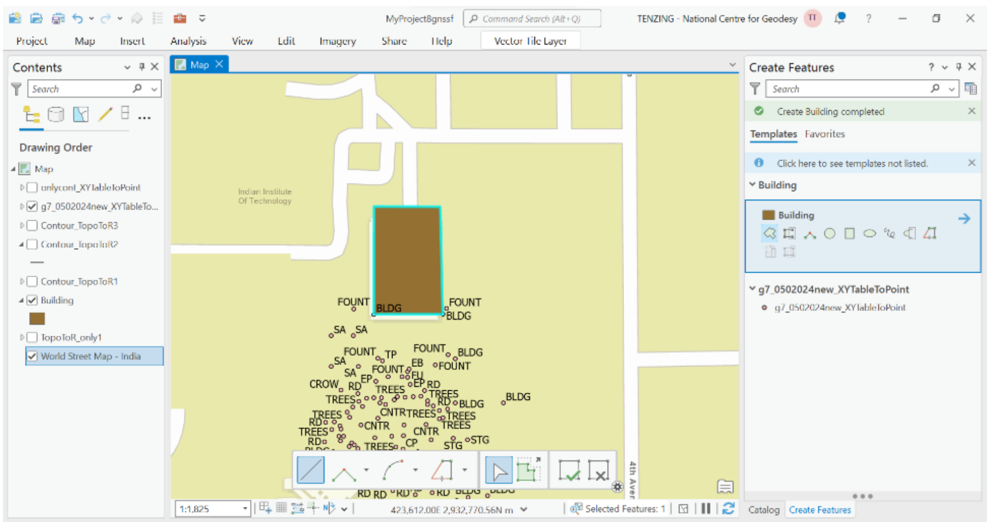

Figure 34: Mapping the area using the point data's

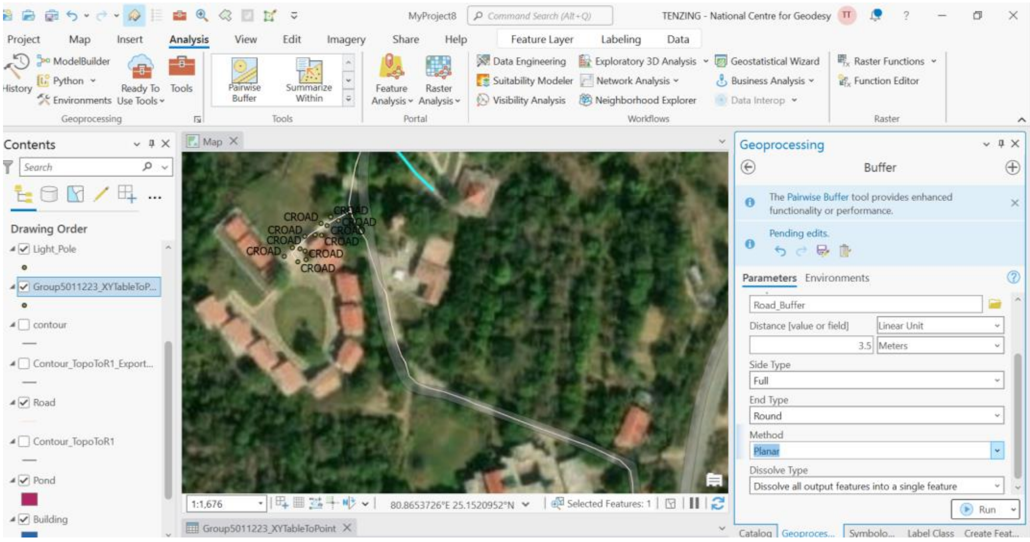

Figure 35: Creating road as line feature

Using Buffer tool

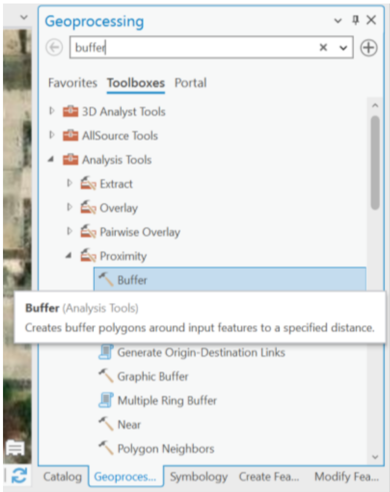

Figure 36: Buffer tool box

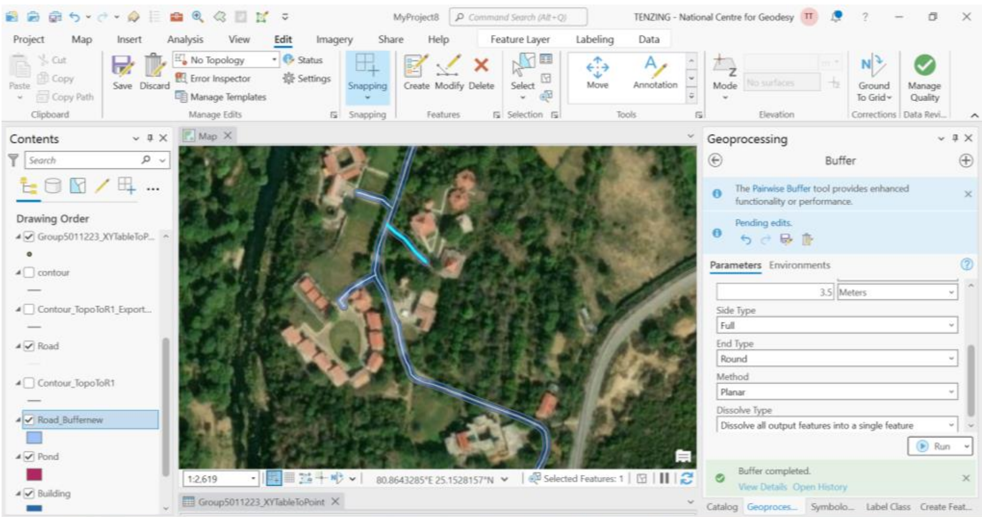

Figure 37: Using Buffer tool on Digitized road to generate smooth road features without sharp edges

Dissolve all features

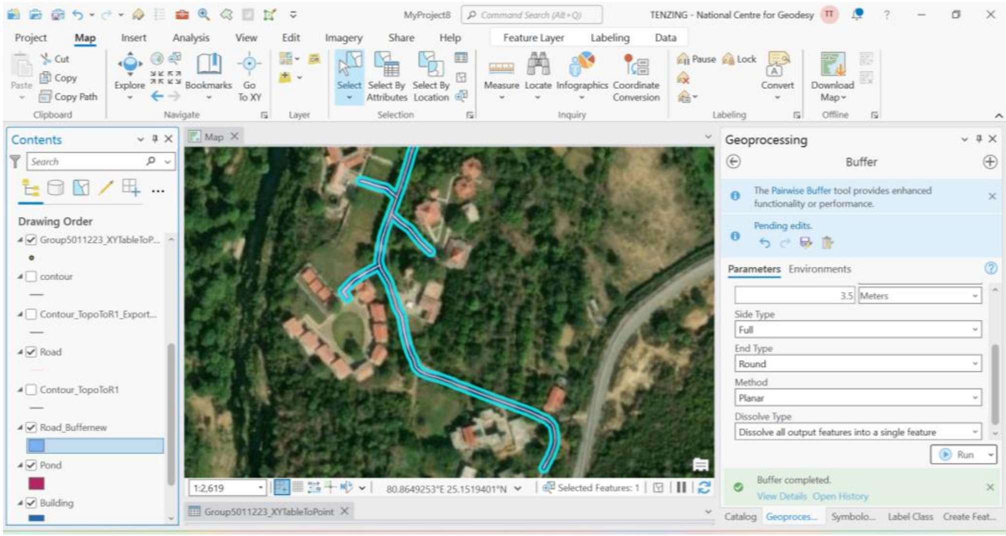

Figure 38: Buffered road of 3.5m

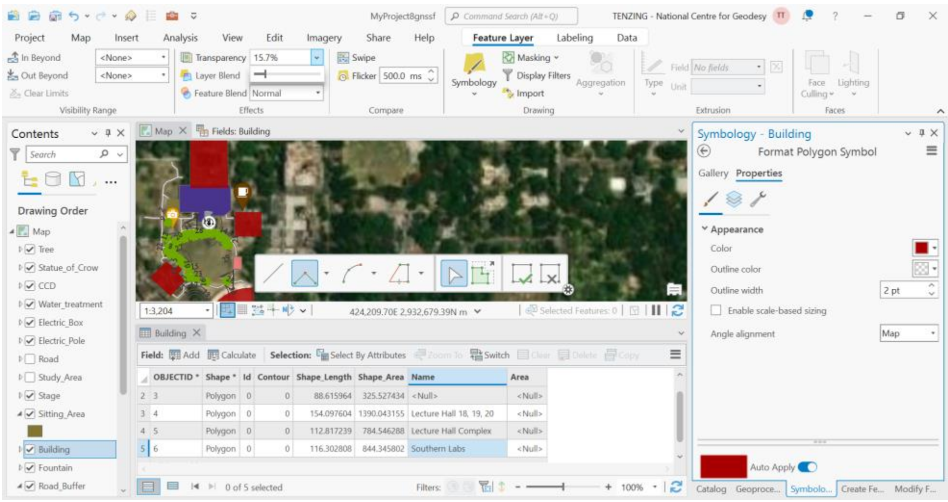

Figure 39: Add in various labels

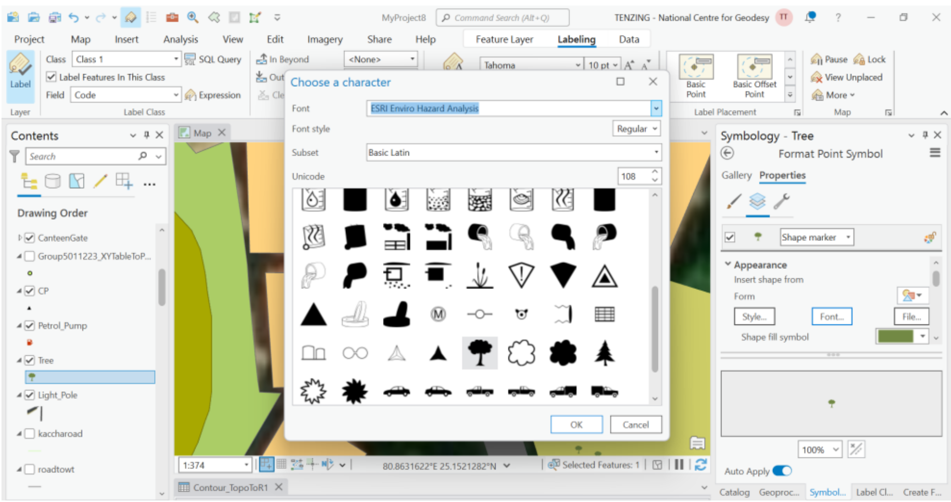

Figure24: usings symbology to modify the shp files with different colours

Map Layout:

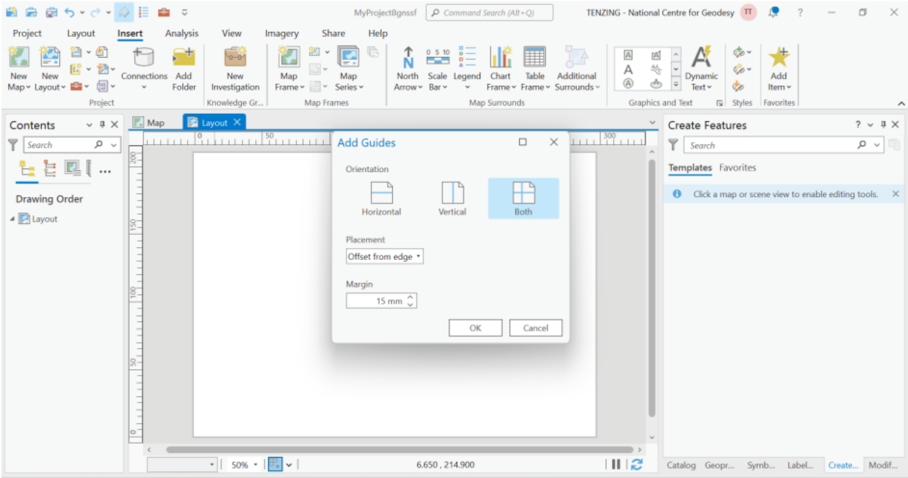

Figure 40: Add Guides

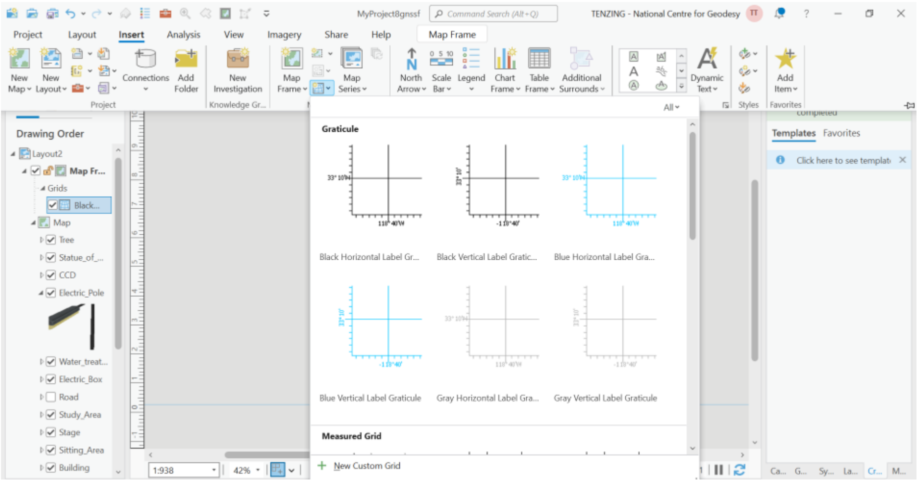

Figure 41: Add Grids

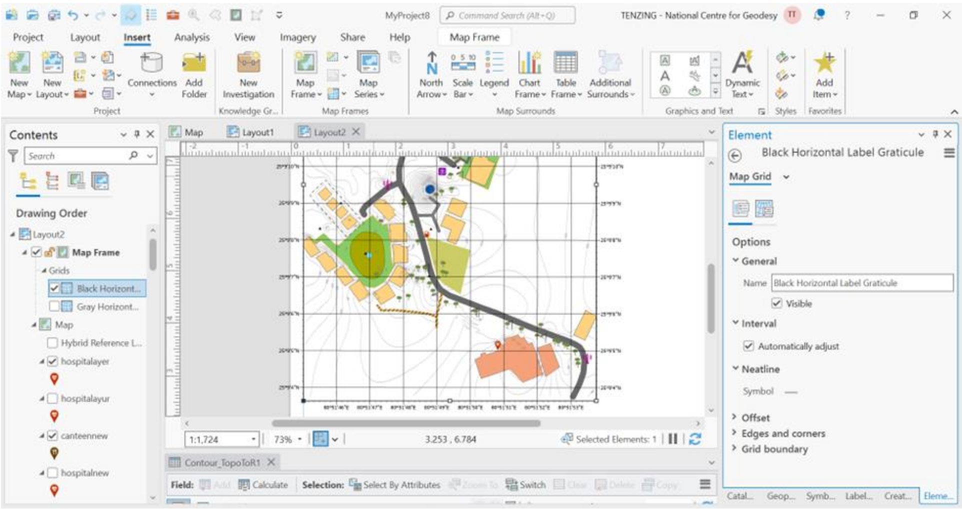

Figure 42: Added Grids

Arrange Grid Orientation, Showing Grids as dash lines.

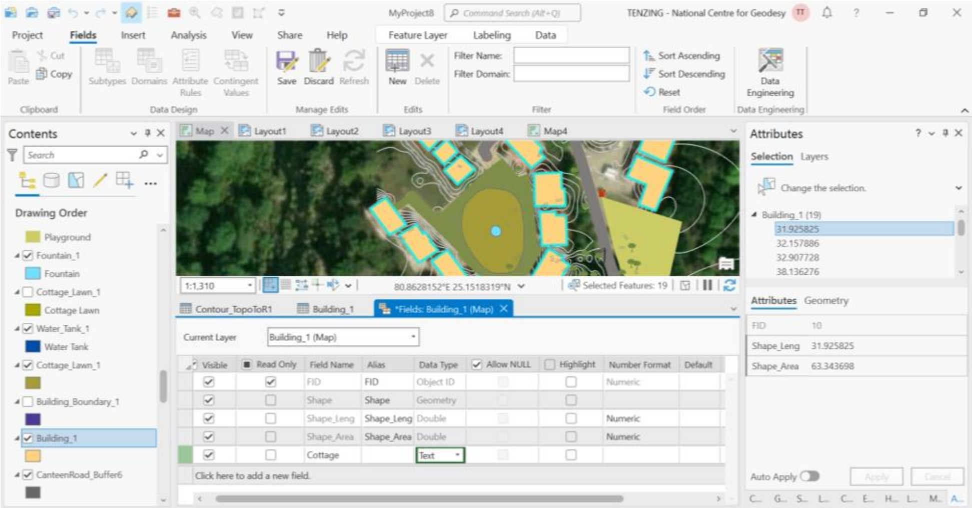

Figure 43: Adding building names by creating new fields

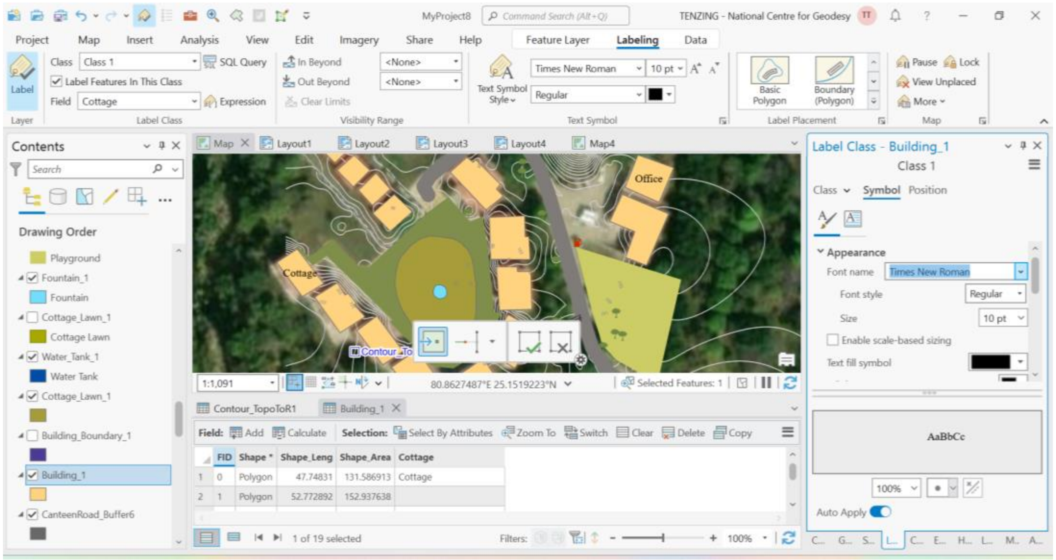

Figure 44: Assigning proper labels of the area

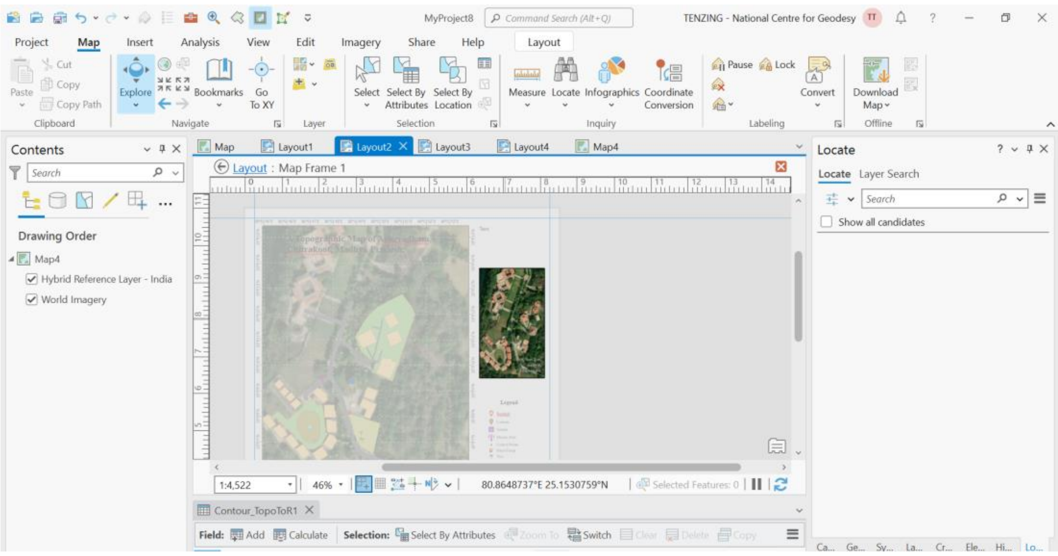

Figure 45: Adding the details of the study area

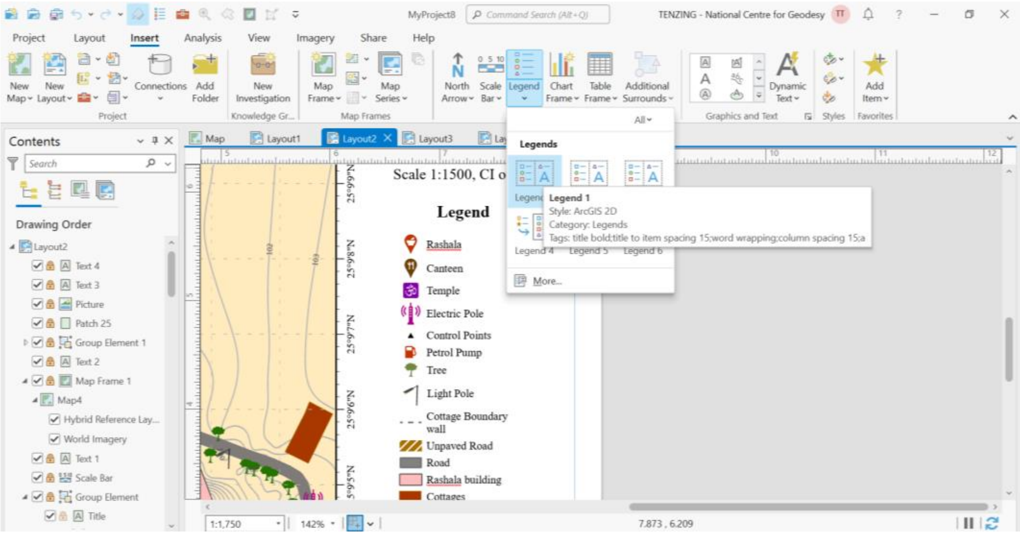

Figure 46: Adding the legends

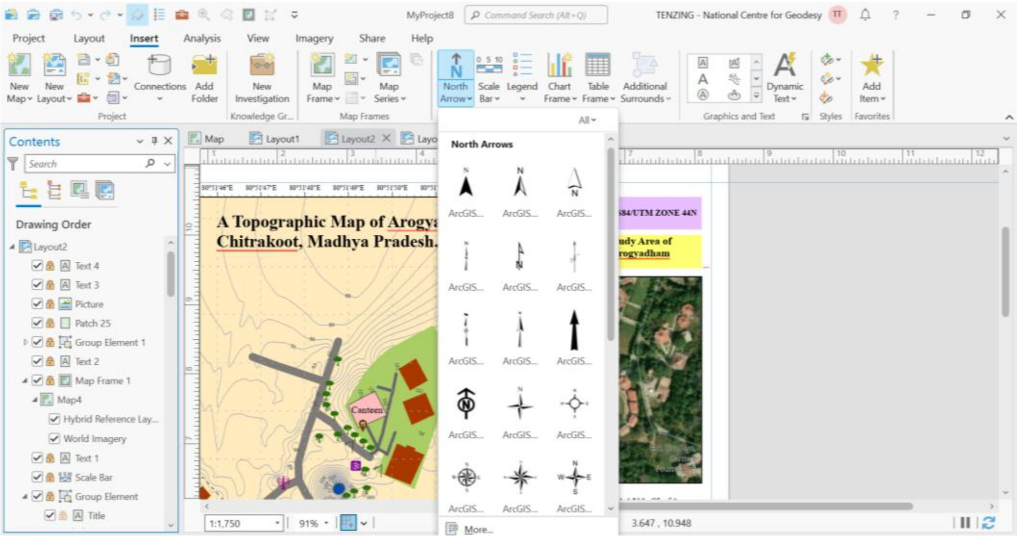

Figure 47: showing North Arrow

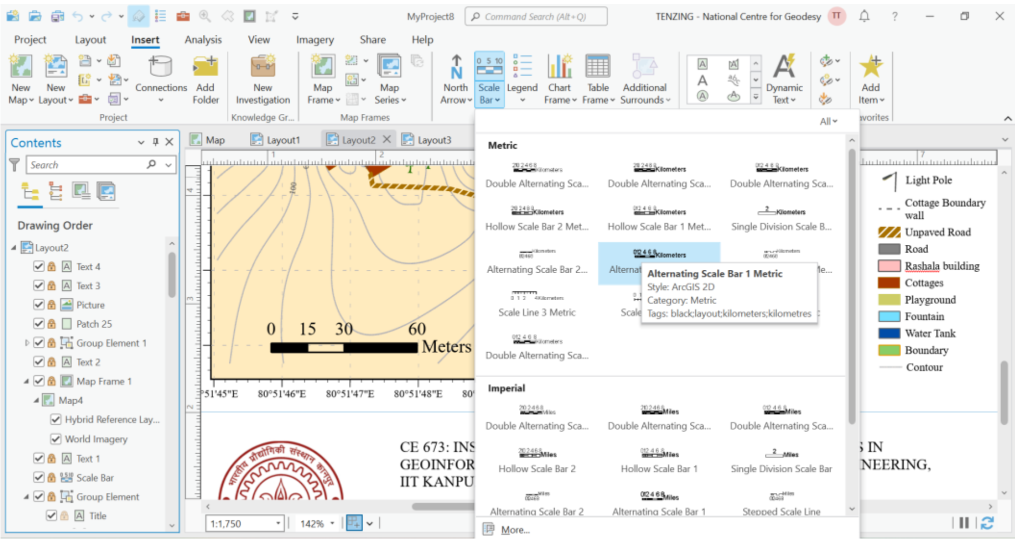

Figure 48: Adding scale

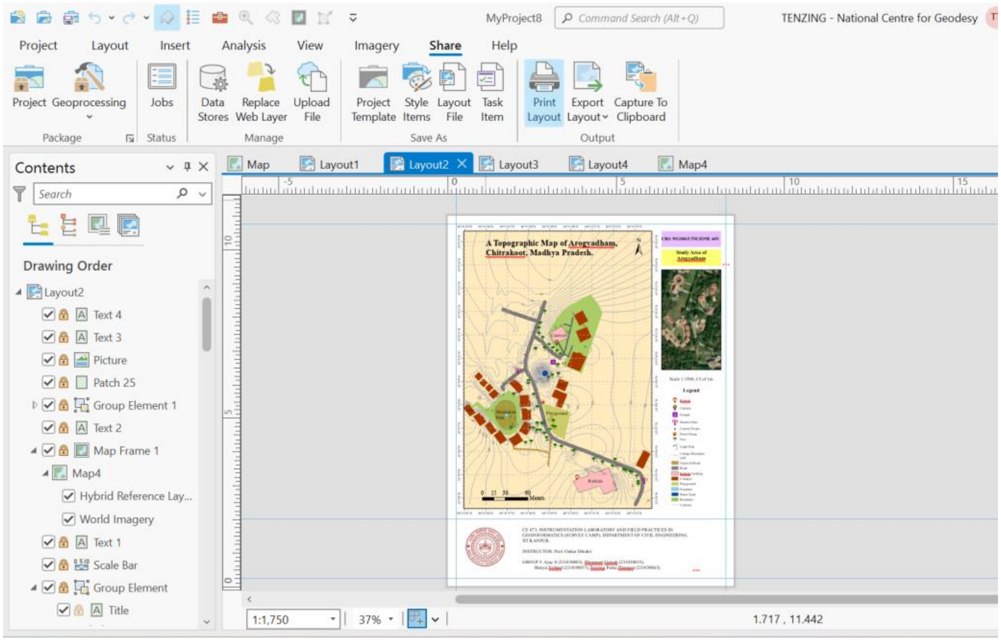

Figure 49: Exporting Map Layout

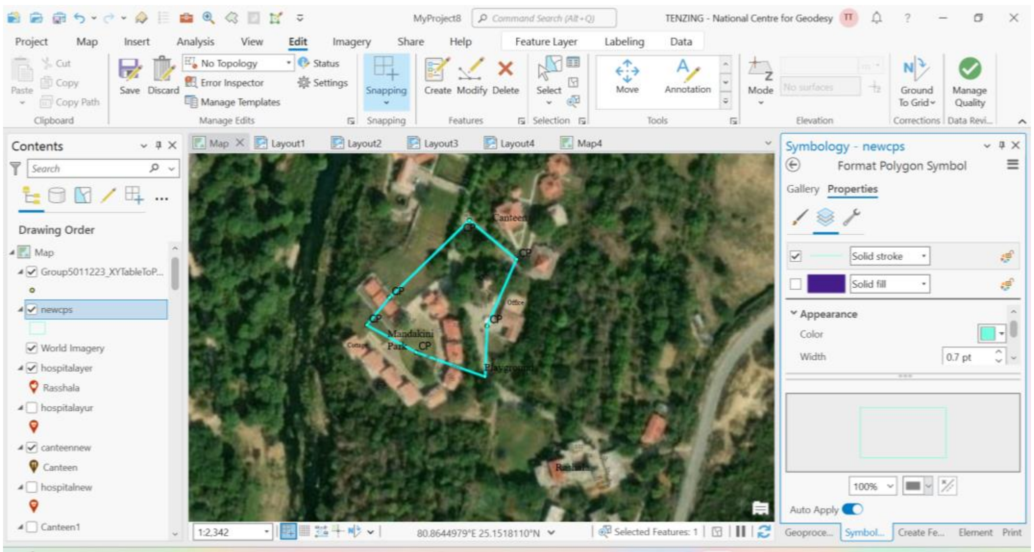

Figure 50: Displaying the seven control points (CP's) that were employed in the survey

GNSS technology provides highly accurate and efficient positioning and navigation data, including latitude, longitude, and altitude. GNSS can cover large areas quickly, making it ideal for large-scale projects and remote locations. GNSS devices are relatively easy to use and provide digital data that can be integrated into GIS and CAD systems. It provides real-time data, which can be useful for immediate decision-making during fieldwork. It offers precise control points that are essential for accurate mapping and establishing geospatial reference frames.

Map Generated:

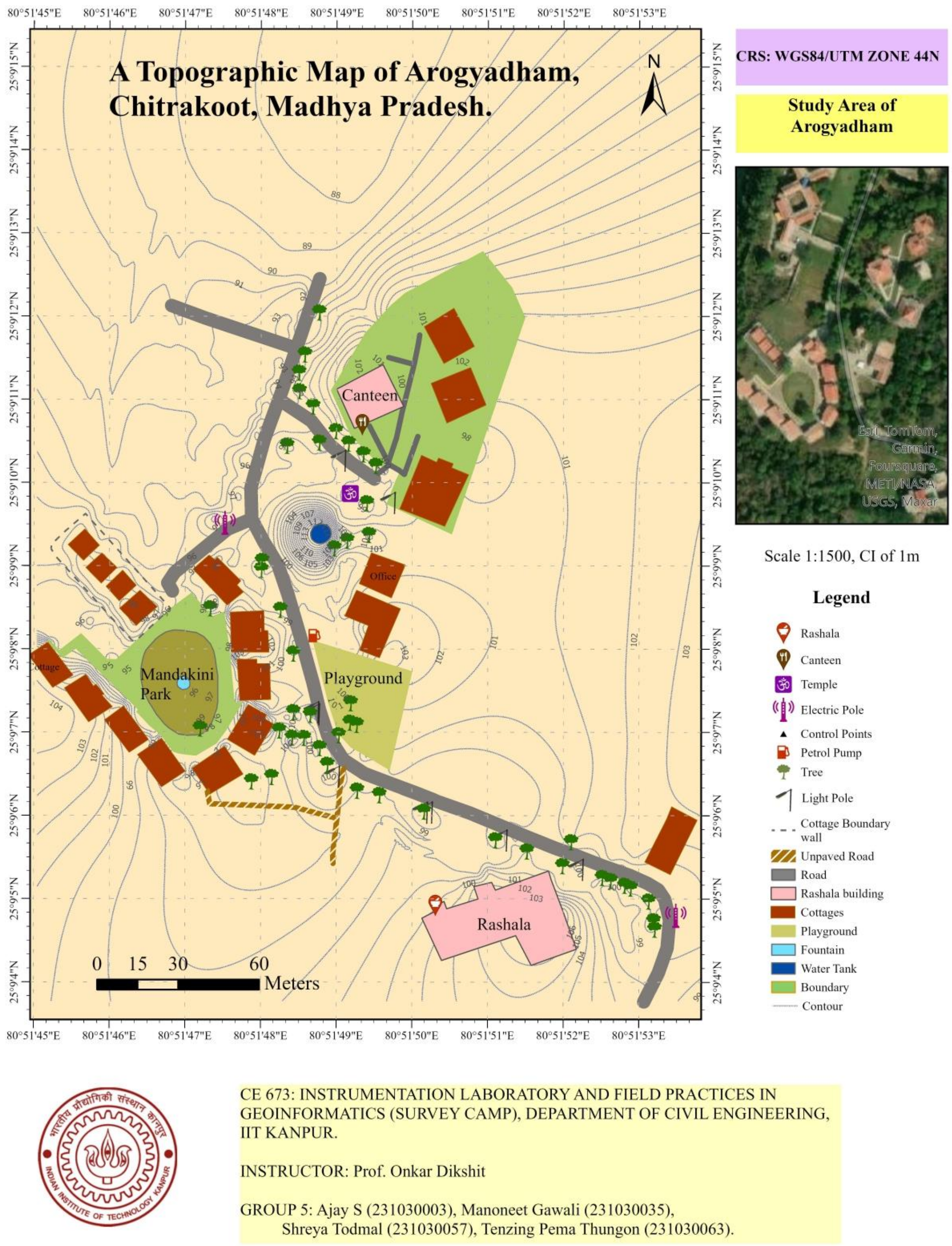

Figure 51: Topographic Map Generated

3.7 Road Profile

Road profiling is a crucial process in civil engineering and infrastructure development projects. It involves the systematic collection of data along a road or highway to analyse its vertical and horizontal alignment, as well as its cross-sectional characteristics. This data is essential for various purposes, including road design, maintenance planning, and infrastructure management. By understanding the elevation and slope variations along the road, engineers can identify potential issues such as steep gradients, drainage problems, and road surface irregularities, allowing for effective design and maintenance strategies.

- Marking Sections: To begin the road profiling process, sections along the road are marked at regular intervals. In this case, sections are marked every 20 meters along the main road connecting the main entrance of Aarogyadham to the main office in Chitrakoot, Madhya Pradesh. These sections are marked using paint for visibility.
- Division of Sections: Each 20-meter section of the road is divided into smaller segments to facilitate detailed analysis. Since the road has a width of 3.6 meters, each section is divided into four subsections, each with a width of 0.9 meters. This division allows for a more granular examination of the road's profile.
- Total Station Setup: A Total Station, a precision optical instrument used in surveying and construction projects, is set up at a control point near the road. The Total Station is positioned to have a clear line of sight to the marked sections along the road.
- Data Collection: Using the Total Station, readings are taken at five points marked on each section of the road. These points are typically located at predetermined intervals within each section. A reflector is placed on each point to facilitate accurate distance and elevation measurements.
- Data Analysis: The data collected by the Total Station includes coordinates (Easting and Northing) and elevation for each surveyed point. This data is then used to plot longitudinal and transverse profiles of the road.
- Longitudinal Profile: The longitudinal profile of the road is plotted by graphing elevation against distance along the road. The distance intervals typically correspond to the spacing between the marked sections.
- Transverse Section: The transverse section of the road is plotted by graphing elevation against distance from the edge of the road for each section. This analysis helps identify variations in elevation across the width of the road, which is critical for understanding the road's cross-sectional characteristics.

The following figure displays the road profile that was thus plotted:

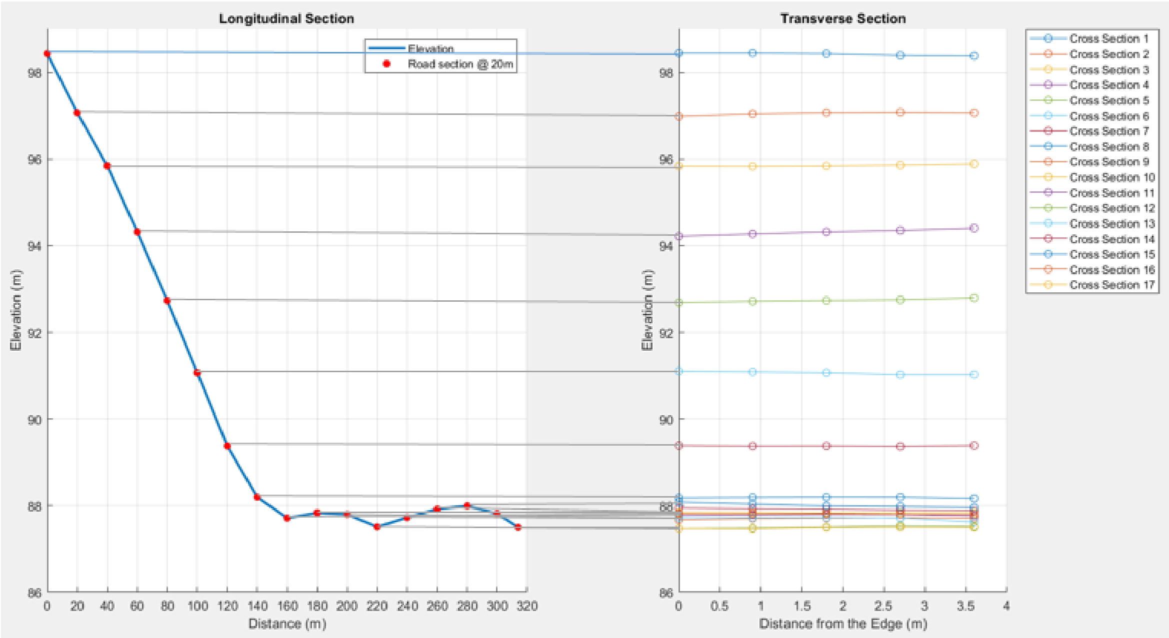

Figure 52: side and top view of Road profile

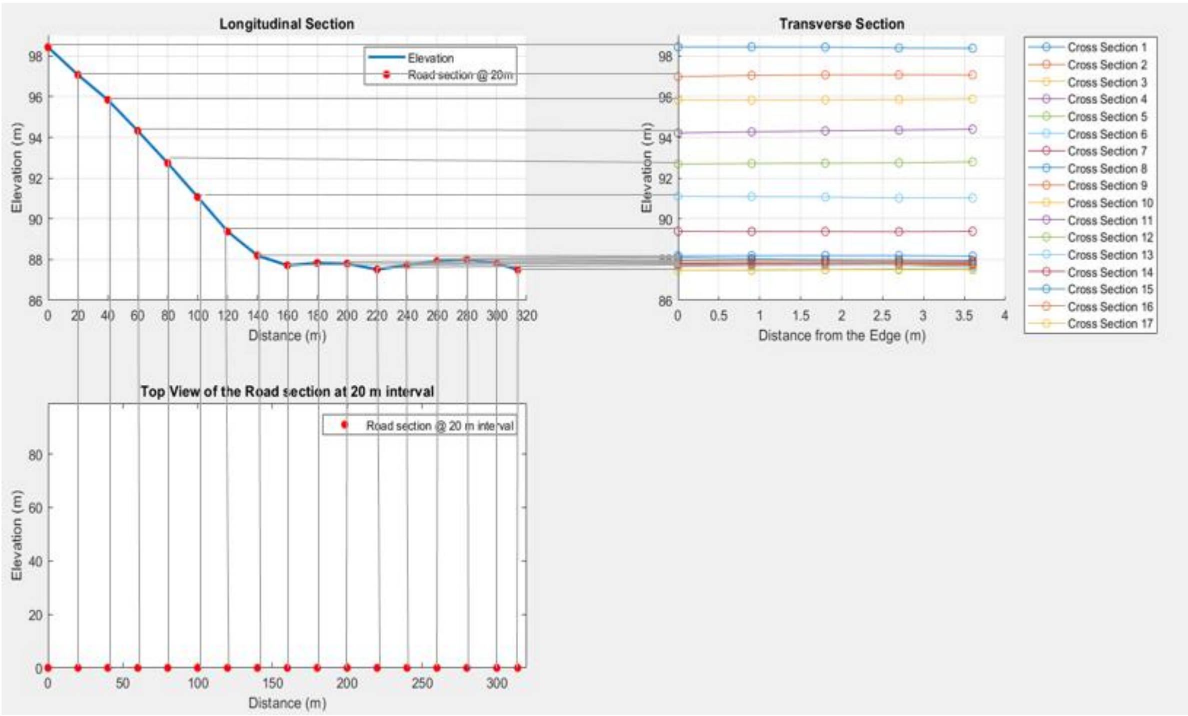

Figure 53: Longitudinal Section, transverse and Top view of the Road Profile

3.8 CALIBRATION FOR EDMI

EDMI : (Electronic Distance Measurement Instrument) is essential to ensure the accuracy and reliability of distance measurements taken using the instrument. Calibration helps identify and correct any errors or discrepancies in the instrument's measurements, including cyclic error curve, reflector-instrument error, and scale error. By calibrating the EDMI, users can trust the accuracy of their measurements, which is crucial for various surveying and construction applications.

Equipment: EDMI, Tape, Reflector, Tripod, Staff.

1) Non linearity/ cycle error:

Station	Taped dist di(m)	taped distance	EDMI dist, Di (m)	Do + Sd (m)	Di-(D0+sum(d)) (m)	correction
0	20	0	19.995	20	-0.005	0.0045
1	21	1	20.997	21	-0.003	0.0042
2	22	2	21.993	22	-0.007	0.0035
3	23	3	22.996	23	-0.004	0.0035
4	24	4	23.991	24	-0.009	0.0026
5	25	5	24.989	25	-0.011	0.0024
6	26	6	25.988	26	-0.012	0.0023
7	27	7	26.988	27	-0.012	0.0023
8	28	8	27.994	28	-0.006	0.0017
9	29	9	27.994	29	-1.006	-0.0983
10	30	10	29.993	30	-0.007	0.0016

The table shows the comparison between the taped distances and the distances measured by the EDMI (Di). The column "Di-(D0+sum(d))" represents the difference between the measured distance and the corrected distance. The correction values are calculated based on the differences observed.

2) Reflector-instrument constant (K):

$$K = \frac{D - \sum di}{n - 1}$$

Taped dist di(m)	EDMI dist., Di (m)	Each segment length
20	3.024	0
21	4.01	1.01
22	5.01	1.01
23	6.015	1.015
24	7.013	1.013
25	8.019	1.019
26	9.009	1.009
27	10.005	1.005
28	11.005	1.005
29	12.009	1.009
30	13.013	1.013

Sum of Di = 10.108

D =10, n = 10   therefore K= -0.012

- The reflector-instrument constant (K) is determined to account for any constant error introduced during measurements.
- It is calculated based on the difference between the sum of EDMI distances and the sum of taped distances.
- A negative value of K indicates that the measured distances are slightly longer than the actual distances, suggesting a systematic error in the instrument.

3) Scale error:

Dk : known distance = 10 m

Dm: Measured distance = 10.108 m

$$Scale\ error(ppm) = \frac{Dk - Dm}{Dk} * 10^6 = -0.108$$

Corrected distance:

Taped dist. di(m)	EDMI dist., Di (m)	Each segment length	Corrected distance (m)
20	3.024	0	19.77905
21	4.01	1.01	20.77023
22	5.01	1.01	21.75548
23	6.015	1.015	22.74764
24	7.013	1.013	23.7319
25	8.019	1.019	24.71912
26	9.009	1.009	25.70733
27	10.005	1.005	26.69653
28	11.005	1.005	27.69166
29	12.009	1.009	27.69166
30	13.013	1.013	29.66908

- The scale error is calculated to determine the discrepancy between the known distance (Dk) and the measured distance (Dm).
- A negative scale error indicates that the measured distances are slightly longer than the known distances.
- This error is expressed in parts per million (ppm).
- The corrected distances are calculated by applying the scale error correction factor to the measured distances.

Overall, these results indicate that the EDMI exhibits some non-linearity or cycle error, a slight reflector-instrument constant, and a small-scale error. By applying the corrections obtained from the calibration process, the accuracy of distance measurements taken with the EDMI can be improved, ensuring more reliable surveying and construction outcomes.

3.9 Distance measurement using chain and tape:

Chaining is the method of measuring distances using a chain or tape, with a chain typically used for ordinary precision work and a steel tape for greater accuracy. The term "chaining" encompasses both measuring distances with a chain or tape.

Equipment's used:

Ranging rods, Pegs, Ranging Pins, Tape, Chain, Cross staff, Optical square, Prismatic Compass , Tripod, Ranging poles.

- In chaining, a survey party typically consists of a leader (at the forward end of the chain), a follower (at the rear end of the chain), and an assistant to establish intermediate points.
- The precision of chaining varies from 1/1000 to 1/30,000 for ordinary work, while precise measurements like baseline can reach up to 1,000,000.
- A chain consists of links connected by oval rings for flexibility and brass handles for dragging, each with a swivel joint to prevent twisting.
- Ranging rods are used for marking stations and ranging lines, painted alternately black and white or red and white for visibility.
- The chain's adjustment should be symmetrical to ensure the central tag's position remains unchanged.
- During measurement, the chain should be laid out straight between end stations along the survey line.

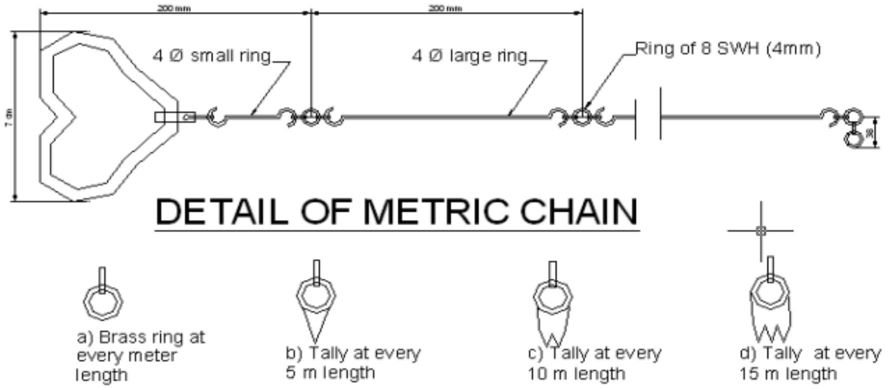

Figure 54: image showing detail of metric Chain

Procedure:

- o **Choose Level Ground**: Start by selecting a relatively flat area. Mark two points on the ground, separated by around 2-3 chain lengths, for measurement.
- o **Mark Points**: Identify two points, A and B, and measure the distance between them using a chain or tape.
- o **Ensure Straight Line**: Confirm that the measured distance is a straight line through ranging.
- o **Identify Intermediate Point**: Find a point roughly one-third of the way along the length between points A and B, and mark it as point C.
- o **Place Ranging Rods**: Set up ranging rods at points A, B, and C.
- o **Align Points**: From point A, use hand signals to align point C with point A so that the rods at points A, B, and C form a straight line.

- **Mark Additional Point**: Locate another point, D, between points C and B, and align them in a straight line using the same method.
- **Measure Distance**: Measure the distance with a chain or tape.
- **Record Data**: Document the collected data in a field book following the chaining method.
- **Create Map**: Use the recorded data to create a map of the area.
- **Calculate Angles**: Utilize a compass to determine the internal angles of the triangle formed. Compute the angles using the forbearing (FB) and back bearing (BB) of lines AB, BC, and CA, and apply checks.
- **Finalize Map**: Use the chain survey and compass survey data to produce the final map.

3.10 Compass Surveying:

To generate a map using Compass and Chain survey

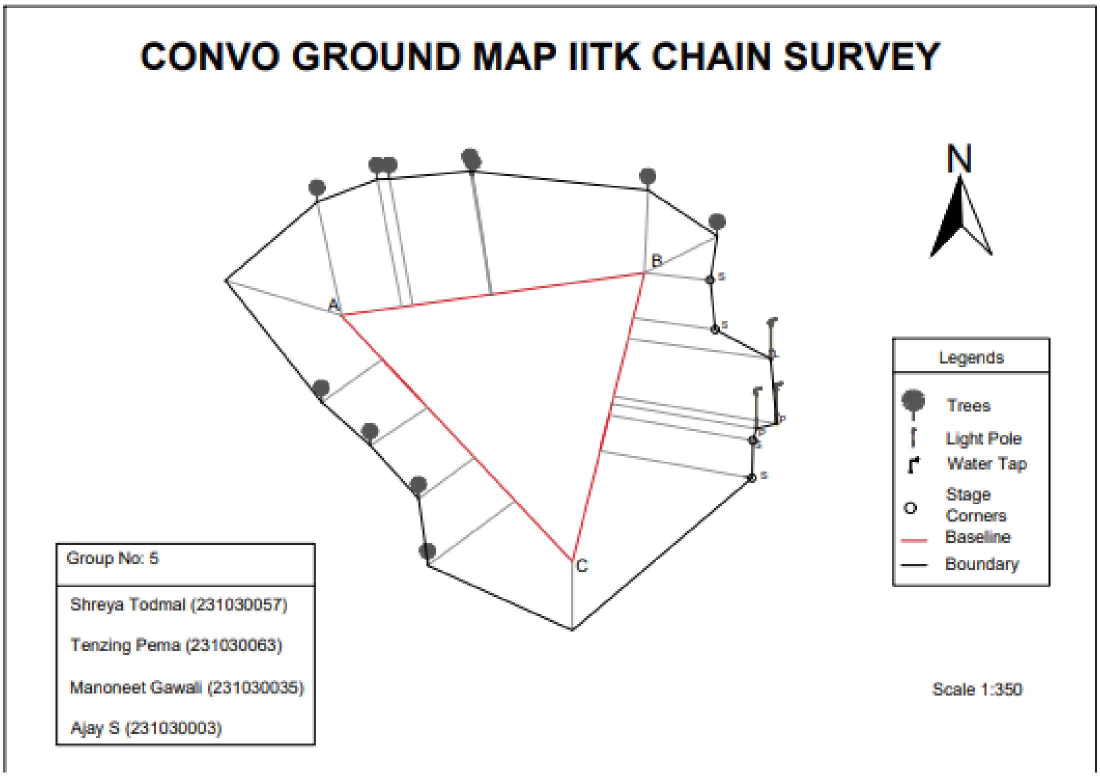

Figure 55: Map prepared using chain and compass survey

Observations

Compass Surveying**:** Readings taken

From	To	FB	BB
A	B	82^o	263^o
B	C	194^o	14^o
C	A	318^o	137^o

Errors due to:

- Faulty linear measurements
- Local attraction

Correction for Local Attraction: done using included angles method

From	To	FB & BB	FB-BB	LA	Error	Correction	Corrected Bearings
A B	B A	82^o 263^o	181^o	Y	1^o	-1^o 0^o	83^o 263^o
B C	C B	194^o 14^o	180^o	N	0^o	0^o 0^o	194^o 14^o
C A	A C	318^o 137^o	181^o	Y	1^o	0^o -1^o	318^o 138^o

BC has no local attraction (LA), LA was found in station A.

Traditional surveying methods like these can be more cost-effective, especially for small-scale projects. Chain and compass surveying can provide very precise local measurements, useful for detailing small areas. These methods allow surveyors to take detailed measurements of features such as trees, poles, and buildings. Unlike GNSS, chain and compass surveying does not rely on satellite signals, so it can be useful in areas with poor signal reception.

3.11 Traverse Adjustment by Total Station:

In this lab exercise, we conducted a traverse adjustment using a Total Station (TS) on a closed traverse consisting of four control points. Procedure carried out in this exercise, including the adjustments and observations made:

- Setup Control Points:
  - Begin by setting up four control points on the field to form a closed traverse.
- Temporary Adjustments:
  - Perform temporary adjustments for the Total Station such as cantering, levelling, and focusing.
- Measure Length of Each Side:
  - Use Electronic Distance Measurement Instrument (EDMI) to measure the length of each side of the traverse.
- Set Up Instrument at Each Station:
  - At each control point (station), set up the Total Station and record all horizontal angles.
- Observe Face-Right and Face-Left Readings:
  - Record both face-right and face-left observations of the horizontal angles.
- Close Horizon and Apply Station Adjustment:
  - While recording the angles, close the horizon and apply any necessary station adjustments.
- Set Instrument to Zero:
  - Begin by setting the instrument at point A to zero, and observe the next point (point D). Record the interior angle.
- Observe and Adjust:

  - Look back to point A' and check the angle, which should be 0°. If there is an error, record the value and adjust accordingly.
- Move to Next Station:
  - Move to the next station, take readings, and repeat the process to find the interior angle of the traverse.
- Repeat for All Control Points:
  - Continue this process for all four control points.
- Use Compass for True North:
  - Utilize a compass to find the true north, which is needed when creating a traverse using the Total Station.
- Repeat from Right Side of Instrument:
  - After completing the left side observations, repeat the procedure from the right side of the Total Station.
  - On the right side of the instrument, the zero reading is set to 180° instead of 0°. This is due to the orientation change when switching from the left to the right side of the instrument, resulting in a difference of 180° between the zero readings.

Figure 56: Setting up of plumb bob in TS

Figure 57: Calibration of EDMI

Sl No.	Station Observed	Face (L/R)	Horizontal Angle				Successive difference	Adjusted angle (DMS)
			Reading (Degrees)	Mean of interior angle	Multiples of average corrections	Correction rounded		
1	A	L	0	144.086235	0.012	0.0125	0.0125	144 5' 55"
	D		144.1572					
	A'		0.0025					
	Error		-0.0025					
	A	R	180					
	D		324.01527					
	A'		179.9991					
	Error		0.0009					
2	B	L	0	94.177625	0.249	0.025	0.0125	94 11' 24"
	A		94.17805					
	B'		0.0011					
	Error		-0.0011					
	B	R	180					
	A		274.1772					
	B'		180.01694					
	Error		-0.01694					
3	C	L	0	72.479995	0.0374	0.0375	0.0125	72 29' 33"
	B		72.47777					
	C'		0.0025					
	Error		-0.0025					
	C	R	180					
	B		252.48222					
	C'		180.00111					
	Error		0.00111					
4	C	L	0	49.206385	0.0499	0.05	0.0125	49 13' 8"
	D		49.16694					
	C'		0.003888					
	Error		0.003888					
	C	R	180					
	D		229.24583					
	C'		180.03888					
	Error		0.03888					
							0.05	360 0' 0"

From the table,

Sum of the interior angles = 359.9504 Degrees
Error = 360 - 359.9504 = 0.04976 Degrees
Distribution of error = e / n = 0.04976 / 4 = 0.01244.
Where 'n' is the number of sides.

- Used the method from **Wolf and Ghilani** to find the adjusted angle.
- The applied e/n to each of the angles and then the e/n values applied to each-angles are rounded to the nearest integer.
- Then find the difference in error between the successive error give to each of the interior angles and then the successive difference is subtracted from the angles observed from the field to get the adjusted angles.
- The adjusted angles thus found is tabulated in the table above.
- The adjusted traverse is shown in the figure below:

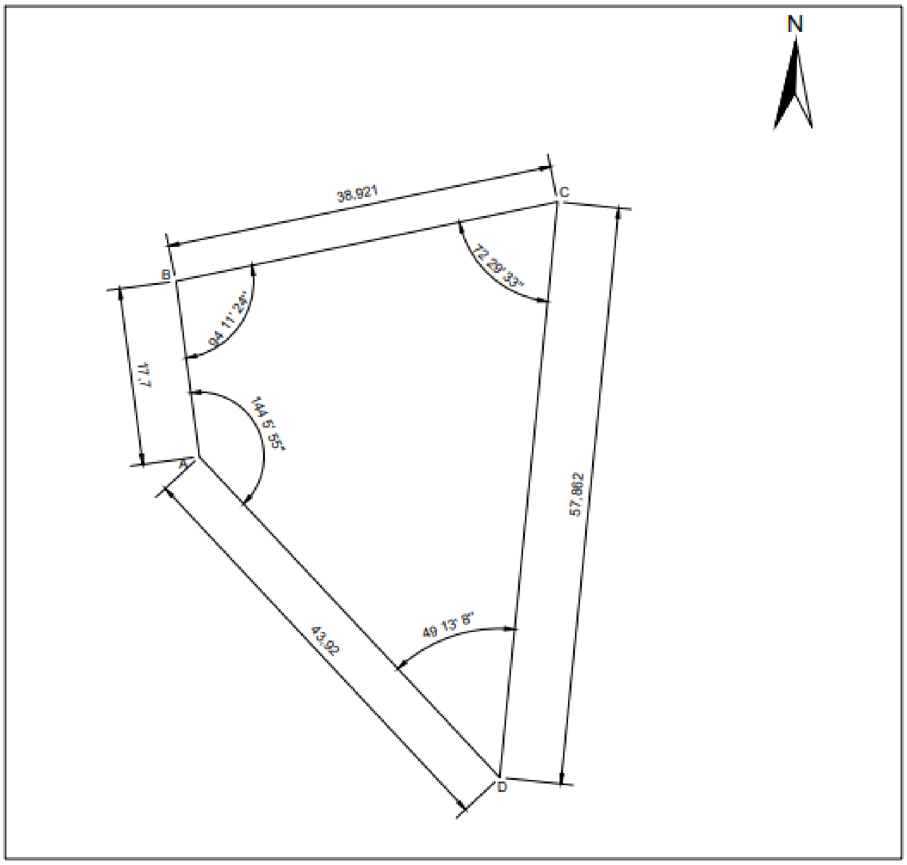

Figure 58: Adjusted traverse obtained

The corrected traverse provides a reliable reference for establishing new traverses in adjacent or related survey areas. It allows us to extend the survey area while maintaining consistency and accuracy. By ensuring the traverse is accurate and reliable, we create a strong foundation for various surveying, mapping, and engineering projects, enabling precise and efficient planning and decision-making across multiple disciplines.

4. Results and Discussions

The survey camp provided valuable insights into the effectiveness of various surveying methods and their respective applications. Our team achieved significant outcomes from each technique employed. Road profiling involved plotting longitudinal and transverse profiles, revealing elevation and slope variations along the road. These variations offer critical insights into potential design and maintenance challenges that need to be addressed for future development projects. Calibration for Electronic Distance Measurement Instruments (EDMI) identified non-linearity, reflector-instrument constants, and scale errors, enabling us to make necessary corrections to enhance the accuracy of distance measurements and ensure reliable data collection. Distance measurement using chain and tape provided a high level of precision in measuring distances, albeit with some influence from environmental factors. The varying degrees of accuracy observed based on equipment choice underscore the importance of selecting the right tools for each surveying task. Compass and chain survey produced useful maps and allowed for the calculation of internal angles. Observations highlighted the influence of potential local attractions on measurements, emphasizing the need for careful assessment and adjustments during fieldwork. Conducting observations on a closed traverse with a total station allowed for the adjustment of angles and distances, resulting in a more precise final traverse map. This demonstrated the importance of using advanced surveying instruments for greater accuracy. The creation of a topographic map of the Arogyadham area provided detailed visual representation of the terrain, including contour lines indicating elevation changes. These maps proved to be essential in understanding the area's geographical features and planning infrastructure projects accordingly.

5. Conclusion

The report provides an in-depth look at different surveying methods, each with its own strengths and areas for improvement. Road profiling and longitudinal and transverse sections enable better understanding of road conditions and aid in effective planning and maintenance. EDMI calibration is crucial for accurate distance measurements, while chaining and compass surveying offer precise mapping capabilities. Total Station traverse adjustment provides high accuracy in measuring horizontal angles. By applying corrections from calibration and addressing identified issues, the overall reliability and accuracy of measurements improve significantly. This comprehensive approach ensures that the design, maintenance, and management of the road are informed by precise and reliable data. As a result, future infrastructure development projects can benefit from these meticulous surveying and road profiling methods. Additionally, the survey camp provided me with real-world applications and hands-on experience with various instruments, offering practical insights into their uses. Such experiences are invaluable for professional growth, and I appreciate the opportunity to participate in such camps. Thank you for conducting this camp, as it has enriched my understanding and prepared me for future challenges in the field of surveying and geoinformatics.

6. References

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