

**DELINEATION AND DETAILED SURVEY OF CHEVRON MAIN OFFICE (TOPCON)  
EKPAN, UVWIE LOCAL GOVERNMENT AREA, DELTA STATE.**

**BY**

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**PGD/ENV/2415302**



**DEPARTMENT OF GEOMATICS**

**UNIVERSITY OF BENIN**

**BENIN CITY, NIGERIA**

**P.M.B 1154**

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE  
AWARD OF POSTGRADUATE DIPLOMA(PGD) IN GEOMATICS,  
IN THE FACULTY OF ENVIRONMENTAL SCIENCES, UNIVERSITY OF BENIN,  
BENIN CITY, EDO STATE, NIGERIA.

NOVEMBER, 2025

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**CERTIFICATION**

This is to certify that this project was carried out by AKHIGBEE, EROMOSELE ANTHONY with Matriculation Number: PGD/ENV/2415302 of the Department of Geomatics, Faculty of Environmental Sciences, University of Benin, Edo State, Nigeria.

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HEAD OF DEPARTMENT

Date

Surv. Dr. S. O. Oladosu

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EXTERNAL EXAMINER

Date

## **DEDICATION**

I humbly dedicate this project to God almighty for his grace upon my life and to my wife Mrs Bridget Akhigbe, my parents Mr & Mrs lucky Oriasotie, and my family for their support in all ramifications. May God continue to bless you all, Amen.

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I appreciate the Almighty God for his endless love and kindness upon me in the University of Benin. I also want to give special thanks to my Family for their financial and moral support that has helped me thus far in life.

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I say God bless you all, Amen.

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Thanks to everyone who has contributed in one way or the other to make this happen. May God bless you all Amen.

## **ABSTRACT**

This project presents the findings of a perimeter and detailed survey conducted at the Chevron Main Office (TOPCON) Ekpan, Uvwie Local Government Area, Delta State. The primary aim was to produce a comprehensive report on the property's boundaries and the features present within the area. This was to facilitate adequate planning and guide future development initiatives for the company's yard. The survey was essential for understanding the current level of structures and developments, thereby identifying how remaining space could be managed or utilized for new construction projects.

The methodology involved several key stages, including office planning, field reconnaissance, and rigorous testing of the survey equipment, a South NTS 362R Total Station, to ensure data accuracy. Fieldwork consisted of perimeter line cutting, traversing to establish control points, and a detailed survey to capture all natural and man-made features. Notable features mapped include administrative buildings, a helipad, warehouses, car parks, a basketball court, and the concrete wall fence defining the property boundary. Data processing involved computing coordinates, checking linear and angular accuracy, and calculating the total area.

The results yielded a detailed digital plan of the site, produced using AutoCAD 2007 software at a scale of 1:2,500. The survey achieved a high linear accuracy of 1:37,000 and determined the total area of the property to be 9.006 hectares. Analysis revealed that a significant portion of the land remains developed, indicating ample space for future projects. The final plan and report serve as a reliable base map and a functional database for the various land use types, fulfilling the project's objectives and providing a vital tool for the company's infrastructural planning and decision-making.

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## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 BACKGROUND OF THE STUDY**

Perimeter (boundary) and detailed (topographic) surveys are essential surveying practices that systematically record the extents and features of a land parcel. In general, a perimeter survey precisely establishes the corners and edges of a property, while a detail survey maps all significant natural and man-made features (buildings, roads, trees, utilities, etc.) within those boundaries. These surveys involve careful field measurements (distances, angles, elevations) and data processing to produce an accurate map or plan. As Pissourios (2023) explains, land use surveys are “targeted, coordinated, and systematic inventory process[es]” that yield a detailed spatial database or map of existing land uses. In practice, combining a boundary survey with a feature (detail) survey gives a comprehensive picture of what exists on the land, from the concrete wall fence defining the perimeter to every structure and open space inside it.

Accurate surveying data is foundational for development planning, land management, and legal clarity. Precise boundary surveys prevent disputes and create the legal descriptions needed for land transactions, while detailed site surveys inform infrastructure design and resource allocation. For example, knowing the exact location of buildings, parking areas, and open lawns on an industrial site allows planners to identify unused space for future projects. As Williamson et al. (2022) emphasize, reliable cadastral and land-use information underpins sustainable development, economic growth, and social order by ensuring that land resources are managed transparently and efficiently. In summary, a well-executed perimeter/detail survey provides a vital base map

showing both property extents and existing features, which guides decision-makers in designing new facilities, allocating space, and complying with regulations.

Recent advances in geospatial technology have dramatically improved survey accuracy and efficiency. Modern GPS/GNSS receivers and total stations now achieve millimeter-level precision in field measurements. Ravindran et al. (2025) note that over the last decades, innovations such as cloud-enabled GIS, satellite remote sensing, and GPS-based surveying have revolutionized spatial data collection and analysis. In addition, unmanned aerial vehicles (UAVs) and LiDAR scanners can rapidly capture high-resolution terrain models. For instance, Badea and Remondino (2024) demonstrate that UAV photogrammetry produces extremely accurate maps of built environments, while LiDAR effectively maps areas under dense vegetation. By integrating these tools, survey teams can create detailed digital terrain models and orthophotos that complement ground measurements. Altogether, these technologies enable faster data acquisition and richer detail, allowing a site survey to record every building, helipad, tree, and walkway with high precision. This enhanced accuracy and detail support better planning: the final survey plan becomes a reliable base map and database for guiding the site's future development.

## **1.2 STATEMENT OF THE PROBLEM**

The primary reason for undertaking this survey is to authoritatively establish the boundary limits of the Chevron Main Office (TOPCON) in Ekpan, to accurately map all existing features within this boundary, and to determine the amount and location of space available for future development. Currently, there is a lack of a single, up-to-date, and comprehensive survey plan that clearly shows the exact extents of the company's property. This situation creates uncertainty and poses several risks. Without a precise perimeter survey, there is a potential for encroachment from adjacent lands

or, conversely, for the company to inadvertently encroach on others' land. This can lead to legal disputes and conflicts over land ownership.

Furthermore, the record of features and structures inside the yard is incomplete. There is no detailed map that shows the precise location, size, and spatial relationship of key infrastructure such as the administrative buildings, the helipad, the warehouse, the jetty, and all other facilities. This makes effective facility management, maintenance planning, and emergency response planning difficult.

Most critically, the company's management lacks a clear understanding of how much of their land is already developed and how much remains vacant. This knowledge gap hinders strategic planning for new projects. Before any new construction can be considered, whether it is a new office block, an expansion of the warehouse, or any other facility, it is essential to know exactly where space is available and how much there is. Without this fundamental information, planning is based on estimates and assumptions, which can lead to inefficient use of space, poor project planning, and increased costs.

Therefore, this perimeter and detailed survey was necessary to resolve these problems by providing a definitive document that clarifies the boundary, inventories all assets, and identifies all available space for the company's future growth and development.

### **1.3 AIM AND OBJECTIVES**

The aim of this project is to delineate and carry out perimeter and detailed survey of the Chevron Main Office (TOPCON) Ekpan, Uvwie Local Government Area, Delta State for updating purpose.

The objectives are to:

- i. delineate the boundary of the study area
- ii. produce various dimensional parameters of the facilities within the study area.

- iii. present the survey plan and report of the study area.

#### **1.4 SCOPE AND LIMITATIONS OF THE STUDY**

The study focuses on the perimeter and detailed survey of the Chevron Main Office (TOPCON), Ekpan, Uvwie Local Government Area, Delta State. It encompasses all technical and procedural aspects required to accurately map and document the site. The survey commenced with reconnaissance to gain a preliminary understanding of the project area and identify potential challenges. Activities carried out included perimeter line cutting, monumentation, establishment of control points, and traversing to ensure accurate measurement of boundaries. A detailed survey of natural and man-made features, such as administrative buildings, helipad, warehouses, car parks, road networks, walkways, and other infrastructural elements, was conducted to create a comprehensive record of the property. Data acquisition was followed by rigorous processing, including computation of coordinates, linear and angular checks, and area determination using established surveying techniques. The results were compiled into a digital plan using AutoCAD software at a scale of 1:2,500, providing a reliable base map and functional database for land use planning, infrastructural development, and future decision-making (Ghilani & Wolf, 2017; Barry, 2016).

The scope of the study was defined by the use of the South NTS 362R Total Station for all field measurements, with all observations and computations adhering to departmental and professional standards. The survey was limited to the premises of Chevron Main Office, with results applicable primarily to assessing current land use, planning for new developments, and guiding infrastructural management. Technical parameters, such as the scale of the plan and the precision of linear and angular measurements, were strictly maintained to conform to the requirements of a third-order survey (Agor, 2015; Nathanson et al., 2015).

Despite the careful planning and execution, the study encountered some limitations inherent to field surveying. Environmental conditions, including rainfall and wind, occasionally restricted field operations and could impact measurement accuracy. Physical obstructions, such as dense vegetation and the concrete perimeter fence, required the establishment of temporary NAIL points in locations where access to pillars was obstructed. Equipment-related factors, such as potential calibration errors of the Total Station or minor EDM inaccuracies, were mitigated through repeated testing, although residual errors may remain (Ghilani & Wolf, 2017). Human error during observation, recording, and processing also posed a potential limitation. Additionally, the study was constrained by time and resources, which limited repeated observations and comprehensive cross-validation. These limitations highlight the need for careful operational planning, continuous equipment calibration, and consideration of environmental conditions in future survey projects. Overall, the scope and limitations reflect a rigorous and methodical approach to conducting a perimeter and detailed survey while acknowledging the practical challenges that may affect precision and data reliability.

## **1.5 JUSTIFICATION OF THE STUDY**

Perimeter and detailed surveys are essential for effective land administration, property management, and infrastructural planning. Accurate delineation of property boundaries ensures legal protection of land, prevents encroachment, and facilitates transparent land transactions. For corporate facilities such as the Chevron Main Office (TOPCON) along Ejeba road, precise knowledge of boundary limits and internal features is critical to effective space utilization, infrastructure maintenance, and planning for future expansion or redevelopment. Without a comprehensive survey, decisions related to construction, landscaping, or asset allocation may be flawed, resulting in financial loss, legal disputes, or inefficient land use.

A detailed survey provides spatially referenced information on natural and man-made features within a property. This allows management to identify developed areas, vacant spaces, and areas suitable for additional facilities or amenities. By generating accurate digital maps and coordinate-based databases, survey data enhances operational efficiency and serves as a reliable reference for engineering, architectural, and environmental planning. In the context of Chevron's operations, such data can support security planning, emergency response, facility maintenance, and optimal land resource allocation.

Additionally, the study contributes to the advancement of professional practices in geomatics by applying modern survey techniques, including Total Station measurements, EDM calibration, and AutoCAD-based digital plan production. This ensures that survey outputs meet required standards for accuracy and precision, providing a benchmark for future surveys within similar corporate and industrial settings. By addressing both practical and technical needs, the study offers valuable insights for management decision-making, regulatory compliance, and sustainable development of the Chevron Main Office premises.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 CONCEPTUAL FOUNDATIONS OF PERIMETER AND DETAIL SURVEYING**

Angelov (2025) explored the use of both classical and modern geodetic tools and methods for achieving precise setting out during construction activities. The study emphasized the importance of accuracy in positioning structural elements in terms of plan, height, and orientation. By combining linear resections, the orthogonal method, GNSS receivers, and coordinate-oriented satellite imagery, the research proposed a methodology to preliminarily assess accuracy relative to construction tolerances. Practical results from completed construction sites demonstrated the efficiency, logistical feasibility, and economic suitability of the approach for similar engineering and geodetic tasks.

Minea et al. (2024) highlighted the critical role of land surveying in areas such as construction, urban planning, and natural resource management, emphasizing the need for precision to support informed decision-making. The study reviewed modern surveying techniques, including GPS and laser scanning, and stressed the importance of adopting best practices to minimize errors. Using structured approaches like the ADDIE model, the research demonstrated how systematic methods can enhance measurement accuracy, reliability, and efficiency, ultimately supporting sustainable land use and resolving legal property disputes.

#### **2.2 SURVEYING EQUIPMENT AND INSTRUMENTS**

Chaudhry et al. (2020) examined the use of Unmanned Aerial Vehicles (UAVs) for surveying, focusing on optimizing data collection and computational efficiency. The study manipulated UAV

flight parameters, including flight line patterns and image overlap percentages, to generate accurate three-dimensional photogrammetric products with fewer data points. Using Ground Control Points (GCPs) and Check Points (CPs), the researchers assessed horizontal and vertical accuracies, finding that careful adjustment of UAV parameters can yield high-accuracy results with reduced computational cost. The study highlights the trade-offs between overlap percentages, data volume, and survey accuracy, providing practical guidance for efficient UAV-based surveying.

Algadhi et al. (2024) investigated the use of Terrestrial Laser Scanners (TLS) for detecting surface anomalies in structures subjected to lateral stresses, such as retaining walls. The study focused on how scanning geometry, specifically distance and angle of incidence, affects the accuracy of TLS point clouds. Three cloud comparison techniques (C2C, C2M, and M3C2) were employed to estimate anomaly depth. The results indicated that TLS can reliably detect surface anomalies at distances of 2–30 m and angles of incidence between 30° and 90°, achieving millimeter-level precision even when scans are taken from different positions. The study emphasizes TLS as a precise, contactless method for structural health monitoring.

Muralikrishnan (2021) reviewed the performance evaluation of Terrestrial Laser Scanners (TLSs) across various applications, including surveying, deformation monitoring, reverse engineering, and digital reconstruction of historical monuments. The study highlighted the wide range of tolerances required in different tasks, from tens of millimeters to micrometers, and the challenges users face in comparing TLS instruments with differing specifications. The review discussed global research efforts to model TLS error sources, develop specialized performance evaluation procedures, and establish documentary standards to ensure metrological traceability. This work

underscores the importance of standardized testing for ensuring TLS reliability and precision across diverse engineering and surveying applications.

Salgues et al. (2020) investigated the effectiveness of SLAM-based mobile mapping systems (MMS) for indoor surveys. They compared two MMS devices, GeoSLAM ZEB-REVO RT and GreenValley LiBackPack C50, against high-precision static TLS data. The study found that while MMS provides rapid 3D point cloud acquisition with remote and mobile capabilities, the geometric accuracy is lower than that of static TLS, highlighting a trade-off between speed and precision for indoor survey applications.

Sestras et al. (2025) proposed a Digital Feature Model (DFM) that integrates UAV photogrammetry and LiDAR data to enhance land surveying accuracy for building planning. UAV photogrammetry effectively mapped textured anthropic surfaces, while LiDAR penetrated vegetation-covered areas. By fusing both datasets, the DFM improved vertical accuracy, achieving an RMSE of 0.075 m, outperforming standalone photogrammetry (0.209 m) and LiDAR (0.130 m). This method provides reliable topographic data, supporting accurate GIS analyses and sustainable land development.

Sprincean et al. (2025) developed a drone-based platform at Moldova State University that integrates UAV LiDAR and photogrammetry for rapid and precise terrain mapping. The combined approach enables fast generation of digital elevation models (DEMs), facilitating efficient data analysis and interpretation for monitoring and assessment purposes.

Zhang et al. (2025) explore the performance of Precise Point Positioning (PPP) and PPP-RTK using modern multi-GNSS constellations and signals. Their study demonstrates that multi-constellation, multi-frequency systems, along with satellite-based augmentation services like PPP-

B2b and HAS, significantly improve convergence time and positioning accuracy. Experiments show PPP-RTK can maintain centimeter-level accuracy even under dynamic conditions, highlighting its potential for high-precision applications.

Zollini and Marconi (2025) examine the use of smartphone-embedded LiDAR and RGB sensors combined with the viDoc RTK Rover for high-precision surveying. Across three diverse case studies, their approach achieved centimeter-level accuracy, comparable to traditional GNSS-based methods. The study demonstrates that modern, lightweight, and low-cost equipment can reliably perform rapid 3D surveys, offering practical solutions for continuous monitoring of structures and infrastructures.

### **2.3 FIELD METHODS AND MEASUREMENT TECHNIQUES**

Gargula (2021) introduces a new unified method for adjusting classical terrestrial survey observations, such as total station distances and angles, together with GNSS satellite vectors within a single 3D reference frame. Unlike traditional approaches, the method eliminates the need to convert data between reference systems or project observations onto an ellipsoid.

The core of the approach involves transforming the classical angular-linear network into a spatial linear (distance-based) network. This transformation allows seamless numerical integration with GNSS vectors. The paper presents detailed formulas for converting standard terrestrial observations (horizontal/vertical angles, slope distances, instrument and target heights) into pseudo-observations, expressed as spatial distances.

Observation equations are then established and linearized using a functional adjustment model, followed by a method for determining the mean errors of pseudo-observations, ensuring rigorous accuracy assessment of the final adjusted coordinates. The proposed algorithm was validated

through a practical case study involving an integrated network combining GNSS vector data and terrestrial angular-linear observations.

Oladosu et al. (2022) examined ground-based methods for seamless topo-bathymetric surveying along the Maiyegun Estate waterfront in Lagos. Using a hydrographic vessel and diver-acquired depth measurements, they produced a 1 m DEM and 0.5 m contours, and analyzed semi-diurnal wave patterns. Regression analyses showed low correlation between wave amplitude, depth, and time, while computed vertical and horizontal uncertainties met IHO Order 1a standards. The study shows that this low-cost approach can serve as an alternative for topo-bathy surveys when applied carefully.

Suru et al. (2025) conducted a statistical comparison of coordinate measurements obtained using Total Station (TS) and Differential GPS (DGPS) for boundary and feature points on a survey site. Using 52 common points, they analyzed Easting, Northing, and Height coordinates with residual analysis, visualizations, ANOVA, and paired t-tests. The study found no statistically significant differences between TS and DGPS measurements, confirming that both methods provide consistent and reliable results when properly calibrated. The authors recommend that TS and DGPS can be used interchangeably for precise boundary and feature surveys, depending on field conditions and project requirements.

Angelov (2025) highlights the use of accessible classical and modern geodetic tools for precise setting-out works during construction. The study examines the accuracy requirements for fixing structural elements in plan, height, and orientation. By combining geodetic linear resections, the orthogonal method, GNSS receivers, and coordinate-oriented satellite images, the author presents a preliminary accuracy assessment method. Practical results from completed construction sites

demonstrate the efficiency, logistical feasibility, and economic suitability of the proposed approach for engineering and geodetic tasks.

## **2.4 DATA PROCESSING AND MAPPING TOOLS**

Borkowski (2023) examines how laser scanning, digital photogrammetry, and BIM technologies can be integrated to support the creation of detailed digital twins, particularly for historic buildings. The study highlights the growing importance of BIM, especially HBIM, for documenting, preserving, and managing heritage structures. Three BIM models were produced from laser-scanned point clouds, demonstrating that the “scan-to-BIM” workflow is both feasible and valuable. While BIM enables the enrichment of geometric models with semantic and non-graphical data, the paper emphasizes that a major challenge remains: the absence of a standardized methodology for constructing BIM models from TLS and image datasets. Nonetheless, the presented case studies confirm that combining laser scanning and photogrammetry significantly enhances accurate documentation, conservation, and long-term management of built heritage.

Koukis & Ioannides (2020) conducted a comprehensive review of nearly 200 studies to evaluate how DEM accuracy has been assessed over the past 30 years. Their analysis covered 14 key aspects of grid-based DEM evaluation, including data sources, reference datasets, assessment models, and evaluation scope. They found that most studies do not follow standardized assessment procedures, researchers often define their own accuracy criteria. Point-based accuracy checks dominate the literature, while linear, surface, 3D, and visual analyses are rarely used. Although error assessment still largely relies on assuming normally distributed discrepancies, data-driven approaches are becoming more common. Persistent gaps remain, such as unclear guidelines for sample size, segmentation criteria, and standardized evaluation of derived parameters. The authors emphasize

the need for unified terminology, standardized methods, and improved quality-oriented indices to ensure more consistent and reliable DEM accuracy assessments.

Ravindran *et al.* (2025) review major advancements in geospatial technologies over the past thirty years, emphasizing how innovations in cloud-enabled GIS, remote sensing, GPS surveying, and AI-driven land cover classification have transformed spatial data acquisition and analysis. The study highlights emerging trends such as edge computing, 5G-enabled geospatial workflows, and advanced semantic segmentation for remote sensing interpretation. Despite these advancements, the authors identify persistent challenges including limited access to high-quality datasets, interoperability issues across platforms, and significant regional disparities in geospatial research and implementation. They conclude that the future of geospatial science lies in the convergence of cloud-edge computing, artificial intelligence, and integrated geospatial frameworks to support sustainable development, environmental management, and smart city initiatives.

Roggero and Diara (2024) present a multi-sensor 3D documentation workflow applied to Frinco Castle, a structurally fragile medieval site undergoing restoration. Because the castle's south front had partially collapsed, comprehensive metric surveying was required to safely capture both accessible and risky areas. The authors integrated data from multiple sources, including Terrestrial Laser Scanning (TLS), DJI Zenmuse L1 Airborne Laser Scanning (ALS), and Zenmuse P1 photogrammetric point clouds. TLS was used as the reference dataset. After verifying internal TLS alignment, point clouds from all sensors were analyzed for point density and roughness, segmented, aligned, and fused. The resulting unified dataset provided complete indoor–outdoor coverage and served as the foundational input for generating accurate 2D and 3D models required for architectural restoration and structural assessment.

Zhang et al. (2023) present a comprehensive survey on deep-learning-based point cloud semantic segmentation, a field that has become increasingly important due to the rising use of 3D sensors and laser scanning technologies. The paper reviews the key research challenges, major segmentation methods, and evaluation practices in point cloud analysis. Methods are categorized into rule-based approaches and point-based deep learning approaches, with detailed explanations of their core principles and representative algorithms. The authors also compare experimental results across major public datasets and outline commonly used performance metrics. The survey concludes by identifying emerging trends and future research directions that could further advance semantic segmentation for applications such as transportation, natural resource management, and environmental monitoring.

Shojaei et al. (2025) address a persistent challenge in land administration: the difficulty many countries face in producing accurate, reliable, and affordable base maps. Traditional mapping efforts are often constrained by limited budgets, inadequate infrastructure, and lack of technical capacity. While Volunteered Geographic Information (VGI) has served as a low-cost alternative, previous implementations typically compromise spatial accuracy, making them unsuitable for high-precision cadastral applications, especially in developed countries where strict accuracy standards apply.

The authors propose an innovative and cost-effective solution that integrates GILA, a user-friendly mobile application, with a portable high-accuracy external GNSS receiver. This participatory approach enables ordinary citizens, even without surveying expertise, to capture parcel boundary corners with professional-level accuracy after minimal training. Two real-world case studies demonstrate that the system meets both technical and stakeholder accuracy requirements, confirming GILA as a viable method for updating cadastral base maps affordably and reliably.

## **2.5 APPLICATIONS IN LAND USE INFRASTRUCTURE AND INDUSTRIAL PLANNING**

Ebrahim (2025) emphasizes the role of advanced surveying and Geographic Information Systems (GIS) in enhancing disaster resilience, particularly in vulnerable regions. The study highlights applications of high-resolution remote sensing, LiDAR, real-time GIS platforms, and predictive modeling for risk assessment, emergency response, and resilient infrastructure planning. These technologies support public health protection by improving disaster preparedness, healthcare accessibility, and disease prevention. Challenges such as data accuracy, technological barriers, and privacy concerns are also discussed, with future directions pointing toward AI integration, improved data sharing, and cross-disciplinary approaches.

Dong et al. (2025) review the role of Geographic Information Systems (GIS) in Environmental Impact Assessment (EIA), emphasizing GIS as the central platform for integrating remote sensing, GPS, and other geospatial technologies. The study highlights GIS applications throughout the EIA process, including baseline data collection, spatial analysis, ecological sensitivity mapping, impact prediction, scenario simulation, and landscape connectivity assessment. It also addresses challenges such as data quality, standardization, interoperability, and model uncertainty. The authors propose solutions like minimum geospatial datasets with clear metadata, interpretable GeoAI, IoT, GIS pipelines for real-time monitoring, and systematic inclusion of cumulative effects and climate scenarios. The study provides a practical framework to enhance transparency, reproducibility, and decision-making in EIA processes.

Guebsi et al. (2024) provide a systematic review of drone applications in precision agriculture, focusing on technological advancements and practical applications. The study highlights drones' use in crop monitoring, multispectral mapping, precision spraying, and drone-assisted seeding.

Integration with AI and IoT enhances early disease detection, yield estimation, and irrigation management. The authors discuss regulatory, technological, and socio-economic challenges limiting widespread adoption, emphasizing the need for harmonized regulations and economic accessibility for small-scale farmers. Future opportunities include drone swarms, improved energy autonomy, and advanced decision-support systems, demonstrating the transformative potential of drones for sustainable and resilient agriculture.

Waghs & Auti (2025) review the role of Geographic Information Systems (GIS) in land use planning, highlighting how GIS enables clear visualization and analysis of complex spatial and temporal data. The study emphasizes GIS's impact on optimizing land utilization, improving decision-making, supporting sustainable development, and enhancing urban design quality. Case studies, such as the urban sponginess coefficient analysis in Caceres, demonstrate GIS's capacity to identify disparities in land availability and sustainability. The authors conclude that GIS is essential for effective land management, cost reduction, and resilience in the context of growing urban populations.

Zaroujtaghi et al. (2023) present a PRISMA-guided systematic review of GIS in transportation planning from 2004–2024. The study highlights trends in sustainability, equity, stakeholder engagement, and the use of advanced technologies such as AI and real-time monitoring. Key domains include land use–transportation coordination, accessibility analysis, and policy evaluation. While GIS has evolved into a core tool for data-driven urban mobility planning, challenges remain in data quality, ethical concerns, and the need for specialized expertise. The authors recommend responsible technology adoption and capacity building to support equitable and efficient transportation systems.

## **2.6 CHALLENGES AND INNOVATIONS IN EMERGING TECHNOLOGIES**

Balado et al. (2025) present a systematic review of low-cost 3D mapping solutions, analyzing 1,380 publications and focusing on 87 recent studies. The research highlights the characteristics, applications, and platforms of low-cost systems, emphasizing accessibility, hardware/software innovation, data fusion, deep learning contributions, and photogrammetry relevance. The study finds that while “low-cost” is often used subjectively, challenges persist regarding data quality compared to high-cost systems, underscoring the trade-offs between affordability and accuracy.

Beltramone et al. (2024) focus on monitoring rockfall-prone slopes using a combination of UAS photogrammetry, robotic total station (RTS) surveys, and satellite Persistent Scatterer Interferometry (PSI). The study demonstrates that these surveying techniques can reliably assess slope stability over time, providing accurate 3D data for hazard evaluation. This work highlights the effectiveness of integrating UAV-based and ground-based geospatial methods for precise and safe monitoring of geohazard-prone areas.

Xing et al. (2025) address the challenge of limited Ground Control Points (GCPs) in UAV photogrammetry, which can reduce survey accuracy. They propose a marker system with colored circles on white backgrounds that acts as additional point feature constraints. Experiments show that the system improves detection of markers and significantly enhances UAV photogrammetry accuracy, even with only four GCPs. Check Point accuracy increased by 37.5% (X), 23.0% (Y), and 78.2% (Z), demonstrating a reliable method for precise aerial surveying.

Zhou et al. (2021) examine the use of robotic total stations (RTS) for continuous monitoring of dam deformations, focusing on improving measurement accuracy. The study presents displacement calculation methods and derives corresponding mean square error formulas. It also

addresses atmospheric refraction errors, proposing two correction methods. Simulations show that the polar coordinate method provides high accuracy ( $<0.5$  mm difference compared to forward intersection) and is efficient for a single RTS setup. Refraction corrections, especially using the closest reference point, effectively enhance monitoring precision, making RTS a reliable tool for precise deformation measurements.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 DESCRIPTION OF THE STUDY AREA**

The study was conducted at the Chevron Main Office, situated along the NPA Expressway in Ekpan, within Uvwie Local Government Area of Delta State, Nigeria. The site lies approximately between latitudes  $5^{\circ}33'23.5''\text{N}$  and  $5^{\circ}33'8.85''\text{N}$ , and longitudes  $5^{\circ}45'35.73''\text{E}$  and  $5^{\circ}45'35.7''\text{E}$ . The office complex encompasses a range of administrative and operational facilities, including offices, warehouses, car parks, helipads, and landscaped areas. It is enclosed by a concrete wall fence, which defines the perimeter and provides a secure environment for the operations conducted within the site.

The terrain of the study area is generally flat, with well-maintained infrastructure and open spaces that facilitate surveying activities. The area is urbanized, with nearby road networks providing easy access to the site. The site's strategic location along a major expressway makes it an ideal case for surveying exercises, offering both natural and constructed features that can be used as reference points for geospatial data acquisition. The study area was mapped in detail to guide the field survey, ensuring accurate identification of key features and proper placement of survey control points.

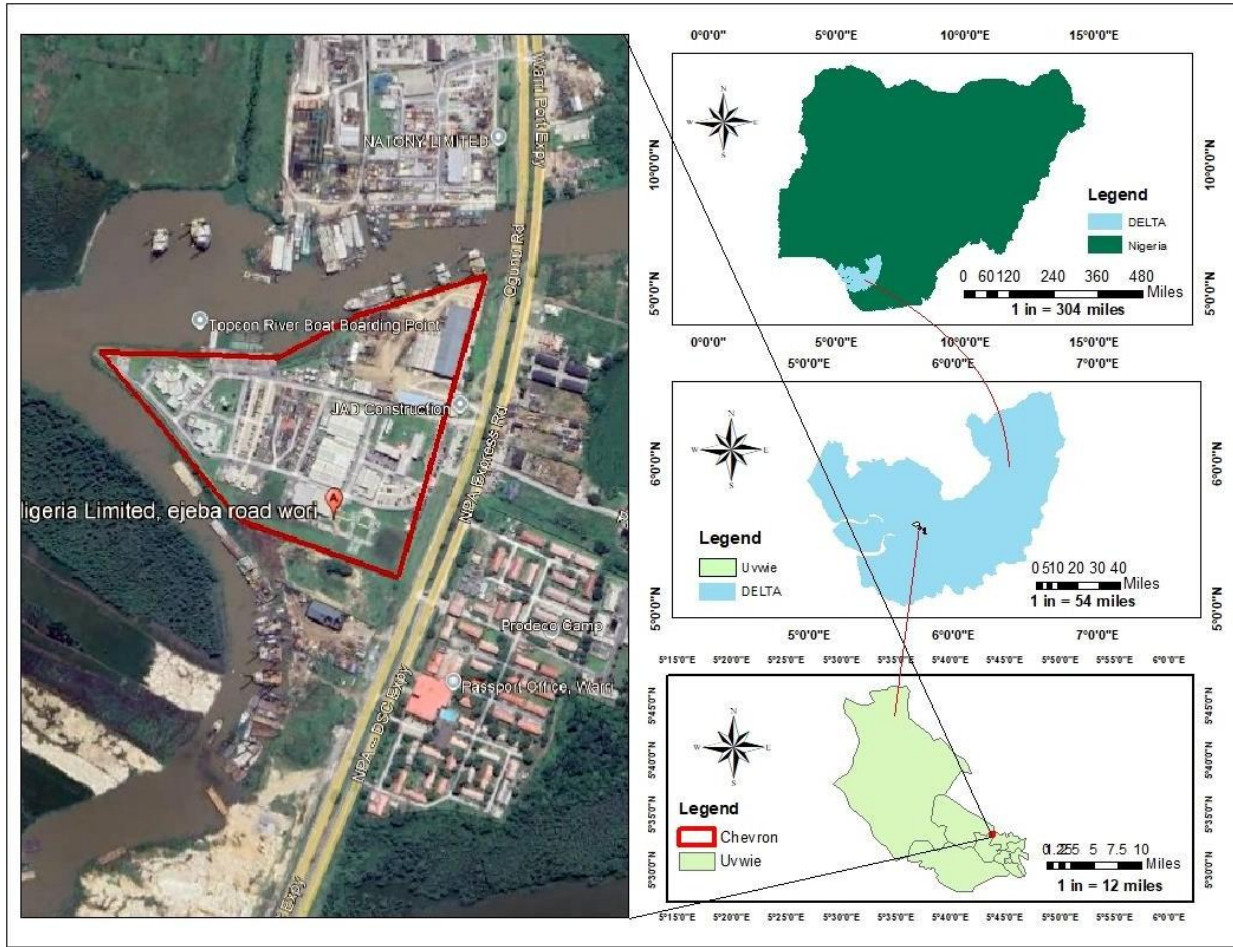


Figure 3.1: Study Area map

### 3.2 PROJECT PLANNING

Project planning is an essential step in surveying, as it ensures that field operations are executed efficiently and systematically. Effective planning allows the survey team to understand the project requirements, anticipate challenges, and prepare resources and strategies before actual data collection begins. In this study, project planning was carried out in two phases: office planning and field reconnaissance.

During the office planning phase, the coordinates of control points to be used for the project were obtained from the Chevron office in Ekpan, Delta State. These controls served as reference points

for all subsequent survey measurements. Table 3.1 presents the controls and their corresponding Easting and Northing coordinates.

Table 3.1: Controls Used for the Project.

<b>Controls</b>	<b>Easting(m)</b>	<b>Northing (m)</b>
Top 04R	366873.764	171972.304
Top 05	366914.875	171838.627
Top 02	367 091.902	171 782.602

The field reconnaissance phase involved an initial visit to the project site to obtain a firsthand understanding of the terrain and features. The site, enclosed by a concrete wall fence, was surveyed with the guidance of the on-duty security personnel. This walkthrough enabled the team to observe the spatial arrangement of the site, identify obstacles, and plan for the placement of additional survey markers. At the end of the reconnaissance, a diagram of all observed features was sketched to serve as a reference for detailed fieldwork (Figure 3.2).

Control points located closer to the project site were verified using a Garmin 78SC handheld GPS receiver to ensure their positions were consistent with office data. This step was critical in confirming the reliability of the established controls before commencing the detailed survey.



### **3.3 EQUIPMENT USED**

The success of a surveying project is largely dependent on the proper selection and use of equipment, as each instrument contributes to the accuracy and efficiency of data acquisition. For this project, a combination of modern electronic and conventional surveying tools was employed to ensure precise measurement of coordinates, distances, and features across the project site.

The primary instrument used was the South NTS 362R Total Station, which provided the capability to measure angles, distances, and coordinates with high precision. To facilitate measurements over longer distances and to access points obstructed by the site's concrete wall fence, prismatic reflectors with poles and ranging poles were employed. A tripod ensured stable mounting of the Total Station during observations, while a 100-meter steel tape was used for verification of short distances and for calibration purposes.

Field operations also required manual tools such as hammers and nails and cutlasses to clear vegetation and establish survey markers. Data recording and processing were supported by a HP Pavilion dv6000 laptop computer with an HP OfficeJet 7500 E910 printer to enable in-field data management and printouts. Observations were documented in field books with supporting writing materials, and a Garmin 78SC handheld GPS receiver was used to verify and locate controls during field reconnaissance.

Before deployment, the Total Station underwent a series of checks to ensure its reliability and accuracy. These included testing for vertical index error, horizontal collimation error, and Electronic Distance Measurement (EDM) accuracy. The vertical index error test involved bisecting a target point 100 meters away and reading the vertical circle on both faces of the instrument. The resulting error was minimal (1"), confirming that the instrument was in proper

condition for the project. Collimation error tests similarly showed a negligible error of 2", validating the reliability of horizontal angle measurements.

The EDM functionality of the Total Station was verified by measuring a known distance of 50 meters between two points on relatively level ground. Multiple measurements were taken from both ends, yielding a mean distance of 49.997 meters, which corresponds to a negligible error of +0.003 meters. This small discrepancy was subsequently applied as a correction factor for all field distance measurements to ensure maximum accuracy.

The careful selection and testing of the equipment, along with the use of both electronic and conventional surveying tools, provided a solid foundation for precise data acquisition across the project site.

### **3.4 INSTRUMENT TESTS (VERTICAL INDEX, COLLIMATION, AND EDM)**

Before deploying the Total Station for field operations, it was essential to verify its reliability and measurement accuracy. Three key tests were conducted: vertical index error, horizontal collimation error, and EDM accuracy.

#### **3.4.1 TEST FOR VERTICAL INDEX ERROR**

The Total Station was set up on point A, with centering, leveling, and focusing adjustments completed. A well-defined target of approximately the same height, located 100 meters away, was bisected. The instrument's vertical circle readings were taken on both face left and face right. The recorded values were 90°02'05" for face left and 269°57'57" for face right, resulting in a sum of 360°00'02". The vertical index error was therefore minimal, calculated at 1", confirming the instrument's suitability for precise measurements. The vertical circle readings, while tested, were

not recorded in the field book due to the instrument's inbuilt program that combines vertical readings with measured horizontal distances.

Table 3.2: Vertical Index Error Test Results.

<b>Parameter</b>	<b>Value</b>
Face left	90 02' 05"
Face right	269° 57' 57"
Sum	269° 57' 57"
Vertical Index Error	$2''/2 = 1''$

### 3.4.2 TEST FOR COLLIMATION ERROR

To assess horizontal angle accuracy, the instrument was set up on point A, with a backsight to point B. The horizontal circle was set to 0°00'00" on face left. Observations on face right yielded 180°00'04". The collimation error, calculated as half the difference (2"), indicated that the horizontal angles could be reliably measured, and the Total Station was confirmed to be in good working condition.

Table 3.3: Collimation Error Test Results.

<b>Parameter</b>	<b>Value</b>
Face left	000 00' 00",
Face right	180° 00' 04"
Sum	180 00' 04"
Collimation Error	$4''/2 = 2''$

### 3.4.3 TEST FOR EDM ACCURACY

The EDM function of the Total Station was tested using a known 50-meter distance between points A and B. Multiple readings were taken from both ends, resulting in mean distances of 49.9962 m

from point A and 49.9980 m from point B. The average measured distance was 49.997 m, giving an EDM error of +0.003 m. This correction factor was applied to all subsequent field measurements to ensure distance accuracy across the survey site.

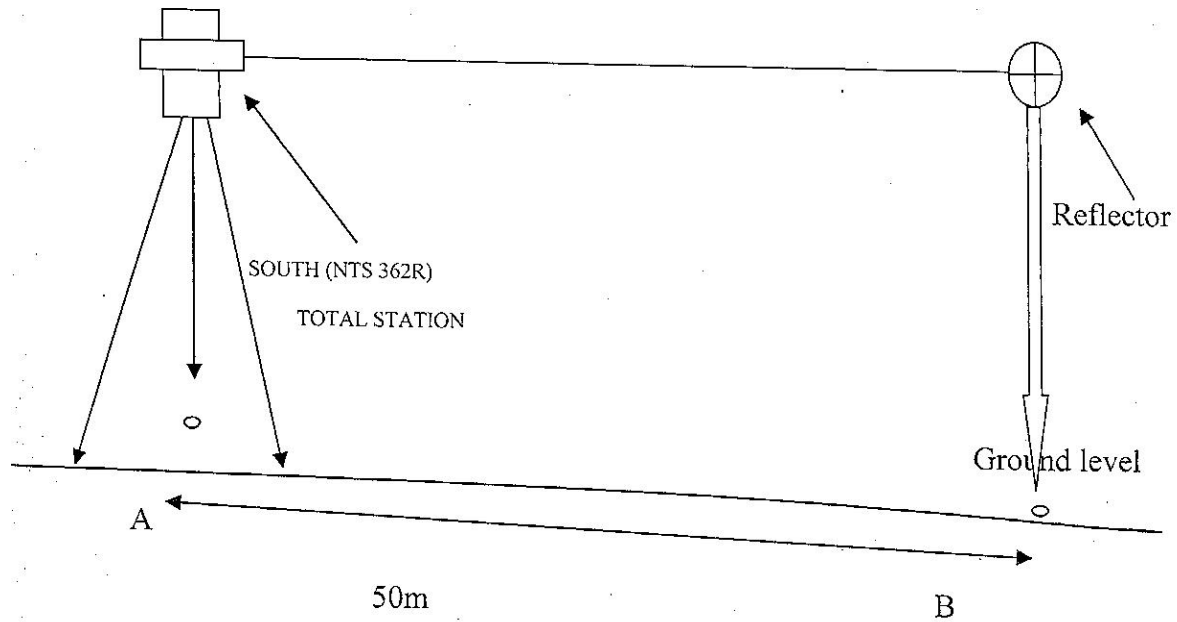


Figure 3.3: EDM Test Illustration

Table 3.4: EDM Distance Readings from Point A

Measurement	Distance (m)
1	49.988
2	49.996
3	50.002
4	49.996
5	49.999
Total	249.981
Mean	49.9962

Table 3.5: EDM Distance Readings from Point B

<b>Measurement</b>	<b>Distance (m)</b>
1	49.996
2	50.003
3	49.997
4	49.996
5	49.998
Total	249.990
Mean	49.9980

Table 3.6: EDM Mean and Correction Calculation

<b>Description</b>	<b>Value (m)</b>
Mean distance from Point A	49.9962
Mean distance from Point B	49.9980
Average of Mean A and Mean B	49.997
Actual distance between A and B	50.000
EDM Error (Actual – Measured)	+0.003

### 3.5 CONTROL CHECKS AND DATA VERIFICATION

Prior to the traversing, controls used for the project were checked for consistency and to ascertain that they are in positions. Angular and linear checks were carried out on controls TOP04R, TOP05 and TOPP02.

The results deduced from the field observation were compared with the corresponding computed values from the given coordinates as follows;

Table 3.7: Angular and Linear Control Checks

<b>Check Item</b>	<b>Observed Value</b>	<b>Computed Value</b>	<b>Difference</b>
Angle at TOP05	162°54'17"	162°54'19"	00°00'02"
Distance: TOP04R to TOP05	139.853 m	139.856m	0.003m
Distance: TOP05 to TOP02	185.679 m	185.681m	0.002m

The verified coordinates of the control points and additional field markers were documented to serve as reference points for the main traverse and detail survey. Table 3.8 presents an extract of the observed coordinates for selected points on the site:

Table 3.8 Extract of coordinates observed

<b>POINTS</b>	<b>EASTING</b>	<b>NORTHING</b>
AL3023AQ	366916.519	171927.619
NAIL1	366982.930	17176.289
AL3024AQ	36686.197	172001.119
AL3025AQ	366830.004	172035.449
AL3026AQ	366770.720	172083.942

The control check process was also represented diagrammatically (Figure 3.4), illustrating the alignment and positioning of the key control points in relation to one another, ensuring a consistent

reference framework for field operations. This verification step provided confidence that all subsequent traversing, line cutting, and detail surveying would be carried out accurately, forming the basis for reliable computation of area, distances, and bearings for the project site.

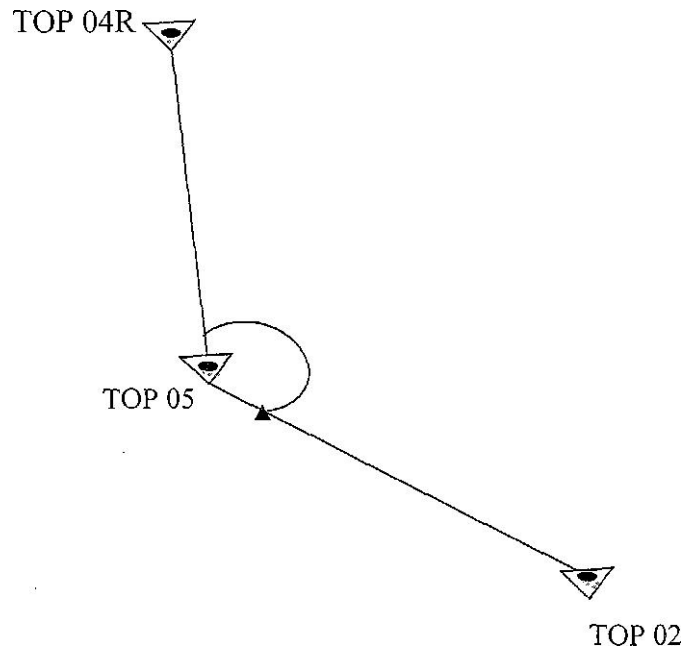


Figure 3.4: Computed Control Check Diagram

### 3.6 DATA ACQUISITION

After completing project planning and verifying the control points, the process of acquiring field data commenced. This stage involved preparing the survey site, establishing reference points, and capturing coordinates for both the perimeter and the details within the project area.

To begin with, line cutting was performed along the site boundaries to remove minor obstacles and ensure clear lines of sight for the Total Station. The fenced boundaries of the site necessitated

selective clearing, particularly where vegetation or structures interfered with measurements. Once the lines of sight were clear, beacons were buried at strategic locations to serve as temporary reference points during surveying. These beacons, along with pre-verified control points, formed the framework for the perimeter and detail surveys.

The main traverse started from control point TOP05 to TOP04R and closed along the same line to ensure proper alignment and minimal error propagation. The Total Station was set up on TOP04R and carefully adjusted for centering, leveling, focusing, and elimination of parallax. Using the coordinate mode, the instrument was oriented with reference to the known coordinates of TOP04R as the station occupied and TOP05 as the back station. The telescope was then used to bisect the reflector mounted on TOP05, confirming the Eastings and Northings. After verifying the back station coordinates, the instrument was rotated to observe the forward station, AL3024AQ.

This observation procedure continued across the site using the ray method, establishing NAIL points at convenient locations where the concrete boundary pillars could not be occupied. The coordinates captured during this process provided the foundation for both the perimeter definition and detail survey of the project site. Table 3.9 presents an extract of the observed coordinates from the field survey.

Table 3.9 Coordinates observed

<b>POINTS</b>	<b>EASTING</b>	<b>NORTHING</b>
AL3023AQ	366916.519	171927.619
NAIL1	366982.930	17176.289
AL3024AQ	36686.197	172001.119
AL3025AQ	366830.004	172035.449
AL3026AQ	366770.720	172083.942

The detail survey involved capturing prominent natural and man-made features within the site, including administrative buildings, aviation facilities, warehouses, F.M. building, helipad, material laydown areas, parking spaces, guest houses, walkways, drainage systems, gate posts, fire service facilities, concrete walls, jetty, transformer, roads, and water treatment areas. A detailed field sketch guided the survey team in accurately recording the positions of these features.

Through careful observation, traversing, and establishment of supplementary markers, the data acquisition phase ensured a comprehensive and reliable set of coordinates. These coordinates would later be used in the computation of area, distances, and bearings, forming the basis for plan production, site analysis, and future decision-making regarding the development of the project area.

### **3.7 DATA PROCESSING AND ANALYSIS**

After completing field data acquisition, the observed coordinates were downloaded and organized for processing. The first step involved verifying the consistency and reliability of the control points by performing angular and linear checks. Observed angles and distances between controls were compared with their known coordinates to ensure the instruments were properly oriented and measurements were dependable.

The perimeter traverse was carried out using the ray method, establishing temporary stations with NAIL points where permanent pillars were inaccessible. Coordinates of all perimeter points and prominent site features were recorded systematically using the Total Station.

Following data acquisition, the coordinates were sorted and formatted in Microsoft Excel before being saved as a script file for plotting in AutoCAD. During processing, key computations were

performed to assess accuracy and determine land area. The linear accuracy of the survey was evaluated using the equation 3.1.

$$\text{Linear Accuracy} = \frac{\sqrt{(\Delta N)^2 + (\Delta E)^2}}{\text{Total Distance}}$$

where  $\Delta N$  and  $\Delta E$  represent the differences in Northing and Easting coordinates, respectively, and the Total Traverse Distance is the sum of all measured traverse lengths.

Additionally, the total area enclosed by the perimeter boundary was calculated using the Double Latitude Method, expressed as in equation 3.2:

$$\text{Area} = \frac{|\sum (\text{Lat.Diff.} \times \text{Long.Diff.})|}{2} \quad 3.2$$

In this formula, Latitude Difference refers to the change in Northing between successive points, and Longitude Difference refers to the change in Easting. The absolute sum of the products is halved to yield the area in square meters, which was then converted to hectares.

In AutoCAD, layers were created to represent different site features such as buildings, roads, and the perimeter boundary. Polylines were used to connect points according to the field sketches, enabling the production of a comprehensive site plan at a scale of 1:2,500.

### **3.8 PLAN PRODUCTION**

Once the field coordinates were organized and verified, the next step involved producing a detailed site plan using AutoCAD 2007. The coordinates were first formatted in Microsoft Excel as text, ensuring each point could be accurately imported into AutoCAD. The data were then saved as a script file, which allowed for automatic plotting of all points within the AutoCAD environment.

Within AutoCAD, layers were created to represent different categories of site features, including the perimeter boundary, buildings, roads, walkways, and other significant structures. The object snap (OSNAP) feature was enabled to ensure precise insertion of points. Using polylines, the points were joined according to the field sketches prepared during reconnaissance, forming an accurate representation of the site layout.

The plotted plan was scaled to 1:2,500 and prepared for printing on A2 paper size, providing a clear and detailed visual representation of the site that could be used for further analysis, planning, and decision-making. This process ensured that all site features were accurately represented, serving as the foundation for subsequent computations such as area, distances, and linear accuracy assessments.

## CHAPTER FOUR

### RESULTS AND DISCUSSION

#### 4.1 LINEAR ACCURACY COMPUTATION

The linear accuracy of the survey was computed using the standard formula:

$$\text{Linear Accuracy} = \frac{\sqrt{(\Delta N)^2 + (\Delta E)^2}}{\text{Total Distance}}$$

Substituting the observed errors:

$$\text{Linear Accuracy} = \frac{\sqrt{(0.004)^2 + (0.041)^2}}{1508.910}$$

$$\text{Linear Accuracy} = \frac{\sqrt{0.000016 + 0.001681}}{1508.910}$$

$$\text{Linear Accuracy} = \frac{\sqrt{0.001697}}{1508.910}$$

$$\text{Linear Accuracy} = 0.00002730093899$$

This yields a linear accuracy of:

$$\text{Linear Accuracy} = 1:37,0000$$

Thus, the linear accuracy is approximately 1:37,000. This indicates a very precise survey, suitable for detailed site planning and analysis.

#### 4.2 AREA COMPUTATION USING DOUBLE LATITUDE METHOD

The area of the site was computed using the double latitude method. The stepwise computation is as follows:

Table 4.1: Area Computation using Double Latitude Method

Latitude Difference	Longitude Difference	Product (Latitude × Longitude)
96.092	-242.248	-23,278.095
264.387	-48.429	-12,803.998
410.090	-52.322	-21,456.729
517.920	-34.193	-17,709.239
600.743	-59.284	-35,614.448
658.200	0.018	11.767
662.922	1.721	1,136.825
664.723	2.362	1,570.076
660.190	74.813	49,390.794
647.980	34.091	22,090.286
616.862	29.748	18,725.860
614.796	20.074	12,362.151
609.848	-0.716	-436.651
597.840	100.336	59,984.874
602.782	0.323	192.760
620.525	54.925	34,082.336
644.818	6.954	4,484.064
691.566	33.165	22,935.786
734.214	19.497	14,314.970
643.313	-28.562	-18,374.306
507.084	175.097	88,788.887
232.103	-87.370	-20,278.839

$$\text{Area} = \frac{|\sum(\text{Latitude Difference} \times \text{Longitude Difference})|}{2}$$

$$= \frac{330,071.436 - 149,952.305}{2}$$

$$= 90,059.565 \text{ m}^2 = 9.006 \text{ Hectares}$$

The developed area excluding lawn space was calculated as:

$$\text{Developed Area} = \text{Perimeter Area} - \text{Lawn Area} = 90,059.426 - 32,134.704$$

$$= 57,924.722 \text{ m}^2$$

This indicates there is significant space available for further development. The final coordinates of the perimeter boundary pillars, which formed the reference for the computed area, were recorded as follows:

Table 4.2: Final Coordinates of Perimeter Boundary Pillars.

<b>Point</b>	<b>Easting (m)</b>	<b>Northing (m)</b>
AL3023AQ	366,916.519	171,927.619
NAIL1	366,982.930	171,976.289
AL3024AQ	366,886.197	172,001.119
AL3025AQ	366,830.004	172,035.449
AL3026AQ	366,770.720	172,083.942

These coordinates were later used for plotting the survey plan and serve as the basis for detailed mapping and future development.

#### **4.3 AREA COMPUTATION OF BUILDINGS IN THE SURVEY PLAN**

The building area comparison reveals significant variation in the sizes of structures within the Chevron Main Office premises. The bar chart illustrating these findings shows that the Project Warehouse occupies the largest footprint, far exceeding all other buildings in the study area. Other major structures such as the Great Hall and the Administrative Block also demonstrate relatively

large spatial coverage, while facilities like the Gate Post, A.G.O. Tank House, and Pedestrance Check occupy considerably smaller areas.

The implication of this distribution on the results is twofold. First, it reinforces the dimensional parameters calculated in Table 4.3, confirming that the survey captured a wide range of structural footprints accurately presented, which focuses on the production of building dimensions. Second, the clear disparity in building sizes suggests a development pattern where a few key facilities drive most of the land consumption. This trend indicates an operational hierarchy and the functional importance of large service-related buildings such as the warehouse. Smaller buildings contribute marginally to overall land use and therefore exert limited influence on the total developed footprint.

Table 4.3: Computed Building Areas

<b>Building Name</b>	<b>Area (Ha)</b>
Aviation Building	0.1922
Warri Training Centre	0.0684
Guest House	0.1115
Great Hall	0.1973
Water Treatment Area	0.0370
Project Warehouse	0.6132
Gate Post	0.0019
A.G.O Tank House	0.0046
Transformer House	0.0487
Pedestrance Check	0.0075
Generator House	0.0229
F.M Building	0.09369
Administrative Block	0.1650

These areas represent the final values obtained from the survey computations and reflect the actual land coverage of each building within the project area.

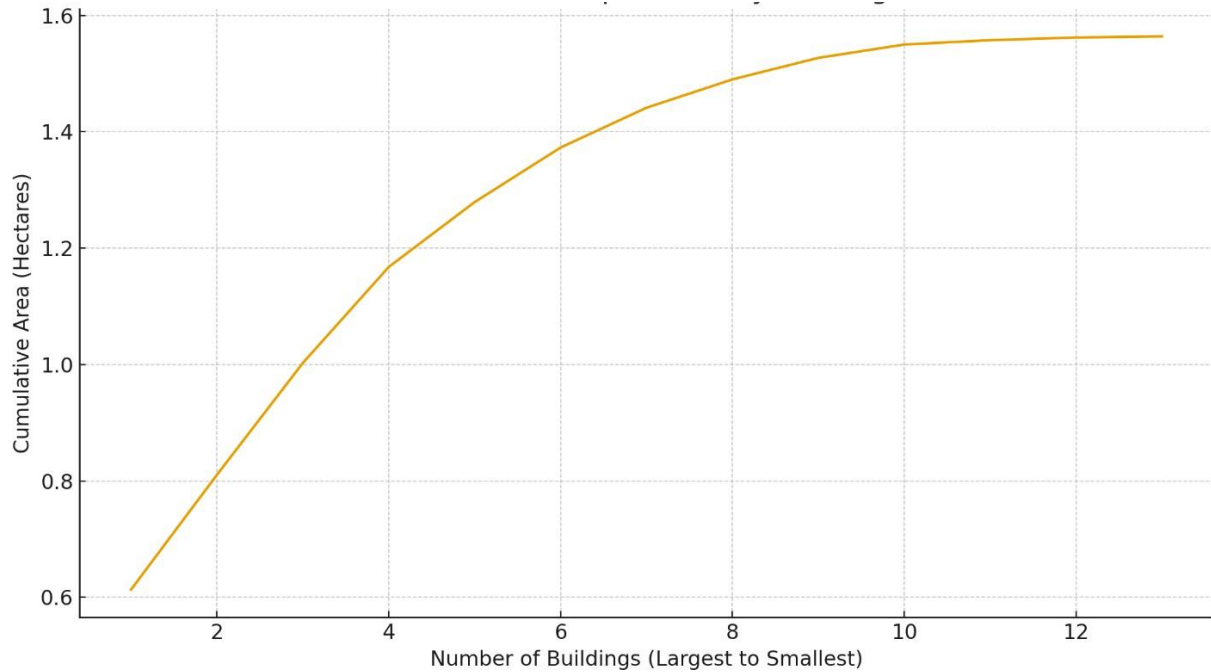


Figure 4.1: Cumulative Development Chart

Figure 4.1 depicts the cumulative development chart which illustrates how the total developed area increases progressively as buildings are added in descending order of size. This chart provides insight into how development within the Chevron Main Office is distributed across different structures. The curve rises sharply at the beginning, indicating that the first few structures, particularly the Project Warehouse, Great Hall, Administrative Block, and Aviation Building, contribute disproportionately to the total developed land area. After these major buildings, the slope of the curve becomes gradual, showing that the smaller buildings collectively add only marginal increases to total development.

This pattern reveals a concentrated development structure, where a limited number of large facilities account for most of the built-up area. Such a distribution aligns with the functional layout of the premises, where operational and administrative activities require more extensive spatial footprints than auxiliary structures. It also contextualizes the role of minor buildings, which, though numerous, have minimal impact on overall land consumption.

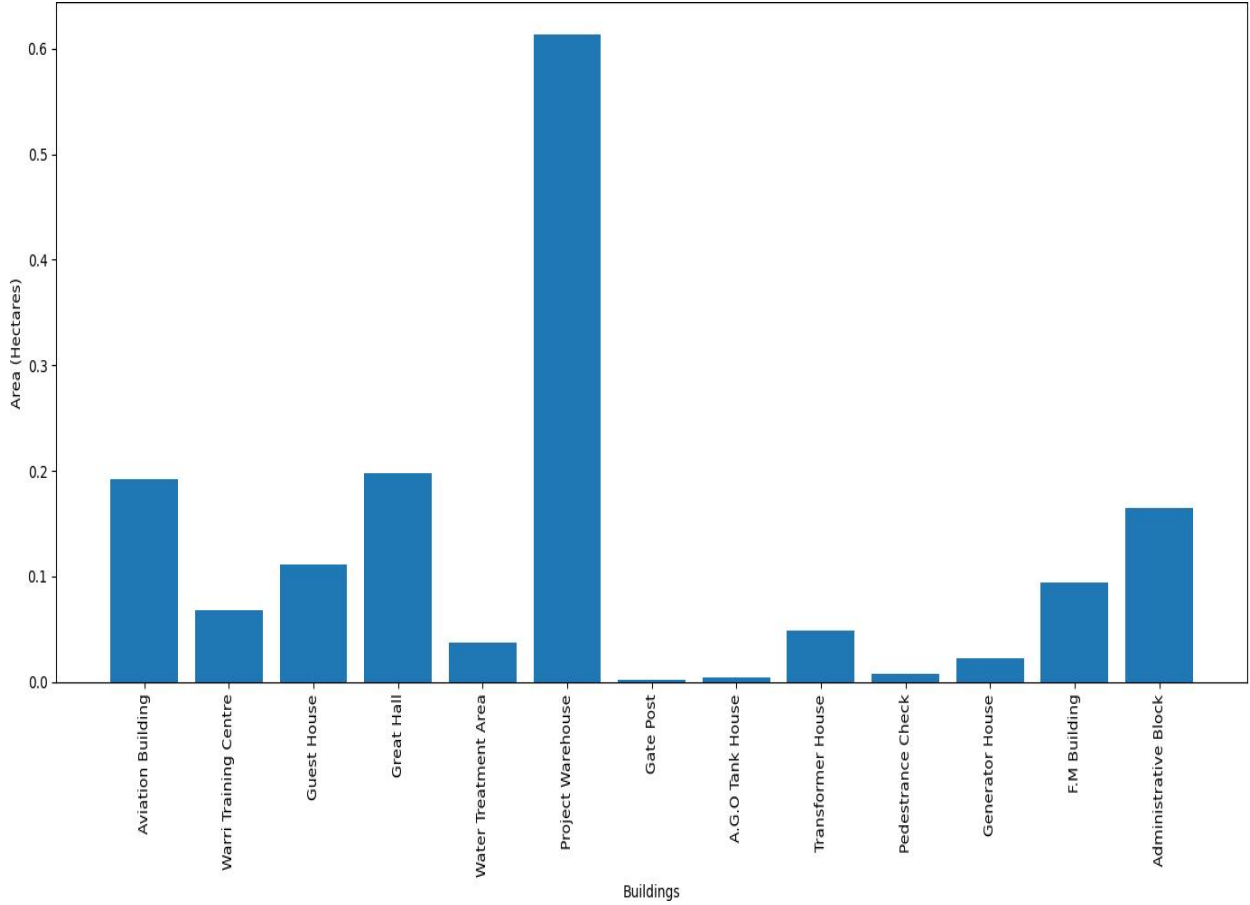


Figure 4.2: Building Area Demarcation

Figure 4.2 shows a bar chart illustrating the area of individual buildings within the Chevron Main Office provides a clear visualization of the spatial distribution of development across the premises. The chart shows that the Project Warehouse is the single largest structure on the site, occupying

0.6132 hectares, which is significantly higher than any other building. This dominant footprint reflects the operational importance of the warehouse and the storage requirements of the facility.

Following the warehouse, the Great Hall, Administrative Block, and Aviation Building also exhibit relatively large building areas. Their considerable sizes indicate that administrative, training, and operational functions constitute major components of land use within the facility. In contrast, smaller buildings such as the Gate Post, A.G.O. Tank House, Pedestrance Check, and similar minor structures occupy minimal land area. These variations in building sizes highlight the mixed functional layout of the premises, combining large operational blocks with smaller service and control units.

The bar chart is instrumental in the production of dimensional parameters for all facilities within the study area. By visually demonstrating the difference in building footprints, the chart validates the computed measurements presented in the tables and reinforces the heterogeneity of land use patterns. Furthermore, the chart assists in understanding how the built environment is distributed, showing that only a few buildings contribute substantially to land consumption while the majority exert minimal impact on overall development density.

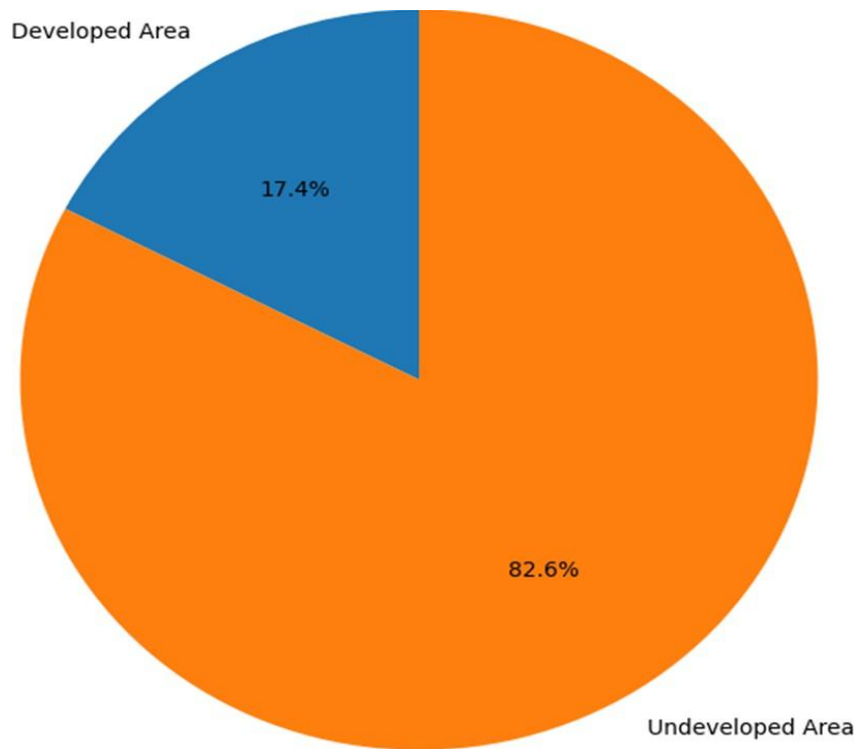


Figure 3.3: Developed and Undeveloped Areas Representation

Figure 4.3 shows a pie chart illustrating the proportion of developed to undeveloped land provides a critical insight into spatial utilization across the site. Only about 17.4% of the total land area (9.006 hectares) is built-up, while a substantial 82.6% remains undeveloped. This sharp contrast has a significant effect on the interpretation of the results.

First, it validates the precision of the computed total area using the Double Latitude Method, since the small proportion of built-up space aligns logically with the extensive lawn, open spaces, and unused land visible in the final survey plan.

Second, the dominance of undeveloped land strongly supports presenting an accurate survey plan and interpreting spatial relationships within the site. The large expanse of open land indicates substantial flexibility for future infrastructural development or functional reconfiguration. Such a

finding is important for planning authorities and Chevron's facility management, as it highlights the potential for the site to accommodate new administrative blocks, service buildings, or supporting infrastructure without needing land acquisition.

Together, the charts enrich the understanding of land use patterns within the study area. The building area chart emphasizes heterogeneity in structural footprints, confirming that the survey measurements captured accurate dimensional characteristics. The developed versus undeveloped land chart demonstrates low spatial saturation, proving that the site remains far from its development capacity.

These visual summaries strengthen the narrative that the study area is accurately surveyed, moderately developed, and holds ample potential for future expansion. They also enhance the clarity of the analytical results in Chapter Four by offering intuitive visual support for the computed values and their implications.

#### **4.4 PRESENTATION OF SURVEY PLAN AND DISCUSSION OF RESULTS**

The final survey plan was produced after completing all computations and verifying the linear and angular accuracies of the field observations. The perimeter coordinates obtained from the adjusted data were used to plot the plan, and these coordinates formed the control framework for the entire mapping exercise. The plan (presented as Figure 4.4) shows the boundary layout of the study area, the distribution of the existing structures, and the open spaces within the perimeter.

The plotted plan clearly outlines the positions of the boundary pillars, which were used to define the extent of the property. Major features such as the built-up sections, paved areas, and the lawn space are shown according to their true ground positions. The internal divisions within the site are

also represented, giving a clear picture of how the land is presently occupied and the portions that remain undeveloped.

The results obtained from the computations further guided the interpretation of the plan. The perimeter accuracy of approximately 1:37,000 indicates that the survey observations were precise and reliable for detailed planning purposes. With a total computed area of 9.006 hectares, the plan confirms the actual land coverage of the site. A comparison of the total area with the measured lawn space showed a developed area of 57,924.722m<sup>2</sup>, which points to the availability of additional space that can be considered for future expansion or redesign.

The survey plan provides a clear graphical representation of the site and aligns with the objectives of the work. The area has been accurately defined, the collected data has been fully processed, and the final plan presents the necessary details required for documentation, planning, and subsequent development activities.



## **CHAPTER FIVE**

### **CONCLUSION AND RECOMMENDATIONS**

#### **5.1 CONCLUSION**

This project has successfully achieved its aim of conducting a comprehensive perimeter and detailed survey of the Chevron Main Office (TOPCON) Ekpan, Uvwie Local Government Area. The fieldwork and subsequent data processing have resulted in an accurate digital plan and a detailed report that fully documents the current state of the property. All features, both natural and man-made, were meticulously captured and mapped.

The survey operations were carried out in strict accordance with established survey rules and regulations, ensuring the reliability and professional standard of the output. The results, including a calculated perimeter area of 9.006 hectares and a high linear accuracy of 1:37,000, confirm that the work meets the required standards for a survey of this nature.

The final survey plan clearly demonstrates that, despite the existing developments, there remains a significant portion of land within the property boundary that is undeveloped. This available space, as identified in the analysis, presents a clear opportunity for Chevron to plan and construct new facilities in the future. Therefore, this project provides a solid and essential foundation for the company's infrastructural planning and development strategy.

#### **5.2 RECOMMENDATIONS**

Based on the experience gained during the execution of this project, the following recommendations are made:

- i. The management of Chevron should incorporate this newly produced survey plan into their land administration system. It should serve as the authoritative base map for all future planning, construction, and facility management activities within the office premises.

- ii. To further improve efficiency in future surveys, there should be a greater emphasis on the use of advanced digital instruments. The adoption of Real-Time Kinematic (RTK) GPS receivers and digital levels should be encouraged to speed up data acquisition and reduce potential human error.
- iii. Surveyors involved in such projects should be thoroughly trained and proficient in the use of modern software packages. Mastery of applications like AutoCAD, ArcGIS, and MATLAB is crucial for efficient data processing, spatial analysis, and professional plan presentation.
- iv. A comprehensive property inventory should be created and regularly updated by the company, using this survey as its foundation. This digital inventory would be an invaluable resource for the company, and could also be referenced by government agencies for urban planning purposes.
- v. For subsequent monitoring and update surveys, the use of drone technology should be considered. Drones can quickly capture aerial imagery and data over large areas like the Chevron yard, making it easier to track changes and identify new developments over time.

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