2021 Population & Housing Census Cartographic Strategy

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2021 Population & Housing Census
Cartographic Strategy

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Preface

Statistics Botswana (SB) embarked on the development of a comprehensive 2021 Population and Housing Census (PHC) Cartography Project Document that will also serve as source for support and resource mobilization for all processes of the exercise and the overall processes of the population and housing undertaking. Statistics Botswana has partnered with GeoSpace International for automation of the 2021 census cartographic exercise. The company will provide Technical Assistance, support and the Implementation of Smart Census Application for the 2021 census cartographic work in Botswana.

This follows the decision by Statistics Botswana to utilize modern geospatial information technologies for the 2021 census pre-enumeration activities as opposed to the traditional method of affixing dwelling numbers on houses. This time around the system has an in-built Geographic Positioning System (GPS) for collecting coordinates for every structure in Botswana to support the production of enumeration area maps. The advantages of using GPS are mainly to improve on the quality of the census population estimates in terms of accuracy, coverage and timeliness; and production of the geodatabase and the listing of dwellings.

Botswana has a tradition of preparing project documents for the censuses with the inclusion of the cartographic operations as a major and first component of the census preparatory activities. This time around the cartographic operations have been separated to ensure that focus is dedicated to the implementation of Geomedia SmartClient for Census application as a major project. Thus, the Botswana 2021 Population and Housing Census Cartography Project Document forms Volume I of the overall census Project Document. This is the first of its kind in the country's history of census undertaking since independence. The second and Volume II of the project would cover the rest of the phases of the 2021 Population and Housing Census undertaking.

The 2021 PHC Cartography Project Document covers the evaluation of the 2011 census processes in terms of cartographic operations, the expected 2021 National Census Structures, roles and responsibilities of different cartography committees, the institutional capacity assessment of the organisation to adopt new census mapping technologies for a successful conduct of the cartographic exercise and to proactively fill the gaps. The project document also acts as a project implementation guide.

Like in the past censuses, it is hoped that the document will assist in resource mobilization especially from development partners to participate in this massive project during the current global economic challenges.

Dr. Burton Mguni
Statistician General
August 2018

1. Background

The traditional role of cartographic exercise in a census has been to support the production of enumeration area (EA) maps and thematic maps derived from available census information. However, due to recent technological developments in geographic information systems (GIS) and other geospatial technologies, the scope of census cartography has been extended to include Cartographic census data analysis and dissemination. The cartography section (now Cartography and GIS Unit) within Statistics Botswana (SB) was set up in 1992 with the aim of fulfilling the above-mentioned purposes. All these roles have been achieved but with the use of more traditional, labour intensive cartographic methods, especially in delineation of enumeration areas. However, with the new technological developments for census operations (which includes data collection, analysis, presentation and dissemination), Statistics Botswana has been moving from traditional cartographic methods towards geographic information systems as the new technological applications in census taking surfaced. For instance, in the 2011 Population and Housing Census Statistics Botswana (the then Central Statistics Office) introduced geographic information systems for census cartography that allowed automation of cartographic processes.

The automation of cartographic processes reduced the number of cartographic operations such as compilation of map/data, drafting of maps and final drawing as was applied in the traditional way of census mapping. There is greater flexibility in handling, processing and producing enumeration maps products. Furthermore, the implementation of GIS in census, improved analysis and dissemination of census results. The digital census cartography approach is a continuous and dynamic process.

The base for the 2021 Population and Housing Census Cartography will be the geospatial datasets prepared during the 2011 census. However, there will be improvements in the 2021 census cartography methodology compared to 2011, in terms of technology application as well as the details of features annotated on the census enumeration maps, for example, the introduction of Smart Census application. Therefore, this document provides the census cartography strategy for the upcoming 2021 population and housing census of Botswana.

2. Introduction

Botswana will be conducting the National Population and Housing Census in 2021. It will be the sixth National population and Housing Census since Independence in 1966. The 2021 Population and Housing census will introduce modern methods and best practices. Statistics Botswana as a custodian of official statistics and mandated to collect and disseminate statistical information, has taken a decision to employ Smart Census for its pre-enumeration activities (census cartography). One of the great achievements is the creation of a Dwelling Unit (DU) Frame, which will be an important new addition during the census cartography phase. This is the first of its kind in Botswana. The DU-frame will provide Statistics Botswana with detailed dwellings and land use information on each and every building structure in Botswana. Structures and Points of Interest (POI) will also be systematically and comprehensively captured in the process. The DU-Frame will greatly improve the quality of the census enumeration area (EA) maps and related activities beyond the census.

As mentioned, Statistics Botswana made a decision to utilize modern census technologies for the 2021 census pre-enumeration activities. To this end, the Smart Census solution was adopted for the whole pre-enumeration census cartographic methodology.

The Smart Census is a total solution that covers the entire life cycle of a population and housing census. It integrates traditional GIS functionality with a powerful workflow and workforce management tool to provide a total solution for census strategies: from pre-enumeration activities, to digital enumeration, to post-enumeration dynamic mapping. It can be used on its own or integrated with a nation or organization's existing GIS infrastructure or platforms. Smart Census also supports statistics offices beyond the census itself, providing the infrastructure to plan, perform and disseminate data for post-census surveys at any scale necessary.

The Smart Census solution is made up of three modules assigned to the different stages of the census process:

a) Pre-enumeration Phase (census cartography): Smart Census enables the digital creation and maintenance of enumeration areas, the planning of canvassing activities, within one tool as well as the creation and maintenance of the Dwelling Unit Frame;

b) Enumeration Phase: Smart Census can integrate with mobile systems such as Computer Assisted Personal

Interview (CAPI) regardless of the type of software used, for example, CSPro or survey solutions, for fast and efficient data collection and ensures continuous enumeration, even in remote areas.

c) Post-enumeration and dissemination phase: Smart Census speeds up dissemination processes by utilizing Hexagon Geospatial Smart M.App technology which presents complex census data based on multiple demographic, economic and geographic factors. The dissemination module allows census and survey results to be disseminated through the Internet using dynamic maps combined with an array of graphs and tables For this project, Statistics Botswana procured the pre-enumeration mapping module of Smart Census. The primary deliverables of the 2021 pre-enumeration mapping project are:

1. an updated geographic frame for Botswana that will reflect the current administrative boundaries of the country;

2. an updated Enumeration (EA) and supervision area (SA) map database with accompanying information to be used during the enumeration phase of the census;

3. a detailed DU-Frame with current image base maps.

4. The secondary deliverables/benefits include:

    a. **upgraded GIS Office hardware and software;**
    b. **mobile data capture devices (PDA/GPS) that can be used in future surveys;**
    c. **sustainable census mapping capacity in Statistics Botswana;**
    d. **updated national geo-spatial and attribute datasets;**
    e. **Smart Census technology that can be used for Enumeration, subsequent surveys and dissemination of data.**

Statistics Botswana will ensure that census activities are implemented based on international standards and best practices for census mapping as recommended by the United Nations.
The census cartography is scheduled to commerce in October 2018 first as a pilot exercise of the new technology. The actual exercise will commence in February 2019.

3. Pre-enumeration Census Cartography

3.1 Justification – The Importance of Census Cartography

The cartographic fieldwork forms the fundamental core activity to the success of any population and housing census. The primary objective is to delineate enumeration areas (EA) in the country to facilitate the counting of inhabitants during enumeration period and fundamentally to ascertain that all areas are covered; that everyone in the country is counted with minimal possibility of under counting as well as the creation of a master sampling frame for socio-economic and household surveys that are conducted during the inter-census period. Enumeration Area (EA) must be big enough for one enumerator to handle during the time of enumeration. The EAs will be delineated and delivered according the National Geo-Frame. The deliverable will be a set of A3-sized EA and SA (supervision area) maps, hardcopy or digital. A further important deliverable of pre-enumeration activities is the creation of the geography layer that is used for enumeration planning and digital enumeration (CAPI) as well as the analysis and dissemination of census results.

The role of maps in the census is twofold: **(a)** to support enumeration activities and **(b)** to present aggregate census results in cartographic form. Advantages of the enumeration maps include: **(i)** ensuring full and unduplicated coverage; **(ii)** estimating resource requirements (travel time and costs); **(iii)** assigning geographical codes; and **(iv)** establishing the numbers of field officers to be hired, vehicles, equipment and materials to be procured.

During the enumeration exercise, these maps are used to guide the enumerators to find their way within the enumeration areas. Enumeration area maps also provide a basis for producing thematic maps for spatial analysis of the census and provide a sound basis for developing a national sampling frame for inter census household surveys. The spatial census database can be combined with other datasets to generate thematic indicator maps, which can be included in a Census Atlas depicting several socio-economic indicators

including poverty and literacy levels that enhance understanding of the spatial dimensions of diverse issues in all sectors of the Botswana economy.

Specifically, census cartography aims to:

a. **To delineate enumeration areas and produce maps used to facilitate counting of inhabitants during the enumeration period;**
b. **Ascertain that all areas are covered and that everyone in the country is counted with minimal possibility of under counting;**
c. **Produce thematic maps for spatial analysis of the census and provide a sound basis for developing a national sampling frame for the inter-census household surveys;**
d. **Estimating resource requirements (costs, fieldworkers, vehicles, equipment etc.), for the Population and Housing Census;**
e. **Produce a spatial census database for use with other datasets to generate thematic indicator maps to enhance understanding of the spatial dimensions of diverse issues in all sectors of the economy.**
f. **Ensure that EA maps easily guide the enumerators to their assigned EAs during the census period.**
g. **Effectively monitor the enumeration process.**

3.2 Project Management Structures

The census cartography project is the responsibility of Statistics Botswana and hence it is important to have a framework which outlines the structures of the project, with clear roles and responsibilities. To this end, a cartographic committee has been formed to oversee the technical part of the project. Membership is drawn from various stakeholders such as Department of Surveys and Mapping, Botswana Defence Force, Department of Environment in the University of Botswana (UB), to mention but a few. This committee will meet on quarterly basis and shall report to the Executive Committee of Statistics Botswana through the chairperson, being the Deputy Statistician General – Statistical and Technical Operations

Other structures within Statistics Botswana such as the Project Steering Committee shall be used to monitor progress and updates on the project on monthly basis.

3.3 Census Cartography Personnel Training and Recruitment

Statistics Botswana has a functional GIS and Cartography unit. The tasks of the office and field staff require a large number of personnel. Currently there are eight (8) office staff of which two (2) are on contract basis. Additional 10 supervisors with a degree in GIS shall be recruited. Forty (40) mappers, comprising high school leavers or any higher discipline shall be recruited for the project and they will be trained accordingly.

The consultancy will train the project team in the use of Smart Census (Configuration and Management), GeoMedia Professional and GIS and Cartography Project Management to further equip them in performing office work and support fieldwork operations. Training will be conducted in batches as and when needed. The methodology development will play a critical role in the scheduling of the training. A detailed census cartography methodology chapter is included in this project document in order to identify the required additional GIS and fieldwork staff as well as the infrastructure compliments necessary to complete the census mapping exercise.

3.4 Quality Assurance and Control

Quality Assurance (QA) and Quality Control (QC) are important to ensure quality and consistency in the outputs of the project. That is, the quality of geo-datasets including maps that are used in the census undertaking has a major influence on the quality and reliability of data collected. In particular, special attention should be given to ensuring production of quality census enumeration area maps.

Provision is being made for quality assurance and control procedures at all steps in the project, from Phase 1

through to the final delivery of the enumeration areas for Enumeration. It is however important to emphasize that the QA and QC must be performed as close to real-time as possible to allow corrections to be made within memorable time frame.

3.5 Sustainability and Risk Factors

Sustainability of the project will be ensured by a number of factors including national commitment, capacity building, quality assurance, availability of transport and all other logistical arrangements, connectivity as well as technological support. National commitment should be reflected through legal actions (Acts and formation of cartographic committees), human, financial, and other resource allocation. Donor commitment is reflected mainly through provision of technical support. National capacity development will be central to the various levels of census planning and implementation including cartography/mapping fieldwork and other processes of the census phases.

Quality control procedures (well-designed and tested tools and plans, spot checks, internal consistency and range checks, independent verification and supervision) will be built into the system. However, a number of challenges and potential risks that need to be taken into account are presented in the risk register below.

TABLE 1 RISKS AND RISK MITIGATION MEASURES

No	Risk Name	Risk Description and consequences	Root Cause	Impact / Consequence Rating	Risk mitigations	Risk owner
1.	Delays in formation of census structures	Delayed formation of census coordination of office.	Unclear roles on which office should initiate the census project. No clear defined reporting lines	Critical	Expedite the formation of National Census office and reporting lines	NCC
		Delayed formation of census district structures will delay the commencement of cartographic work therefore time over-runs for this project.	Lack of guidance and experience in carrying out the census project	Critical	1. Address the district commissioners about the census project. 2. Inclusion of resource in the committee that has exposure. And experience in undertaking census	NCC
		Denied access to households due to lack of publicity	inadequate publicity due to delayed implementation of the publicity plan of the cartographic exercise	Critical	Manager (SFS) to advise when to officially implement publicity and advocacy plan of the project	Manager (SFS)/ DCC
2.	Delays in getting spatial data from LAPCAS project	Data received from LAPCAS project has gaps, not complete.	Data for the surveyed plots have not been submitted from the land boards to Dept. of Surveys & mapping	Catastrophic	Sourcing of satellite imageries from other institutions i.e. DIS & BDF	Manager SFS

The key used to quantify the impact/consequence of the risks is as follows:

	Catastrophic: Occurrence/s with the potential to lead to suspension of operations or closure of Statistics Botswana.
	Critical: Events which can be endured, but which may have a prolonged negative impact and/or extensive consequences
	Serious: Events which can be managed, but require additional resources and management effort
	Significant: Events which can be managed under normal operating conditions
	Minor: Consequences can be readily absorbed

TABLE 1 RISKS AND RISK MITIGATION MEASURES Cont.

No	Risk Name	Risk Description and consequences	Root Cause	Impact / Consequence Rating	Risk mitigations	Risk owner
3.	High staff turnover	Most of employees used are temporary staff	Engaged employees go for better opportunities or job security since they are employed on temporary basis	Serious	Have a reserve pool of staff	HR
4.	Insufficient knowledge and skills on Smart census	Smart census is a new technology and most people are not knowledgeable about it and this will delay cartographic progress	New technology and there is need to get grip with the concepts	Serious	Continuous adequate training and usage of the system.	Manager SFS
5.	Non adherence to the procurement plan	Failure to secured equipment and material on time	Delayed release of funds.	Critical	1. Borrow already available equipment e.g. BDS 2. Borrow funds from already running projects within SB.	DSMIS
			Failure to deliver by service providers on time.	Critical	BDS gadgets to be used in the case that the specified gadgets are not delivered on time.	Manager SFS
			Failure to start the pro-curement process on time.	Critical	Procurement to comment	Ass Manager-Procure-ment

TABLE 1 RISKS AND RISK MITIGATION MEASURES Cont.

No	Risk Name	Risk Description and consequences	Root Cause	Impact / Consequence Rating	Risk mitigations	Risk owner
6.	Low quality data pro-duced	Lack of staff commitment	Low staff morale	Significant	1. Motivate staff through various ways e.g. Communication, HR. 2. Performance agreements to include projects and ensure rigorous supervision	Manager SFS
			1. Lack of discipline. 2. non adherence to terms and conditions of the contract by temporary staff during data collection	Significant	1. Follow disciplinary processes and actions to be taken accordingly. 2. Explain to temporary terms and conditions of their contracts including absenteeism, undesirable behavior, etc. and how much would be dealt with. 3. Staff should be requested to sign their contract as well as the rules leaflet (to be pro-vided by HR)	1. Manager SFS 2 & 3 Manager HR
		Recruitment of non-experienced data collectors	lack of database of previously used data collectors	Significant	1. Recruit a large of those who have previously collected data in Statistics Botswana 2. Early recruitment of staff and ensure adequate and in-depth training	Manager HR & Manager SS (for training)

TABLE 1 RISKS AND RISK MITIGATION MEASURES Cont.

No	Risk Name	Risk Description and consequences	Root Cause	Impact / Consequence Rating	Risk mitigations	Risk owner
7.	Technol-ogy failure	Insufficient server storage which will result in the server crushing	Insufficient server capacity	Critical	1. Sign a contract to use the consultant's server (in Pretoria) on temporary basis, through Virtual Private Network. 2. To procure a new Server by end of November 2018. 3. Current server at Statistics Botswana to be assessed for specifications to host pilot data	IT Manager
8.	No external data backup	Loss of data	No external data backup	Catastrophic	To have an external data backup	IT Manager
9.	Con-nectivity failure	Low internet speed	Low bandwidth, old switches and cabling	Critical	To be addressed by moving to the new home by 31 December 2018	IT Manager
		Interrupted data transmission	No or low network coverage by mobile service providers	Critical	Approach mobile service providers about network coverage	IT Manager
10.	Environ-mental and climate factors, rains	extended number of days without field work being done due to weather conditions	Heavy rains, floods and any other natural disasters	Critical	1. factor weather conditions in the work plan. 2. Procure protective clothing and equipment to enable work during rainy season	Manager SFS/ HR

3.6 Project Cost

The estimated budget for the 2021 PHC cartography operations is 44 Million Pula. The cost of the project is wholly sponsored by the Government of Botswana. The budget is spread over the 3-year period, P21million for 2018/19, P14 million for 2019/20 and P9 million for 2020/21. Table 2 below displays the budget breakdown.

TABLE 2: 2021 PHC CARTOGRAPHY BUDGET BREAKDOWNS

Item No.	Item Description	Unit Cost	Quantity	Duration (months)	Total Cost
A	**Consultancy**				
1	Consultancy Services	5,994,670.00	1.00	1.00	5,994,670.00
	12% VAT				719,360
	Total				**6,714,030**
B	**Human Resources**				
2	· Commuted Allowance for Supervisors, mappers and Drivers	4,500.00	70.00	22.00	6,930,000.00
3	· Salaries for Supervisors	8,000.00	10.00	22.00	1,760,000.00
4	· Salaries for mappers	5,050.00	40.00	22.00	4,444,000.00
5	· Salaries for Drivers	4,000.00	20.00	22.00	1,760,000.00
6	· Salaries for GIS Specialist	21,000.00	2.00	48.00	2,016,000.00
7	· Salaries for IT Personnel	21,000.00	3.00	48.00	3,024,000.00
8	· Supervisors Airtime	150.00	10.00	22.00	33,000.00
9	· Quality Controllers Airtime	200.00	8.00	22.00	35,200.00
	Sub Total				**20,002,200.00**
	12% VAT				**2,400,264.00**
	TOTAL				**22,402,464.00**
C	**All Equipment**				
10	· GIS Workstations	65,000.00	8.00	1.00	520,000.00
11	· Laptops	20,000.00	12.00	1.00	240,000.00
12	· Rugged Computer Tablets	60,000.00	40.00	1.00	2,400,000.00
13	· A3 Colour copier/printer	100,000.00	1.00	1.00	100,000.00
14	· A0 Plotter	118,330.00	1.00	1.00	118,330.00
15	Colour Printers	40,000.00	3.00	1.00	120,000.00
16	external harddrives	4,000.00	8.00	1.00	32,000.00
17	Transport (robust vehicles)	455,400.00	6.00	1.00	2,732,400.00
18	Fieldwork Personnel Attire	84,000.00	1.00	1.00	84,000.00
19	Fuel and other Lubricants	5,004.00	24.00	22.00	2,642,112.00
20	License to access remotely sensed data	1,400,000.00	1.00	2.00	2,800,000.00
21	Printing and Packaging of final EA maps	65,000.00	1.00	1.00	65,000.00
22	Camping Equipment	671,821.00	1.00	1.00	671,821.00
23	Stationary	132,375.00	1.00	1.00	132,375.00
	Sub Total				**12,658,038.00**
	12% VAT				**1,518,964.56**
	TOTAL				**14,177,002.56**
	GRAND TOTAL - excl VAT				**38,654,908.00**
	GRAND TOTAL - incl VAT				**4,638,589.0**
	GRAND TOTAL				**43,293,497.0**

3.7 Roles and Responsibilities

a. The Statistician General

The overall responsibility for the Population and Housing Census Cartographic operations lies with the Statistician General Office. The office is responsible for the role of political leadership in the project and is required to communicate the census message at the highest level. In order to do so the office will be regularly briefed of the census cartography project processes, progress and the required resources on regular basis through executive meetings. The same office will play advocacy role which is crucial to ensure political buy-in and mobilize the support of the population at large.

b. The National Census Coordinator or Deputy Statistician General – Statistical and Technical Operations (DSG_STO)

The National Census Coordinator or DSG_STO office is responsible for keeping the SG informed on the methods and status of the project on regular basis. This can be done through monthly executive project status reports and meetings. The office is also responsible for major decision making in the areas of resource mobilization and utilization as required for a successful implementation of the census including the pre-enumeration cartography project. The office will support the census where high level interventions are required; play an important role in the coordination and mobilization of support from external stakeholders. This office also chairs the Census Cartographic Committee.

c. The Director

With the assistance of the Census Cartography Project Manager, the Director is accountable for the overall coordination and management of the census cartography project operations, administratively and technically to ensure that the project runs smoothly, time lines are kept and that resources are utilized efficiently. As such, he/she must be aware of all the census cartography processes and project details to enable him/her to provide required guidance and make informed decisions on the project. The Director is also responsible for the overall coordination of project meetings with internal stakeholders as well as the supervision of the Census Cartography Project Manager.

d. Census Cartography Project Manager

With the assistance of the GIS and Cartography Unit head, the Census Cartography Project Manager is responsible for and required to supervise the mapping project team. The Census Cartography Manager must therefore be up to date in all aspects of the project in order to ensure that the project accomplishes the results required within the timeframe set. The Census Cartography Project Manager is also responsible for the supervision of GIS and Cartography Unit head.

e. Head, GIS and Cartography Unit

The head of unit is responsible for the operational management of the pre-enumeration mapping exercise. The head is also responsible for supervision of GIS specialists and hence should be up-to-date with field operations and their status, report progress to the Census Cartography Project Manager regularly or on agreed frequency.

f. GIS Specialists and Technicians

Reporting to the head, GIS and Cartography, the GIS Specialists and Technician are responsible for the management of the GIS office work and staff, the scheduling of work, reporting on the progress and status of work, requests for technical assistance and (additional) training, resolving issues that could potentially affect the quality and delivery of the GIS Office work. This team is also responsible for the production of all maps required for enumeration purposes as well as quality control activities.

g. Fieldwork Supervisors

Fieldwork Supervisors are responsible for the overall management and supervision of the census EA delineation fieldwork teams. This entails the scheduling of work according to the agreed schedule, reporting on the progress and status of work, requests for assistance and (additional) training, escalation of issues that could potentially threaten the quality and delivery of the fieldwork. He/she will work in close collaboration with head, GIS and Cartography unit to ensure that all the required field maps are produced timely and according to the agreed standards.

h. Fieldwork Mappers

Fieldwork mappers are responsible for data collection, EA delineation and capturing of data for the creation of Dwelling Unit Frame.

i. Database Administrator

The Database Administrator will be responsible for maintenance of GIS systems, monitoring the flow of data from field to office and managing the geo-database. He/she will be reporting to the head of unit.
A detailed overview of functions for Census Cartography team is displayed as **Appendix I.**

3.8 2021 PHC Cartography Project Schedule

The project schedule below displays census cartography activities and timelines.

TABLE 3: 2021 CARTOGRAPHIC FIELDWORK OPERATIONS MILESTONE CHART

SR NO.	YEAR / PLAN OF ACTIVITIES	2017/18 Q1	2017/18 Q2	2017/18 Q3	2017/18 Q4	2018/19 Q1	2018/19 Q2	2018/19 Q3	2018/19 Q4	2019/20 Q1	2019/20 Q2	2019/20 Q3	2019/20 Q4	2021 Apr
1	**Project Planning (Needs Assessment)**													
a	Situational Analysis	■												
b	Map Inventory	■	■											
c	Formation of 2021 census cartographic Committee		■	■	■	■								
d	Project Proposal and Budgeting		■	■	■									
e	Signing of Contract with GeoSpace International					■								
f	Development of PM (budget) and release of funds				■	■								
g	Preparation of the Tender Documents and Awarding				■	■	■							
h	Development of Project Document					■	■							
2	**Procurement of Vehicles, GIS Equipment and Geomedia Professional**													
a	Fieldwork Vehicles						■	■	■	■				
b	Tender award for procurement of cartography equipment					■	■							
3	**System Design, Manual Productions and Geodatabase**													
a	Document Management System Design			■	■	■	■							
b	Geodatabase Development			■	■	■	■	■	■					
c	Develop Quality Control Management System			■	■	■	■	■	■					
d	Mappers Manual Production						■							
4	**Geographic Data Collection and Map Updating**													
a	Data acquisition (collection)	■	■	■										
b	Data Cleaning (Update EA maps from 2011 PHC)	■	■	■	■	■	■							
c	Produce and print base maps for fieldwork operations			■										
5	**Development of Data Collection Instruments**													
a	Pre-Listing Form						■	■						
b	Site Conditioning Form						■	■						
c	Daily Workload Form						■	■						

TABLE 3: 2021 CARTOGRAPHIC FIELDWORK OPERATIONS MILESTONE CHART

SR	YEAR	2017/18				2018/19				2019/20				2021
NO.	PLAN OF ACTIVITIES	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Apr
6	**Procurement of Fieldwork Equipment/Supplies**													
a	Camping Equipment, field attire, airtime, stationary, etc.													
b	Internet connectivity for data transfers													
c	Engagement of Mobile Phone companies													
7	**Recruitment of Field Staff**													
a	Recruitment of temporary GIS / Cartographic Technicians													
b	Recruitment and training of supervisors and mappers													
c	Recruitment of temporary drivers (pilot and main exercise)													
8	**Training**													
a	Geomedia Pro advanced													
b	Smart Census System													
9	**Publicity (Stakeholder Relations)**													
a	Develop and implement Communication plan													
b	Involvement of Districts													
c	Publicity Materials (TV Adverts & Radio Jingles)													
10	**Cartographic Fieldwork**													
a	Conduct Pilot													
b	Main Mapping Exercise commencement													
c	Quality control (fieldwork and Office)													
d	Cartographic Inspection													
11	**Delineation of Enumeration Areas and Map Production (Office)**													
a	Production of EA and Supervision Area maps													
b	Printing and packaging of EA maps													
c	Distribution of district maps to Districts													
d	Updated Locality Coding List / Geocoding Scheme													

4. CENSUS CARTOGRAPHY METHODOLOGY

4.1 Overview

The census cartography provides the basis for most logistical planning for census enumeration operation, as well as the crucial details of the number of enumeration areas and their estimated size. A number of innovations were introduced for the 2011 Census, including using GIS and new sources of spatial data to improve the design of enumeration areas. More improvements will be introduced in the 2021 census cartography methodology compared to 2011. The biggest innovations for the 2021 census (compared to 2011) are the use of 50cm or less orthophotos as the base map for the entire country (compared to 2,5m panchromatic OPM in 2011). More importantly, is the introduction of Smart Census solution. Smart Census pre-enumeration mapping module is a client-server solution specifically designed for census mapping exercise. Through unique workflows the data capturing and management of the entire project is managed.

The 2021 Census pre-enumeration cartographic mapping will be carried out in four main phases namely:

a. Fieldwork exercise where dots are placed on each dwelling unit (DU) on a hardcopy 2011 EA map;

b. Verification and updating of existing prominent features (PF) data using Smart Client for Census;

c. Prominent features include educational facilities, health facilities, community centres, places of worship and police stations;

d. Capturing of GPS location as well as attribute information for PFs not already in the database using Smart Census;

e. Verification and modification of existing enumeration areas boundaries through field updating.

f. Production of enumeration maps.

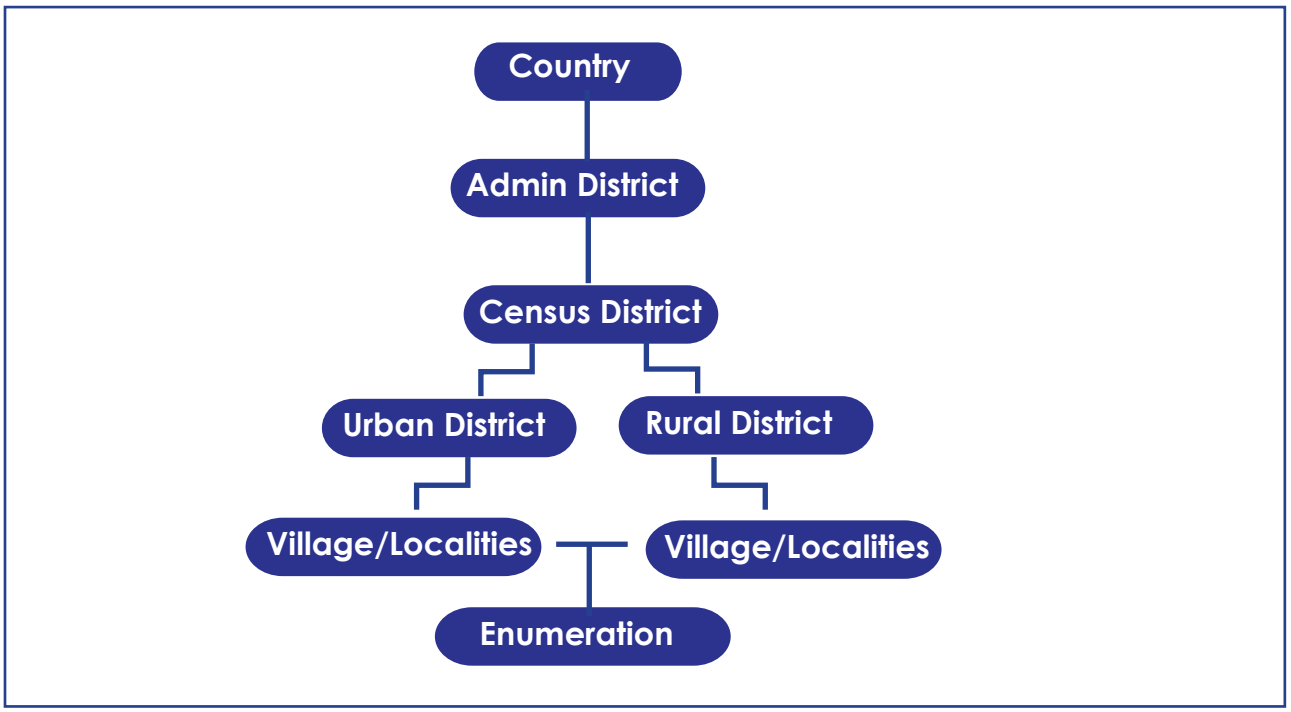
Since the 2011 census there has been a lot of growth in terms of physical developments across the country especially in urban and peri-urban areas. This growth has led to villages expanding into nearby land areas thereby swallowing them up as residential plots were demarcated and allocated in these areas. The outcome of this growth is that rural EAs that were delineated for the 2011 census in these land areas no longer exist. It is, therefore important that all these changes are captured before the start of the cartographic fieldwork. This growth has also affected the enumeration areas boundaries and hence calls for the updating of the EA maps as well as the realignment of the EA boundaries.

Delineation of EAs will be carried out on base maps on the basis of the estimated number of dwellings and the recorded population during the listing of households' exercise. An EA in rural areas normally consists of about 75 – 150 dwellings depending on the ecological zone it is situated; 110-220 dwellings in urban and village areas, and has definite boundaries. In effect, this is an operational unit for enumeration. The entire country will completely be covered by a network of EAs.

The EAs will be coded numerically different for identification purposes so as to facilitate reporting of the census data using a four-digit code. The complete code number for an EA can be increased to eight digits with the first 4 digits representing the census district and the village code respectively.

4.2 Census Geographic Hierarchy in Botswana

A census geographic hierarchy involves creating a list of all administrative and statistical reporting units in the country, with the relationships among all types of administrative and reporting unit boundaries defined. Every country has its own specific administrative hierarchy. The lowest level of administrative unit is an EA. For the purpose of the census taking Statistics Botswana uses a generic census geographic hierarchy as illustrated by figure below.



Geographically Towns and Cities fall within the boundaries of administrative districts but due to their peculiarities they are designated as independent census districts for census operations. This applies to administrative districts that have not been subdivided and newly established sub-districts though the determination of district boundaries is a very serious challenge. It should be noted that, in urban districts, town/cities are villages and the extensions within them are designated as localities as opposed to the rural districts, where the setup is fairly straight forward. In rural districts, villages, cattleposts and lands areas are themselves localities.

4.3 Use of Imagery Base Maps

During the 2011 census, a mapping innovation was introduced through the use of digitized enumeration area maps. These were produced using data collected from various sources, colour aerial photographs (OPM) and the panchromatic OPM covering the entire country. In some areas satellite imagery was used. The base maps were updated and verified in the field during the cartographic fieldwork operations to facilitate the production of comprehensive digitized maps.

4.4 Evaluation of the 2011 Population and Housing Census Cartography

The evaluation of the 2011 PHC cartography exercise revealed the following as problems encountered during the exercise;

a. Maps were inaccurate in terms of labelling and caused more confusion among the enumerators.

b. EA Identification: problems relating to the identification of EA boundaries during census enumeration.

c. EA size: some enumeration areas were too big to be covered by one enumerator during enumeration.

d. The black and white OPM covering the whole country was outdated and the resolution was not good enough for large scale mapping.

e. Data gaps: some areas were covered using sketch maps.

f. The manual numbering of dwellings and building structures caused a lot of problems during census enumeration. This is caused by legibility issues since they were hand written.

g. Unlisted localities and dwellings even in urban areas

h. Combined or Lumped EAs: These occurred due to insufficient map information to separate adjacent EAs

i. Some images were cloud-blurred and could not be used in rural areas e.g. OMP

The introduction of the new mapping approach, including the Smart Census mapping module, will address the problems encountered during the 2011 PHC cartographic operations. The following will be done;

a. For pre-enumeration activities for the 2021 census, archived high resolution satellite imagery (25cm and 50 cm), topographical dataset, cadastral data (LAPCAS), line map data and 1.5m satellite imagery (AirBus) will be acquired to complement the ESRI image base map and to replace the outdated panchromatic OMP. The high resolution satellite imagery will be used for densely populated areas (fast growing) such as urban and peri-urban areas while the topographic data will be used for medium scale mapping in rural areas.

b. The cadastral data will be used for large scale mapping. This will provide an updated layer of all the land parcels across the country with a systematic numbering of dwellings and building structures, particularly in villages where there are no plot numbers. The 1.5m satellite image will cover the most remote parts of the country such as lands area, cattle post, farm etc. in conjunction with the topographic data.

c. The use of satellite imagery will eliminate most, if not all, of the problems encountered during the 2011 while the cadastral data will address the issues relating to the numbering of dwellings and building structures. This will contribute to the best possible pre-enumeration mapping and will ultimately result in better quality EA maps for the census.

4.5 Consultancy to Determine the Feasibility to Implement Smart Census

Statistics Botswana benchmarked on the use of new technology for census undertaking. The use of Smart Census solution was demonstrated to the Organisation's management. GeoSpace International Company was invited to make a presentation to Statistics Botswana in May 2017. From the presentation it surfaced that there are key requirements to be satisfied before Smart Census solution could be implemented. The requirements are as follows;

a. The need for a comprehensive and complete geo spatial database

b. Procurement of hardware, software infrastructure and addressing connectivity issues

c. Availability of latest and cleaned geo spatial data (imagery, etc.) and

d. Procurement of GeoMedia Professional (cleaning software) and training of staff on such

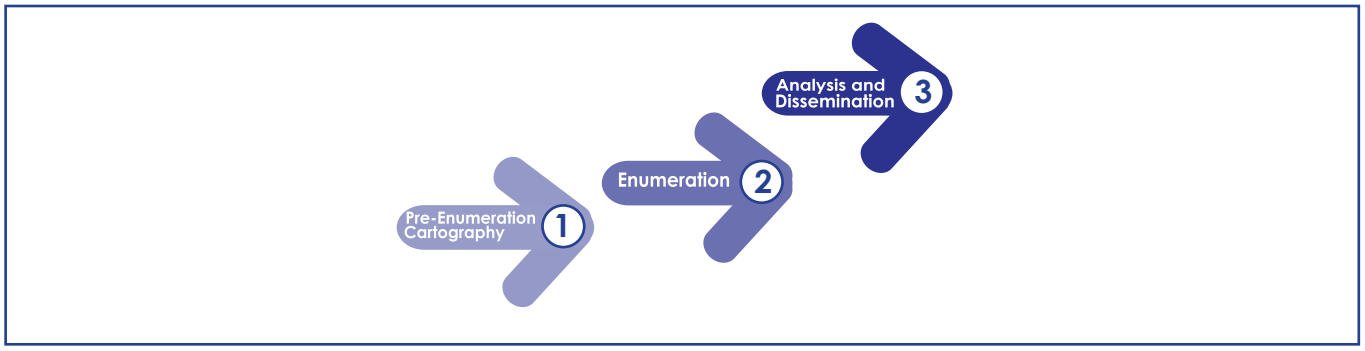
Following the presentation, the company was contracted to conduct a situational analysis to determine the feasibility of implementing Smart Census for 2021 Population and Housing Census cartographic work. A comprehensive report of the consultancy was prepared in June 2017 and was titled 'Short-term Consultancy on Pre-Enumeration Census mapping, Statistics Botswana'.

The consultancy revealed that, while the environment is conducive for the implementation of Smart Census, there are however, data gaps and base maps issues to be resolved and hence a need for development of a clean geo spatial database; procurement of software and hardware including Geomedia Professional and staff trained on the same as well as improving internet connectivity. Data availability was viewed as a prerequisite for Smart Census implementation. Data is normally obtained from Department of Surveys and Mapping (DSM). On average, the consultancy recommended the adoption of the technology as Statistics Botswana satisfied most of the requirements.

4.6 Smart Census Solution

Statistics Botswana made a decision to utilize modern census mapping technologies for the 2021 census pre-enumeration activities. For this reason, Smart Census solution has been adopted for the whole pre-enumeration census mapping methodology. The Smart Census solution was developed by Hexagon Geospatial in

association with GeoSpace International. It is a total solution that covers the entire life cycle of a Population and Housing Census and is a client-server software platform that integrates traditional GIS functionality with a powerful workflow and workforce management tool to provide a total solution for census strategies.
Smart Census provides a solution for each phase of a census: **1)** Pre-enumeration mapping; **2)** digital enumeration, and **3)** post-enumeration dynamic mapping for the dissemination of census results.



These phases are explicitly elaborated in the introduction. However, only the pre-enumeration census mapping module is procured for this project. The solution for the project includes the full Pre-enumeration mapping module covering the configuration, training, implementation and technical support.

The Smart Census is an integrated solution that enables all users (office and field) to work on the same database and execute the tasks allocated to them within a given Production Unit (PU) at any given moment in time. Workflows and users are pre-defined and vary by User Type and User Need (see Appendix). The production units for the project will be the census districts as described above under the census hierarchy of Botswana.

The Solution has online and offline functionality. This implies that certain users can execute certain tasks online and other tasks offline. This is important for fieldwork where Internet access is often not guaranteed. It is important to understand a few concepts first before we get to the hands-on use of the application.

The Smart Census pre-enumeration mapping module and the field component runs on Microsoft Windows Mobile as well as iOS and Android

4.7 Advantages of Smart Census

The benefits of Smart Census are as follows:

- **Cost-effective solution (replaces the need for big numbers of desktop GIS licenses);**
- **Speed up field mapping process;**
- **Better control and management of the project;**
- **Provide data validation and coding processes in the field;**
- **Improves completeness by filling the entire compulsory variables to be collected;**
- **Immediate quality control at the moment of data typing;**
- **Control of data filling by introducing controls to reduce errors. Such controls will include skip patterns, consistency checks, and message prompts;**
- **Limit data loss risks since data is loaded onto the system on a regular basis;**
- **Real time tracking of field data collection by directly transmitting collected data to central system.**

This allows monitoring and evaluation of field mapping implementation progress and outputs achieved;

- **Can be used as a tool for the planning and management of subsequent phases of the census; and**
- **It can also be used as a dissemination tool for census data.**

4.8 Design Criteria for Enumeration Areas

The principal objective of EAs delineation is to create EAs that are ideal size in terms of number of dwellings, population and area size. The ideal dwelling's population size is the number of dwellings that one enumerator is expected to enumerate during the period of census enumeration. The total dwellings one enumerator is expected to enumerate will vary by enumeration type settlement as well as by ecological zone type, thus density of population and type of terrain. The criteria will also vary depending on whether the areas are urban or rural. The proposed design criterion for EAs is given below in a table.

TABLE 4: DESIGN CRITERIA FOR ENUMERATION AREAS

EA TYPE	DWELLINGS	PERSONS
Urban	110 - 220	300 - 600
Villages	110 - 220	300 - 600
Localities	75 - 100	100 - 250

The estimates of persons are based on the population recorded at dwelling level during the cartographic mapping exercise. The rural areas are separated according to the ecological zones since the settlement patterns and topographic terrain vary significantly between the various zones. Enumeration areas in most remote areas such as lands and cattle posts are constituted by grouping of localities which are normally far apart hence small number of dwellings.

Enumeration areas are delineated with identifiable boundaries, which do not overlap. The enumeration areas should not cut across boundaries of administrative and census districts. An EA will be given a code which will distinctly identify it when combined with codes of administrative areas in which it is located. The EA map should indicate clearly its boundaries, include notable landmarks such roads and rivers, as well as building structures as guides to identify different parts of the EA. Standardized symbols should be used for clear understanding and the map should be of such a scale that it will be easy to handle and read.

4.9 Coding Scheme

The development of a coding scheme is necessary for assigning a unique code to each enumeration area. The coding scheme, reflecting the administrative hierarchy, should be flexible enough and well-structured to incorporate new and future administrative divisions. In order to ensure consistency and clarity of the numeric identifiers, a hierarchical coding scheme will be followed. In this approach the geographic units will be numbered at each administrative hierarchy. The proposed geo-coding will be in line with census geographic frame as given below.

TABLE 5: CARTOGRAPHY CODING SCHEME

Locality Type	Locality Code
Cities and Towns	0
Village	1
Lands Area	2 or 7
Cattle Post	3 or 8
Mixture (lands and cattle post)	5
Freehold Farm	4 or 9
Border Post, work camps etc.	6

4.10 Enumeration Maps Production

An enumeration area map is a map that an enumerator will carry out for fieldwork and act as a guide while an assistant supervisor map is a map that contains 3-4 EA and various landmarks such as roads, rivers and name of localities.

The census map production process will be part of Smart Census solution. It will automatically take the census enumeration area boundary files, determine an appropriate scale for printing, add the administrative boundaries information and apply defined rules for cartographic presentation. The standardized symbols for clear understanding of the maps and placement of text will also be automated. The enumeration area maps will clearly indicate its boundaries, including infrastructure establishments as guides to identify different parts of an EA. The automated map production system will store map files in PDF. Further to EA maps to be designed, supervision area and district maps for Supervisors and District Census Officers respectively will also be designed.

Overall the process of enumeration maps design, printing and packaging will take approximately 10 months.

4.11 Field Mapping Time Requirements

Based on experience from the past census, it is estimated that a team of four mapping assistants provided with two vehicles and equipped with one GPS receiver set (rugged tablet computer) and other necessary materials, will cover at least 2 to 3 EAs per day depending on the terrain and road conditions. Therefore, for this exercise to be fully conducted on time, at a comfortable pace that will ensure accuracy and complete coverage, a period of 18 months is needed and another four (4) months reserved for the finalization of logistical arrangements. In total the exercise of field mapping will be conducted by 50 mapping personnel divided into 10 teams, each comprising of one fieldwork team leader, four (4) mappers and two (2) drivers. The team leader is in charge of the team and he/she is professionally more qualified than the mapping assistants.

5. PUBLICITY AND ADVOCACY PLAN

5.1 Introduction

The Communication, Publicity and Advocacy (CPA) plan identifies and presents the key strategic interventions that will facilitate the participation of all stakeholders in the implementation of the 2021 Population and Housing Census (2021 PHC) cartography operations. The principal anchors of the CPA include national ownership, multi-stakeholder engagement and the general public's right to information.

The CPA plan outlines the key programmes and activities that will raise awareness about the 2021 Population and Housing Census Cartographic work and its objectives with the view to engage all stakeholders to ensure that the project is supported, and therefore successful. Further, the plan identifies the resource needs with regards to time, staff, structures and funds.

5.2 Communication, Publicity and Advocacy Committee

The Publicity and Advocacy Committee (CPAC), will be responsible for informing and preparing the general public on the activities of the cartographic exercise and the need for multi-stakeholder cooperation. The committee will be headed by the Manager-Communication, Documentation and Dissemination. Specific roles of this Committee will be to:

i. **Develop and Implement a communication, publicity and advocacy plan;**
ii. **Develop communication, publicity and advocacy materials;**
iii. **Develop a plan for disseminating the cartography results;**
iv. **Prepare press releases;**
v. **Organize workshops, seminars and public meetings for the purpose of informing the relevant authorities and the general public;**
vi. **Work with District Census Officers (DCOs) to facilitate publicity of the cartography in the districts**

5.3 The Communication, Publicity and Advocacy Plan

This Committee will work closely with the Technical Working Group (TWG) to incorporate technical aspects of the cartographic exercise in various publicity materials.

For the cartographic exercise to succeed, key stakeholders, and the general public should co-operate and participate willingly. This requires undertaking of sensitization of key stakeholders at local, district and national level through existing structures, and total community mobilisation through a targeted and intensive Information, Education and Communication (IEC) programme. The sensitization and mobilisation initiatives will deliver messaging on the importance of the cartographic exercise to individuals, the community, and the country. It is expected that through increased awareness and understanding of the data to be generated through this exercise, and how it will be used to facilitate development planning at various levels increased cooperation will be achieved. A CPA plan that will guide all work in this area will be developed and implemented.

a. Sensitization of Key Stakeholders

Sensitization of key stakeholders will be done for both the pilot and enumeration stages of the census cartography project through various fora, viz;

i. Letters and Public address:

- Letters will be written to the Councils, District Commissioners, House of Chiefs, NGO Council, Council of Churches, Embassies, Parliament and the Parliamentary Population Committee, and other key groups to inform them of the project and to enlist their support in cartographic operations.

- SB will make presentations through its CPA committee to Councils, District Authorities, and other groups to enlist support

ii. Kgotla Meetings:

- Batswana's traditional system of communal meetings in the Kgotla will be used to sensitize local authorities, and garner their support

iii. Local Government and Rural Development Meetings:

- Scheduled meetings for the Ministry of Local Government and Rural Development will be utilised to enlist support as this ministry oversees district structures.

iv. Print Media:

- Production of cartography brochures and posters (in English and Setswana) for distribution to key stakeholders;
- Newspaper advertorials will be used to deliver notices regarding the cartographic exercise

v. Broadcast Media:

- Radio and Television news items, public announcements and discussions will be used to sensitize key stakeholders

vi. Cartographic Project Launch:

- A launch will be hosted with key stakeholders including the media fraternity in attendance.

vii. Press Conferences & Media Releases:

- These tactics will be employed at identified times to keep the stakeholders informed through public and private media.

Note: These activities will be implemented to the extent possible during the pilot stage, and more widely during full project implementation.

b. Community Mobilization

Community mobilisation is imperative for the success of the CPA. As such, a lot of effort will be placed in this activity through different channels.

i. Development of 2021 Population and Housing Census theme

- The theme will be executed through the song and jingles, and shall be implemented through various media to increase recall of project messaging.

ii. Digital Communication

- Email and SMS blasts to the general public multiple times
- SB email signatures will carry the cartographic project advertorial banner
- Social Media (Facebook, Twitter, You Tube) Advertising: Cartoons, Infographics, videos and short stories will be used to relay messaging
- Website: Regular Updating of the census and media sections in the website with project news. SB will publish information about the project in BW-Statistics News, an external news publication that is distributed through the website.

iii. Broadcast Media

- Radio jingles and public announcements in Setswana and English will be produced and used to inform stakeholders of the cartographic project. Radio discussions through the BW-Statistics Radio show and on other public and private radio station programmes and News items will be used to keep the community informed about the project at various stages.

- Television discussions and news items will be used to keep the community informed about the project at various stages. SB will explore the possibility of purchasing a specific slot on television where regular updates and education on the census project will be given.

- Press Releases will be issued at agreed junctures to provide content for news coverage for television and radio.

iv. Print Media

- Press Releases will be issued at agreed junctures to provide content for news coverage for newspapers and business magazines
- Newsletters: Articles carrying the project messaging will be shared with PROs of various Ministries, Government Departments, Private Sector Organizations and Non-Governmental Organizations and Faith Based Organizations for publishing through their newsletters
- Posters and Brochures: These will be produced in Setswana and English and distributed in a targeted manner.

v. Mid-Media

- Activations will be done in public spaces in all selected districts and locations. The activations will use the edutainment approach to attract the public, and deliver messaging.

- Loud Speakers on SB vehicles will be used to announce cartographic work in various locations

vi. Branded Promotional Material

- Promotional material such as t-shirts, hats, bags, vehicle stickers and bibs will be produced and used during the project. These materials will carry pertinent information about the project. The material will be used by field workers for purposes of identification, while some will be used as incentives for participation during sensitization and mobilization activities.

vii. Traditional system of communal meetings:

- The "Kgotla" and "Freedom Squares", fora will be utilized to mobilize the community and garner project support.

Note: These activities will be implemented to the extent possible during the pilot stage, and more widely during full project implementation.

a. Possible Constraints

Factors that are beyond the publicity team's direct control but which are bound to influence the planning and execution of the cartographic exercise CPA plan should be taken into account. The value in considering such factors is that the risks associated with them can then be identified and appropriate risk-management tactics can be developed. Failure to identify such constraints early enough is likely to impact negatively on the CPA plan. Major constraints include:

- Budget provision;
- CPA implementation done only through a small number of officers;

- Security Fear by public; and
- Public attitudes.

b. Estimated CPA Budget

An estimated budget of P1 058 160.00 is required to implement the proposed CPA plan. This cost estimate is based on historical experience of implementing similar publicity programmes at Statistics Botswana and will be financed under the main census budget funds.

TABLE 6: ESTIMATED 2021 CARTOGRAPHY EXERCISE PUBLICITY AND ADVOCACY BUDGET

ITEM DESCRIPTION	QUANTITY	PRICE (BWP)
POSTERS A2	1000	4 500.00
Brochures A4 ADL Trifold	5000	6 500.00
DAILY NEWS (adverts (strip, half page, full page))	10	86 560.00
RB II FM (Adverts ,jingles ,spot announcements ,production)	100	120 000.00
BTV (Adverts ,jingles ,spot announcements ,production)	20 000+	158 600.00
SMS blasts service	20 000+	24 500.00
Digital/Social Media publicity	10 000+	18 500.00
Private Media Publicity (x 7 Newspapers and x 3 Radios stations)		179 000.00
Outdoor Activations (malls space rental, Public Space, Main towns activations with Roadshow truck n Stage Hire)		180 00.00
Publicity merchandise (Branded T-shirts ,Caps, stationery, give away goodies Bag)		175 000.00
Staff Welfare of Project coordinators (overtimes, accommodation, meals and travels)		105 000.00
TOTAL		**1 058 160.00**

APPENDIX I: Detailed Roles and Responsibilities of Census Cartography Team

Users are created in Smart Client based on the task breakdown of the census mapping methodology. Take note that the Smart Client users have a range of responsibilities that are not all being managed and done through Smart Client. Some fieldworkers will for example not even use Smart Client at all. The detailed tasks and responsibilities of all parties are discussed in detail elsewhere in this manual. Below is the Smart Client users team created for the project as well as their main tasks in Smart Client:

- Office Supervisor (OS)
- Office Data Capturer (ODC – GIS Specialists)
- Fieldwork Team Supervisor (FWTS – Supervisor))
- Fieldwork Tablet Operator (FWTO - Mapper)

1. Office Team Composition

1.1 Office Supervisor (OS)

The Office Supervisor will, as the name indicates, operate from the SB Head Office in Gaborone. He will have a laptop computer that is linked to the SB LAN through either a cable or Wi-Fi. His role will be:

- Create a list of FWTL and FWTO associated with each fieldwork team.
- Allocate PU(s) to FWTLs
- Accept completed PUs from FWTLs
- Create progress reports from the system to be used for the day-to-day management of the project as well as for the creation of project status reports for SB management.

1.2 Fieldwork Team Leader (FWTL)

The FWTL will operate mainly in the field although he/she will visit Head Office from time to time to collect and return fieldwork materials. The FWTL will be issued with a laptop computer and a 3G simcard or higher for connection to the internet whilst not at Head Quarters. The role of the FWTL is:

- Receive e.g. allocated to him/her by the Field supervisor (FS);
- Allocate (2011) EAs within the areas of assignment(s) allocated to him/her to the FWTO;
- Approve the work submitted by the FWTO as per the 2011 EA;
- Edit 2011 EA boundaries to create the 2021 EAs per CD;
- Completed PUs to OS for approval.

The FWTO will operate mainly from the field. The FWTO will be issued with a Trimble Yuma 2 Field tablet computer. The FWTO will be the only Smart Census user and will be able to work online as well as offline. The online tasks differ from the offline tasks and can be summarized as follows:

Online:

- Receive EA(s) allocated to him/her by the FWTS

Offline:

- Verify/edit/update existing Prominent futures of Interest (PFs) within the allocated EAs through physical visits;
- Capturing of all prominent futures with attribute information for all PFs that are not already in the System.
- Upload work done to Smart Client Server
- Submit work completed (EAs) to FWTS for approval.

1.3 Office Data Capturer (ODC)

The ODCs will, as the name indicates, operate from the SB GIS Office in Gaborone. Their main tasks will be:

- Validation and quality assurance of data received from the field;
- SA boundary creation;
- EA and SA map creation;
- Creation of other maps required by the census enumeration; and
- Printing of maps

2. Field Team Composition

The pre-enumeration mapping project will consist of three main components:

- Preparatory office work
- Fieldwork
- Office work: fieldwork validation and EA/SA map creation and printing

A fieldwork team will consist of seven (7) members: Fieldwork Team Leader; four (4) Fieldwork Tablet Operators and two (2) drivers.

Each team will have two (2) vehicles, a laptop (linked to the 3G cell phone network); and four (4) rugged fieldwork tablets as well as hardcopy and softcopy maps of the PU(s) assigned to them during fieldwork. A census district will be the production unit. The focus of the fieldwork is to update existing data and to capture new data where applicable. The data capturing and EA delineation will be done in the field and will be submitted in digital format via the 3G network to the Census Mapping Application server in Gaborone.

The main tasks of the team members are as follows:

2.1 Fieldwork Team Leader

- Makes sure that the team has all the necessary equipment needed before proceeding to the field.
- Receive the PU(s) from the office supervisor
- Introduces the census cartography project and its activities to the District Commissioner, chiefs and other senior officials.
- Selects the best place for camping site/accommodation in order that the team has the shortest possible distance to get to their place of work.
- Specifies to each team member the description of his/her duties for the day, check the work of the team members in the field as well as at the end of the day in the camp, and updates the master copy.
- Assign the work for the driver each morning, having the drivers collecting the team members in their work-areas and whenever possible, ensuring availability of transport for mappers assigned to areas with many dispersed small settlements like cattle posts. The supervisor must strictly check that unauthorised trips are not made.
- Helps resolve technical problems as they arise and pay special attention to team members who are encountering special problems or who do not keep the estimated workload.
- All correspondence to head office should be through the Supervisor. Communication is necessary when permission has to be given for any member of the team to return to Gaborone as well as informing the main office about any changes in work hours.
- The supervisor should report to head office members not present or tick onto the daily workload form, and in the evening fill in the number of dwellings worked by each member of the team. The supervisor should also check that dates are written onto each pre-listing and the site condition forms.
- Do her/his best to ensure that team members list the planned daily workload and that team members work 38 ¾ hours weekly in accordance with Government Rules and Regulations. The daily work hours can be distributed differently from the official Government work hours as long as the weekly 38 ¾ hours are kept and that the main office is informed in advance.
- Assists mappers to identify their assigned enumeration areas

2.2 Fieldwork Tablet Operator (FWTO – Fieldwork Mappers)

The FWTO will physically visit each and every Point of Interest (POI) within the EA(s) assigned to him/her and to verify/update/capture data related to the POI. Examples of POIs include police stations; community centres; educational facilities (e.g. schools, crèches, colleges and universities); health facilities (e.g. hospitals and clinics); accommodation facilities (e.g. hotels and guesthouses); places of worship; shops, Lands Areas and cattle posts.

- Completes the data collection instruments:

o Site Conditioning Form
o Pre-Listing Form
o Daily workload Form

- For every existing prominent feature in the assigned EA(s):

o Verify the attribute data related to the POI; and
o Update the data where applicable.

- For every prominent feature in the assigned EA(s) for which no point exists:

o Capture a new point; and
o Complete the fields in the application relevant to the new POI.

3. Procedure for Creation of the 2021 EA Layer

The creation of the 2021 EA layer will be done through a process that effectively implies the maintenance/ updating of the existing 2011 EA layer. This will be done by the FWTL using the laptop computer with inputs from the entire team. The FWTL must first log into Smart Client for Census and zoom into the area where the fieldwork team had been working on that particular day. He/she will firstly verify and accept the work submitted by the FWTO for the relevant (2011) EAs. With the DU counts, the updated POI information as well as the proposed changes to the EA boundaries annotated on the hardcopy EA maps the FWTL will edit the 2011 boundaries to incorporate the relevant inputs from the field. The geocoding will be done automatically by the software during the editing process.

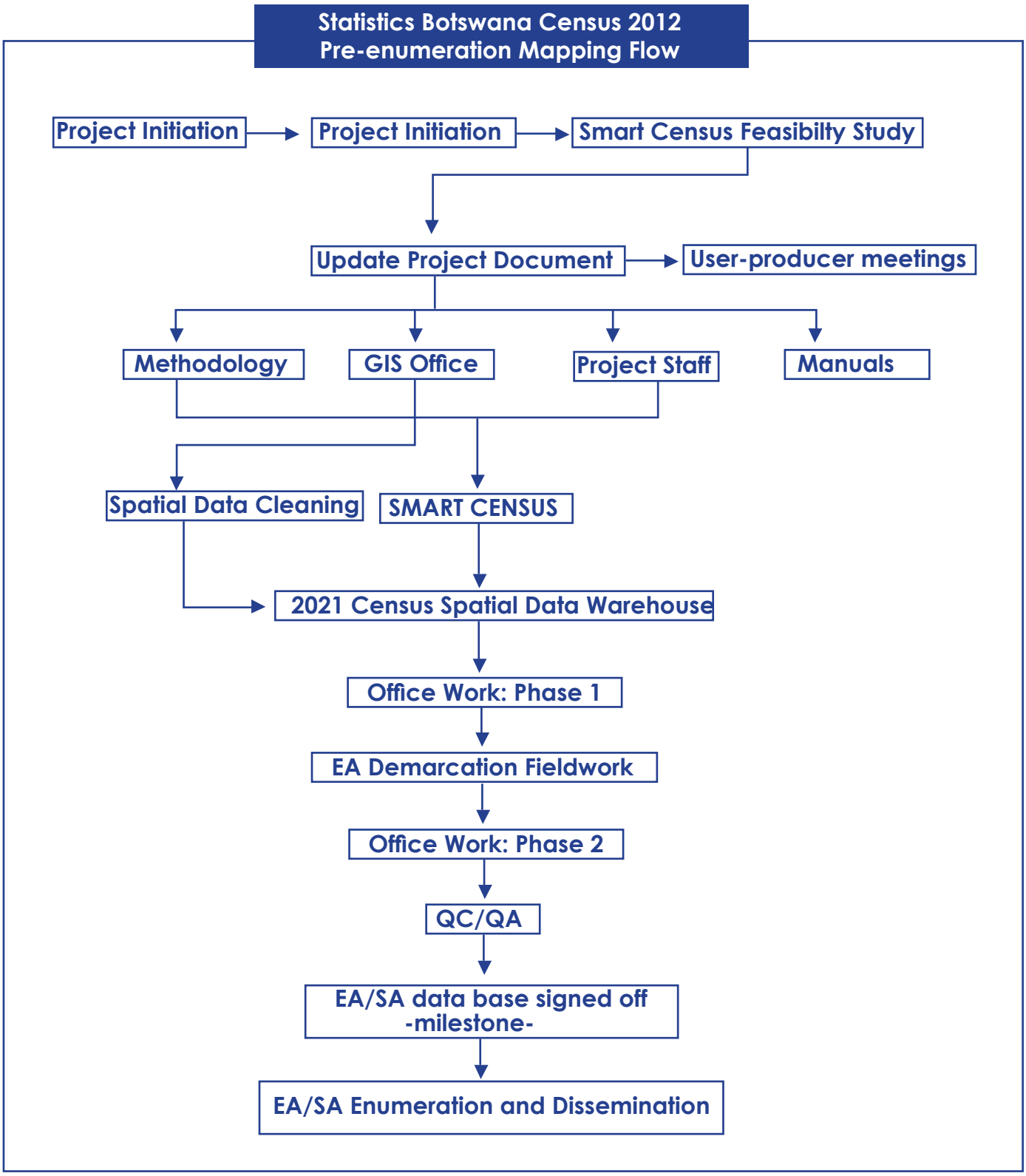
The FWTL will however be responsible to enter the "Type of EA code" in the relevant field because this code describes the EA-type and cannot be deduced from the geographical layers in the database. The DU count in the EA polygon that is being edited is displayed inside the polygon – this serves as a guide of EA size. Once the EA editing for a particular EA is completed, the geocoding will be automatically updated by the system to incorporate any changes that might have had an impact on the coding.

When all the EAs that were covered during a particular day in the field had been edited, the FWTL will assign the EA(s) for the next day to the FWTO and the entire fieldwork process is then repeated daily until the entire PU has been covered. Once ALL the EAs within a given PU had been edited, the PU is submitted by the FWTL for approval by the Office Supervisor. The Office Supervisor will then either approve or reject the PU and, depending on the outcome, assign new PU(s) to the FWTL. Once the PU is approved the fieldwork team will move on to the next PU and the entire process, as described before, is repeated.

NOTE: Delineation of Supervision Area (SA) boundaries will be done as part of the office work. Once all the EAs and SAs have been delineated the EA/SA map creation and printing will be done at Headquarters.

APPENDIX II: Project Process flow

Following is the logical process flow of the Census Mapping project. Certain phases have already commenced and others have been finalized. Phases to be finalized will be discussed in more detail later in the document.



APPENDIX III: Methodology and Solution

The methodology development was done in conjunction with the consultants. Methodology will be a "living" document that will be updated as and when required.

1 Methodology and solution: Smart Census

Smart Census is a WEB-based, client-server GIS viewing and data capturing application specifically developed for census mapping by GeoSpace in collaboration with Hexagon Geospatial. The latest updated version of the software is based on Hexagon Geospatial M.App Enterprise platform and it now also includes modules for Enumeration and Dissemination. This product came as a direct result of years of experience in census projects where we developed mobile field data capturing applications with integrated data transfer functionality that complimented our usual GeoMedia desktop GIS solutions. As mentioned above, Smart Census is a joint development between GeoSpace and Hexagon Geospatial - a leading global geospatial solution provider.

Smart Census has rich client (office) as well as thin client (field) functionality. Rich client runs on Ms Windows whilst the thin client field application(s) run on Ms Windows mobile, Android and iOS. Clients (users) can either be online or offline when they use the application. The standard software configuration assumes that office GIS staff will have access to the Internet/Intranet (WEB server) whilst they do their work whilst field staff will not be online when they do their work. Some of the key advantages of the software when compared to conventional census mapping solutions are as follows:

- **Client-server platform:** the application and data is hosted on a Webserver hence EVERYBODY access and use the same database. This immediately eliminates the two persons (office or field) working in/on the same area at the same time.
- The above facilitates proper control over each phase of the project – a huge advantage.
- **GIS functionality:** the system has all the GIS functionality required for pre-enumeration mapping.
- The geospatial component in the Enumeration and Dissemination modules is unique to census/ survey platforms. It facilitates better quality enumeration since enumerators can only work in the EA(s) assigned to them. The dissemination module is based on Hexagon Geospatial exciting dynamic/interactive Smart M.App platform.
- **Workforce management:** Each person/user is assigned to a unique post. Each post has a specific role. The role of each post is guided by workflows. Access protocols means that every user (field and office) log onto the system using their assigned username and passwords. This enables proper tracking of staff's work allocation, progress and performance.
- Production Units: Project Manager(s) can define Production Units (PUs) for each phase of the project. The most appropriate geographical unit to be used as a PU for each phase of the project will be determined in consultation with the colleagues from SB. This is used for the planning and allocation of work as well as project monitoring and reporting.
- Simple to use interface results in less (application-specific) training and ease of use – both office and field.
- Offline capability of the software makes is a critical fieldwork requirement in Africa.
- Dashboard with integrated reporting system enables real-time reporting at all levels of the project and within the organisation. Management (even senior management) can access the application through the Internet/Intranet with their allocated Username / Password to generate live status reports per phase of project as and when desired.

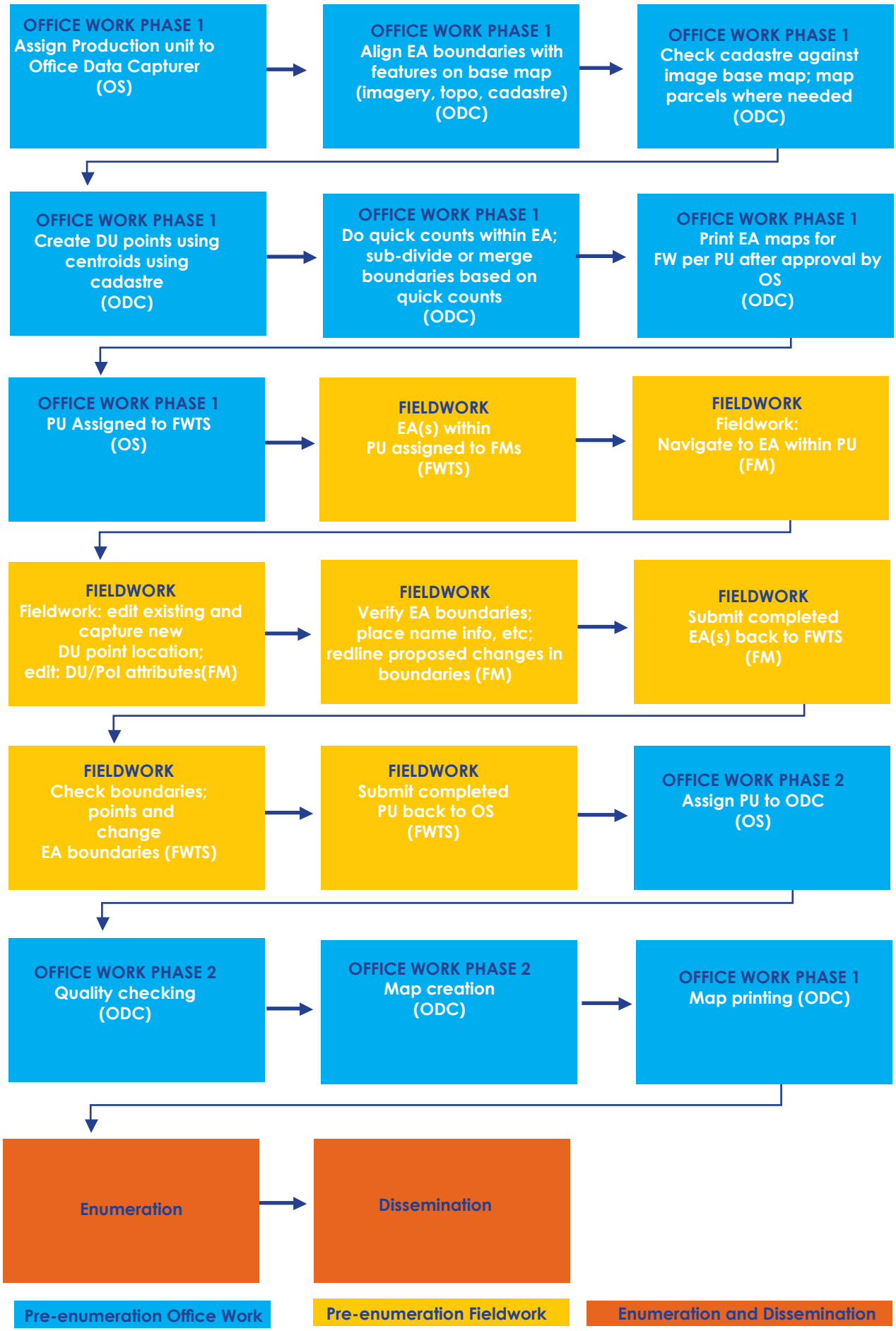
2 Smart Census: Proposed Roles and Workflows

Smart Census can be configured and customised to meet the unique needs and requirements of a particular NSO and country. Based on our understanding of the needs/requirements of SB the following roles are proposed for the 2021 pre-enumeration census mapping in Botswana:

- Office Supervisor (OS);
- Office GIS data capture (GIS Specialist and Technician) (ODC);
- Fieldwork Team Supervisor (FWTS); and
- Field Mapper (FM).

Three main workflows are proposed for pre-enumeration mapping: Office Work phase 1; Fieldwork; and Office Work Phase 2. The workflows can be summarised as follows:

APPENDIX IV: Workflow for Pre-Enumeration Mapping for the 2021 Census



The above workflow makes provision for maintenance of the 2011 EA boundaries as well as the establishment of a Dwelling Unit (DU) Frame. The DU Frame consists of dwelling units as well as Points of Interest (POI). The above workflow needs to be further refined to include all logical tests and rejection/ acceptance options before testing and implementation. This will be done during configuration in consultation with the counterparts from SB.

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