SECTION A:	***QUALIFICATION DETAILS***				
QUALIFICATION DEVELOPER	University of Botswana				
TITLE	Bachelor of Science in Applied Geophysics			***NCQF LEVEL***	*7*
FIELD	Natural, Mathematical and Life Sciences	***SUB-FIELD***	Applied Geophysics	***CREDIT VALUE***	*520*
New Qualification			*Review of Existing Qualification*		✓
SUB-FRAMEWORK	*General Education*		*TVET*	*Higher Education*	✓
QUALIFICATION TYPE	*Certificate* *I* *II* *III* *IV* *V*		*Diploma*	*Bachelor*	✓
	Bachelor Honours		*Post Graduate Certificate*	*Post Graduate Diploma*	
	Masters		*Doctorate/ PhD*		

RATIONALE AND PURPOSE OF THE QUALIFICATION

RATIONALE: Botswana is endowed with many mineral resources and an acute scarcity of water resources. The country is also prone to potential geological hazards such as earthquakes, flooding, and ground fissures. The mineral industry in Botswana has grown substantially to dominate the economy over ten (10) five-year national development plan periods (NDP) since independence in 1966 and contributes the largest share to the national GDP. However, the mineral resources of Botswana are largely under-explored/unexplored. Since the driving force in the mineral industry is exploration, the demand for trained expertise in the relevant disciplines, notably the geosciences, has also grown substantially over the same period. In developing countries such as Botswana, the mineral industry will continue to play a major role in the economic development of the country and exploration for minerals will have to be stepped up in order to meet the needs of the expanding mining industry. Botswana has an arid climate which leads to heavy/much dependence on groundwater resources for mining activities, and groundwater is the major source of water both for domestic/livestock and industrial uses. With an increase in population and an expanding economy the demand for water both for industrial and domestic uses will continue to rise and exploration for groundwater

will need to greatly improve, so as to increase drilling success rate and optimise borehole yields for adequate

water supply. The quality of the groundwater also needs to be secured from anthropogenic activities.

Furthermore, in the case of Botswana, mineral and groundwater exploration has moved to new frontiers of the Kalahari Desert covered by thick loose sand. The sand cover hides all potential targets from direct observation, and hence it requires the application of indirect, non-invasive exploration techniques (Applied Geophysics) to make discoveries. Currently, there is no similar programme in the southern Africa region as a whole. A market survey also showed that the mining and related industries, water, environmental and civil engineering fields in the country and the SADC region has the capacity to absorb on average up to 15 graduates of applied geophysics annually for the near future. In line with the UB Strategy for Excellence (2008) (Relevant and Quality Programmes; Extending Access and Participation), this programme harnesses and expands a number of fragmented courses in the geophysics field offered to students in Geology and Physics departments into a coherent curriculum to provide students with the requisite knowledge to pursue applied geophysics related careers after graduation, and for further personal intellectual growth, including postgraduate study. Furthermore**,** HRDC (2016) states geophysics as one of the top occupations in demand for the minerals, geotechnical, groundwater and environmental sectors, including soft skills like teamwork.

The ETSSP (2015-2020) strategic priorities include amongst others, improving the Quality & Relevance of Education-Fostering innovation and generating new knowledge and skills for the socio-economic and sustainable development of the nation; and developing a Responsive Tertiary Education System with appropriate programs to meet the new demands of the economy. In addition, the NDP11 (2017-2023) in Chapter 4, p.55 emphasises Developing Diversified Sources of Economic Growth to contribute to the diversification in mineral resources utilisation and development of more downstream industries. Finally, VISION 2036 (Chapter 3) has several pillars linked to geoscience education: Pillar 1 Sustainable Economic Development (including knowledge-based economy): p.15 - Mineral sector, Pillar 2 Human and Social Development: p.20 – Education and Skills Development, and Pillar 3 Sustainable Environment p.22-24–

Water Security; Energy Security; Pollution & Waste management.

PURPOSE:

The purpose of this qualification is to produce graduate with the knowledge, skills, and competence to:

- Demonstrate mastery of fundamental/core concepts and critical thinking, with the ability to interrogate conventional formulation of problems, hypotheses, methods, and solutions independently and in a creative way.
- Demonstrate the ability to design and safely and timely carry out a geophysical field survey or laboratory experiment for acquiring, processing, and interpreting recorded data in a professional and ethical manner using sophisticated instruments or computer software.

- Deal rationally with the uncertainty that geophysical data are always incomplete and be able to recognise when it is or is not acceptable to make sound judgements and decisions based on incomplete data.
- Understand the importance of taking risks in geophysics and be able to critically assess the risk and make good judgements about it while recognising and taking advantage of opportunities in a field that is rapidly changing.
- Effectively communicate complex geoscientific and environmental matters, both orally/verbally and in writing, for the benefit of both the profession and society at large.

ENTRY REQUIREMENTS (including access and inclusion)

i. Certificate IV, NCQF level 4 (GE/TVET) or equivalent, NCQF level 5.

ii. RPL and CAT shall apply in admission and progression of learners in accordance with ETP policies which are aligned with national/BQA policies.

SECTION B	***QUALIFICATION SPECIFICATION***
GRADUATE PROFILE (LEARNING OUTCOMES)	***ASSESSMENT CRITERIA***
1. Demonstrate specialised knowledge and understanding of contemporary theories, principles, and concepts as well as key scientific reasoning skills of the discipline.	1.1 Identify, describe, and apply the core concepts and principles of the discipline. 1.2 Demonstrate the relationships among the core concepts and principles. 1.3 Identify the range and limits of applicability of the core concepts and principles. 1.4 Critically appraise the limitations of the basic techniques used in the discipline. 1.5 Demonstrate logical thinking and identify naive and flawed scientific reasoning, and corrective measures implemented.
2. Demonstrate mastery of professional and ethical practice in design, planning and safe conduct of field geophysical surveys within an environmentally responsible mindset.	2.1 Design, Plan and Execute/Conduct detailed field geophysical surveys/measurements in familiar and unfamiliar areas, within an environmentally responsible mindset. 2.2 Collect and record data accurately, truthfully and in appropriate formats with precautions, error and field data quality analysis incorporated. 2.3 Conduct timely preliminary field assessment of geophysical anomalies and adjust surveys accordingly. 2.4 Execute comprehensive data reduction, processing and interpretation using current industry-standard software to produce concise reports, including uncertainty analysis, geo-structural and depth maps, resources maps.
3. Provide reasoned geophysical solutions to geological, geotechnical, and environmental problems to the industry and community in an ethical and timely manner.	3.1 Critically investigate geophysical, geological, geotechnical, and environmental problems for industry and society. 3.2 Identify ways of preventing and mitigating the impacts of geohazards and georisks. 3.3 Identification of potential geohazards and affected areas, including pollutant pathways. 3.4 Provide timely, reasoned technical advice on infrastructure development to public and private entities to ensure safety.

	3.5 Educate the public on geohazards, georisks and waste management best practices.
4. Critically assess and evaluate geological reserves and waste at mining sites, including resource management and environmental considerations.	4.1 Identify resource types (UNFC code) and their value for informed decision making. 4.2 Estimate the quantity of the reserves for sustainable mining operations. 4.3 Execute cost analysis and delineation of mineral resources for efficient operations. 4.4 Optimise mining production in accordance of industry health and safety standards. 4.5 Identify tailings disposal sites and subsequent monitoring implemented.
5. Supervise and conduct mineral, fossil fuels and groundwater exploration projects with an inclusive and integrative mindset.	5.1 Conduct reconnaissance based on GIS, remote sensing, airborne and regional geophysics using current tools and software. 5.2 Execute geophysical borehole siting and logging to assess by-passed reserves. 5.3 Contribute to design of mining plans and strategies for effective operations. 5.4 Provide advice to other professionals in the exploration programs and projects. 5.5 Apply organisational skills to manage work teams and provide evidence of successful and effective team management.
6. Communicate complex geoscientific matters in writing, orally and using visual, symbolic and/or other forms of representation to both technical and non-technical people in diverse settings.	6.1 Apply scientific language correctly to produce clear and coherent written documents, which follow appropriate scientific conventions and standards. 6.2 Apply appropriate referencing conventions, avoid plagiarism and respect intellectual property. 6.3 Integrate knowledge from various disciplines or modes of enquiry, in solving geoscientific and real-world problems for societal benefit. 6.4 Ethically and culturally sensitive decisions on the effects of

	scientifically based activities on society are made.

SECTION C		***QUALIFICATION STRUCTURE***				
FUNDAMENTAL COMPONENT *Subjects/ Courses/ Modules/Units*	***TITLE***		***Credits Per Relevant NCQF Level***			***Total (Per** Subject/ Course/ Module/ Units)*
		Level [5]	***Level [6]***	***Level [7]***	***Level [8]***	
	Academic and Professional Communication Skills I & II	***24***				***24***
	Computing Skills Fundamentals I & II	***16***				***16***
	Introductory Mathematics I & II		***24***			***24***
	Geometrical Optics and Mechanics, Vibrations and Waves		***16***			***16***
	Electricity, Magnetism & Modern Physics		***24***			***16***
	General Chemistry I & II		***32***			***32***
	Introduction to Geology I & II	**24**				***24***
	Calculus I & II			***24***		***24***

CORE COMPONENT *Subjects/Courses/ Modules/Units*	Fundamentals of Geophysics		***12***			***12***
	Surveying			***12***		***12***
	Mathematical Methods for Physical Sciences			***12***		***12***
	Electricity and Magnetism			***12***		***12***
	Properties of Matter, Thermodynamics and Nuclear Physics			***12***		***12***
	Petrography		**12**			***12***
	Sedimentology & Stratigraphy			***12***		***12***
	Structural Geology			***12***		***12***
	Gravity & Magnetic Methods			***12***		***12***
	Electrical & Electromagnetic Methods			***12***		***12***
	Law and the Environment			***12***		***12***
	Land and Mineral Resources Law			***12***		***12***
	Seismic Imaging Theory & Applications			***12***		***12***

	Geophysical Data Processing & Analysis			***12***		***12***
	Geology & Geophysical Field School			***16***		***16***
	Well Logging & Formation Evaluation			***12***		***12***
	Seismic Data Processing & Interpretation			***12***		***12***
	Geophysical Time Series Analyses			***12***		***12***
	Economic Geology & Mining Geophysics				***12***	***12***
	Engineering Geology & Environmental Geophysics				***12***	***12***
	Research Project I & II				***24***	***24***
ELECTIVE/ OPTIONAL COMPONENT *Subjects/Courses/ Modules/Units*	Numerical Methods			***12***		***12***
	Basic Electronics			***12***		***12***
	Mechanics and Physical Optics			***12***		***12***
	Microcomputing for Physical Sciences			***12***		***12***
	Introduction to Hydrogeology			***12***		***12***
	Remote Sensing & GIS			***12***		***12***

	Ore Geology			***12***		***12***
	Geotectonics & Global Geophysics			***12***		***12***
	Regional Geology of Southern Africa			***8***		***8***
	Sustainable Development			***8***		***8***
	Structured Programming			***16***		***16***

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	*Credit Value*
5	*60*
6	*100*
7	*232*
8	*48*
TOTAL CREDITS	*520*

Rules of Combination:

(Please Indicate combinations for the different constituent components of the qualification)

	Mining Geophysics Specialisation	Environmental Geophysics Specialisation
Fundamentals	152	152
Core	328	328
Optional/Electives*	60	60
Total credits	520	520

*Although the total credits for Options/Electives in Section C add up to 132, the 60 credits is the minimum required as per Rules of Combinations.

ASSESSMENT ARRANGEMENTS

All assessments, formative and summative, leading/contributing to the award of credits or qualifications should be based on learning outcomes and/or sub-outcomes.

5.1 Formative assessment

Formative assessment contributing towards the award of credits will be based on course outcomes. This will include tests, assignments and projects as well as simulated and real work settings. The contribution of formative assessment to the final grade qualification shall be 50**%.**

5.2 Summative assessment

Candidates may undergo assessments, including written practical and simulated projects. The final examination for each course contributes 50**%** of the final mark for that course. All summative practical assessments must, as far as possible, be conducted in real work settings.

- Engaged Assessors and Moderators will be BQA accredited and will adhere to ETP policy, which is aligned with National/BQA on assessment.

MODERATION ARRANGEMENTS

1. *Internal moderation requirements*

Cluster Moderation

Departmental Quality Assurance Team (DQAT) Moderation

Departmental Board Moderation

2. *External moderation requirements*

Internal and External Review Process every four years to keep pace with current and new developments in the area of discipline in accordance with applicable policies and regulations.

RECOGNITION OF PRIOR LEARNING (if applicable)

Candidates may submit evidence of prior learning and current competence and/or undergo appropriate forms of RPL assessment for the award of credits towards the qualification in accordance with applicable university RPL policies and relevant national-level policy and legislative framework. Implementation of RPL shall also be consistent with requirements, if any, prescribed for the field or sub-field of study by relevant national, regional or international professional bodies.

CREDIT ACCUMULATION AND TRANSFER

CAT shall be recognised and applied in accordance with prevailing University, national, regional and/or international

Policies and procedures.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

1. Learning Pathways

1.1 Horizontal Articulation (related qualifications of similar level that graduates may consider)

Bachelor of Science Earth Sciences, Bachelor of Science Geosciences, Bachelor of Science Exploration Geophysics; Bachelor of Technology Geophysics

1.2 Vertical Articulation (qualifications to which the holder may progress to)

Bachelor of Science (Honours); Master of Science Geophysics, Master of Science Exploration Geophysics, Master of Science Mineral Exploration, Master of Science Hydrogeology, Master of Science in Geospatial Science; Master of Science Applied Geosciences; Master of Philosophy Geophysics.

2. Employment Pathways

Bachelor of Science Applied Geophysics degree will equip graduates with knowledge and skills to practice and consult professionally in the following areas, amongst others:

1 Mineral exploration and resource evaluation and development
2 Water resources evaluation and development
3 Geotechnical Engineering/Environmental investigations
4 Geohazards, Georisk and Geosites assessment/mitigation
5 Geospatial and Geographic Information System (GIS) mapping
7 Academia, Research and Development
8 Mapping ordnance and nuclear hazard monitoring

The following are examples of the relevant job titles

- Geophysicist
- Mining Geophysicist
- Environmental Geophysicist
- Seismologist
- Petrophysicist
- Earthquake Seismologist/Analyst
- Field Geophysicist
- Petroleum Geophysicist

- Geoscience Consultant
- Research Scientist/Geophysicist
- R&D Geophysicist

Minimum standards of achievement for the award of the qualification

To be awarded a Bachelor of Science (Applied Geophysics) degree, a candidate is required to achieve a minimum of **520** credits inclusive of 252 credits for Core courses, 132 credits for Optional/Elective courses, and 136 credits for Fundamental or General Education Courses (GECs).

Certification

A certificate will be awarded upon successful completion of the qualification.
Candidates meeting prescribed requirements will be awarded the qualification in accordance with standards prescribed for the award of the qualification and applicable policies. Candidates who do not meet the prescribed minimum standards may, where applicable, be considered for appropriate exit awards in accordance with applicable policies.

REGIONAL AND INTERNATIONAL COMPARABILITY

There is no university locally, regionally or internationally that was found currently offers a subject combination of Applied Geophysics similar to the one at the University of Botswana. The qualification has, therefore, been benchmarked against BSc Geosciences and BTech Geology degree awards. The qualification, generally, compares well with all the qualifications studied since the exit outcomes cover similar scope and depth and are aligned to exit-level descriptors typical of this level and type of qualification as well as competencies required for a bachelor's honours geoscience degree.

Although the qualifications examined generally follow similar structures and standards, there are minor differences in that the modules are not offered at identical levels of the degree, and that module credits are not the same from the different universities.

1. University of Pretoria's BSc Exploration Geophysics is worth 440 Credits and produces graduates with the competence to demonstrate knowledge and skills relevant to the various areas of exploration geophysics, including key scientific ideas, principles and concepts, computer skills, as well as ethics associated with geophysics. [Not a registered learning programme currently]
2. Nelson Mandela University's BSc Geosciences is worth 360 credits and develops competencies in leadership research for promoting the development of knowledge and skills that are required in all sub sectors of geosciences, to release the potential of people and to provide opportunities for people to apply

scientific knowledge and ways of thinking to societal issues, considering ethical and cultural considerations.

3. Tshwane University of Technology's BTech Geology is worth 480 credits, covering the areas of mining and exploration, geohydrology, engineering geology, geophysics, mineral economics and environmental geology.
4. Michigan Technological University's BS in Applied Geophysics is a four-year programme with a minimum of 128 credits.

This generic BSc Qualification Standard is comparable to other similar BSc qualifications from around the world with regards to outcomes and assessment criteria, degree of difficulty and notional learning time. It is regionally benchmarked against SAQA criteria, which are in turn, internationally benchmarked based upon published work of the National Quality Assurance bodies in England, New Zealand, and Australia.

REVIEW PERIOD

The revision period is every five (5) years.