QUALIFICATION SPECIFICATION							**SECTION A**
QUALIFICATION DEVELOPER	Botswana International University of Science and Technology						
TITLE	Bachelor of Engineering (Honours) in Geological Engineering				**NCQF LEVEL**		8
FIELD	Manufacturing, Engineering and Technology (Field 10)				**SUB-FIELD**	Geological Engineering	
New qualification	✓	Review of existing qualification					
SUB-FRAMEWORK	General Education		TVET		Higher Education		✓
QUALIFICATION TYPE	Certificate		Diploma		Bachelor		
	Bachelor Honours	✓	Master		Doctorate/PhD		
CREDIT VALUE					660		

RATIONALE AND PURPOSE OF THE QUALIFICATION

RATIONALE

The sustainable development of an economy and a society cannot be realized without the help of modern geoscience. Geological Engineering, a modern geoscience discipline deals with the practical application of principles, concepts, and techniques of the earth sciences to provide sustainable engineering solutions to human needs. Geological Engineers help find the best ways to use the earth's resources to solve technological problems in an environmentally sustainable manner.

The strong influence of human activity as Botswana craves for and need for technology-intensive industries for a knowledge-based economy has brought into being a complex, interactional, and accelerated system linked to social and economic activities.

Consequently, the Bachelor of Engineering in Geological Engineering qualification at Botswana International University of Science and Technology (BIUST) is multidisciplinary, fundamental, and strategic to the design and construction in areas of civil, mining and petroleum engineering, and environment (Gonzalez de Vallejo and Ferrer, 2011), and related industries in Botswana and the Southern Africa region. The Geological Engineer deals with mineral resource exploitation and management, environmental and geotechnical design involving rock, soil, and water interaction, and the non-destructive investigation of the subsurface environment for engineering purposes. The Geological Engineer employs methods and techniques to protect the earth while still exploiting it through careful industrial practices. This is of vital importance given the extensive mining activities and construction works in Botswana, the surrounding region and globally. The qualification emphasizes the integration of Geosciences and Engineering with applications in areas such as construction, rock engineering, foundation design, site selection, resource production, geo-hazard assessment and mitigation, waste disposal, and restoration of pollution sites

Currently, BIUST is the only tertiary institution in Botswana and the SADC Region that is training Geological Engineers in response to the critical need and shortage of Geological Engineers in SADC region in general and Botswana in particular.

The Human Resource Development Council (HRDC) report of 2016 lists some specialization areas of Physical and Earth Science, and Mining and Construction among the top occupations that are in high demand in the Mining, Minerals, Energy, Water Resources, and Manufacturing sectors and highlights the need for continuous engagement with industry to develop graduates that are ready to address the ever-changing needs of the industry (HRDC, 2016). The qualification is designed considering the exploration of construction materials and mineral resources in Botswana and the region, and to bridge the gap between civil engineering and geology. The qualification seeks to develop skills and competences among Geological Engineers that will enhance the civil construction, mining, and environmental industries for industrial development. This is to meet the critical needs within Botswana in creating and growing technology-intensive industries for a knowledge-based economy. The qualification is undertaking world-class quality research and teaching that is problem oriented, interdisciplinary, and relevant to a society that will contribute towards business development in Botswana and the region. At present, Botswana does not train its own Geological Engineers, though the country's economic development and sustainability also depends largely on these professionals. The qualification aligns with PILLARS 1, 2, and 3 of HRDC Vision 2036 and the mission and vision of the University i.e., focus on mining, mineral, environment,

water resources, and construction engineering which are critical for the sustainable development of Botswana.

References*

1. Gonzalez de Vallejo, L I. and Ferrer M. (2011). Geological Engineering. 1st edition, Taylor and Francis Group, CRC Press, ISBN 9780415413527, 700p.
2. HRDC (Human Resources Development Council). (2016). Top Occupations in high demand, HRDC Research Report.
3. HRDC (Human Resources Development Council), (2016) Vision 2036. Achieving Prosperity for All, Lentswe La Lesedi (Pty) Ltd, Gaborone.

PURPOSE OF THE QUALIFICATION

The purpose of this qualification is to produce industry-ready Geological Engineering graduates with skills and competences to:

- Assess the quality of rock, soil, water, and other sites conditions for infrastructural and mine development.
- Perform geotechnical investigations for foundation design, slope stability and mitigation of geologic hazards,
- Provide solutions to the problems related to land reclamation, water and air pollution, and sustainability,
- Explore and develop water and mineral resources in an environmentally sustainable manner.

ENTRY REQUIREMENTS (including access and inclusion)

Entry into this qualification is through any one of the following requirements:

1. Certificate IV, NCQF level 4 (General Education or TVET)or equivalent.
2. Applicants who do not meet the above criteria but possess relevant industry experience may be considered through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) policies.

GRADUATE PROFILE (LEARNING OUTCOMES)		ASSESSMENT CRITERIA
1	Apply systematic, extensive, and comparative knowledge to solve Geological Engineering problems using the concepts and principles of Geology and Engineering.	1.1 Apply, identify, describe, and categorise the core concepts and principles of Geological Engineering. 1.2 Identify the relationships among the core concepts and principles of Geology and Engineering. 1.3 Assess the range and limits of the applicability of the core concepts and principles of Geological Engineering. 1.4 Apply the core concepts and principles of Geological Engineering to solve practical societal and industrial problems. 1.5 Analyse and appraise the limitations of basic techniques used in Geological Engineering. 1.6 Recognise and assess the significance of contested scientific knowledge in a contemporary context. 1.7 Demonstrate an understanding of how engineering information and ideas become generally accepted. 1.8 Demonstrate an understanding of how scientific information and ideas become generally accepted.
2	Access, evaluate and synthesize scientific information in Geological Engineering.	2.1 Access information through the library, internet and other data storage and retrieved facilities. 2.2 Apply scientific reasoning to evaluate the quality of information. 2.3 Synthesise information from a variety of sources, which may be contradictory or divergent. 2.4 Discern the cause effect relations in the face of uncertainty or gap in the available information.
3	Generate scientific information in Geological Engineering.	3.1. Design, select, and apply appropriate procedures for generating relevant information with due concern for bias and any ethical or safety considerations. 3.2. Apply standard procedures within the discipline of Geological Engineering to conduct appropriate forms on enquiry. 3.3. Collect and record data accurately, truthfully and in appropriate formats.

		3.4. Analyse and evaluate data and scientific evidence from which valid arguments and conclusions are presented. 3.5. Conduct appropriate forms of enquiry by applying standard Geological Engineering procedures such as experimental or computational techniques, or deductive reasoning.
4	Apply advanced knowledge of design principles when making solutions for infrastructure	4.1 Ensure the design process conforms to social, legal, health, safety, and environmental standards and regulations. 4.2 Develop briefs and specifications for Geological Engineering projects. 4.3 Generate possible solutions for Geological Engineering problems. 4.4 Select and develop solutions further considering possible external factors. 4.5 Recommend construction of solutions to meet the specifications recommended by Geological Engineers. 4.6 Monitor the implementation of recommended solutions.
5	Demonstrate key scientific reasoning skills in Geological Engineering.	5.1 Demonstrate logical thinking. 5.2 Identity naïve and flawed scientific reasoning. 5.3 Distinguish between inductive and deductive reasoning. 5.4 Apply hypothetico-deductive reasoning. 5.5 Discern cause-effect relations in the face of some level of uncertainty or gap in available information. 5.6 Reflect upon thinking and reasoning processes. 5.7 Demonstrate the self-conscious capacity to judge when understanding has been achieved or a problem has been adequately solved.
6	Conduct environmental impact assessment and make recommendations for project implementation	6.1 Assess the geological environment to determine the impact of the proposed project on the environment and community. 6.2 Conduct sampling and testing of geomaterials in relation to proposed project. 6.3 Carry out analysis of results from test investigations 6.4 Produce written and oral reports of findings.

		6.5 Make recommendations for further solutions.
7	Effectively demonstrate utilization of Information and Communication Technology (ICT) skills in Geological engineering.	7.1 Use ICT to record, retrieve and disseminate information to stakeholders. 7.2 Use geological engineering software packages such as Rocscience, Surpac, Datamine for the computation, simulation and modelling of data. 7.3 Critically assess the validity of ICT solutions for problems posed by Geological Engineering as a discipline.
8	Communicate scientific understanding in Geological Engineering, both verbally and in writing, using visual, symbolic, and/or other forms of representation.	8.1 Apply scientific language correctly to produce clear and coherent written documents, which follow appropriate scientific conventions. 8.2 Present Geological Engineering information verbally to Engineering and non-technical audiences. 8.3 Apply appropriate referencing conventions, avoid plagiarism, and respect intellectual property. 8.4 Apply non-verbal forms of representation correctly and appropriately.
9	Work effectively as a member of a team in engineering project and/or investigations.	9.1 Contribute effectively to the group in execution of team projects 9.2 Participate actively in the execution of team projects 9.3 Effectively communicate the outcomes of teamwork with respect for contributions of each member of the group.
10	Use Geological Engineering knowledge and ways of thinking to societal issues, taking into account ethical and cultural considerations.	10.1 Apply Geological Engineering knowledge ethically to evaluate complex Geological Engineering problems. 10.2 Critically evaluate public information dealing with current industrial and environmental- related issues. 10.3 Appraise ethically and culturally sensitive decisions on the effects of Geological Engineering- based activities on society. 10.4 Identify and assess the socio-economic impact of Geological Engineering interventions in society and industry. 10.5 Demonstrate application of Geological Engineering knowledge for the direct benefit of society and to drive

		socio-economic development through industrialization.
11	Design, manage, and organise learning activities responsibly in Geological Engineering.	11.1 Demonstrate and assess appropriate study skills (learning from text, note-taking, summarizing, analysis and synthesis). 11.2 Ensure effective learning strategies which suite personal needs and context are developed and applied. 11.3 Demonstrate effective time management.
12	Conduct Geological and Geomechanics research related to Mining, Exploration, Environment and Civil Engineering applications.	12.1 Gather and analyze data to produce sound written report for Engineering audience. 12.2 Apply Geological Engineering principles to solve existing problems. 12.3 Discover new ideas through research.
13	Apply the principles of entrepreneurship and innovation in Geological Engineering as tools for driving socio-economic development.	13.1 Demonstrate understanding and application of the principles underpinning entrepreneurship for the exploitation of product/service/process opportunities. 13.2 Explain and illustrate models of business innovation and entrepreneurship. 13.3 Develop comprehensive and well-structured business innovation plans.

	QUALIFICATION STRUCTURE **SECTION C**		
	Title	**Level**	**Credits**
FUNDAMENTAL COMPONENT Subjects / Units / Modules /Courses	Introduction to Technical Communication & Academic Literacy	5	6
	General Chemistry	5	24
	Pre-Calculus	5	24
	Introductory Mechanics	5	12
	Introduction to Programming	5	6
	Engineering Graphics	5	12
	Introduction to Electricity and Magnetism	5	12
	Introductory Calculus	6	12
	Workshop Practice	6	12
	Introduction to Engineering	6	12
	Technical and Professional Communication	6	6

	Object Oriented Programming	6	12
	Engineering Mathematics	6	36
	Statics	6	12
	Material Science	6	12
	Strength of Materials	6	12
	Land Surveying	6	12
CORE COMPONENT Subjects / Units / Modules /Courses	Fundamentals of Geological Engineering	6	12
	Principles of Engineering Geology	6	12
	Introduction to Stratigraphy and Sedimentology	6	12
	Introduction to Mineralogy and Petrology	6	12
	Introduction to Entrepreneurship	6	6
	Computer Applications in Mining	6	12
	Engineering Project Management	6	12
	Unit Operations I	6	12
	Environmental Assessment and Management	6	12
	Principles of Hydrogeology	7	12
	Earth and Its Material	7	12
	Structural Geology & Map Work	7	12
	Soil Mechanics	7	12
	Introduction to Geochemistry	7	12
	Economic Geology	7	12
	Geographic Information System and database	7	12
	Industrial Training	7	36
	Fluid Mechanics I	7	12
	Geology of Botswana and Southern Africa	7	12
	Geological Field Mapping and Reporting	8	12
	Mineral Exploration	8	12
	Rock Mechanics	8	12
	Mining Geology	8	12
	Rock Engineering I	8	12
	Geological Engineering Design Project I	8	12
	Mineral Project Evaluation	8	12
	Foundation Engineering	8	12
	Applied Geotechnical Engineering	8	12
	Professional Practices & Ethics	8	12
	Geological Engineering Design Project II	8	24

	Mineral Resource Estimation	8	12
	Rock Engineering II	8	12
	Elective	8	12
ELECTIVE COMPONENT Subjects / Units / Modules /Courses	Economics, Business and Entrepreneurship	8	12
	Mining Laws and Regulations	8	12
	Mine Backfill	8	12

RULES OF COMBINATIONS, CREDIT DISTRIBUTION (where applicable):

The Bachelor of Engineering (Honours) in Geological Engineering constitutes a total of 660 credits which are distributed as follows (based on the above Qualification Structure) with respect to NCQF levels.

NCQF Level	Fundamental	Core	Elective	Total
5	96	-	-	96
6	138	102	-	240
7	-	144	-	144
8	-	168	12	180
Totals	**246**	**402**	**12**	**660**

Students need to choose one elective at NCQF Level 8 out of the 3 electives listed above.

Elective module need to be chosen in consultation with the Department of Mining and Geological Engineering, subject to the availability and pre-requisite requirements being met.

CREDIT ACCUMULATION AND TRANSFER

Credit Accumulation

Credits for the courses in the qualification are calculated according to notional study hours that represent the time it takes an average full-time student to master a unit of learning. The Bachelor of Engineering (Honours) in Geological Engineering qualification is a five-year programme that

accumulates a minimum of 660 credit units (125 credits per year). However, a minimum of 180 credits must be at NCQF level 8.

Credit Transfer

Credits already obtained in a particular qualification from other Education and Training providers are recognised if the skills acquired are equivalent to the skills the student will acquire in a specific module. The credit transfer is applicable within five years from the time the credits were accumulated.

ASSESSMENT AND MODERATION ARRANGEMENTS

ASSESSMENT ARRANGEMENTS

All assessments, formative and summative, leading/contributing to the award of credits or a qualification should be based on learning outcomes and/or sub-outcomes. Assessors are selected internally.

Formative Assessment

Formative assessment or continuous assessment contributing towards the award of credits should be based on course outcomes. This can include tests, assignments, and projects as well as simulated and real work settings. The contribution of formative assessment to the final grade shall be to **40%.**

Summative Assessment

Candidates may undergo assessment including written and practical and simulated projects. The final examination for each course contributes 60**%** of the final mark for that course.

MODERATION ARRANGEMENTS

Pre moderation will be carried out before administering assessments that contribute towards the award of credits in this qualification and post- moderation will be carried out after the assessment tasks have been marked.

Internal Moderation - All assessment instruments shall be subjected to internal moderation by BQA registered and accredited Assessors and Moderators before administering to ensure fairness, validity, reliability and consistency of assessments.

External Moderation –All assessment instruments shall be moderated by an External Moderator to ensure fairness, validity, reliability and consistency of assessments.

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 RPL Institutional policies and national policies and legislative framework.

Candidates may submit evidence for exemptions, where applicable, in line with Credit Accumulation and Transfer (CAT) policy.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

HORIZONTAL ARTICULATION

Graduates may articulate horizontally to:

- Bachelor of Engineering (Honours) in Mining Engineering
- Bachelor of Engineering (Honours) in Civil Engineering
- Bachelor of Engineering (Honours) in Environmental Engineering

VERTICAL ARTICULATION

Graduates may articulate vertically to:

- Master of Engineering in Geological Engineering
- Master of Engineering in Mining Engineering
- Master of Engineering in Civil Engineering
- Master of Engineering in Environmental Engineering

EMPLOYMENT PATHWAYS

The graduates of this qualification can be employed as.

- Geological engineers
- Engineering Geologists
- Geologists
- Environmental Engineers
- Field Regiment Engineers (Army)
- Materials Engineers

The graduates have opportunity to get employment in the government/private organizations related to civil construction, mining, mineral exploration, ground engineering, quarrying, military and coastal protection agencies, and environmental hazard management.

In addition, they can be entrepreneurs and run their own consultancy firms.

QUALIFICATION AWARD AND CERTIFICATION

Minimum standards of achievement for the award of the qualification

A candidate is required to achieve a minimum of 660 credits, inclusive of the fundamental, core and elective components. Candidates meeting prescribed requirements will be awarded the qualification of Bachelor of Engineering (Honours) in Geological Engineering in accordance with standards prescribed for the award of the qualification and applicable policies.

Certification

A certificate and transcript of the degree of Bachelor of Engineering (Honours) in Geological Engineering will be given upon successful completion of the qualification.

REGIONAL AND INTERNATIONAL COMPARABILITY

The University of Waterloo (Canada): The University of Waterloo runs a four-year undergraduate Geological Engineering qualification leading to the award of Bachelor of Applied Science (BASc) degree with a minimum of 120 credits. The University of Waterloo BASc in Geological Engineering Qualification has three specialisations namely Geology specialisation: Hydrogeology specialisation & Soil, Rock and Structures specialisation and offers Coop programme in Geological Engineering in addition to offering workplace working experience in industry. Present BEng in Geological Engineering Qualification offers BEng (Hons) in Geological Engineering with minimum of 660 credit hours in five years, do not have specializations but provides workplace working experience in industry similar to University of Waterloo.

Colorado School of Mines (United States of America): It offers a four-year Bachelor of Science (BS) in Geological Engineering with a total of 139.5 Semester hours. The students are required to do courses in Physical Education and History of USA as core courses for graduation. Colorado School of Mines uses semester hours and units. Present BEng in Geological Engineering Qualification offers BEng (Hons) in Geological Engineering with minimum of 660 credit hours in five years and also offers social science and entrepreneur-related modules which differ from

University of Colorado but similar with geological engineering research design project modules in the final year and industrial attachment.

Monash University (Clayton, Australia): Monash University offers 4-year Bachelor of Engineering (Honours) in Geological Engineering with 192 credit points. Monash University incorporates 'Solar and Renewable Energy' a subject area, offers many Geological Engineering Technical Electives to choose one for each term, research design project modules and the ratio of Continuous Assessment and Final Examination is 50:50. Present BEng in Geological Engineering Qualification offers BEng (Hons) in Geological Engineering with minimum of 660 credit hours in five years and offers only one elective at the exit level and ratio of continuous and final examination remain at 40:60. It has similarity in terms of research design project modules at the exit level and industrial attachment.

Kwame Nkrumah University of Science and Technology (Ghana): The Kwame Nkrumah University of Science and Technology (KNUST) offers a four-year Bachelor of Science (Honours) in Geological Engineering with a total of 167 Credit hours. If offers 53 modules and three electives, petroleum geology, ground engineering, Geostatistics. Present BEng in Geological Engineering Qualification offers BEng (Hons) in Geological Engineering with minimum of 660 credit hours in five years and offers only one elective at the exit level which differs from that of KNUST It has similarity in terms of research design project modules at the exit level and industrial attachment.

Similarities and differences

The BEng (Hons) in Geological Qualification though differs with above-mentioned Qualifications in terms of credit hours and number of years, they are largely similar with respect to education and employment pathways. This Qualification like others, allows to entry into postgraduate qualifications in universities. Similarly, offers employability opportunities, entry or working as geological engineers, engineering geologists, environmental engineers, materials engineers in the fields of site investigations, foundation design, slope stability, mitigation of geologic hazards, mineral exploration, environment, mine development, groundwater management etc. This Qualification also provides opportunity as Field Regiment Engineer (Army) in Botswana which is not true globally. At the same time, This Qualification do not provide opportunity in Oil and Gas sector as it does not provide skills in that area of specialization.

Academic Qualifications in Botswana are accredited by the Botswana Qualifications Authority (BQA). ABET, CEAB and AEAC are aligned to the Washington accord. All programmes produce graduates who qualify for professional engineering registration by the appropriate boards or organizations in their respective countries.

REVIEW PERIOD

The review of qualification is five years.

OTHER INFORMATION