| ***SECTION A:*** | ***QUALIFICATION DETAILS*** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***QUALIFICATION DEVELOPER (S)*** | University of Botswana | | | | | | | | | | | | | | | | | |
| ***TITLE*** | Master of Science in Hydrogeology | | | | | | | | | | | | | | ***NCQF LEVEL*** | | *9* | |
| ***FIELD*** | Field 12: Natural, Mathematical and Life Sciences | | ***SUB-FIELD*** | | Hydrogeology | | | | | | | | | | ***CREDIT VALUE*** | | 240 | |
| *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:***

The world faces a challenge of recurring droughts, shortage of water, and water pollution related to industrial development and agriculture. Since groundwater contributes a large share of the water supply in most countries, there is an acute need to develop capacity in the hydrogeological space, including, but not limited to, groundwater exploration, development, and management. Increasing and strengthening skills development in the field of hydrogeology will help to fill these gaps and challenges. In line with this, the Botswana National Research, Science and Technology Plan of the Ministry of Communications, Science and Technology (MCST) (Ministry of Communications, Science and Technology, 2005: Chapter 2, Water Research, pp. 16), VISION 2036 (Ministry of Communications, Science and Technology, 2005: Chapter 3, Contribution to Vision 2016 of planned research in various sectors of Botswana, Water Sector, pp. 24), and NDP11 (National Development Plan 11, 2016: Chapter 7, Sustainable Environment, Water Quality, Conservation, Supply and Efficiency

Programme, pp. 35), highlight the Government's commitment in stimulating and encouraging research that will develop the skills required to ensure sustainable management of the Nation's natural resources. Currently in the country, hydrogeology skills are among the list of top occupations in demand as they are critical in municipal and rural water supply institutions like Water Utilities Corporation, Departments of Waste Management and Water Affairs, Botswana Geological Institute (BGI), mining companies, agriculture and academic institutions. Moreover, it is important to develop hydrogeological capacity to meet the future demand for water through research and innovation as the world population increases.

***PURPOSE:***

The Master's Hydrogeology program aims to provide students with theoretical and practical knowledge in hydrogeology to enable them to work independently and collaboratively, have critical thinking and evaluation skills, and contributes to national, regional and international development and education. Furthermore, the MSc hydrogeology programme is expected to improve learning outcomes, to contribute to life-long learning and to strengthen skills development required for groundwater assessment and management. In general, the purpose of the Master's Hydrogeology is to produce graduate with the knowledge, skill, and competence to:

- Carry out critical analysis and independent evaluation of qualitative and quantitative groundwater resource data. Well balanced understanding of contemporary theories, principles and concepts in hydrogeology that can form the basis for professional judgment and/or research groundwater exploration, development, utilization and management.
- Demonstrates a high level of mastery in the field of hydrogeology and provide solutions to groundwater exploration, development, utilization and management problems. Demonstrate problem-solving skills relating to assessment and evaluation of groundwater reserves or storage. Demonstrate capacity in the development of of hydrogeological professional practice through research or reviewing existing hydrogeological knowledge;
- Apply a range of advanced specialist knowledge and skills to manage groundwater projects and contractors, and liaise with hydrologist, ecologists, engineers and other professionals in the national, regional and international research and work in water resources assessment, development, utilization and management.

| ***ENTRY REQUIREMENTS (including access and inclusion)*** |
|---|
| i. NCQF Level 7 in Geology or related subject from any recognized university.<br>ii. RPL shall apply in admission of learners in accordance with ETP policies which are aligned with national/ BQA policies in Botswana. |

| ***SECTION B*** | ***QUALIFICATION SPECIFICATION*** |
|---|---|
| ***GRADUATE PROFILE (LEARNING OUTCOMES)*** | ***ASSESSMENT CRITERIA*** |
| 1. Appraise, critically analyse and synthesize available groundwater, surface waters and climate data to conduct original research. | 1.1 Identify different groundwater problems.<br>1.2 Perform data collection and analysis and prepare hydrogeological report.<br>1.3 Develop one complete research proposal with well-defined problem statement, clear objectives, and research questions as well as the significance of the research that lead to conduct original research. |
| 2. Demonstrate groundwater exploration skills for precise location of wellfields and siting of wells. | 2.1 Evaluate and analyse the different groundwater exploration methods used in Botswana in the context of its geological setup.<br>2.2 Formulate, design and planning of one complete groundwater exploration project using a minimum of two groundwater exploration methods.<br>2.3 Conduct a minimum of one groundwater exploration using a minimum of two groundwater exploration methods. |
| 3. Demonstrates a high level of knowledge of groundwater and provide solutions to different groundwater problems related to its occurrence, development, recharge, quality, utilization and management. | 3.1 Identify a minimum of one wellfield with groundwater problem, in consultation with the responsible office of the country, and investigate the causes of the problem and provide solutions to the problems.<br>3.2 Make a minimum of two presentations on groundwater resources and the associated different problems in relation to its quantity, quality, development, utilization |

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|---|---|
| | and management with a comprehensive literature review in departmental or national scientific meetings.<br>3.3 Interact appropriately with people from diverse communities and educate the public on groundwater quality problem and management in minimum of one area.<br>3.4 Undertake a minimum of one planning, design and supervision of waterworks project and develops/formulate operational and managerial staff and resources for water infrastructures. |
| 4. Characterize and evaluate groundwater resource. | 4.1 Collect and analyse well drilling data from a minimum of two wells and identify the types of aquifer in the wells.<br>4.2 Perform a minimum of two pumping test data collection, which were conducted in different aquifer types, and analysis and prepare groundwater evaluation report.<br>4.3 Conduct one groundwater modelling analysis in one of the existing wellfields and prepare groundwater modelling report.<br>4.4 Conduct groundwater sample collection (in one of the existing wellfields) and analysis and prepare groundwater quality evaluation report. |
| 5. Demonstrate a high level of capacity to retrieve, evaluate, analyze and interpret information to make propositions and judgments in forecasting and assessment. | 5.1 Develop rainfall-runoff (hydrological) models for assessing flooding and river runoff regimes in at least two catchments.<br>5.2 Design flood and size of flood protection structures such as dams/ dam spillways, bridges, culverts, etc. in at least two case study catchments. |

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|---|---|
| | 5.3 Design drought volumes, yields and capacity of dams on at least one case study site.<br>5.4 Describe and apply the concepts of drought, types of drought, drought monitoring and drought forecasting using at least one case study site.<br>5.5 Describe the application of remote sensing for drought monitoring and forecasting in at least two case study sites. |
| 6. Engage in interdisciplinarity and teamwork. | 6.1 Appraise the significance of team spirit/teamwork through one group work exercise in all taught courses.<br>6.2 Conduct at least two assignments in different topics of groundwater in teamwork's and make presentations in class.<br>8.3 Apply interdisciplinarity approach through a minimum of one project work/term paper as part of each course. |

| ***SECTION C*** | ***QUALIFICATION STRUCTURE*** | | | | |
|---|---|---|---|---|---|
| ***COMPONENT*** | ***TITLE*** | ***Credits Per Relevant NCQF Level*** | | | ***Total*** ***(Per** Subject/ Course/ Module/ Units)* |
| | | ***Level [ 9 ]*** | ***Level [ ]*** | ***Level [ ]*** | |
| ***FUNDAMENTAL COMPONENT*** *Subjects/ Courses/ Modules/Units* | | | | | |
| | | | | | |
| | | | | | |
| ***CORE COMPONENT*** *Subjects/Courses/ Modules/Units* | Applied Hydrogeology | *16* | | | ***16*** |
| | Surface water and Vadose Zone Hydrology | *16* | | | ***16*** |
| | Groundwater Geochemistry | *16* | | | ***16*** |
| | Geophysical Exploration for groundwater | *16* | | | ***16*** |
| | Application of Remote Sensing and GIS in Hydrogeology | *16* | | | ***16*** |
| | Applied groundwater modeling | *16* | | | ***16*** |
| | Integrated water resources management | *12* | | | ***12*** |

| | | | | | |
|---|---|---|---|---|---|
| | Supervised Research and Dissertation | *120* | | | ***120*** |
| | | | | | |
| ***ELECTIVE/ OPTIONAL COMPONENT***<br>*Subjects/Courses/ Modules/Units* | Geological aspects of groundwater occurrences | *12* | | | ***12*** |
| | Characteristics of hydrogeologic systems | *12* | | | ***12*** |
| | Stochastic hydrology | *12* | | | ***12*** |
| | | | | | |
| | | | | | |

| *SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL* | |
|---|---|
| *TOTAL CREDITS PER NCQF LEVEL* | |
| ***NCQF Level 9*** | ***Credit Value*** |
| ***FUNDAMENTAL COMPONENT*** | ***-*** |
| ***CORE COMPONENT*** | ***228*** |
| ***ELECTIVE/ OPTIONAL COMPONENT*** | ***12*** |
| ***TOTAL CREDITS*** | ***240*** |

***Rules of Combination:***

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

In the first year first semester, students are expected to choose one optional course.

## *ASSESSMENT ARRANGEMENTS*

1**. Formative assessment**

The contribution of formative assessment (such as quizzes, tests and assignments) to the qualification shall be 50%.

2**. Summative assessment**

Candidates may undergo assessments such as project work or project evaluation, written exam and practical work. The final examination for each course contributes 50% the final mark for that course.

***MODERATION ARRANGEMENTS***

Moderation and assessment will be done by BQA accredited moderators and assessors following ETP policy which is aligned with National/BQA policy.

***RECOGNITION OF PRIOR LEARNING***

The department recognizes prior learning in terms of related work experiences with respect to accumulation of credits towards gaining of the qualification.

***CREDIT ACCUMULATION AND TRANSFER***

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***PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)***

**LEARNING PATHWAYS**

**1. Horizontal Articulation(related qualifications of a similar level that graduates may consider)**

Master of Philosophy in Geochemistry

Master of Philosophy in Structural Geology

Master of Science in Applied Geophysics

Master of Science in Integrated Water Resources Management

Master of Science in Environmental Sciences

Master of Science in Geospatial Science

2. **Vertical Articulation (qualifications to which the holder may progress to**)

Doctor of Philosophy in Hydrogeology

Doctor of Philosophy integrated water resources management

Doctor of Philosophy in Hydrogeology

**EMPLOYMENT PATHWAYS**

Hydrogeologists can be employed as a hydrogeologist, water resources manager, groundwater expert, groundwater engineer, groundwater researcher in the private sector and companies, public sector, academia, Mining companies, as well as environmental and groundwater consulting firms. Hydrogeologists are also hired as consultants for water supply projects.

## *QUALIFICATION AWARD AND CERTIFICATION*

*1. Minimum standards of achievement for the award of the qualification*

- All students enrolled for the Master of Science Degree Program in Hydrogeology must take and pass the 9 core courses, 1 optional course and a dissertation.
- To be awarded MSc in Hydrogeology a candidate is required to achieve a minimum of 240 credits inclusive of 228 credits for core courses and 12credits for the optional/elective courses.

*2. Certification*

Master of Science Degree in Hydrogeology certificate will be awarded upon successful completion of the qualification.

## *REGIONAL AND INTERNATIONAL COMPARABILITY*

There is no university locally or regionally that was found currently offering MSc in Hydrogeology by course work and research dissertation similar to the one at the University of Botswana. However, internationally, the following universities award a Master's degree in Hydrogeology by course work and research dissertation similar to the program at the University of Botswana. The qualification has, therefore, been benchmarked against MSc Hydrogeology awards from these universities.

The main exit outcomes of the proposed qualification generally compare well with the main exit outcomes of the qualifications in the University of Western Australia and University of Nevada. The exit outcomes in these universities cover similar scope and depth and are aligned to exit-level descriptors typical of this level and type of qualification.

Both Universities award master's degree by course work and dissertation similar to the University of Botswana. The UB MSc Degree is a 4-semester programme – Minimum 240 Credits, Level 9. It offers 7 core courses with total credit points of 108 and one optional course with credit points of 14/12. The Dissertation work is done with

a research project work that has 120 credit points. This would be equivalent to the MSc at universities in Western Australia and Nevada (USA). The MSc degrees in Nevada (USA) are at 700-Level.

University of Western Australia awards 96 credit points for the qualification, being 72 credits for coursework, and 24 for thesis. It offers 6 core courses with total credit points of 36 and two optional courses with total credit points of 12. The Dissertation work is done with four research project work that has 6 credit points each. The duration of the qualification is 2 years (full-time) similar to the University of Botswana. University of Nevada, on the other hand, awards (a minimum of) 30 credits, 24 of which go to coursework and 6 go to the thesis. It offers 5 core courses with total credit points of 15 and a minimum of one optional course with minimum credit points of 3. The Dissertation work is done with a research project work that has 6 credit points. The duration of the qualification is 2 years (full-time) similar to the University of Botswana.

The credit ratio of thesis to coursework for both these universities is 1:3 whereas the ration at the University of Botswana is 1:1. The qualification at UB better prepares the graduate for future engagement in research.

The proposed qualification generally compares well with the same qualifications in the University of Western Australia and University of Nevada since the employment and employment pathway are similar to the University of Botswana. Similar employment opportunities such as the resources industries, government agencies dealing with resources or environmental companies and agencies, academic institutions, environmental consultant and environmental manager, groundwater Industries and consultant as freelance contractor are mentioned by these universities, which are also listed as potential employment opportunities in this qualification of the University of Botswana.

***REVIEW PERIOD***

The MSc Hydrogeology Program is reviewed every five years.