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GSNI Geological
Survey of
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Geological Survey of Northern Ireland Annual Report 2021–2022

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FOREWORD

I am pleased to set the scene for the Geological Survey of Northern Ireland's (GSNI) 2021/2022FY Annual Report for the Department for the Economy (DfE). This report summarises how GSNI performed and the impact of its work for Northern Ireland's economy, infrastructure, environment, tourism, health, and education sectors.

GSNI staff have had another remarkable year, especially as the pandemic continued. Some of the most significant work includes GSNI's contribution to heat policy, specifically on geothermal energy that is included in the DfE's Energy Strategy published in December 2021. GSNI is a named co-delivery partner on DfE's Energy Action Plan published in January 2022.

GSNI was asked by DfE to establish a Geothermal Advisory Committee (GAC) in July 2021 involving industry, academia, public sector, and professional organisations based in UK and Ireland. The purpose of the GAC is to inform and advise on the development of geothermal as a strategic, low-carbon source of heating, cooling, energy storage, power, and green jobs in Northern Ireland.

GSNI designed and produced detailed specifications for a demonstrator geothermal project to be procured in 2022/23 and delivered in 2023/24. The pioneer project will prove the geothermal potential in Northern Ireland and the clean heat is of economic, environmental, and social value.

GSNI was asked by W5, an award-winning science and discovery centre in Belfast which attracts 350k visitors per year, to contribute to its redeveloped exhibition space. GSNI now has a significant presence through the new 'Climate Through Time' display found within the 'In Our Nature' permanent exhibition. GSNI provided substantial content as well as geological samples for the exhibition.

A major output of GSNI's work this year is our contribution to Northern Ireland Water's new groundwater abstraction project at Moneymore in Co. Tyrone which supplies water to 2000 homes. Groundwater is pumped from the underlying sandstone aquifer, passed through a modular onsite treatment plant before being discharged into an onsite service reservoir. A 50 Kw photovoltaic array mounted on the service reservoir roof generates the energy required to run the operation which will add an extra 600,000 litres of water per day into the system. This will allow water from the main supply water treatment works to be delivered to other service reservoirs, improving the networks' overall resilience to high demand events, reducing operational costs and carbon emissions.

As well as delivering a geoscience work programme for our parent Department, GSNI also worked on service level agreements for the Northern Ireland Environment Agency (NIEA), Newry Mourne and Down District Council, and Armagh City Banbridge and Craigavon Borough Council. GSNI is also working to inform Department for Infrastructure (DfI) /Department of Agriculture, Environment and Rural Affairs (DAERA) co-chaired Coastal Forum Working Group to identify the data gaps needed to inform

climate change adaptation. GSNI is also a project partner on two EU INTERREG projects; AGEO on geohazard risk management, and CatchmentCARE on groundwater quality.

This year we were delighted to welcome two new hydrogeologists to our team in Belfast; their knowledge, expertise and skills will augment and optimise what we can achieve together, and we all look forward to more new staff in next financial year.

Dr Marie Therese Cowan PGeo, MIO D MRIA
Director, Geological Survey of Northern Ireland

OUR STRUCTURE

The Geological Survey of Northern Ireland (GSNI) is an office of the Department for the Economy (DfE) in Northern Ireland staffed by scientists of the British Geological Survey (BGS) based in Dundonald House, Belfast. GSNI sits within the Energy Group of the DfE.

The policies and processes framework for the operation and administration of GSNI are documented in the GSNI Procedures Manual, a key reference in any audit of GSNI. To provide an effective governance and assurance mechanism, DfE reviews progress on its service-level agreement (SLA) with GSNI at quarterly SLA review meetings.

The SLA review meetings are chaired by the DfE Director of Heat, Minerals and Operations Division.. It is attended by the GSNI Director and the Head of Minerals and Petroleum Branch. The purpose of the meeting is to review GSNI’s SLA performance dashboards, monitor spend against budget, risk register information, and action points from previous meetings.

The GSNI Director chairs monthly meetings of the GSNI Senior leadership team where monthly reports are reviewed, issues and opportunities are considered, risks are escalated and health and safety items are managed. These meetings are minuted, and saved to the Northern Ireland Civil Service (NICS) Information Management system.

GOVERNANCE AND ADMINISTRATION

The GSNI Director, supported by one business assistant, is responsible for the governance and administration of the organisation, including strategic direction, leadership, finance, stakeholder engagement and partnerships, health, safety and well-being, continued professional development of all staff and monitoring and reporting on performance. In 2021/2022FY, GSNI’s research programme was delivered by three teams as outlined below. This structure changed in 2022/2023FY but for the purposes of this Annual Report, the former structure has been described.

ENERGY, MINERALS AND WASTE

The Energy, Minerals and Waste (EMW) team provides advice and support to DfE on resources and energy-related issues including oil and gas exploration, geothermal energy, underground energy storage and carbon capture and storage. The EMW team also provides geoscientific advice and support on the economic development of natural resources and assists Minerals and Petroleum Branch of DfE with minerals licensing. The team contributes to policy development for minerals and energy through the provision of scientific advice and data.

INFORMATION AND INFRASTRUCTURE

The Information and Infrastructure (II) team provides geological information through the enquiries service to external customers and stakeholders, ensures that GSNI’s data is collated, managed and distributed effectively, and responds to planning consultations through the local council and regional planning process. They are also responsible for the monitoring of Northern Ireland’s abandoned mines many of which are vested in DfE, and contribute to the development of geological tourism and education resources.

GEOLOGY AND GROUNDWATER

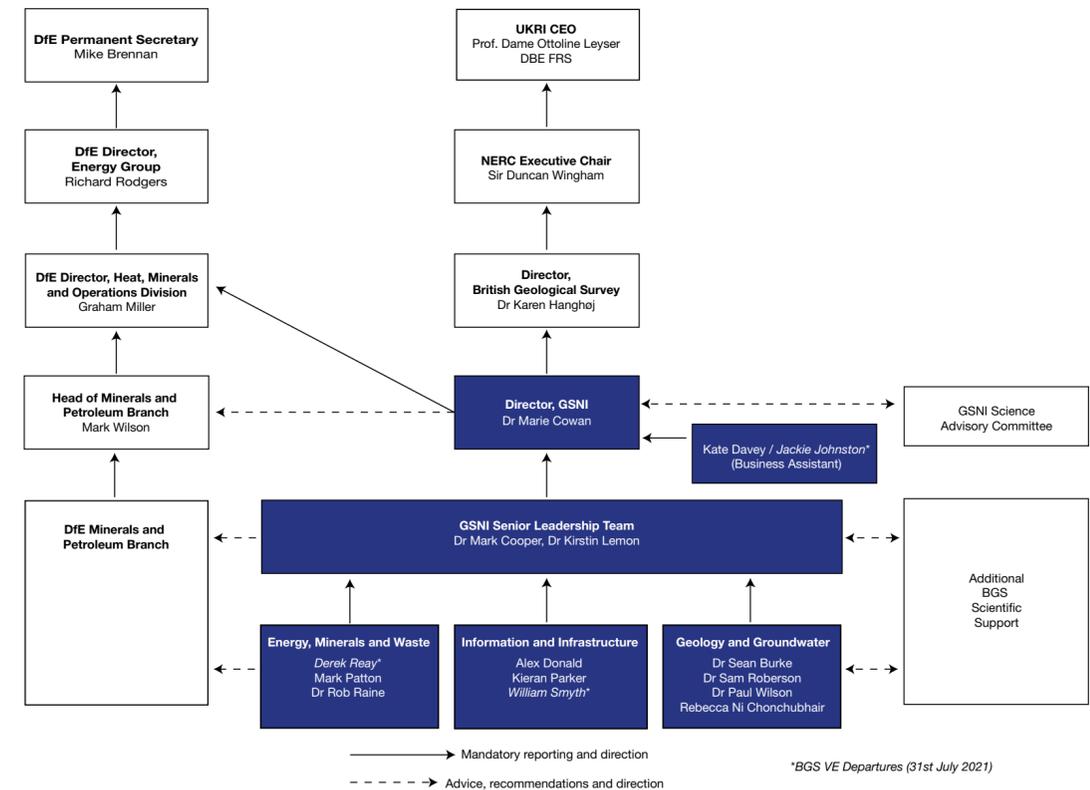
The Geology and Groundwater (GG) team provides information on the extent, thickness and properties of geological materials, primarily in the form of bedrock and superficial geological mapping. The

GG team also provides information and advice on groundwater resources in Northern Ireland and contributes to groundwater monitoring.

THE GSNI SCIENCE ADVISORY COMMITTEE

The role of the GSNI Science Advisory Committee (SAC) is to advise the GSNI Director and senior leadership team on the development and delivery of GSNI’s public role and science strategy. The SAC is made of 18 external members from all sectors, trade bodies and professional bodies in Northern Ireland, and representatives from Ireland and Great Britain.

This committee meets twice per year and the position of Chair rotates each meeting amongst the university representatives; this year the SAC met online in May and November.





Science highlights

DEVELOPING A SUSTAINABLE ECONOMY

POLICY-BASED DEVELOPMENT OF GEOTHERMAL ENERGY IN NORTHERN IRELAND

A new Geothermal Advisory Committee (GAC) for Northern Ireland was established in July 2021 bringing together a group of experts from industry, academia, public sector, and professional organisations based in UK and Ireland. This group provides independent advice to DfE aimed at informing, supporting, and developing public policy on geothermal energy for Northern Ireland as part of the new Energy Strategy for Northern Ireland.

The committee is chaired by the Director of the Geological Survey of Northern Ireland together with a vice-chair, a UKRI-funded QUADRAT Doctoral Training Partnership student, from Queen's University Belfast Centre for Sustainability, Equality and Climate Action. The committee also involves the DfE official leading on Heat Policy alongside three Northern Ireland government departments.

The purpose of the GAC is to inform and advise on the development of geothermal as a strategic, low-carbon source of heating, cooling, energy storage, power, and green jobs in Northern Ireland.

The role of the GAC is to provide independent advice to DfE, aimed at developing and supporting public policy and strategic thinking on geothermal energy in Northern Ireland. The GAC is identifying the implications of geothermal development(s) for Northern Ireland legislation and regulation. It provides advice on the refinement and implementation of actions to be taken in the

short, medium, and long-term that are aimed at underpinning and supporting a longer-term geothermal strategy. This includes considering how to stimulate the growth of a geothermal sector, and its associated green jobs, productivity, competitiveness, and skills. This activity occurs alongside, compliments, and fed into DfE's analysis of the Energy Strategy Policy Options Consultation responses and its Heat Policy Working Group activities.

The GAC provides leadership and vision on geothermal heating, cooling and power potential. It delivers evidence, data and subject matter expert advice to inform the government's decision-making process. It aims to identify low-regret geothermal opportunities that will contribute to a cost-effective pathway to energy sector decarbonisation by 2050, identify gaps in evidence and recommend research required to address these.

In 2021/2022FY, the committee had seven meetings involving invited experts from the Netherlands, Germany, Scotland, and Ireland; reviewed GSNI's geothermal prospectivity report for Northern Ireland, considered planning barriers with DfI, drafted specifications for a market-led sector development report, and produced a #NIgeothermalweek proposal.

Members of the Geothermal Advisory Committee include representatives from DfE, GSNI, BGS, DfI, DAERA, Geothermal Association of Ireland, Geological Society of London, Institute of Geologist of Ireland, NIEA, Northern Ireland Housing Executive, Queen's University Belfast, and University of Ulster.

GSNI submitted a response to DfE's Policy Options Consultation Paper for the new Energy Strategy in June 2021. This potential for geothermal energy to help reach the Climate Change Act (Northern Ireland) 2022 emissions targets and contribute to Northern Ireland's overall renewable energy mix has been acknowledged in the Northern Ireland Executive's Energy Strategy Pathway to Net Zero, published in December 2021.

Building on this, the DfE Energy Action Plan for 2022 published in January includes geothermal in Action 16. GSNI is a named co-delivery partner with DfE to develop and commence delivery of a geothermal demonstrator project.

PROMOTION, RESEARCH AND REVIEW OF POTENTIAL USE OF GEOTHERMAL ENERGY

In Northern Ireland, despite suitable geology, geothermal energy remains a seldom used source of renewable energy, compared to other countries. GSNI recognises that the provision of geological data and advice can help geothermal energy to be considered as an option in the planning and design stages of projects. We have worked to highlight, research and to review the potential uses of geothermal energy in Northern Ireland. In November 2021, GSNI launched a report summarising the geothermal potential of Northern Ireland. Since publication of the report GSNI has been approached by and met with local councils and other public bodies who are seeking to understand the resource in their areas and to provide geoscientific advice and data for future developments.

In 2021/2022FY GSNI designed and produced a specification for a pioneer geothermal project that would be procured in 2022/23 and delivered in 2023/24. The pioneer project will be designed to prove the geothermal potential of the aquifers in Northern Ireland and to prove that the resulting heat is of economic value and can be used to decarbonise a public building, domestic heating or a commercial venture.

WORKING TOWARDS WATER SECURITY IN NORTHERN IRELAND

GSNI has been increasing their provision of hydrogeological support to NI Water. GSNI's role has been to strategically advise NI Water on groundwater use, to develop a scope of works for groundwater exploration projects that are issued to the private sector, to supervise the consultants working on those projects and to review the outputs on behalf of NI Water. One of the main aims of this work is to increase the use of groundwater as a water supply that will have the dual benefit of helping enhance water security and also help NI Water to meet their carbon emissions targets by reducing the need to transport surface water from other sources.

A major output of the work with NI Water is the new groundwater abstraction project that is about to go into distribution close to Money more in Co. Tyrone. Groundwater is pumped from the underlying sandstone aquifer, passed through a modular onsite treatment plant before being discharged into an onsite service reservoir. A 50 Kw photovoltaic array mounted on the service reservoir roof, generates almost all the energy required to run the whole operation which will add an extra 600,000 litres of

water per day into the distribution system. This will free up water from the main supply water treatment works to be delivered to other service reservoirs, improving the networks’ overall resilience to high demand events.

IMPROVING THE EVIDENCE BASE FOR MINERALS POLICY

Mineral exploration and development in Northern Ireland have been ongoing for over five decades under the terms of the Mineral Development Act (Northern Ireland) 1969. Over the last 10 years mineral exploration has received growing attention and as result there is an increase in public interest in the mineral licensing process. In addition to enhanced public awareness and concerns for environmental protection, the climate crisis and government plans for a transition to a Green Economy have all thrown a spotlight on mineral development.

To address the changing landscape, DfE commissioned research to look at the potential economic, societal and environmental impacts of mineral exploration and mining in Northern Ireland. The foundation for the terms of reference for the research stemmed from an earlier assessment of the current licensing regime, carried out by GSNI. The results of this commissioned report will inform a review of mineral policy in Northern Ireland aimed at updating the current government position.

GSNI continues to manage the compilation of the annual return on quarry production on behalf of DfE. This has been a key input to the development plans created by Local Council planning teams when considering their local mineral development policies.

The information supplied by the operators can provide detail on the location of mineral resources that may need protection from surface development sterilisation. Additional information requested to support the plan process covers known reserves at extraction sites.

Research supported by GSNI and DfE is aimed at establishing the potential for Northern Ireland to host minerals that are critical to the economy and those required for the transition from hydrocarbons to renewable energy. GSNI are working with BGS colleagues, providing the information and expertise relating to Northern Ireland’s potential in meeting the UK critical mineral demand. GSNI contributed to a commissioned report produced by BGS assessing the strengths and weaknesses of current approaches to managing the supply of critical raw materials. The Northern Ireland case study presented an example of how a central licensing system that manages exploration data collected by licensed companies can be used to inform ongoing exploration activity, encouraging further investment and avoid duplication of effort.

INFORMING DECISION-MAKING FOR HYDROCARBON EXPLORATION

DfE funded research to assess the economic, societal and environmental impacts of future onshore petroleum exploration and production, including unconventional oil and gas (UOG) concluded in July 2021. The research, carried out by Hatch Regeneris was overseen by a steering group that included officials from across the DfE Energy Group, GSNI and the Northern Ireland Environment Agency (NIEA). GSNI provided available geological and exploration data to the researchers and carried

out technical reviews of the geological aspects of the report for DfE. Whilst the report remains to be published, it will inform DfE’s consideration of options for consultation on the future of petroleum licensing policy in Northern Ireland.

GSNI has provided further technical advice and briefings to government on developing petroleum legislation. In March 2022 GSNI provided a briefing to the Committee for the Economy in their consideration of the Onshore Fracking (Prohibition) Bill. The briefing covered a technical overview of shale gas and the processes of hydraulic fracturing.

UNDERPINNING INFRASTRUCTURE GEOSCIENCE INFORMATION FOR DEVELOPMENT PLANNING

GSNI, through DfE, is a statutory consultee for planning applications in the development management process as stipulated in The Planning (General Development Procedure) Order (Northern Ireland) 2015. This is for all mineral applications and for all applications for hydrocarbon exploration or extraction. In addition, GSNI is a non-statutory consultee for planning applications that may be impacted upon by geological issues including but not limited to abandoned mines, compressible ground, and geological hazards. In 2021/2022FY, there were 182 planning consultations, with 48% being statutory.

The table provided shows the annual breakdown for 2021/2022FY on statutory consultations issued (by application type) and response status counts.

Type	Number of Consultations	% returned on time
Regional	1	100
Major	10	70
Local	79	97

As part of the development management process, GSNI supports Planning Officials through the provision of expert advice including recommending necessary site investigations needed for specific sites and reviewing a wide range of assessments including, but not limited to, Environmental Statements, slope stability reports, landslide risk assessments and mine risk assessments. GSNI has also provided support to Planning Officials through the provision of expert advice on matters of slope stability for a proposed development currently proceeding through the Planning Appeal Commission.

With the publication of GSNI’s ‘Guidance for planning developments in areas of abandoned mines’ there has been an increase in engagement with developers where GSNI has provided advice and data for the carrying out of mine risk assessments. This has resulted in developers assessing the feasibility of developments at an early stage, streamlining the process by ensuring risks associated with ground stability have been considered within the application and also enabled Planning Officials to make informed decisions in the interest of public safety and structure sustainability.

GEOSCIENCE INFORMATION FOR COASTAL MANAGEMENT

GSNI has continued to attend and contribute to the DAERA and DfI led Coastal Forum Working Group (CFWG) together with nominated representatives from Central Government, Local Government and the National Trust.

Part of the identified work programme of the CFWG is a result of the Baseline Study and Gap Analysis of Coastal Erosion Risk Management in Northern Ireland. This report identified significant shortfalls in the knowledge base around coastal erosion in Northern Ireland one of which was coastal geology datasets. In order to close this knowledge gap, in 2021/2022FY GSNI, working closely with DAERA, produced a new coastal bedrock geology dataset for the Northern Ireland extending from 200m inland and to 10m below sea level, and carried out a pilot study to define the methodology to produce a coastal superficial geology dataset.

Whilst this work has gone some way to addressing elements of the knowledge gap in relevant coastal datasets, there remains much uncertainty in the geological survey of offshore bedrock geology that can only be resolved through future further site investigations.

CONTRIBUTING TO ENERGY SECURITY - STANDING ADVICE FOR PLANNERS AND DEVELOPERS ON PEAT SLIDE RISK ASSESSMENTS

Working in partnership with the NIEA, GSNI has produced a draft Standing Advice document for planners and developers seeking planning

permission for development of land which may require a peat slide risk assessment (PSRA).

The types of development that most commonly give rise to peat landslides are those that occur in upland peatlands. The most common type of development in this environment is associated with wind farms so ensuring that they are developed effectively, safely and with minimal impact on the environment is vital so they can fulfil their important roles as part of Northern Ireland's energy mix.

Peat slides have the potential to cause significant environmental impact, not only where they are initiated, but their run out can cause substantial downstream devastation to infrastructure and biodiversity, especially stream ecology. Development in upland areas can trigger peat landslides, often attributed to a change in the surface/subsurface drainage and increased surface loading.

This standing advice has been developed to provide information on methods for identifying the need for PSRAs, the information that this should include, and the role that this document plays within the Northern Ireland Planning Process. Both GSNI and NIEA have a role to play in assessing PSRAs which are often interlinked, so by producing this document in partnership it provides clear guidance on the expectations from both organisations to ensure a timely and efficient response as part of the planning process.

MONITORING THE ENVIRONMENT CONTRIBUTING TO RESILIENT ECOSYSTEMS - PROGRESS WITH CATCHMENTCARE

CatchmentCARE is an EU-funded project that aims to improve freshwater quality within the North Western and Neagh Bann international river basins. The project is focussed across three cross-border river catchments, the Arney, Blackwater and Finn. The aims will be achieved through development of water quality improvement projects and installation of groundwater monitoring stations across the region.

In 2021/2022FY, GSNI has supervised the drilling of boreholes in the Blackwater and Hillsborough Catchments as part of the requirement to construct 50 groundwater monitoring boreholes. Each groundwater monitoring station was carefully designed to achieve various set objectives, including establishing study sites for investigating the effect of dykes on groundwater flow. Each borehole had a pumping test carried out to determine initial aquifer property estimates and samples have been collected to help characterise the baseline hydrochemistry at each station.

Nine of the sites have since been added to the NIEA monitoring network. All the data for each station will be collated into a data pack and released at the end of the project to encourage uptake of further research at the stations. All of the borehole infrastructure will remain to aid in long term understanding and promotion of how groundwater is impacted by land use.

Groundwater visualisation continues to be advanced as part of CatchmentCARE. A virtual reality (VR) package has been developed in cooperation with the Marble Arch Caves in Co. Fermanagh with the augmented reality element nearing completion in 2021/2022FY. This product will be a valuable educational tool to increase the awareness of groundwater, including how it flows in to rivers, helping to further augment the project's legacy.

SUPPORTING THE DESIGNATION OF NATIONALLY IMPORTANT EARTH SCIENCE SITES

An Earth Science Conservation Review (ESCR) report entitled 'NE County Antrim Karst ESCR' has been delivered as part of the NIEA SLA. It provides a brief introduction to the Northern Ireland 'Karst and Caves' ESCR subject block and provides information on five new sites hosted within the Cretaceous Ulster White Limestone Formation.

These recently discovered sites are significant because they demonstrate linkages between hydrology, hydrogeology, geology and ecology. The aim of the ESCR report to provide evidence to support the designation of these important sites as Area of Special Scientific (ASSI) as defined in the Wildlife and Natural Environment Act (Northern Ireland) 2011.

Elements of several of these sites are already being used to help train and raise the awareness of NIEA staff (ecologists, habitat assessment and planners) when it comes to decision making and seeking out expert assistance.

ENHANCING CLIMATE RESILIENCE THROUGH POLICY INTERACTION

GSNI continues to respond to public consultations and requests for information on a variety of policy documents. GSNI recognises that a knowledge of geoscience is not only vital for developing the Northern Ireland economy, but it also underpins infrastructure, helps to safeguard the environment, and contributes to public and animal health.

By producing effective responses to relevant consultations and requests for information, it allows the Government to make informed decisions and ensures that geoscience is an integral factor in the policy of multiple Government departments.

In recent years, GSNI responses have had a strong focus on climate resilience with an emphasis on enhancing and supporting energy, water and food security, contributing to climate resilient infrastructure, and reducing the risk from geological hazards. The policy interaction that took place in 2021/2022FY is listed in the table below.

Policy name	Input	Lead Government Department
Consultation on policy options for the new Energy Strategy for Northern Ireland	GSNI response to public consultation	DfE
Consultation on Review of Strategic Planning Policy on Renewable and Low Carbon Energy - Issues Paper	GSNI response to public consultation	DfI
Public consultation on the draft EU Peace Plus Programme (2021–2027)	GSNI response to public consultation	SEUPB
Draft Environment Strategy for Northern Ireland	GSNI response to public consultation	DAERA
3rd Climate Change Risk Assessment (CCRA3)	Drafted response from DfE to the NI National Summary for CCRA3	DEFRA (via DAERA)
2nd Northern Ireland Climate Change Action Plan (NICCAP2)	Reporting on climate change adaptation project at GSNI	DAERA
Draft Green Growth Strategy for Northern Ireland	GSNI response to public consultation	DAERA
Local Nature Recovery Plan Strategy	Contribution to BGS response to public consultation	DEFRA
Scottish Government 4th National Planning Framework (NPF4)	Contribution to BGS response to public consultation	Scottish Government

PROTECTING HUMAN AND ANIMAL HEALTH RESPONDING TO AND REMEDIATING A POTENTIAL ABANDONED MINE COLLAPSE IN AN URBAN AREA

Following a reported subsidence event in an area of dense historic mine activity, GSNI attended and investigated the site as part of its abandoned mine response service and mine management programme. The incident occurred within a residential housing development in Coalisland within an area of historic shallow coal pits. Initial desk studies of the available mine records for the area were carried out as well as geophysical surveys in 2021/21. The results of these indicated the possibility that the subsidence was due to the presence of underlying mine workings.

During 2021/2022FY, intrusive site investigations were carried out to determine the cause. This included a shallow trench to assess structural impact to the property and its buried utility

network. A series of four boreholes was drilled and the findings concluded there is no evidence of mine voids, collapsed or backfilled workings. Whilst it was not possible to conclusively rule out the possibility of historic mine workings at the location, there was no evidence of mining activity encountered within the area of subsidence. The findings indicated the cause of the subsidence unlikely to be caused by historic mining and likely to be as a result of shallow processes.

RESEARCH INTO THE PROVISION OF AN ABANDONED MINES RESCUE SERVICE IN NORTHERN IRELAND

Following on from work carried out by GSNI and DfE and substantive engagement with the emergency services, research into the provision of an abandoned mine rescue service in Northern Ireland was completed in 2021/2022FY. This independent research was commissioned by DfE and conducted by Wardell Armstrong. The scope of the work covered:

- research into what companies/agencies currently have the expertise to perform underground search & rescue /recovery operations;
- assess the current capability of each organisation to carry out the task of underground search & rescue / recovery within abandoned mine environments;
- evaluate equipment requirements and specialist training for the task; and,
- provide a range of options and evaluate each in terms of capability, response time and annual cost.

The report detailed a number of recommendations that will be reviewed to progress the emplacement of mine rescue provision for abandoned mines. In addition to this research, specialist mine rescue equipment was acquired during the year and is currently in place to be deployed by GSNI emergency response team in the event of an incident at an abandoned mine.

In support of this, GSNI delivered underground abandoned mine familiarisation exercises to the Northern Ireland Fire & Rescue Service Specialist Rescue Teams. This exercise provided an overview of potential hazards likely to be encountered, a walk-through of the mine to provide familiarisation of the abandoned mine working environment and mine specific GSNI information/data available that would assist mine rescue.

DATA GATHERING TO SUPPORT GEOHAZARD RISK MANAGEMENT (AGEO)

The Platform for Atlantic Geohazards Risk Management (AGEO) is funded under the Interreg VB Atlantic Area programme and is for a total of €2.5 million between 2019 and 2023. AGEO is being led by the University of Lisbon, with GSNI being one of 12 other partners involved in the project that will see the launch of seven Citizens’ Observatory pilot sites across France, Portugal, Spain, Ireland and UK. The aim is to encourage local communities to actively participate in geohazard monitoring, and to enhance local capacity in risk management.

As part of the project, GSNI has developed the Causeway Coast pilot as a Citizen’s Observatory to monitor geohazards. The pilot encompasses both

the Giant’s Causeway and Carrick-a-rede, and work in 2021/2022FY has focused on data collection to understand environmental changes and geohazards and also working with stakeholders to develop good practice in using data to inform risk management.

An important element has been the vast array of data available from Copernicus, the EU’s Earth observation programme. Data from the Copernicus Sentinel constellation of satellites has been evaluated to determine ground motion at the sites over the past decade through the use of InSAR techniques. Satellite data has also been used to assess the role that land-use and water moisture within the ground contribute to landslide events. This has been combined with daily rainfall data acquired from the Met Office and records of all landslide events held by the site managers, The National Trust.

On the ground, GSNI has been working with project partners Université de Bretagne Occidentale (UBO) to deliver high resolution photogrammetry models of the Giant’s Causeway. A high-resolution LiDAR scan was also completed with plans for a second scan in 2023. The results of the data will be interrogated and analysed to detect areas susceptible to landslides, response to climate changes, change detection rates and frequency. Further data is also being collected by the public through the AGEO mobile application. The monitoring tools will be reviewed and assessed for their capabilities and usefulness to assist in improving the risk management procedures for the sites.

ENHANCING TOURISM SUPPORTING THE NATIONAL DEVELOPMENT OF UNESCO GLOBAL GEOPARKS

GSNI has continued to support existing and aspiring UNESCO Global Geoparks, both in Northern Ireland, and elsewhere in the UK and Ireland.

After a delay of over a year due to Covid-19, Mourne Gullion Strangford Aspiring UGGp and Cuilcagh Lakelands UGGp were assessed by UNESCO-assigned evaluators for evaluation and revalidation purposes respectively. GSNI helped in planning for both of these assessments and attended in person for the duration, providing geological support for each. GSNI also produced a significant amount of documentation to facilitate the assessments including geological site databases and descriptions, geological maps as well as a geological comparative study between the two areas.

In 2021/2022FY, GSNI held the position of Chairperson for both the UK Committee for UGGps (UKCUGG) and the Irish UGGp Committee (IUGGC). This involved providing mentoring and support for aspiring UGGps and in 2021/2022FY this was an area of heightened activity. A pre-application submission assessment took place for Joyce Country and Western Lakes Aspiring UGGp in Co. Galway / Co. Mayo, and numerous mentoring meetings took place with Arran Aspiring UGGp (Scotland), Jersey Aspiring UGGp (Channel Islands), Cross Channel Aspiring UGGp (England / France) and Isle of Wight Aspiring UGGp (England).

RESEARCH INTO THE IMPACT OF CLIMATE CHANGE ON NORTHERN IRELAND LANDSCAPE-BASED TOURISM LOCATIONS

The Northern Ireland tourism sector is reliant on natural landscapes, some of which are designated as UNESCO-designated sites bringing with it a commitment to sustainable tourism and a requirement to protect their key values. Despite their importance, there has been little consideration of the impacts of climate change on them, nor on their ability to adapt.

In 2021/2022FY, GSNI carried out research at three sites: Causeway and Causeway Coast World Heritage Site, Cuilcagh Lakelands UNESCO Global Geopark and Mourne Gullion Strangford Aspiring UNESCO Global Geopark. By using a Climate Vulnerability Index (CVI) approach, key values were identified that included geological heritage in addition to other heritage assets such as biodiversity, cultural heritage and landscape value. These were assessed against potential climate stressors, with all locations classified as being at extreme or high risk from climate change with extreme temperatures, precipitation changes, increased storm intensity and frequency, storm surges, and sea-level rise (depending on location) being the main stressors. Climate change will also impact on socio-economic and other environmental aspects, threatening their position as sustainable tourism destinations.

In addition to climate change impacts, the adaptive capacity of each site was assessed. Whilst all three areas are delivering climate change adaptation

measures to a lesser or greater degree, it is clear that most have been delivered as co-benefits of other activities and are therefore not achieving as much as they could.

This research provides a basis on which to assess the impacts of climate change on key landscape-based tourism sites which should be combined with awareness raising of climate change issues, and specifically on climate change adaptation measures. This will ensure that site managers can be better-informed ensuring that key tourism sites can be made as climate resilient as possible.

CLIMATE CHANGE MITIGATION AND ADAPTATION IN UK UNESCO GLOBAL GEOPARKS

In preparation for COP26 in Glasgow 2021, GSNI organised a climate change workshop in association with the UK National Commission for UNESCO (UKNC) to assess the current contribution of UK UGGps to climate change mitigation and adaptation.

The workshop was open to all UK and Irish UGGps as well as Aspiring UGGps and a total of 32 people attended the virtual session. In addition to providing information on key climate change terminology and how it will impact upon the UK, the workshop outlined what constitutes climate change mitigation and adaptation. This allowed for all participants to fully understand the contribution of their UGGp in this area which in most cases was much greater than expected.

The content of the workshop was compiled and produced as a briefing note that has been

circulated globally by both UNESCO and the UKNC in the wake of COP26 highlighting the UK UGGps contribution to climate change mitigation and adaptation. This has also been presented internationally at the 9th International Conference on UGGps in Jeju Island UGGp, South Korea and has been specifically requested by a number of UGGps worldwide including in Japan, Canada, Finland, Brazil, Norway and Slovenia. It was also presented by invitation to the Institution of Environmental Sciences Webinar Series on Cultural Heritage and Climate Change.

SUPPORTING EDUCATION GEOSCIENCE INPUT FOR NORTHERN IRELAND SKILLS STRATEGY DEVELOPMENT

GSNI has made a conscious effort to focus on more strategic geoscience education initiatives. This is in response to the dire situation regarding geoscience education at all levels, including a diminishing number of secondary schools offering single subject geology, and no higher education establishments offering geology.

One of the ways this was achieved in 2021/2022FY was by coordinating a comprehensive response from numerous members of the geoscience education community to the Draft Northern Ireland Skills Strategy, published by DfE. GSNI organised a roundtable discussion on key issues including the overall objectives of the strategy, the contribution of geoscience to the skills gaps identified in the Northern Ireland Skills Barometer, and the inclusion of representatives of the geoscience sector on the expert panel for the Digital Skills Action Plan.

GSNI submitted a comprehensive response that was directly aligned to the organisational work programme and the strategic direction of GSNI. Other organisation such as Ulster University, Queen’s University, W5, MPANI, Methodist College Belfast and Foyle & Londonderry College also submitted responses.

A summary of lectures, conferences and invited talks is provided in the table below.

Event	Quantity
Invited talks / lectures	10
Conference presentations	6
Fieldtrips / guided walks	10

GEOLOGICAL SURVEY AND MAPPING FAULTS, DYKES AND RESERVOIR COMPARTMENTALISATION REPORT

This work on faults and dykes aims to assess their impact on Northern Ireland Permo-Triassic and other key reservoirs and aquifers. Preliminary structural and architectural data has been gathered to gauge how faults and dykes influence fluid flow. An immediate application of this work is that conceptual models can now include measured attributes such as dominant orientations, average spacings, segments lengths, dyke thicknesses and gaps. Such information is helping to define aquifer and reservoir compartment dimensions and connectivity. This in turn aids the development of realistic 3D and 4D flow models required for future geothermal, energy storage and groundwater applications.

CONTRIBUTION TO THE UNDERSTANDING OF THE TRIASSIC AND JURASSIC PERIOD

GSNI worked with a consortium of researchers to produce a special issue of the Proceedings of the Geologists’ Association covering the latest Triassic to earliest Jurassic interval from outcrop studies and through research on cores held in the GSNI archive. The papers presented in the Special Issue include sedimentary, palaeontological and geochemical evidence across this interval, which is one of global significance in terms of the post-Palaeozoic evolution of life on Earth, recognised as one of the ‘Big-Five’ extinction events of the Phanerozoic and providing a platform for the diversification and evolution of many groups of organisms through the Mesozoic. Highlights include the first record of dinosaurs from the island of Ireland and the reporting of the thickest Jurassic sedimentary sequence encountered in onshore Ireland. Although generally well-represented at outcrop and sub-crop across much of the British Isles, this interval has been relatively little studied in Ireland until now. GSNI contributed to 7 of the 13 papers in the Special Issue.

NORTHERN IRELAND’S GROUNDWATER ENVIRONMENT

Work has neared completion on Northern Ireland’s Groundwater Environment with a final manuscript now ready for publishing. This book is a regional overview of the groundwater environment in Northern Ireland. It separates Northern Ireland into 11 different aquifers and using data collected in GSNI’s Groundwater Data Repository, characterises each one in a consistent approach in terms of

aquifer properties and groundwater chemistry. It uses the aquifer conceptual model as a basis for describing how groundwater in each aquifer is normally recharged, the processes that affect it and how it discharges back out to surface typically.

The book will be a helpful reference tool for a range of audiences from students through to hydrogeologists. It also provides a consistent approach to describing the hydrogeology of Northern Ireland. The published book will be launched in 2022/2023FY and will serve as a platform for further detailed understanding of each of the different aquifers in Northern Ireland.

DESK-BASED INTERPRETATION OF SUPERFICIAL DEPOSITS: NEWRY 1:10,000 SHEET MAPPING

The Newry sheet, from Newcastle in the northeast, to Greencastle in the southwest, encompasses the Mourne Mountains and Mourne Plain. In 2021/2022FY the desk-based interpretation of superficial geology and geomorphology was extended across 100% of the sheet area. This area was composed primarily of upland regions dominated by till, bedrock, and peat, with lowland regions characterised by glaciofluvial outwash, till incised by meltwater channels and terminal moraine complexes. At the coast these lowland deposits are incised by onlapping raised beaches, with modern beach deposits at lower elevations. The distribution of raised beach deposits is indicative of the extent of former marine-terminating glaciers, corroborated by adjacent bathymetry.

Field checking was more extensive than the previous season, covering a total of ten quarter

sheets, revealing granite-dominated, granular tills in the upland regions, mixing into tills dominated sandy Hawick Group argillaceous limestones and Gala Group sandstones. Onshore moraines are characterised by low-angle thrust complexes of sands and gravels, underlain in some locations by red marine clays. Coastal tills are characterised by moderate stratification with frequent evidence of water-escape structures, indicating water at the glacier bed and warm-based conditions. The top metre of raised beach and raised estuarine deposits, with evidence of periglacial conditions, in the form of ice-wedge casts and vertical clast sorting.

UK 1:625,000 SUPERFICIAL GEOLOGY MAP

A new 1:625,000 scale dataset of UK Superficial geology has been created from GBDigMap 50k and NIDigMap 10k superficial geology using automated cartographic techniques. These methods have recently been used to produce new GBDigMap 50k map sheets.

Since the first edition UK 1:625k Quaternary map was produced in 1977, BGS and GSNI has published over four hundred superficial geology map sheets at 1:50 000 scale. The current 1:50,000 scale BGS lexicon of 1031 lithostratigraphic classes is reduced to 12 deposit types: Aeolian, Alluvial, Alluvial (Fan), Fluvial (Terrace), Till dominant, Glaciofluvial, Glaciolacustrine, Lacustrine, Mass Movement, Marine and Coastal, Organic and Residual. To reflect this, the Northern Ireland 1:10,000 scale lexicon has been reduced.

Generalization was automated using a python script run in ArcGIS Pro's v2.8 python distribution. The script consists of: (1) assigning a new geological rank to polygons, (2) eliminating polygons invisible at the map scale, (3) widening or eliminating the thinner areas of the filtered polygons, and (4) simplifying the remaining polygons to preserve bends and polygon shape. Polygon quality and geological integrity were manually checked and assessed topologically.

These geological data are presented in two map sheets, UK North and UK South, alongside Devensian and Anglian ice sheet limits, and the QRA's UK Top Quaternary Sites.



Data, enquiries, corestore and engagement highlights

DATA PORTAL

GSNI, with the assistance of the BGS Informatics team, developed and deployed the infrastructure for a new GSNI data portal. This portal uses the widely adopted, open-source, GeoNetwork software.

It provides an application to manage spatially referenced resources providing powerful metadata editing and search functions as well as an interactive web map viewer. It provides discovery and view services and can be accessed through an API and from widely used GIS software.

The portal is used to manage both internal and external data resources and will grow as more resources are published.

The portal is accessible at <https://gsni-data.bgs.ac.uk>

ENQUIRIES

GSNI responded to 540 enquiries with an average time to completion of 7 days. The sector represented and enquiry type have been collated from the enquiries database and are shown in the tables below.

Sector	Number of enquiries
Commercial	221
Local Government	202
Public	46
Education / Research	36
Central Government	30
NGO	5
Total	540

Category	Number of enquiries
Abandoned Mines	187
Infrastructure	86
Environment	78
General Geology	49
Hydrogeology - resources	39
Energy	25
Geohazards (ex. abandoned mines)	20
Minerals	19
Quarries	15
Research / Education	9
Other	13

CORE STORE

The core store received funding from BGS to purchase 800 replacement core boxes that will enable existing historic core to be better archived and curated.

Ongoing research on the core archive has included collaboration with Durham University on the stable isotope record of the Permo-Triassic of Northern Ireland, critical element distribution in the Mourne granites with UCD, and stratigraphy and geochemistry of the Antrim Lava Group with Birmingham University.

Visitor numbers remained low for the 2021/2022FY due to continuing Covid-19 restrictions with five visitors recorded in total.

SUMMARY OF PUBLICATIONS AND CONSULTATIONS

Type	Qty	Description
Papers	11	Peer-reviewed publications
Reports	9	Internal and external reports
Conference abstracts	1	Abstracts submitted as part of an academic conference
Responses to planning consultations	182	Responses to consultations via the Northern Ireland Planning Portal
Consultation responses	6	Public policy consultations



ENGAGEMENT HIGHLIGHT 1

MUSEUM EXHIBITS

GSNI contributed to two significant public science exhibitions in 2021/2022FY.

The first of these was at W5, an award-winning science and discovery centre with which GSNI has worked for many years. GSNI was asked to contribute to the redeveloped exhibition space and now has a significant presence in the very prominent ‘Climate Through Time’ display found as part of the ‘In Our Nature’ permanent exhibition. GSNI provided substantial content as well as geological samples for the exhibition.

The second exhibition was as part of Geological Survey Ireland’s ‘Down to Earth’ exhibition at the National Museum of Ireland’s Collins Barracks in Dublin. GSNI provided limited content in the form of contribution to maps and the provision of geological samples to this all-island exploration of Ireland’s geology. This exhibition is in celebration of the 175th anniversary of Geological Survey Ireland.



ENGAGEMENT HIGHLIGHT 2

GEOHERMAL WEBINARS

In the 2021/2022FY GSNI worked with Queen’s University Belfast and the Geothermal Association of Ireland to host 11 webinars on geothermal energy. A further co-host, Geological Survey Ireland joined in January 2022. In total, the webinars attracted 1235 registrants, and all are now available on the BGS YouTube channel.



ENGAGEMENT HIGHLIGHT 3

NORTHERN IRELAND'S GEODIVERSITY CHARTER

Northern Ireland’s Geodiversity Charter 2021–2024 was officially launched in December 2021. The Charter was produced in association with the NIEA.

A week-long social media campaign accompanied the virtual launch that included communication of vision, aims and outcomes of the Charter on GSNI’s Facebook, Twitter and Instagram accounts. Overall, there were a total of 12 posts on each platform and the campaign reached 6,000 people on Facebook, and had 10,000 impressions on Twitter.

As a follow-up to the launch, GSNI and NIEA jointly-hosted a webinar on Northern Ireland’s Geodiversity, preceded by information on the purpose of the Charter. This event was attended by over 140 participants from all across Northern Ireland, Great Britain, Ireland and internationally.



ENGAGEMENT HIGHLIGHT 4

SOCIAL MEDIA

The use of GSNI’s social media was restricted to targeted campaigns due to time pressures on staff. Despite this, there was still an increase in followers across all platforms. The increase are as follows:

- Facebook 2%
- Twitter 2%
- Instagram 17%

A number of campaigns were delivered including Northern Ireland’s Geodiversity Charter 2021–2024 launch. In addition, a social media campaign in the run up to COP26 took place that highlighted the role of GSNI in contributing to climate change mitigation and adaptation. In total there were seven posts each on Twitter, Facebook and Instagram. This reached 8,000 people on Facebook and 14,500 on Twitter.



How we performed

GOVERNANCE

Under the Minerals (Miscellaneous Provisions) Act (Northern Ireland) 1959, a Service Level Agreement (SLA) to undertake a research programme exists between DfE and UKRI represented by the BGS and carried out by the GSNI. The GSNI Director reports monthly, quarterly and annually to the DfE on the delivery of this work programme. The governance of GSNI and the performance of its work programme is also audited and reviewed as required by DfE. In addition, as a science Director at BGS, the GSNI Director is a member of the BGS Senior Management Board and reports to the BGS Director

PROCEDURES MANUAL

All aspects of GSNI governance is detailed in its Procedures Manual, an internal organisational document, which is updated as required, reviewed and signed by all staff annually and is also audited cyclically by DfE.

In 2021/2022FY the Procedures Manual was completely revised due to substantial additions and amendments in previous years.

HEALTH, SAFETY AND WELL-BEING

Health, safety and well-being has continued to be a high priority as many home working continued in 2021/2022FY. As staff have returned to field working, and limited amounts of travel undertaken risk assessment and Covid Safe Systems of Work were completed regularly.

In total, there were 55 risk assessments and 23 Covid Safe Systems of Work completed.

As public events slowly re-emerged in 2021/2022FY, the importance of first aid training has come to the fore and all staff involved in delivering these events have undergone full first aid training or have refreshed existing training.

DFE RESEARCH PROGRAMME

A summary of the research programme delivered as part of the DfE SLA is provided below.

Energy, Minerals and Waste		
Objective No.	Objective	Targets Achieved in 21/22
1	Support the regulatory and administrative functions of DfE Minerals & Petroleum Branch	Yes
2	Support DfE in Mineral Potential Development	Limited progress due to impact of reactive work
3	Support DfE in Quarry Information Management	Yes
4	Support the regulatory and administrative functions of DfE Minerals & Petroleum Branch for petroleum exploration and development.	Yes
5	Increase knowledge, awareness and use of low C Earth energy resources	Yes
6	Develop the EU Peace Plus Geothermal bid	Yes
7	Increase knowledge and awareness of potential for geological storage of energy and carbon	Yes
8	Curate and promote the GSNI core archive	Only partially due to Covid
9	Carry out data collection, analysis and baseline monitoring to maintain & enhance EMW science capability	No progress
Information and Infrastructure		
Objective No.	Objective	Targets Achieved in 21/22
1	Provide DfE with advice on abandoned mines and reduce the associated risks	Yes
2	Increase the understanding of and increase resilience to geological hazards to minimise their impact on the Northern Ireland economy	Yes
3		
	Assess Northern Ireland Coastal data and define parameters of a work programme to establish the coastal vulnerability of Ni and potential impacts	Yes
4	Provide advice and data to a diverse range of stakeholders and customers to underpin and support DfE interests	Yes
5	Realise the full potential of sustainable geological tourism and the benefit that it has for the Northern Ireland economy	Yes
6	Maintain and develop the underpinning digital infrastructure and datasets that are essential for the delivery of all GSNI tasks	Yes
7	Improve Data Discovery and Access and implement the findings of the GSNI Data Survey.	Yes
8	Implement Data Strategy Planning	Yes
9	Produce a consistent and high-quality graphic design and publication service across all GSNI teams to assist in the delivery of the DfE SLA	Yes
10	Increase the understanding of geoscience and its impact on the economy and the public of Northern Ireland	Yes

Geology and Groundwater		
Objective No.	Objective	Targets Achieved in 21/22
1	Undertake baseline geological survey of prescribed areas of Northern Ireland and provided digital outputs to support DfE and stakeholder functions	Yes
2	Advance 3D geological models and their uptake by stakeholders at national and city scales, to allow visualization and assessment of the subsurface volume	Yes, but end product changed on advice of stakeholders
3	To maintain and develop Northern Ireland's hydrogeological datasets, knowledge and understanding in support of the sustainable use and protection of groundwater resources	Yes
4	Define the groundwater bodies and aquifers of Northern Ireland and describe the hydrogeology of each of the main aquifers	Yes
5	Develop and inform a close and effective network of stakeholders in the sustainable development of groundwater resources	Yes
6	Identify and undertake collaborative, high impact research and funding bids to support DfE and stakeholder needs.	Yes
7	Support and carry out research related to the GGW work programme	Yes

For further detail on actions completed see Appendix 1.

OTHER RESEARCH PROGRAMMES

A summary of the research programmes delivered as part of non-DfE SLAs is provided below.

NIEA

GSNI has been operating under an SLA with the NIEA to deliver key actions under the Water Management Unit and Natural Heritage Directorates within NIEA. The current SLA is renewed annually with a work programme being established to deliver a number of key tasks as outlined below:

- Project management & provision of geoscientific advice
- Promotion of Northern Ireland's Geodiversity Charter 2020-2024
- Earth Science Training for NIEA staff
- Supporting geoscientific information for the designation of NE County Antrim Karst identified under the Earth Science Conservation Review (ESCR)
- Sand Dunes Groundwater Level Monitoring
- Sand Dunes Groundwater Sampling and Analysis
- Sand Dune Hydrogeology Report

NEWRY MOURNE AND DOWN

DISTRICT COUNCIL

GSNI has been operating under an SLA with Newry Mourne and Down District Council to deliver key actions to obtain UNESCO Global Geopark status for the region. The current SLA is for a three-year period from 2020 to 2023, during which time there are a number of key deliverables including the preparation the evaluation visit from UNESCO and the organisation and delivery of the visit.

NI WATER

GSNI has been operating under an SLA with NI Water to provide hydrogeological oversight for the development of groundwater resources to supplement the Northern Irish drinking water supply. GSNI's main role is to scope relevant work required from external hydrogeological consultants, as well as the assessment and review of such work, and to present this internally to NI Water.

DAERA COASTAL DATASETS

A new SLA for 2021/2022FY has been established with DAERA for the provision of a new coastal bedrock geology dataset for the Northern Ireland extending from 200m inland and to 10m below sea level, and carried out a pilot study to define the methodology to produce a coastal superficial geology dataset.

OUR STAFF

LEARNING & DEVELOPMENT

Learning and Development (L&D) is primarily managed by the L&D team at BGS who provide and support training in leadership and management, behavioural / soft skills, IT, science, Health and Safety, bespoke coaching, mentoring and other training opportunities as they arise.

All staff completed BGS mandatory training on:

- GDPR
- Security Awareness
- Taking Security Home
- Security Awareness Proficiency Assessment
- Equality, Diversity and Inclusion

All staff completed NICS mandatory training on:

- Fire Safety
- Display Screen Equipment

The table below highlights non-mandatory courses that were taken by GSNI staff in 2021/2022FY.

Course Type	No. Courses	Total no. of courses delivered
Leadership and Management	9	11
Behavioural / Soft Skills	8	12
Technical	2	2
Health and Safety	1	5
IT (including Cyber Security)	3	3

CONTINUING PROFESSIONAL DEVELOPMENT (CPD)

Continuing Professional Development is encouraged and supported at all levels. The CPD highlights for 2021/2022FY are as follows:

- One staff member has graduated from SOAS with a distinction in MSc in Climate Change and Development.
- Two staff members have been appointed to the Royal Irish Academy’s Multi-Disciplinary Committees (Climate Change and Environmental Sciences, and Geosciences and Geographical Sciences).
- One staff member has been accredited as a Professional Geologist (PGeo) by the Institute of Geologists of Ireland.
- Two staff members are working towards Chartership and/or PGeo from either the Geological Society of London.
- One staff members has been accredited as a project manager by the Association of Project Managers.

DEPARTING STAFF

Three staff members left the GSNI in June 2021 having taken advantage of a Voluntary Exit scheme funded by UKRI.

The staff who left, having played a vital role within the GSNI over the past 40 years, were

- Jackie Johnston, Business Assistant.
- Derek Reay, Energy Geologist, Energy, Minerals and Waste Team leader and GSNI Senior Leadership Team.
- William Smyth, Information Service Manager.

NEW STAFF

GSNI has been able to add three new members of staff to the team in 2021/2022FY reflecting the growing demand on GSNI skills and expertise.

Dr Sean Burke is a Senior Hydrogeologist with BGS and has been working closely with the hydrogeology team at GSNI on the Catchment Care project. Sean officially joined the GSNI team in 2021/2022FY to assist with the Geothermal Pioneer Project.

Rebecca Ní Chonchubhair is a Hydrogeologist who previously worked with GSNI as an intern, before gaining experience with Tetrattech, an environmental and engineering consultancy. Rebecca joins the growing hydrogeology team at GSNI and started in January 2022.

Ronan Crossen is a Business Administration Apprentice with Belfast Metropolitan College, and will be based with GSNI for two years. Although Ronan did not start with GSNI until September 2022, the recruitment process was carried out in 2021/2022FY.

OUR COLLABORATIONS

GSNI collaborates with numerous stakeholders to deliver a number of strategic objectives. A list of the main collaborations is provided below:

Stakeholder Type	Stakeholder	Description
International	GSI, EMD, InvestNI, Geoscience Ireland, Enterprise Ireland	Support DfE in maintaining the profile of the Northern Ireland minerals industry on the virtual global stage at PDAC, Toronto.
	UNESCO	Work with the UNESCO Global Geoparks Council and UNESCO Secretariat to maintain and develop UNESCO Global Geoparks internationally and to raise profile of Northern Ireland.
	North-East Atlantic Geological Surveys	Partnership of 10 Geological Surveys within the Northeast Atlantic area exploring geological themes where there is a significant overlap in interest.
	Royal Irish Academy	Geosciences and Geographical Sciences Committee
	BGS, GSI and GSNI Directors	Memorandum of Understanding between three geological surveys in the UK and Ireland
Research	Leeds University	Ongoing visits from staff and students and the development of research projects on ore deposits in Northern Ireland
	Queen's University, Belfast	GSNI and QUB led an international conference on geothermal energy and are delivering a follow-on series of monthly webinars
	Durham University	Triassic palaeoclimates and geochemistry
	Birmingham University / Ulster Museum	Jurassic Triassic boundary across Northern Ireland
	iCRAG	Member of the iCRAG Governance Board
	Catchment Care	EU INTERREG VA Programme - Donegal County Council (Lead Partner), Agri-Food and Biosciences Institute, Inland Fisheries Ireland, Loughs Agency, University of Ulster, Armagh City Banbridge & Craigavon Borough Council, Geological Survey Ireland
	AGEO	EU INTERREG VB Atlantic Area Programme - Instituto Superior Técnico Lisbon (Lead Partner), Associação Portuguesa de Geólogos, Universidade da Madeira, Câmara Municipal de Lisboa, La Palma Research Centre, Instituto Geológico y Minero de España, University College Dublin, Laboratório Nacional de Energia e Geologia, Laboratório Nacional de Engenharia Civil, Université de Bretagne Occidentale

Stakeholder Type	Stakeholder	Description
Central Government	Dfi	Leading on the development of the Minerals Working Group
	DoJ / Emergency Services	Liaison with DoJ, emergency services and local resilience groups to maintain the Abandoned Mine Emergency Response Plan
	DAERA / NI Water	Leading on the development of the Groundwater Resources Working Group
	DfE / Dfi	Representation on UK Minerals Forum together with GB government, industry, professional bodies and NGOs
	DAERA / Dfi	Representation on the Coastal Forum Working Group
	Dfi / DAERA / HSENI / NI Water / NIHE / Airports	Representation on the Northern Ireland Planning Forum together with other Statutory Consultees
	OSNI / DAERA / Dfi	Representation on the Northern Ireland Earth Observation Steering Group
	DAERA	Collaboration to better assess and respond to Peat Slide Risk Assessments as part of the Northern Ireland development planning process
	DAERA / Dfi	Assessment of Northern Ireland Coastal Vulnerability and adaptation to climate change as part of potential PeacePlus EU-funding bid
	GSNI/GSI and others	PeacePlus geothermal bid
	DfE and others	Geothermal Advisory Committee
	LPS / OSNI	Potential to help in expanding gravity base station network in Northern Ireland in conjunction with BGS.
	OSNI / DAERA / Dfi	Representation on the newly-established Northern Ireland Earth Observation Steering Group
DAERA	Collaboration to produce coastal geology datasets to aid coastal management	

FINANCE

2020–2021FY Projects	Amounts*	%
NI Public Service Level Agreements	£850,178.00	79.9%
BGS Teams (UKRI)	£111,900.62	10.5%
Personal Development (UKRI)	£34,465.97	3.2%
Research	£66,331.03	6.2%
Other/Covid-19	£1,581.88	0.1%
	£1,064,457.50	100%

*excludes overheads

NORTHERN IRELAND PUBLIC SCIENCE

GSNI predominantly provides public science research services to government departments and Northern Ireland councils, primarily for DfE as part of its three-year recurrent work programme managed under a service level agreement (SLA).

ADDITIONAL RESEARCH

GSNI also has funding from UK Research and Innovation (UKRI) via BGS and EU programmes. GSNI-based staff work on BGS Teams (UKRI) either on external research or internal ‘national-capability’ or operational projects.

PROFESSIONAL DEVELOPMENT

As GSNI staff are UKRI employees, BGS (UKRI) pays for their continuing professional development (CPD), mandatory training including health and safety.

FORWARD LOOK

NEW ORGANISATIONAL STRUCTURE

We look forward to next financial year when we will pilot a new work package-based structure, streamlined line management and Executive team at GSNI to deliver our work programme for DfE and Northern Ireland government in preparation for a new three-year work programme cycle scheduled to begin in April 2023.

Our focus is firmly on providing geoscientific evidence to central and local government on clean heat, raw materials and groundwater working with research partners as required, making available more data, maps and tools for our user community, and for the first-time involve citizens in our work on geohazards.

GEOHERMAL ADVISORY COMMITTEE

In 2022/2023FY, the Geothermal Advisory Committee will steer the inaugural #NIGeothermalweek in June 2022. It will also review two reports by social scientists at Queens University Belfast on recommendation and vision for geothermal sector development in Northern Ireland.

It will also begin work together with Invest NI and others to assess required skills for a future geothermal sector in Northern Ireland. It will also facilitate a national conversation on geothermal energy and aid public awareness and understanding of this topic.

GEOHERMAL PIONEERS

GSNI is named as a co-delivery partner in DfE’s Energy Action plan published January 2022; we will work to prepare detailed project plans, produce sets of technical specifications and work to support and manage DfE’s call to tender for a £2.7M geothermal demonstrator project.

PEACEPLUS – GEOHERMAL AND COASTAL

GSNI, together with strategic project partners, is preparing to submit significant bids to the EU Peace Plus Programme 2021–2027 under both its Geothermal and Coastal themes. If successful, this funding would help platform and deliver GSNI’s strategic science ambitions for these topics in Northern Ireland.

PUBLICATIONS

GSNI produces numerous publications each year in the form of peer-reviewed papers, reports, conference abstracts, magazine articles, and various online publications. A list of all those produced in 2020/2021 are listed below:

PEER-REVIEWED PAPERS

Bond, A.D., Dickson, A.J., Ruhl, M. and **Raine, R.J.** In review. Marine redox change and extinction in Triassic–Jurassic boundary strata from the Larne Basin, Northern Ireland. *Palaeogeography, Palaeoclimatology, Palaeoecology*.

Boomer, I., Azmi, A., Copestake, P. and **Raine, R.** (2021). Lower Jurassic (Hettangian–Pliensbachian) microfossil biostratigraphy of the Ballinlea-1 well, Rathlin Basin, Northern Ireland, United Kingdom. *Proceedings of the Geologists' Association*, 132, 657–666. <https://doi.org/10.1016/j.pgeola.2020.06.002>.

Boomer, I., Copestake, P., **Raine, R.**, Azmi, A., Fenton, J.P.G., Page, K.N. and O'Callaghan, M. (2021). Stratigraphy, palaeoenvironments and geochemistry across the Triassic–Jurassic boundary transition at Carnduff, County Antrim, Northern Ireland. *Proceedings of the Geologists' Association*, 132. <https://doi.org/10.1016/j.pgeola.2020.05.004>.

Boomer, I., **Raine, R.J.** and Simms, M. (2021). The Upper Triassic and Lower Jurassic of Ireland. *Proceedings of the Geologists Association*, 132, 625–626. <https://doi.org/10.1016/j.pgeola.2021.10.002>.

Jaud, M., Le Dantec, N., **Parker, K.**, **Lemon, K.**, Lendre, S. and Gomes, R.C. (2022). How to Include

Crowd-Sourced Photogrammetry in a Geohazard Observatory – Case Study of the Giant's Causeway Coastal Cliffs. *Remote Sensing*, 14 (14), 3243. <https://doi.org/10.3390/rs14143243>.

Jeram, A.J., Simms, M.J., Hesselbo, S.P. and **Raine, R.** (2021). Carbon isotopes, ammonites and earthquakes: Key Triassic–Jurassic boundary events in the coastal sections of south-east County Antrim, Northern Ireland, UK. *Proceedings of the Geologists' Association*, 132, 702–725. <https://doi.org/10.1016/j.pgeola.2021.10.004>.

Laborde-Casadaban, M., Homberg, C., Schnyder, J., Borderie, S. and **Raine, R.** (2021). Do soft sediment deformations in the Late Triassic and Early Jurassic of the UK record seismic activity during the break-up of Pangea? *Proceedings of the Geologists' Association*. 132, 688–701. <https://doi.org/10.1016/j.pgeola.2021.02.007>.

Raine, R.J., Fenton, J.P.G., Boomer, I., Azmi, A. and Copestake, P. (2021). Uppermost Triassic to Lower Jurassic stratigraphy in the Lough Foyle Basin of County Londonderry, Northern Ireland. *Proceedings of the Geologists' Association*, 132, 641–656. <https://doi.org/10.1016/j.pgeola.2021.09.007>.

Russell, A., McDermott, F., McGrory, E., **Cooper, M.R.**, Henry, T. and Morrison, L. (2021). As-1 Co-Ni sulfarsenides in Palaeogene basaltic cone sheets as sources of groundwater arsenic contamination in

Co. Louth, Ireland. *Applied Geochemistry*, <https://doi.org/10.1016/j.apgeochem.2021.104914>.

Stoker, B.J., Livingstone, S.J., Barr, I., Ruffell, A., Storrar, R. and **Roberson, S.** (2021). Variations in esker morphology and internal architecture record time-transgressive deposition during ice margin retreat in Northern Ireland. *Proceedings of the Geologists' Association*, 132 (2-4). <https://doi.org/10.1016/j.pgeola.2021.03.002>.

Zheng, W., Liu, B., McKinley, J.M., **Cooper, M.R.** and Wang, L. (2021). Geology and geochemistry-based metallogenic exploration model for the eastern Tethys Himalayan metallogenic belt, Tibet. *Journal of Geochemical Exploration*, 224, 106743. <https://doi.org/10.1016/j.gexplo.2021.106743>.

CONFERENCE ABSTRACTS

Lemon, K. (2021). UNESCO Global Geoparks in the UK: Fighting Against Climate Change. 9th International Conference on UNESCO Global Geoparks, Jeju UNESCO Global Geopark, 12-16 December 2021.

REPORTS

Lemon, K. (2022). Report from the Irish UNESCO Global Geoparks Committee – 2021. Global Geoparks Network.

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Appendix 1

APPENDIX 1 - DfE SLA RESEARCH PROGRAMME GOVERNANCE AND ADMINISTRATION

OBJECTIVE & TARGET	NO	ACTIONS	COMPLETE	COMMENT
Ensure compliance on all aspects of corporate governance at GSNI	1a	Participate in monthly BGS SMB mtgs and working groups as required e.g. Policy bi-annual, National Geoscience monthly catch-ups.	Complete	
	1b	Comply with relevant NI (and EU) legislation, policy, audit and information procedures and quarterly management of risk assessment	Complete	
	1c	Fulfil internal DfE & NIO audit requests as required	Not required	Not required.
	1d	Facilitate quarterly invoice verification and monitor budget v actuals	Complete	
	1e	Bid for and secure funding for the next UKRI-DfE SLA for 2022/2025	Not required	SLA review delayed. One year addendum for 22/23.
	1f	Responsible for GSNI staff's health, safety and wellbeing	Complete	
	1g	Update GSNI Procedures manual as required; annual review and signature by all GSNI staff	Complete	
Provide administrative operational support for work programme	2a	To respond to and complete admin requests within agreed timeframe	Complete	
	2b	Procurement via I-procurement on UKSBS / GPC	Complete	
	2c	Travel – organised through CTM following NICS & UKRI regulations	Complete	
Monitor and report on DfE contract deliverables and finance	3a	Monthly GSNI Senior Leadership Team meeting	Complete	
	3b	Preparation of paperwork in advance of meetings. Recording and transcribing of minutes. Preparation and saving of relevant documents to TRIM	Complete	
	3c	Produce quarterly SLA reports and report to DfE at SLA review mtgs	Complete	
	3d	Publish Annual report ensuring approval of GSNI Science Advisory Committee	Complete	
Processing sales and sales transactions	4a	Process and record sales from publications	Complete	
	4b	Sales reconciled and forwarded to UKSBS weekly	Complete	

OBJECTIVE & TARGET	NO	ACTIONS	COMPLETE	COMMENT
Work with stakeholders and key partners to define and deliver GSNI public tasks	5a	Engage, collaborate and communicate with NI gov depts, NDPBs, councils, universities, NGOs	Complete	
	5b	Nurture and develop BGS/GSI/GSNI MoU with annual formal mtg and quarterly informal mtgs	Complete	
	5c	Bi-annual NAG meetings and EuroGeoSurveys strategic project development	Complete	
	5d	Bi-monthly HoGGS mtgs	Complete	
	5e	Participate in NIA All-Party Group STEM mtgs (2/3 pa), annual NI Science Festival, and annual Science in Stormont event	Complete	
Co-ordination, monitoring and income receivable of GSNI enquiry system	6a	Process income enquiries. Upload & monitor database. Process related payments (invoices & credit card).	Complete	
Work with DfE and stakeholders to define and deliver the future public science tasks of GSNI	7a	Consult and engage GSNI parent dept and stakeholders on draft strategy and on delivery plan	Not required	Progress delayed to align with other external strategies.
	7b	Prepare for and host and Bi-annual Science Advisory Committee (SAC) mtgs	Complete	
	7c	Lead the strategic development of GSNI, its culture, staff and recruit 2x new staff	Complete	
	7d	Fulfil duties on BGS Merit Promotion Science Panel 1 (SSO-PSO)	Complete	
Lead a geothermal €20M EU PEACE PLUS project bid with partners	8a	Lead the scoping and development of a project bid with GSNI as lead partner partners to SEUPB call timelines	Complete	

- Complete
- Not complete
- Not required / no planned progress due to Covid-19

ENERGY, MINERALS AND WASTE

OBJECTIVE & TARGET	NO	ACTIONS	COMPLETE	COMMENT
Support the regulatory and administrative functions of DfE Minerals & Petroleum Branch	1a	Support MAPB operational requirements in the geological and technical reviews and assessments of mineral prospecting licence applications on existing and new licences.	Complete	
	1b	Provide technical assessment of notified licence field activities with respect to environmentally designated sites.	Complete	
	1c	Provide written reviews of annual licence reports within 2 weeks of receipt of report from MAPB	Complete	
	1d	Provide operation support to administration of mineral prospecting licence	Complete	
	1e	Provide operation support to administration of mineral policy development	Complete	
Support DfE in Mineral Potential Development	2a	Submit mineral prospectivity reports through BGS publications	In Progress	Regular meetings but no additional progress.
	2b	Follow up areas identified through prospectivity analysis in order to validate desktop findings.	Not Started	No progress due to reactive work.
Support DfE in Quarry Information Management	3a	Continue development of python programming to develop one click processing of 2019 and subsequent quarry return information submitted through the DfE online portal	Complete	
	3b	Compile Annual Mineral Return within 2 weeks of close of collection	Complete	
	3c	Compile supplementary material movement supporting document.	Not Started	Impacted by reactive work. First draft submitted in Q1 22.
Support the regulatory and administrative functions of DfE Minerals & Petroleum Branch for petroleum exploration and development.	4a	Provide independent assessments of DfE commissioned studies into issues associated with petroleum exploration and production. (project will conclude at end of March, some workflow into Apr 2021)	Complete	
	4b	Provide advice on technical aspects of Petroleum Licencing within two weeks of request	Complete	
	4c	To provide scientific evidence & advice in support of petroleum policy development	Complete	
Increase knowledge, awareness and use of low C Earth energy resources	5a	Research, review and publicise potential use of geothermal energy	Complete	
	5b	To provide scientific and technical support to underpin evidence-based policy development	Complete	
Develop the EU Peace Plus Geothermal bid	6a	To help prepare bid and provide supporting documents for Geothermal Peace Plus Bid	Not Started	Delays to PeacePlus Call
	6b	Stakeholder engagement for Peace Plus bid	Complete	
	6c	Plan scientific research for geothermal EU Peace Plus bid	Complete	

OBJECTIVE & TARGET	NO	ACTIONS	COMPLETE	COMMENT
Increase knowledge and awareness of potential for geological storage of energy and carbon	7a	To review current research on underground energy storage in porous media and salt caverns	Complete	
Curate and promote the GSNI core archive	8a	To improve the core and rock archive and to increase its profile and use as a valuable scientific and teaching resource. Collaborate where appropriate with projects leading to high quality research	In Progress	Only partially complete due to Covid.
Carry out data collection, analysis and baseline monitoring to maintain & enhance EMW science capability	9a	Baseline seismicity monitoring	In Progress	Seismometer procured in Q4
	9b	Baseline space weather monitoring	Complete	
	9c	Characterisation of bedrock & superficial sediments	Complete	

INFORMATION AND INFRASTRUCTURE

OBJECTIVE & TARGET	NO	ACTIONS	COMPLETE	COMMENT
Provide DfE with advice on abandoned mines and reduce the associated risks	1a	Monitor and manage NI abandoned mines prioritising emerging issues, and ensure that overall mine risk is mitigated, and report to NIMOC as required.		
	1b	Fulfil emergency response responsibilities as required.		
	1c	Provide support to MAPB on all matters related to abandoned mines		
	1d	Support the Abandoned Mines Programme by being part of the ERP on-call rota, taking part in quarterly ERP training sessions, attending NIMOC meetings, and delivering awareness campaigns as identified in the Inform and Warn strategy.		
Increase the understanding of and increase resilience to geological hazards to minimise their impact on the NI economy	2a	Expand the knowledge base and promote awareness of geological hazards		
	2b	Incorporate the potential of geological hazard monitoring through incorporating the use of satellite observation.		
Develop GSNI's capability in coastal and marine geology, and contribute fully to the AGEO Geohazards Project.	3a	Define the parameters of a work programme to establish the coastal vulnerability of Northern Ireland's coastline, including the identification of necessary datasets and coastal risk indicators, the essential delivery partners, and the social, environmental and economic benefits that this will provide		
	3b	Carry out an assessment of NI Marine data with a particular focus on renewable offshore energy potential, identify data gaps and explore opportunities to develop collaborative off-shore research that could assist NI Government energy strategy		No progress due to other priorities.
	3c	Fulfil all the actions identified as part of the AGEO project to develop a Pilot Observatory at the Giant's Causeway and to improve the public understanding and awareness of geological hazards in the Atlantic Area of Europe.		
Provide advice and data to a diverse range of stakeholders and customers to underpin and support DfE interests	4a	Provide an efficient and high-quality enquiry service by responding to 90% of all enquiries within 21 calendar days and prepare for handover of enquiries service before end Q1.		
	4b	Continue to improve the efficiency and quality of GSNI planning responses by streamlining the system within GSNI, standardising responses, carrying out quality checks and ensuring a turnaround time of 90% within the statutory timeframe.		
	4c	Instigate the transition from a manual enquiries service to an automated enquiries service to ensure equitable and fair access to GSNI's data, making sure its provision is managed in a transparent and accountable manner.		
	4d	Provide accurate and timely information for Planners and developers by responding to 90% of planning consultations within the statutory deadline and 90% of all major and regional planning consultations and LDP responses within the DfE timeline.		

OBJECTIVE & TARGET	NO	ACTIONS	COMPLETE	COMMENT
Realise the full potential of sustainable geological tourism and the benefit that it has for the NI economy	5a	Support and enhance the sustainable development of NI's geological tourism by providing geological advice and guidance to UNESCO-designated sites, working with UNESCO in the UK, Ireland and internationally, and by promoting NI's UNESCO sites through the EGN and the GGN.		
	5b	Enhance the knowledge base on the impacts of current and future environmental change, especially climate change on the NI tourism economy through targeted research activity.		
	5c	Continue to work with NMD Council to achieve and then maintain UNESCO Global Geopark status for the Mourne Gullion Strangford area.		
Maintain and develop the underpinning digital infrastructure and datasets that are essential for the delivery of all GSNI tasks	6a	Ensure effective IT systems are in place by managing the GSNI server, installing relevant scientific software and troubleshooting 95% of related issues within 14 days.		
	6b	Attend meetings/workshops. Update NIMA data on GSNI Systems. Provide local support to GIS users, Process OSNI DSMs/integration of LiDAR surveys		
Improve Data Discovery and Access and implement the findings of the GSNI Data Survey	7a	Work with BGS GeoSemantics team to deploy a GSNI GeoNetwork portal for GSNI metadata. Prepare and deliver training for GSNI Staff to populate metadata records.		
	8a	Resolve issues relating to or plan for Release of boreholes / Site reports, Redeveloping GeoIndex, Redaction of records before release, Database requirements for strategy projects		
Implement Data Strategy Planning	8b	Upon release of GeoNetwork portal work with OpenDataNI team to harvest GSNI metadata records for display on OpenDataNI		
	8c	Engage with OSNI regarding publication of material containing OS data.		
	8d	Update/Replace the GSNI Website		
Produce a consistent and high-quality graphic design and publication service across all GSNI teams to assist in the delivery of the DfE SLA	9a	Preparation of the Hydrogeology Red Book, Annual Report, GSNI Strategy Document update the PDAC stand for the 2022 conference, Social Media images Adverts / magazine images/articles and figures as required		
	10a	Increase the awareness of GSNI and its public good science role through a quarterly social media communication plan, and public engagement opportunities as they arise and establish a Geoscience Education Forum with a draft road map for geoscience education in NI, identifying priority areas for the next 5 years		

GEOLOGY AND GROUNDWATER

OBJECTIVE & TARGET	NO	ACTIONS	COMPLETE	COMMENT
Undertake baseline geological survey of prescribed areas of Northern Ireland and provided digital outputs to support DfE and stakeholder functions	1a	Continue extending the Newry 1:10k superficial and artificial geological map as part of the GSNI geological mapping programme		
	1b	Continue to work with BGS on the UK Quaternary domains mapping and UK geological enhancement.		
	1c	'Faults and Dykes project'		
Advance 3D geological models and their uptake by stakeholders at national and city scales, to allow visualization and assessment of the subsurface volume	2a	Complete the update of the Belfast City 3D geological model (Be3D) and present to end-users as a working model.		Output changed to depth-to-bedrock dataset due to stakeholder feedback.
	2b	Continue to contribute to the BGS TopRock project		
To maintain and develop Northern Ireland's hydrogeological datasets, knowledge and understanding in support of the sustainable use and protection of groundwater resources	3a	20 new high-quality groundwater borehole stations added to the Groundwater Data Repository (GDR)		
	3b	Respond to groundwater related enquiries within 10 working days		
Define the groundwater bodies and aquifers of Northern Ireland and describe the hydrogeology of each of the main aquifers	4a	The Northern Ireland's Aquifers Publication available for printing and/or online publication		Final draft complete. Publication in 2022/23.
	4b	New digital groundwater map published on GSNI Geoindex and Spatial NI		
Develop and inform a close and effective network of stakeholders in the sustainable development of groundwater resources	5a	Host 2 meetings of the Groundwater Resources Working Group		
	5b	Enhance the Northern Ireland Hydrogeology Platform by 2 new participants		Platform under review due to low engagement.

OBJECTIVE & TARGET	NO	ACTIONS	COMPLETE	COMMENT
Identify and undertake collaborative, high impact research and funding bids to support DfE and stakeholder needs.	6a	Continued support of existing research commitments. Identify strategic research areas for future collaboration.		
	6b	Increase the awareness of Northern Ireland Hydrogeology across the Island of Ireland		
	6c	Increase the inclusion of groundwater resources in relevant Northern Ireland central and local government publications		
Support and carry out research related to the GGW work programme	7a	Continue to develop and support geology research projects in and related to Northern Ireland with a special emphasis on those that are beneficial to the NI economy.		
	7b	Future Minerals Research		

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