Knocknacran West Open-Cast Mine and Community Sports Complex

Environmental Impact Assessment Report

Prepared for: Saint-Gobain Mining (Ireland) Ltd.

SLR Ref: 501.00545.064954
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1.0 INTRODUCTION

1.1 EIAR and Proposed Development

This document comprises an Environmental Impact Assessment Report (EIAR), prepared in support of a Planning Application made by Saint-Gobain Mining (Ireland) Limited ('SGMI or Saint-Gobain') to Monaghan County Council ('MCC') for permission for the following (Figure 1.1):

- Excavation of the former (Drumgoosat) underground mine by open-cast mining methods for the purposes of gypsum extraction at Knocknacran (East & West) and Drumgoosat, Co. Monaghan. Development will include the construction of a Cut-and-Cover Tunnel under the Carrickmacross to Kingscourt regional road (R179) for the transport of gypsum (by haulage truck and covered conveyor) to the existing processing plant area at Knocknacran, and for the transport of overburden and interburden (by haulage truck) to the existing Knocknacran Open-Cast Mine site for ongoing restoration purposes. The construction of the proposed tunnel will necessitate a temporary realignment of the R179 during the tunnel construction period to allow the R179 to remain in constant use. Development will also include: the demolition of one residential house and three unoccupied houses and sheds in the townlands of Knocknacran (East & West), Co. Monaghan; and the pumping of water from the existing Drumgoosat underground workings via an existing borehole on the Knocknacran West Mine site.

- The continued ongoing restoration of the existing Knocknacran Open-Cast Mine located in the townlands of Derrynascobe, Derrynaglah, Enagh, Knocknacran (East & West) and Drummond, Co. Monaghan, permitted under Reg. Ref. 17/217 and operating subject to Industrial Emissions (IE) Licence P0519-04 and Mining Lease M139. The proposed development includes a modification to the existing (approved) restoration plan to return the existing Knocknacran Open-Cast Mine to near ground levels.

- The continuation of use and refurbishment of the existing Knocknacran Processing Plant area, including water treatment facilities and associated infrastructure (including discharge pipeline to the River Bursk) in the townlands of Enagh, Derrynaglah, Drummond, Derrynascobe and Clontrain, Co. Monaghan.

- The Proposed Development will include a replacement vehicular access to the existing Knocknacran Open-Cast Mine and Knocknacran Processing Plant area site from the L4816.

- The further development of a Community Sports Complex (permitted under Reg. Ref. 20/365) located in the townlands of Drummond, Derrynaglah and Knocknacran West, Co. Monaghan which provided for a playing pitch, dressing rooms, welfare facilities, parking and associated drainage/wastewater infrastructure. This proposed development includes the next phase of the Community Sports Complex to include: 2 no. further playing pitches (one with perimeter running track and the other is an all-weather pitch) with associated goal posts, ball stops, dugouts, pitch fencing, flood lighting; a new building to incorporate reception, meeting / club rooms, sports hall, handball alley, changing rooms and toilets, viewing gallery; a part covered grandstand and additional parking and all associated siteworks.

This EIAR has been prepared by SLR Consulting Ireland Ltd. ("SLR") with the support of other consultancy advisors and SGMI staff. A list of the main contributors to this EIAR is provided in Section 1.10 below. Key areas of information presented within this EIAR concern the nature and extent of the Proposed Development, the character of the receiving environment and likely interactions (cumulative impacts) between the two that could result in significant environmental impacts. Information presented on the receiving environment identifies the intrinsic value and importance of potential impact receptors.

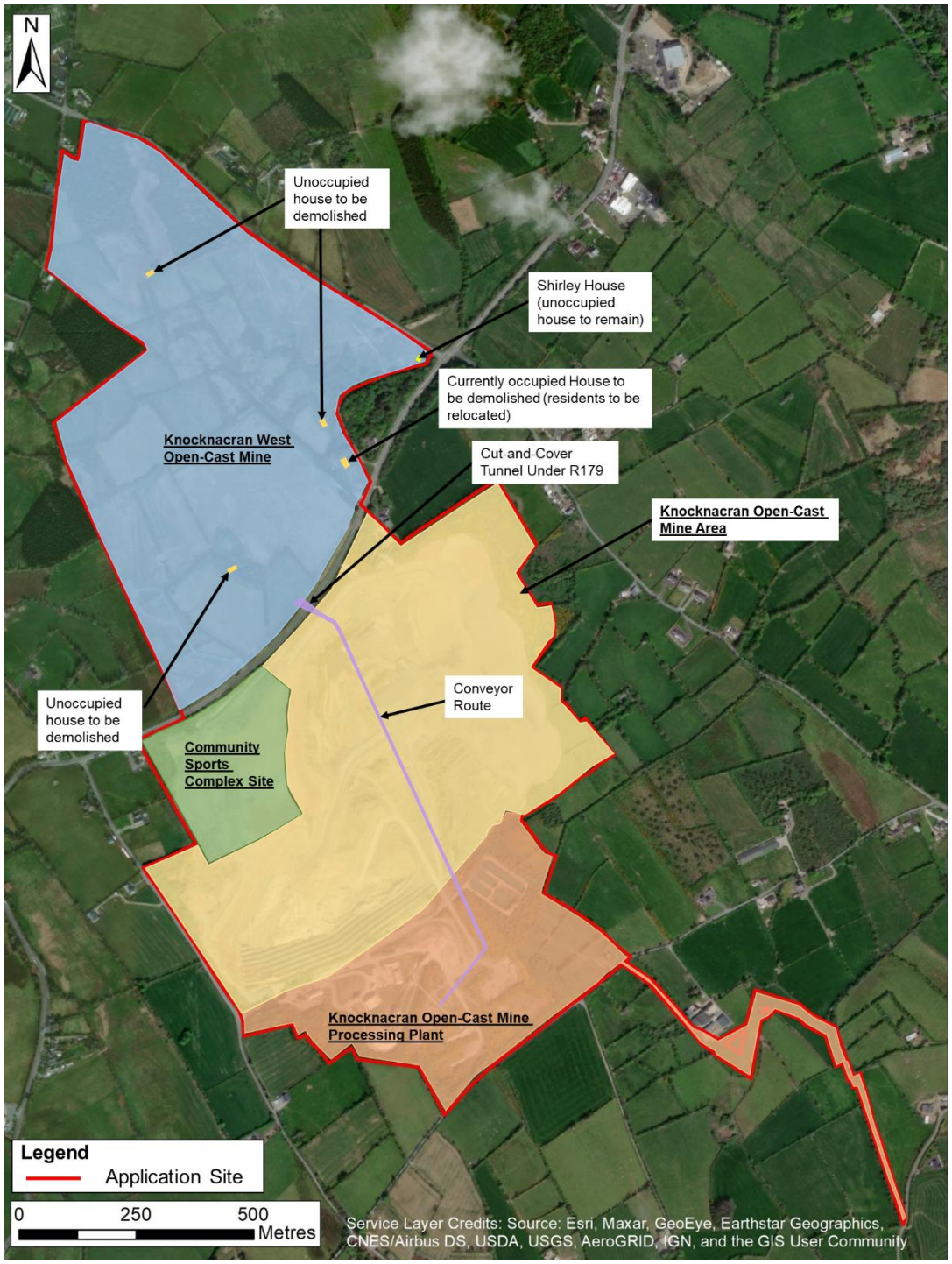

Figure 1.1: Proposed Development areas

1.2 Terminology

As the development consists of two distinct elements (relating to the Mine Development or the Community Sports Complex development), each element will be referred to within the relevant subheadings in the EIAR, attention will also be paid to their cumulative effects, where relevant.

The two distinct elements of the Proposed Development are as follows:

i) The proposed 'Mine Development' which includes the following:

- The proposed 'Knocknacran West Open-Cast Mine'/ (Knocknacran West Mine) where it is proposed to extract gypsum and source material (interburden and overburden) for the restoration of the existing Knocknacran Open-Cast Mine back to near original ground level. Material will be extracted by open-cast mining methods. The proposed mine encompasses the majority of the remaining old workings at the former Drumgoosat (underground) Mine. It also includes the construction of a Cut-and-Cover Tunnel under the Carrickmacross to Kingscourt regional road (R179) for the transport of gypsum (by haulage truck and covered conveyor depending on operational demands) to the existing processing plant at Knocknacran Open-Cast Mine, and for the transport of overburden and interburden (by haulage truck) for the purpose of restoring the existing open-cast Knocknacran Open-Cast Mine. The Cut-and-Cover Tunnel will require the temporary diversion of the R179 during construction, the diversion will be a two-lane diversion ensuring continuous use of the R179. To enable development of the Knocknacran West Open-Cast Mine, the demolition of one residential house and three unoccupied houses and sheds will be required. This development will also require the pumping of water from the existing Drumgoosat underground workings via an existing borehole on the Knocknacran West Mine site. Upon cessation of mining activities, Knocknacran West Open-Cast Mine will also undergo restoration;
- The 'Knocknacran Open-Cast Mine'/ (Knocknacran Mine) area, is located on the existing Knocknacran Open-Cast Mine site, where it is proposed to restore the existing open-cast extraction area using material (interburden and overburden) from the proposed Knocknacran West Open-Cast Mine to near original ground level. The existing Knocknacran Open-Cast Mine will be in active closure and restoration during the operation of the proposed Knocknacran West Open-Cast Mine. This proposed restoration plan is a revision of the existing plan included in the CRAMP (Closure, Restoration & Aftercare Management Plan). The existing mine entrance will also be replaced on this site;
- The continuation of use of the current Knocknacran Open-Cast Mine processing plant, water management facilities and associated infrastructure (including mine water discharge pipeline and discharge point), which is to be referred to as the 'Knocknacran Processing Plant'. This is located on the existing Knocknacran Open-Cast Mine site and to the immediate south of the proposed Knocknacran Open-Cast Mine Restoration area; and

ii) The proposed 'Community Sports Complex' where it is proposed to construct a community sports complex. Monaghan County Council (MCC) recently granted permission for a playing pitch, dressing rooms and associated infrastructure/facilities on the Community Sports Complex site under Reg. Ref. No: 20/365. The 20/365 permission relates to an initial phase of development of the proposed Community Sports Complex.

1.3 The Applicant

The Applicant for the Proposed Development is Saint-Gobain Mining (Ireland) Limited (SGMI) a wholly owned subsidiary of Saint-Gobain Construction Products (Ireland) Ltd (SGCPI).

1.3.1 Saint-Gobain Construction Products (Ireland) Ltd. (SGCPI)

SGCPI is one of the leading manufacturers and suppliers of gypsum related construction/building materials in Ireland and is a major supplier of plaster, plasterboard and dry-lining systems, to the Irish Building and Construction Industry.

The success of the Applicant has been built upon three vital elements – people, products and progress. Materials and products are manufactured at plants operating independently assessed assurance schemes to ISO 9001. The Company is a progressive employer and neighbour in its areas of operation and remains steadfastly committed to providing a service to their customers that focuses on people, products and progress.

1.3.2 Saint-Gobain Mining (Ireland) Ltd.

Saint-Gobain Mining (Ireland) Ltd. (SGMI), which is a wholly owned subsidiary of Saint-Gobain Construction Products (Ireland) Ltd (SGCPI), owns and operates two existing gypsum mines in Ireland; the Drummond underground mine and the Knocknacran Open-Cast mine. Saint-Gobain operates all its mines in accordance with its own corporate social responsibility and sustainability practices, and current best practice for the mining industry, as set out in the publication Guidelines on Environmental Management in the Extractive Industries published by the Environmental Protection Agency (EPA, 2006). The existing mines at Drummond and Knocknacran, along with the proposed open-cast mine at Knocknacran West will operate in compliance with the Guidelines to the Safety, Health and Welfare at Work (Quarries) Regulations 2008, as amended in 2020 (Health and Safety Authority, 2020).

Established in 1665, Saint-Gobain is a world leader in design, production and distribution of construction materials, delivering innovative products and services. Today, Saint-Gobain operates in 64 countries, employing ca. 191,500 people across four sectors: Construction Products (including plaster, plasterboard and dry-lining systems), Innovative Materials, Building Distribution and Packaging. Saint-Gobain's Gypsum business (Gyproc) in Ireland has been operating since 1936. Saint-Gobain has become a major contributor to the Irish construction industry, employing ca. 250 people.

Saint-Gobain is committed to achieving and maintaining industry leading environmental standards. Saint-Gobain strives to develop and maintain good working relationships with the local community, businesses and the Local Authority.

1.3.3 Saint-Gobain Sustainability

Appendix 1.1 provides a copy of the Saint-Gobain Group's 2021 Integrated Report, which sets out its values that are embodied in nine Principles of Conduct and Action. The report identifies global risks and opportunities relating to the business and sets out a vision for Saint-Gobain to be a leader in sustainable construction, with Corporate Social Responsibility as a source of value creation with stakeholders. The report also identifies interactions between the Group's value chain and the United Nations Sustainable Development Goals and the circular economy, with opportunities highlighted for Saint-Gobain to contribute

to the achievement of these. The Applicant seeks to exist as a good neighbour in the areas it operates and to adopt an open communication policy.

1.3.4 Saint-Gobain Environmental Management

Saint-Gobain operates an independently audited and accredited ISO 14001 Environmental Management System (EMS); and an ISO 50001 independently audited and accredited Energy Management System. It also operates the internationally recognised BES6001 standard of Environmental and Energy Management.

Environmental management is critical to the future of Saint-Gobain, and this is a management priority. Saint-Gobain aims for continuous improvement in its EMS with regard to the following:

- Minimise the environmental impact of their activities;
- Conserve mineral and energy resources;
- Reduce the visual impact of their operations; and
- Minimise waste generation.

Saint-Gobain products are utilised throughout the building industry including new residential developments and renovations, commercial construction, education and healthcare building projects. With this involvement comes a responsibility and a commitment to produce and provide the best quality, and highest performing products and services, and a continuously raising of the bar for their operational and business practices.

Saint-Gobain's ambition is the preservation of the environment and to offer its customers the greatest added value with the minimum environmental impact. Saint-Gobain have therefore set two objectives: (i) zero environmental accidents; and (ii) the minimization of the impact of their activities on the environment thanks to actions associated with the following five priorities:

- A policy of sustainable resource management with minimal production waste, reuse, and integration of maximum recycled content into their products;
- A reduction in energy consumption and greenhouse gas emissions of their industrial processes, infrastructure and transport, thanks to their industrial excellence programs, the involvement of all operators, the sharing of best practices;
- A reduction in water withdrawals to move towards "zero discharge" of industrial water, starting with areas of water stress and ensuring that it does not interfere with the local population's access to drinking water;
- Preserve, restore, strengthen and enhance the biodiversity of all their sites; and
- Anticipate and deal with risk factors related to environmental accidents and nuisances.

Saint-Gobain's eco-innovation strategy is developing products and solutions that help reduce the environmental impact of buildings and considers the whole life cycle from their product's initial conception to end of life. These products and solutions then help improve system durability and adaptability while reducing the operational use of resources (particularly energy and water) in buildings and infrastructure.

1.3.5 Product Quality

Gypsum (the raw product) is fire resistant, non-toxic and infinitely recyclable. The gypsum mined from Knocknacran, and Drummond mines is primarily used in the manufacture of plasterboard and plaster (at the Applicant's manufacturing facilities located near Kingscourt) which consist primarily of gypsum.

The Applicant manufactures all its products and materials to a third party registered quality management system to the international standard ISO 9001. The quality management standard ensures that all quality related operations are conducted in a controlled manner with the emphasis on achieving the required standard consistently and working towards continual improvement.

To achieve their goal of continuously improving products and services, and retaining ISO 9001 certification, all employees and sub-contractors play their part. The Company ensures that all employees are fully conversant with these objectives through an on-going training and education programme.

This means all employees are working consistently to the agreed procedures as set out in the ISO 9001 quality management system and are constantly looking for and sharing ways of improving what they produce and do. Line management are directly responsible for implementation of the quality management systems.

1.4 Mining History

The existence of the gypsum deposits in the Kingscourt-Carrickmacross area have been known for over a century. Historical records indicate that extraction began in 1871, when a short-lived open-cast mine at Knocknacran provided the first recorded gypsum output in the area. Although exploration work proved the existence of gypsum in other areas, there was no further development of the gypsum deposits until 1920 when an open-cast mine was opened at Ballynaclose, County Meath. This venture was unable to compete with imported plasters and the mine closed down in 1927. In 1936, the Ballynaclose facility was re-opened as Gypsum and Bricks Ltd, the plant is now operated by Saint-Gobain Construction Products Ireland Ltd, the parent company of Saint-Gobain Mining (Ireland) Ltd.

Initial production was from the Ballynaclose open-cast mine, but soon shifted underground to the Lisnaboe mine. This was succeeded in 1943 by an underground mine at Drumgill. A rising demand for gypsum necessitated the opening of additional mines at Cormey (1952 to 1961) and Drumgoosat (1958 to 1989). Exhaustion of reserves resulted in the closure of Drumgill and Drumgoosat in 1989, with production being replaced by open-cast mining at Knocknacran.

1.4.1 Knocknacran Open-Cast Mine

The Company's open-cast mine at Knocknacran has been in operation since 1989.

This followed the granting of planning permission by Monaghan County Council in 1984 (Planning Permission Reg. Ref. No: 83/461) and An Bord Pleanála in July of 1985 (Planning Permission Reg. Ref: PL 18/5/67892), and subsequent extensions granted by Monaghan County Council in 2007 (Planning Permission Reg. Ref. No: 07/430) and in 2017 (Planning Permission Reg. Ref. No: 17/217).

Gypsum from Knocknacran supplies a plaster and plasterboard factory owned and operated by Saint-Gobain near Kingscourt, Co. Cavan (the factory itself is located in Ballynaclose, Co. Meath). Both the Irish cement industry and the Irish agricultural industry are also supplied with gypsum from Knocknacran Open-Cast Mine. The output of the workings is dependent upon market demand as well as operating requirements. The

quality of the extracted gypsum is variable so on-site crushing, blending and homogenising are employed to maximise resource recovery, and therefore, the sustainability of the operation.

The proposed Knocknacran West Open-Cast Mine seeks to maintain the supply of gypsum to the factory site by replacing the current finite resource at Knocknacran Open-Cast Mine. Once the proposed Knocknacran West Open-Cast Mine is in operation, the existing Knocknacran Open-Cast Mine will undergo final restoration.

1.4.2 Drummond Mine

To supplement reserves and efficiently maximise the recovery of gypsum at the Knocknacran Open-Cast Mine, planning permission was granted for extraction of gypsum from underground in 2004 (the Drummond Mine, Figure 1.2). The underground mine commenced full production in 2006, and extracts gypsum from the Lower Gypsum Unit. The existing processing facilities and infrastructure at Knocknacran Processing Plant are utilised by the underground mine.

Drummond will continue to operate as permitted under Reg. Ref. 03/578 to 2032. The proposed Knocknacran West Open-Cast Mine will maintain the supply of gypsum following cessation of mining at Knocknacran Open-Cast Mine.

Figure 1.2: Drummond Mine Area (30 September 2021)

1.5 Proposed Development Context

The town of Kingscourt is located ca. 7 km south of the Application Site along the R179, and the town of Carrickmacross is located ca. 7 km north of the Application Site, also along the R179. The Application Site lies within the administrative boundary of Monaghan County Council (MCC). The existing topography in the vicinity of the Application Site is undulating in nature and varies in height from approximately 40 to 70 m above OD.

The Application Area is ca. 140.4 ha[1], of which the proposed Knocknacran West Open-Cast Mine comprises ca. 54.3 ha; ca. 24.6 ha comprises the Knocknacran Processing Plant, ca. 8.6 ha will comprise the Community Sports Complex and ca. 51.5 ha will comprise the restoration area for the existing Knocknacran Open-Cast Mine, Figure 1.3. Each of these developments is elaborated on in the following sections.

[1] The red line area encompasses a small area of the R179 (ca. 1.4 ha) which accounts for the slight discrepancy in total site area.

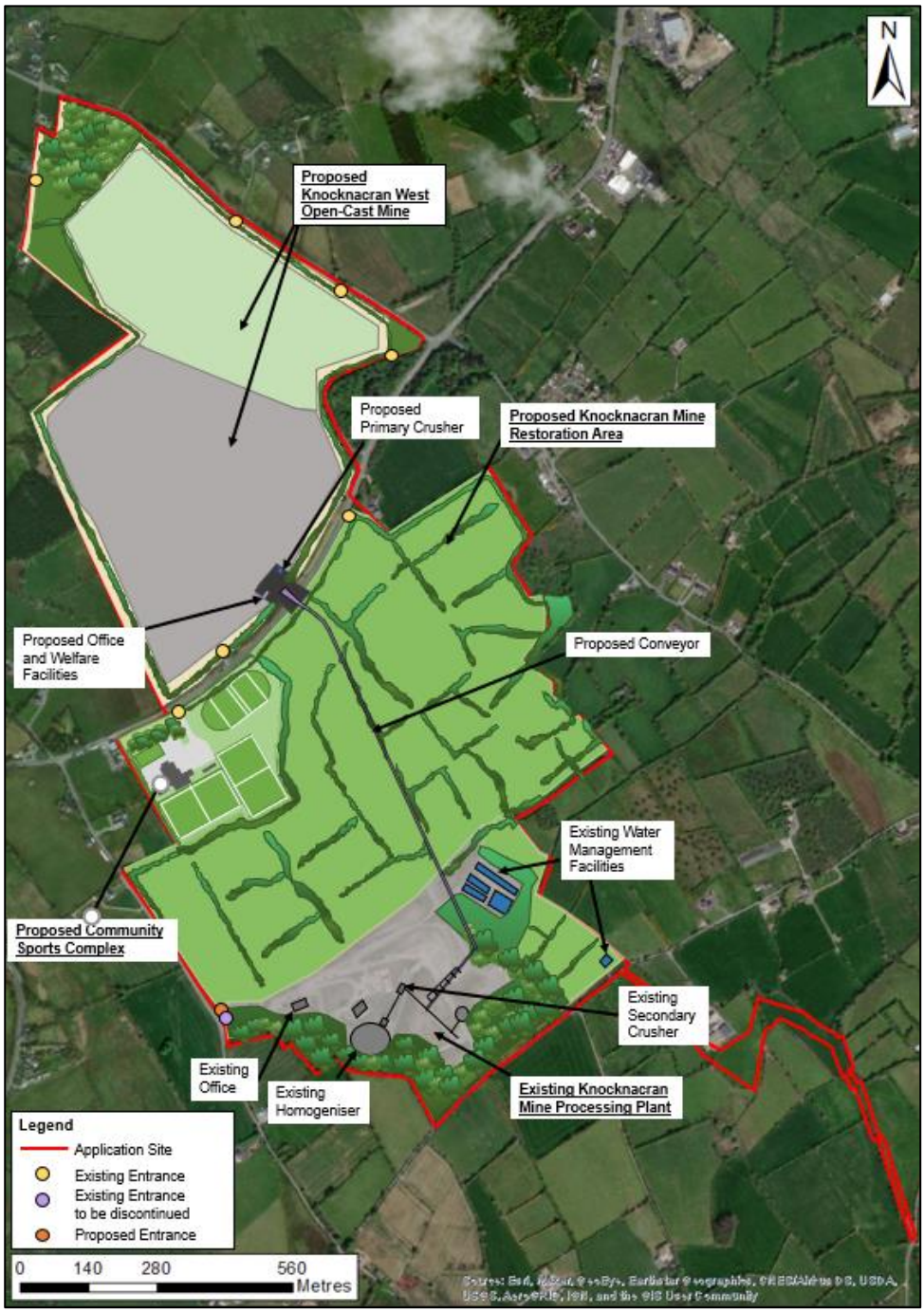

Figure 1.3: Proposed Development Layout

1.5.1 Mine Development

Knocknacran West Open-Cast Mine Location

The proposed Knocknacran West Open-Cast Mine site is located in the townlands of Knocknacran (East & West) and Drumgoosat, Co. Monaghan (Figure 1.3).

The Application Site primarily comprises agricultural lands, overlying underground mining workings dating from the 1950s to 1989 (when the mine was closed). The area is subject to ongoing monitoring and management. One residential house and three unoccupied houses and sheds are located within the site in the townlands of Knocknacran West and Knocknacran East (Figure 1).

The residential house and three unoccupied houses are under the ownership of the Applicant.

Knocknacran Open-Cast Mine Location

The proposed restoration area is located within the townlands of Enagh, Derrynascobe, Knocknacran East and Drummond and within the existing Knocknacran Open-Cast Mine extraction area, to the south of the R179 (**Figure 1.*3***

The site is currently part of the existing operational Knocknacran Open-Cast Mine which has planning permission to 2027.

Knocknacran Processing Plant Location

The existing Knocknacran Processing Plant is located on the existing Knocknacran Open-Cast Mine site to the south of the R179, in the townlands of Enagh, Derrynaglah, Drummond and Derrynascobe (Figure 1.3).

The processing plant is currently used to process gypsum from the existing Knocknacran Open-Cast Mine and from the Drummond Mine before it is transported offsite, via truck, to the SGMI factory site in Ballynaclose, Co. Meath (south of Kingscourt, Co. Cavan) for final processing.

House Locations

1.5.2 Community Sports Complex Development Location

The proposed Community Sports Complex site is located to the south of the R179 and to the immediate west of the existing Knocknacran Open-Cast Mine site in the townlands of Drummond and Knocknacran West (Figure 1.3).

Planning permission has been granted under Reg. Ref. 20/365 for the development of a new playing pitch, goalposts, ballstops, dugouts, pitch fencing, single storey dressing rooms and toilets, parking area, wastewater treatment system, percolation and attenuation areas, boundary fencing, new entrance onto the R179 public road, and all associated site works.

The Proposed Development seeks to extend the Community Sports Complex with the construction of a further two playing pitches (one with perimeter running track) and all-weather pitch, with associated goal posts, ball stops, dugouts, pitch fencing, flood lighting, new building to Incorporate reception, meeting / club rooms, sports hall, handball alley, changing rooms and toilets, viewing gallery, part covered grandstand, additional parking and all associated siteworks at Drummond, Derrynaglah and Knocknacran West, Carrickmacross, Co. Monaghan.

1.5.3 Rationale for the Mine Development: Knocknacran West Open-Cast Mine, Continuation of use of Knocknacran Processing Plant and Knocknacran Open-Cast Mine Restoration

SGMI proposes to apply to Monaghan County Council for permission to extract the remaining pillars, overlying room beam / pillar and previously un-mined areas from both the Upper and the Lower Gypsum

Units using open pit mining methods at Knocknacran West. The recovery of gypsum from the historical underground workings will provide further engineering control over the recent subsidence events.

It is proposed to continue to use the existing processing facility on the existing Knocknacran Open-Cast Mine site for the processing of the extracted gypsum from Knocknacran West Open-Cast Mine via a Cut-and-Cover Tunnel under the main Carrickmacross to Kingscourt regional road (R179). The Cut-and-Cover Tunnel allows for access between the two sites without impacting on the local road network. The gypsum will be transported by haulage truck and covered conveyor. The tunnel will also be used for the transport of overburden and interburden (by dump truck) to the Knocknacran open pit mine for use in ongoing restoration.

Additionally, it is proposed to restore the proposed extraction area of the Knocknacran West Open-Cast Mine site using overburden and interburden stripped from the site itself.

To enable the development of Knocknacran West Open-Cast Mine (i.e. the extraction of gypsum by open-cast means) one residential house and three unoccupied houses and sheds will be demolished as they lie within the footprint of the open-cast area. A relocation plan has been agreed with those effected.

The development at Knocknacran West Open-Cast Mine and continuation of use of Knocknacran Processing Plant will sustain benefits to the national and local economies through the continuity of sustainable jobs directly related to the operation as well as indirect benefits through the use of local supplies and services. It will achieve this by integrating its operation into the overall running of the Knocknacran/Drummond Mines to provide a sustainable, high quality gypsum feed to the Saint-Gobain owned and operated plasterboard and building plasters factory south of the town of Kingscourt, Co. Cavan.

The Knocknacran West gypsum deposit is a continuation of the existing gypsum deposit at Knocknacran and Drummond Mines. As gypsum is a naturally occurring mineral found within the subsurface, the process of extraction of natural gypsum can only be undertaken through mining methods.

Gypsum is a non-metallic mineral, which is found in rock form and is a valuable commodity in everyday life as it provides safer working and living environments, aids in the recovery of damaged limbs and enables food production in areas previously infertile. Due to its unique composition, gypsum offers considerable fire protection which is why gypsum is widely used in the construction industry to line the walls of houses, offices and commercial outlets. Gypsum has a wide number of uses including the following:

- Plaster and Plasterboard;
- Cement Manufacture;
- Soil conditioner;
- Pottery, glass and metal moulds;
- Medical casts; and
- Dental plaster moulds.

Gypsum reserves at the existing Knocknacran and Drummond mines are being depleted in line with demand. A new supply of gypsum is required in the near future to maintain the viability of the Irish gypsum industry as the existing operations onsite represent the only gypsum operation in the country.

Non gypsum material (i.e. overburden and interburden, including mudstone and dolerite which are not part of the gypsum resource) from the proposed Knocknacran West Open-Cast Mine will be transported under the R179 road via truck for use in the ongoing restoration of the existing Knocknacran Open-Cast Mine. Subsequently, the remainder of this material will be used to remediate the Knocknacran West Open-Cast Mine. The restoration plan for mining operations envisages the restoration of the Knocknacran Open-Cast Mine area to near original ground level (primarily for agricultural use[2]), and the Knocknacran West Open-Cast Mine to a biodiverse habitat with native grassland, scrub and woodlands planted around a waterbody (Figure 1.4).

The restoration plan (CRAMP - Closure Restoration and Aftercare Management Plan) currently in place for the Knocknacran and Drummond Mines (Appendix 1.2) will be revised to include the Knocknacran West Open-Cast Mine as part of the IE Licence revision process.

[2] Field boundary shapes provided in the restoration plan were informed by considering the historical field boundaries (pre-mining) and constraints such as the Shirley Estate land holding, the realignment of the R179 in the 1990s, the existing Community Sports Complex site and the (current) general size of fields in the surrounding area. Field boundaries are indicative at this stage in the process, and will be agreed with the relevant authorities as part of the final closure and restoration plan for the site.

Figure 1.4: Proposed Restoration Plan

1.5.4 *Rationale for Development: Community Sports Complex Development*

The proposed Community Sports Complex is a further development of the existing Community Sports Complex permitted under Reg. Ref.: 20/365.

There have been discussions with the management of the (former) community sports complex (GAA) and the Applicant for a number of years regarding relocating the facilities to a nearby site in advance of the proposed Knocknacran West Open-Cast Mine development. It has been long presented that a relocation of the community sports complex (from the north side of the R179), to enable the development of the Knocknacran West Open-Cast Mine, would require a replacement facility.

However, a subsidence event in 2018, beneath the (former) community sports complex created an immediate need for a new permanent facility to be built in the area, phase 1 of which has been provided under Reg. Ref.: 20/365. The proposed further development of the Community Sports Complex represents the delivery of the next phase of the facility, Figure 1.5.

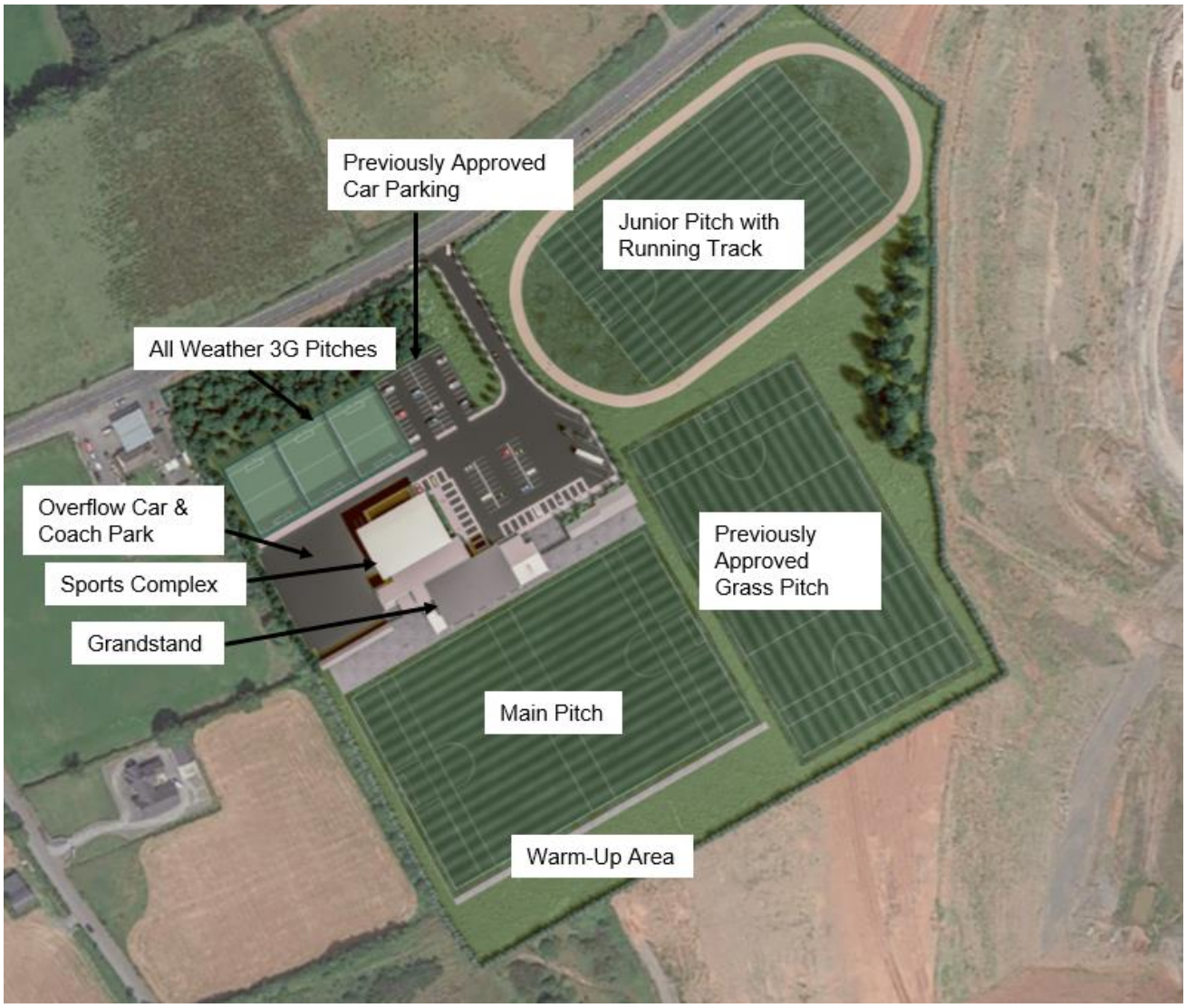

Figure 1.5: Community Sports Complex - Conceptual Plan

1.6 EPA Licence

The Knocknacran and Drummond Mines currently operate under an EPA Industrial Emissions Licence (IE Licence), Reg. Ref. P0519-04. This licence also incorporates the factory site which is located in County Meath and which is not part of the Application Site for the Proposed Development presented in this EIAR.

A licence review process will be undertaken to seek an extension to the current licence to incorporate the proposed open-cast mine into the IE Licence. A pre-application meeting has been held on 16th November 2022.

The initiation of a licence review process to incorporate the mining operations (as outlined in this EIAR) cannot be undertaken until a valid planning application has been lodged with the Council in respect of the proposed Mine Development.

Emissions related to the Mine Development are expected to be regulated by the Local Authority during the construction phase (refer to Chapter 3.0) while activities during the operational phase (refer to Chapter 3.0) are expected to be regulated by the EPA due to the nature and scale of the activities proposed.

As part of the operational phase of the mine it is presented by SGMI that overburden will be required to be removed to access the gypsum on the Knocknacran West site. The point at which this would begin is once the Cut-and-Cover Tunnel is constructed and overburden is then moved from the Knocknacran West site through the tunnel.

The provisions of section 173A of the Planning and Development Act 2000 (as amended) and section 87(1F) of the EPA Act 1992 provide details in respect of the interaction between a planning authority and the Agency in respect of an application for planning permission where an Industrial Emissions (formerly Integrated Pollution Prevention and Control) Licence is required. Section 99F of the EPA Act that clearly sets out the demarcation of functions between the EPA and the planning authority/the Board.

1.7 Need for an EIAR

Environmental Impact Assessment (EIA) is a process undertaken for certain types of development. It provides a means of drawing together the findings from a systematic analysis of the likely significant environmental effects of a scheme to assist local planning authorities, statutory consultees and other key stakeholders in their understanding of the impacts arising from the development.

The European Union's 1985 EIA Directive (85/337/EEC) was amended by Directives 97/11/EC, 2003/35/EC and 2009/31/EC, and the Directive and its amendments were codified in 2011 by Directive 2011/92/EU. The current Directive 2014/52/EU amends the 2011 codified Directive but does not replace it.

This amending Directive was transposed into national planning consent procedures in September 2018 through the European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 (S.I. No. 296 of 2018).

The Department of Housing, Planning and Local Government (currently the Department of Housing, Local Government and Heritage) published the following in the draft Guidelines for Planning Authorities and An Bord Pleanála in relation to carrying out Environmental Impact Assessment, (August 2018):

"The objective of Directive 2011/92/EU, as amended by Directive 2014/52/EU, is to ensure a high level of protection of the environment and human health, through the establishment of minimum requirements for environmental impact assessment (EIA), prior to development consent being given, of public and private developments that are likely to have significant effects on the environment."

The amended EIA Directive prescribes a range of environmental factors which are used to organise descriptions of the environment and these factors must be addressed in the EIAR. Article 3(1) of the amended Directive states that:

"The environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors:

a) population and human health;

b) biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC;

c) land, soil, water, air and climate;

d) material assets, cultural heritage and the landscape;

e) the interaction between the factors referred to in points (a) to (d)."

EIA is mandatory for certain types of projects and for other projects that meet or exceed thresholds as set out in Annexes I and II of the Directive (and Part 1 and Part 2 of Schedule 5 of the Planning and Development Regulations 2001, as amended).

A review of the Planning and Development Regulations (as amended) Schedule 5 thresholds (Developments for the purposes of Part 10), indicates that the proposed mining operations meet the EIA threshold for a mining project, as it meets the criterion set out under Part 1 of Schedule 5 of the Regulations as follows:

"19. Quarries and open-cast mining where the surface of the site exceeds 25 hectares."

The mining operations within the Proposed Development also require an EIA as they meet the criterion set out under Part 2 of Schedule 5 of the Regulations as follows:

"2. c) All extraction of minerals within the meaning of the Minerals Development Acts, 1940 to 1999."

In the light of these regulations, an EIA is necessary for the mining operations. The Community Sports Complex in itself is considered sub-threshold, but it has been considered in the EIAR where appropriate.

1.8 Relationship of the EIAR to the Planning Application

The EIAR accompanies the Planning Application for the Proposed Development to Monaghan County Council. The Planning Application documentation also includes the following:

- Application forms, notices and covering letter;

- Site Characterisation Reports for welfare facilities;
- Letters of consent from third party landowners;
- Plans, drawings and sections; and
- Natura Impact Statement (NIS).

1.9 EIAR Document and Chapter Structure

The findings of the EIA are set out in this EIAR and comprise the following chapters as presented in Table 1.1. The methodology used within the EIAR is outlined in Chapter 2.0 (Scoping and Methodology). The responsible parties examining the respective topic areas have also been provided in Table 1.1. The EIAR was completed by a project team led by SLR, who also prepared a number of the chapters.

A Non-Technical Summary (NTS) accompanies the EIAR and provides a summary of the key findings of the EIA in non-technical language.

Table 1.1: Knocknacran West Open-Cast Mine and Community Sports Complex development EIAR Chapter Structure

EIAR Chapter	Chapter Title	Responsibility
1.0	Introduction	SLR
2.0	Scope and Methodology	SLR
3.0	Project Description	SLR
4.0	Alternatives	SLR
5.0	Population and Human Health	SLR
6.0	Biodiversity	Nature-Scape
7.0	Land, Soils and Geology	SLR
8.0	Water	Piteau Associates
9.0	Climate	WSP (formerly known as Golder)
10.0	Air Quality	WSP (formerly known as Golder)
11.0	Noise	ITPEnergised
12.0	Vibration	SLR
13.0	Landscape and Visual	Macroworks

14.0	Traffic	PMCE
15.0	Archaeology and Cultural Heritage	Dr. Charles Mount Heritage Services
16.0	Material Assets	SLR
17.0	Major Accidents and Disasters	WSP (formerly known as Golder)
18.0	Interactions	SLR
19.0	Mitigation and Monitoring	SLR

1.10 EIA Project Team

The Environmental Impact Assessment Report (EIAR) was completed by a project team led by SLR, who also prepared a number of the chapters.

The members of the team and their respective inputs are presented in Table 1.2.

In accordance with EIA Directive 2014/52/EU, we confirm that lead specialists involved in the preparation of the EIAR are fully qualified and competent in their respective field. Each has extensive proven expertise in the relevant field concerned, thus ensuring that the information provided herein is complete and of high quality.

Table 1.2: EIA Project Team

Discipline	Specialist	Qualifications	Accreditations	Years of professional Experience
Introduction; Scope and Methodology; Alternatives; Population & Human Health; Climate; Vibration; Material Assets; Interactions	Hannah McGillycuddy (SLR)	BSc. (Hons) Environmental Sciences (Geology) MSc. Exploration Geology	MIT IGI	6+
Introduction; Scope and Methodology; Population & Human Health; Alternatives; Climate; Interactions	Lynn Hassett (SLR)	BSc (Hons) Applied Ecology MSc Environmental Impact Assessment	Practitioner Member of the Institute of Environmental Management and Assessment	16+
Project Description; Land, Soils and Geology	Barry Balding (SLR)	BA (Mod) Natural Science (Geology) MSc Applied Geophysics	PGeo, EuroGeol	30+
Major Accidents and Disasters	Kevin McGillycuddy (WSP)	BA (Mod) Botany MSc Environmental Science	Practitioner Member of the Institute of Environmental Management and Assessment	8+

Planning	Eamonn Prenter (Cunnane Stratton Reynolds)	BA (Hons) Joint Geography and History (University of Ulster) Diploma Town and Country Planning (Queens University of Belfast) Masters of Science in Town and County Planning (Queens University Belfast)	Corporate Member of the Irish Planning Institute Corporate Member of the Royal Town Planning Institute	34
Biodiversity	Freddy Brookes (Nature-Scape)	MSc Aquatic Ecosystem Management	Member of the Chartered Institute of Ecology and Environmental Management (MCIEEM) Member of the Institute of Fisheries Management (MIFM)	15+
Water	Geoff Beale (Piteau Associates)	BA (Hons) Lancaster University	-	40+
Air Quality, Climate	Rachel Lansley (WSP)	MSc Environmental Monitoring and Analysis, BSc Physical Geography	Chartered Scientist (CSci), Member of the Institution of Environmental Sciences (IES) Member of the Institute of Air Quality Management (IAQM)	12+
Noise	Simon Waddell (ITPEnergised) Gregor Massie (ITPEnergised)	BSc (Hons.) Environmental Geoscience PG Dip Acoustics and Noise Control BEng. MSc IoA Postgraduate Diploma Cert Competence Env Noise Measurement	MIOA AMIOA	12+ 5+
Landscape and Visual	Richard Barker (Macro Works)	MLA, PG Dip Forestry, BA Env	Corporate Member Irish Landscape Institute	15+
Traffic	Peter Monahan (PMCE Consultants)	BE, MSc, RSACert, CEng, FIEI, FConsEI	CEng; FIEI; FConsEI	20+

Archaeology and Cultural Heritage	Charles Mount (Dr. Charles Mount Archaeology and Cultural Heritage)	M.A. Archaeology Ph.D. Archaeology Dip. EIA & SEA Management	MIAI Member of the Discovery Programme	25+

In addition, the EIA project team has been supported by the following specialists in the preparation of the EIAR, Table 1.3, below.

Table 1.3: Supporting Specialist Consultants

Consultancy & Discipline	Specialist	Qualifications	Accreditations	Years of Professional Experience
SRK Consulting (geotechnical assessments (of underground workings) and vibration assessments)	Neil Marshall	MSc DIC, BSc (Hons)	CEng, MIoM3	40 years
Tembusu Limited (EPA licence support and Mine Closure, Restoration, Aftercare Management Plan)	Stephen Wheston	BSc Chemistry & Biochemistry MSc Environmental Management Diploma Environmental Science Diploma Applied Science (Nutrition) Diploma Safety and Health	-	+25 years
O'Donnell Environmental (ecological survey work to inform baseline for Biodiversity)	Tom O'Donnell	BSc (Hons) Environmental and Earth System Science (Applied Ecology) MSc Ecological Assessment	Chartered Environmentalist Full Member of the Chartered Institute of Ecology and Environmental	+10 years
Delichon Ecology (ecological survey work to inform baseline for Biodiversity)	Eamonn Delaney	BSc (Hons) Science MSc Environmental Science	Full and Chartered Member of the Chartered Institute of Ecology and Environmental Management (CIEEM)	+15 years
Triturus Environmental Limited (aquatic baseline reporting for the Corduff Stream)	Ross Macklin	PhD candidate, BSc Applied Ecology, HDip GIS, Dip IPM	MCIEEM, IFM, BSBI member	+18 years
Arboriculture Survey work (for consideration in Biodiversity)	Paul Holly	L4 DipArb. Currently studying 'Accredited Training Programme in Urban Tree Management'.	Tech member Arboricultural Association	+2 years as a Consultant Arborist and 12 years as a Climbing Arborist

Dr. Emmet Power (Department of Psychiatry, RCSI University of Medicine and Healthcare Service, Beaumont Hospital) specifically has had input into the consideration of the concept of "Solastalgia"	Dr. Emmet Power	MB BCh BAO MRCPsych MCPsychI.	Clinical research fellow in psychiatric epidemiology and youth mental health at the Royal College of Surgeons in Ireland Member of the Royal College of Psychiatrists (UK) Member of the College of Psychiatrists of Ireland	7 years

1.10.1 Description of EIAR Study Team's Background and Experience

SLR Consulting Ireland Limited

SLR Consulting is a leading environmental consultant with a network of 19 offices across Ireland and the UK. The company was established in 1994 and delivers advice and support on a wide range of strategic and project-specific issues to a diverse and growing base of business, regulatory and government clients. SLR specialise in the built environment, industry, infrastructure, mining and minerals, energy and power sectors.

WSP Consulting Ireland Limited (formerly Golder Associates Ireland Limited)

Golder Associates Ireland Limited was acquired by WSP Consulting Ltd. in 2021. WSP Ireland Consulting Ltd. provides a wide range of integrated services to the Extractive Industry and has been responsible for the management of site assessments, project due diligence, planning applications, environmental and social impact assessments, and closure and restoration plans. WSP Ireland Consulting Ltd. provide such services to local, national, European and international projects.

Piteau Associates

Piteau is an employee-owned, global organization providing a comprehensive range of geotechnical, hydrogeological and environmental consulting services to the mining, resources, municipal and industrial sectors worldwide and was established in 1976. Piteau provide world-leading expertise in hydrogeologic characterisation, open pit and underground mine dewatering, pit slope depressurization and groundwater resources and are experienced in preparing site wide water balances to design and optimize mine water management systems and infrastructure.

ITPEnergised

ITPEnergised was formed following the acquisition of ITPE Limited (formerly known as ITPower Consulting Limited) by Energised Environments Limited. ITPEnergised is the trading name of the merged businesses and provides a wide range of services to a variety of international clients.

ITPE Limited was originally established in 1981 as part of IT Power, a world leading renewable energy consultancy firm offering technical, engineering and advisory services to public and private sector clients in all aspects of sustainable energy. The ITPEnergised team have vast experience providing renewable energy and climate change consulting on over 2500 small to large scale projects, in more than 150 countries.

PMCE Consultants

PMCE is an engineering consultancy which focuses on providing expert independent engineering advice in relation to Road Safety Engineering (Road Safety Audits, Historical Collision Analysis and Road Safety Inspections), Road Planning & Design and Traffic Analysis & Assessment. PMCE has extensive experience in Traffic Analysis and in preparing Traffic & Transportation Assessments (TTA), including planning applications and environmental impact assessments relating to proposed developments, continuation of existing operations, or for applications for licences in relation to quarry or waste-related sites.

Macro Works

Macro Works is a leading consultancy firm specialising in visual impact analysis and visual impact graphics. Macro Works has considerable experience in areas such as wind energy developments, civil engineering projects and the extractive industry. Macro Works has partnered SLR on numerous environmental impact assessments concerning quarrying and mining related projects. Macro Works hosts a dedicated team of professionals to fulfil the key roles within their operations, including Landscape and Visual Impact Assessment, geographic information systems (GIS) and photo-simulation.

Dr. Charles Mount

Dr. Charles Mount is an Archaeologist with more than 30 years' experience of archaeology, cultural heritage and project management. He has extensive experience of environmental impact assessment gained over the last 30 years in a wide range of industries in the private and semi-state sectors including energy, extractive, waste, water, residential, transport and agri-food. Dr. Mount is a member of the Institute of Archaeologists of Ireland and the Discovery Programme. He is a graduate of University College Dublin with an M.A, and Ph.D. in Archaeology and has completed the UCD Diploma course in EIA and SEA Management.

Tembusu Limited

Stephen Wheston was the environmental manager at the Lisheen Mine, Co. Tipperary and currently operates Tembusu Limited. The former Lisheen Mine is currently one of only two mines in Ireland which have undergone mine opening, operation and closure under the current Irish regulatory regime (including through the EPA licencing process). He has over 25 years of environmental mining experience and remains involved in the oversight of the CRAMP for the Lisheen Mine.

SRK Consulting UK Limited

SRK is an independent, international consultancy providing focused advice and solutions to clients, mainly in the earth and water resource industries. For mining projects, SRK offer services from exploration to mine closure. SRK's specialists work on due diligences, technical studies, mine waste and water management, permitting, and mine rehabilitation. SRK's geotechnical professionals have extensive experience in designing and operating stable underground mine workings, pit slopes, tunnels, road cuttings, and tailings dams. SRK provide clear, comprehensive design options and assessing their associated time- and mining-related risks.

Among SRK's clients are many of the world's major, medium-sized, and junior metal and industrial mining houses, exploration companies, financial institutions, EPCM firms, and government departments.

O'Donnell Environmental Limited

O'Donnell Environmental Ltd. is an independent ecological consultancy based in Cork City, operating nationwide. O'Donnell Environmental is a Chartered Institute of Ecology and Environmental Management (CIEEM) Registered Practice which demonstrates their commitment to achieving the highest professional and best outcomes for both their Clients and for biodiversity.

Holly Arboriculture

Paul Holly, studied at the Merrist Wood College, Surrey, and holds a L4 Diploma in Arboriculture. Following a PLC in Horticulture from Colaiste Stiofain Naofa, Paul has been working in the arboricultural industry since 2005. He has extensive practical experience working in Australia, the US, and Ireland.

Paul's goal is to provide professional opinions on trees to ensure that existing trees are taken into consideration in development plans and throughout the development process. Paul aims to find a balance – between the practicality of development and the protection of key arboricultural features. The protection of these features not only sees the preservation of nature but also contributes greatly to the value of development and property.

Delichon Ecology

Eamonn Delaney of Delichon Ecology is a Full and Chartered member of Chartered Institute of Ecology and Environmental Management (CIEEM). Eamonn has experience in ecological consultancy and routinely undertakes a range of field surveys including bird surveys (vantage point and walked transect surveys) habitat surveys, botanical surveys and invasive species surveys. Recent and ongoing project involvement include assessments for planning applications culminating in Environmental Impact Assessments (EIA), Ecological Impact Assessments (EcIA) & Appropriate Assessments (AA) for windfarms, greenways, flood relief schemes, pedestrian and cycle routes, road schemes and water infrastructure projects.

Triturus Environmental Limited

Triturus Environmental Ltd. ecological consultancy based in Cork City. Triturus Environmental Ltd. specialise in aquatic ecology and are experienced in undertaking fisheries assessments, baseline aquatic assessments, site surveys, river Q sampling and aquatic impact assessments.

Dr. Emmet Power

Dr. Emmet Power is currently employed as a clinical research fellow in psychiatric epidemiology and youth mental health at the Royal College of Surgeons in Ireland, primarily undertaking research on modifiable risk factors for mental disorders amongst young people.

He has extensively published in national and international peer reviewed publications and presented his work at national and international academic meetings in academic discipline areas of population health, neuroscience, youth mental health and psychiatry. The areas of interest that he publishes in, include climate change & mental health, biomarkers of stress, unemployment, marginalization, substance use, childhood trauma, and substance use disorder, risk factors for psychosis, mental health service development for young people and risk behaviours in adolescence. He is a member of the Royal College of Psychiatrists (UK), and also a member of the College of Psychiatrists of Ireland.

1.11 References

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APPENDIX 1.1

Saint-Gobain Group Integrated Report 2021

2021 2022

INTEGRATED ANNUAL REPORT

SAINT-GOBAIN

The Stavros Niarchos Foundation Cultural Center in Athens is a sustainable urban complex, located in one of Athens' largest green areas. It offers an array of educational, cultural and sporting events and activities, redefining the very concept of public space. Restoring the Stavros Niarchos Park's former connections with sea and city, the project features new facilities for the National Library and the National Opera. Rigips solutions and Saint-Gobain glazing contributed to a LEED certification.

RECEIVED: 11/04/2023

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TABLE OF ILLUSTRATIONS

PIERRE-ANDRÉ DE CHALENDAR
Chairman of the Board of Directors of Saint-Gobain

More than ever, Saint-Gobain proved its ability to reinvent and surpass itself in 2021. A successful transformation, its financial results, as well as its commitments and progress in ESG (environment, social and governance) matters are proof of this. Transparency, fluidity and the quality of exchanges among the Group's governance bodies are also essential factors in achieving our growth objectives.

With this second edition of its integrated report, Saint-Gobain is pursuing its efforts to promote ever more transparent communication with regard to its model. In a context marked by greater geopolitical and economic uncertainty, the Group is all the more determined to play a strategic role in the creation of a circular economy and a decarbonized, safer and fairer world. This responsibility extends to both the sectors in which we operate and society as a whole. This is why we want to continue to share, as clearly as possible, how we create shared value with all our stakeholders.

Saint-Gobain had a remarkable year in all respects, posting record-setting financial results and pursuing our corporate social responsibility objectives in a methodical and disciplined manner. The first year of the "Grow & Impact strategic" plan proved the relevance of our model in terms of growth and profitability. Our solution-based approach sets us apart and enables us to meet the expectations of the construction and renovation markets, as well as the industry's decarbonization challenge. The dynamic management of our business profile, through the disposal of the most under-performing assets and the pursuit of value-creating acquisitions, enabled us to strengthen the Group and establish its status as the worldwide leader in light and sustainable construction, improving the daily lives of everyone thanks to its high performance solutions.

Our development trajectory is driven by global trends - as regards the climate, resources, urbanization, digitalization and lifestyles - which represent both challenges and opportunities in equal measure; in a context of renewed tensions, we are confident in our ability to achieve both profitable and sustainable growth. Our positioning and our solutions, our potential for innovation, and the quality and diversity of our talent are the keys, in the medium and long term.

BENOIT BAZIN
Chief Executive Officer of Saint-Gobain

PHLA+ is the first "Certified Passive House" built in Los Angeles.
The project, developed with the help of CertainTeed, combines comfort with very low energy consumption, while ensuring high indoor air quality.

1

GROUP OVERVIEW

SAINT-GOBAIN, A UNIQUE MODEL

HIGHLIGHTS OF 2021

JANUARY

Saint-Gobain once again obtains **"Top Employer Global"** global certification. Only 16 companies worldwide have received this label, awarded by the Top Employers Institute.

FEBRUARY

The Board of Directors decides to separate the functions of Chairman and Chief Executive Officer of the Group.

The Group announces exceptional results with a record-setting free cash flow for 2020 as well as a record-setting operating margin and recurring net income for the second half of 2020.

MARCH

Saint-Gobain concludes an **energy purchase agreement** in the United States for a period of 12 years with Invenergy. Involving 120 megawatts, this agreement is the largest signed by the Group in renewable energies to date and is a key step towards achieving carbon neutrality by 2050.

APRIL

Saint-Gobain inaugurates in Eindhoven the **first individual house in the world made entirely of three-dimensional printed concrete.** The Group, through its Dutch subsidiary Saint-Gobain Weber Beamix, developed special high-tech mortars that can be used in 3D printing and designed the printing technique in collaboration with Witteveen + Bos, a consulting and engineering company.

MAY

Saint-Gobain signs an **agreement to acquire Chryso,** a leading global player in the **construction chemicals** market, offering innovative solutions.

The Group announces an investment of approximately €25 million in its plasterboard plant in Fredrikstad in Norway, to make it the **world's first carbon neutral plasterboard plant in the world.**

JUNE

The Group announces that it has completed the sale of Lapeyre to Mutares, a company listed on the Frankfurt Stock Exchange.

JULY

Benoit Bazin succeeds **Pierre-André de Chalendar** as Group Chief Executive Officer, the latter remaining Chairman of the Board of Directors.

AUGUST

Saint-Gobain announces that it has sold the French company Aurys, which specializes in the shaping and processing of flat glass.

SEPTEMBER

The Group announces that it has completed the acquisition of **Panofrance.**

GROW & IMPACT

OCTOBER

Saint-Gobain signs an agreement to acquire **IMPAC,** a leading player in the construction chemicals market in Mexico.

Saint-Gobain holds a meeting for investors and analysts, which addresses the Group's strategy and its objectives for the 2021-2025 period. On this occasion, the Group launches its **"Grow & Impact"** strategic plan.

NOVEMBER

Saint-Gobain announces its **decision to invest more than $400 million** over the next four years to increase roofing, insulation and plaster production capacities at four production sites in the **United States.**

DECEMBER

Saint-Gobain announces that it has concluded an agreement whereby Saint-Gobain will acquire all GCP Applied Technologies shares. This acquisition is a decisive step to **establish the Group as a world leader in construction chemicals.**

SAINT-GOBAIN AT A GLANCE

HUMAN RESOURCES

166,000

EMPLOYEES

SALES

€44.2 bn

CO_2 EMISSIONS

- 23%

REDUCTION
FROM 2017 TO 2021*

WITHDRAWALS AVOIDED

9.952 Mt

OF NON-EXTRACTED
VIRGIN RAW MATERIALS

RESPONSIBLE PURCHASING

100%

OF PURCHASES
COVERED BY THE
SUPPLIERS' CHARTER**

SOCIAL PROTECTION

88%

OF EMPLOYEES COVERED
BY "CARE BY SAINT-GOBAIN"

PRODUCTION

800

INDUSTRIAL SITES
AROUND THE WORLD

INNOVATION

+400

PATENTS FILED
EACH YEAR

R&D

3,600

RESEARCHERS

START-UP

50

AGREEMENTS SIGNED IN 2021

** on scopes 1 and 2*
*** for trade purchases in Europe*

75 AN INDUSTRIAL PRESENCE IN COUNTRIES

GROUP ACTIVITIES

NEW CONSTRUCTION AND RENOVATION

Saint-Gobain provides construction and renovation solutions for both individual houses and collective buildings. These solutions meet the needs of professional and private customers both in terms of **building interiors and the distribution of spaces** (notably with partition systems, thanks to brands such as Placo®) and **building envelope** (with light façade systems or cutting-edge glass solutions, thanks to brands such as Saint-Gobain, Weber, Isover and CertainTeed, the leader in the North American market).

The Group's solutions also include **recycling services to recover waste** on construction sites (notably to supply Saint-Gobain's industrial manufacturing processes), or **services dedicated to professionals and individuals** (with programs such as Solu+ or La Maison Saint-Gobain in France). The Group's strong presence throughout the construction value chain, thanks notably to its retail chains – such as Point.P and Cedeo in France and Optimera and Dahl in the Nordic countries – enables it to roll out an unparalleled range of solutions for hundreds of thousands of craftsmen, and to play a leading role in Europe's fast-growing renovation markets.

Saint-Gobain's advanced expertise in the field of innovative materials also enables architects to design iconic buildings with original and innovative shapes.

INDUSTRY DECARBONIZATION

For its customers in mobility markets, Saint-Gobain produces **glazing that provides daily safety and comfort for motorists,** but also for the **aeronautical and rail sectors,** the **maritime sector** and **industrial vehicles.** The Group also offers solutions to **improve the performance of electric vehicles** (energy efficiency, well-being, safety and connectivity); distributes replacement automotive glazing on the independent market; designs and supplies bearings and tolerance rings. Saint-Gobain also offers high-performance technological solutions such as airborne and ground radomes.

For all its industrial customers, and notably for **the construction industry,** Saint-Gobain draws on its technological competencies **(materials science, formulation, design of glass applications, ceramics, abrasive solutions, performance polymers and fiberglass)** and its expertise in multiple cutting-edge applications that use the particular properties of its materials (**resistance to high temperatures, abrasion, chemical stability, surface properties**, etc.).

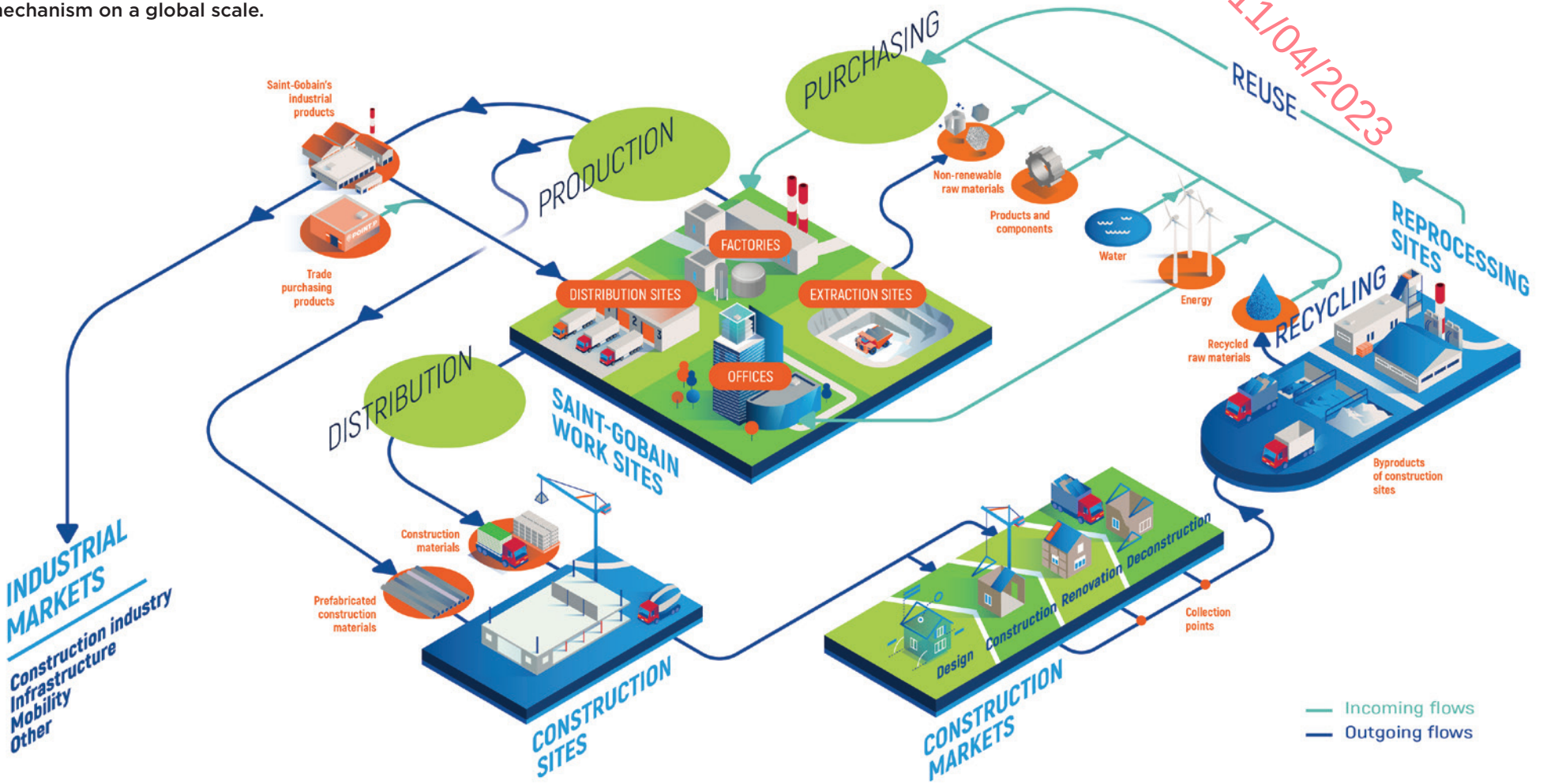
Many solutions are co-developed with customers, notably **in high-performance plastics and refractories for metallurgy or the glass industry.**

BUSINESS EXPERTISE

GLAZING • CEILINGS • CONSTRUCTION CHEMICALS • DISTRIBUTION • CONSTRUCTION INDUSTRY AND INFRASTRUCTURE
CERAMICS • GYPSUM – INSULATION • EXTERIOR PRODUCTS • PIPE • SURFACE SOLUTIONS

THE VALUE CHAIN

The value chain corresponds to all interconnected activities, each of which develops value for Saint-Gobain by integrating upstream (suppliers) and downstream (customers and other relevant stakeholders). The synergies between the Group's various activities (from resource extraction to distribution, the production of materials and systems and the provision of services), the complementarity of its offers, its solution-oriented approach and its scope – both global and local – constitute a complete chain of activities linked by the massive use of data and make up an industrial, logistical and human clockwork mechanism on a global scale.



THE FUNDAMENTALS OF THE GROUP'S IDENTITY

PURPOSE

Saint-Gobain's purpose, "Making the World a Better Home", is the result of a process conducted with its stakeholders: nearly 15,000 internal contributions, more than 600 workshops around the world, and contributions from external stakeholders such as investors, associations, partners and opinion leaders.

With this purpose, the Group took on its ambition to improve everyone's lives by making the planet a fairer, more harmonious and sustainable living space.

Through its business model generally and its solutions in particular, Saint-Gobain has a tangible impact on the life of each individual, their environment and their way of working, caring for themselves and getting around. The Group's purpose is the link between the infinitely small unit of each person's living space and the infinitely large one of our shared home: the planet.

CODE OF ETHICS: PRINCIPLES OF CONDUCT AND ACTION

Through its purpose, the Group bases its development on strong values embodied in nine Principles of Conduct and Action, which constitute a true **code of ethics.** Formalized in 2003, translated into 31 languages, and distributed to all employees, these principles constitute an ethical reference applicable in action. They are a condition of belonging to Saint-Gobain.

5 principles of conduct:

- Professional commitment
- Respect for others
- Integrity
- Loyalty
- Solidarity

4 principles of action:

- Respect for the law
- Caring for the environment
- Respect for health and safety at work
- Respect for employee rights

HEALTH, SAFETY, OPERATIONAL PERFORMANCE

By committing to protect **health and promote well-being,** Saint-Gobain affirms its desire to take action to maximize its positive impact and avoid or minimize any potential negative footprint related to its activity. With regard to its **employees,** this involves promoting a healthy working environment and taking action to protect their health. With regard to **customers** and **end users,** this involves, in particular, ensuring the safe use of its solutions. With regard to **local residents** and **communities** around the Group's sites, this involves complying with applicable regulations and striving to go beyond them, collaborating with local public health agencies, or participating in the social development of communities.

Saint-Gobain also places operational excellence at the heart of its model, by cultivating **an ever-greater proximity to its customers.** The Group thus rolls out its "Solutions for Growth" program, analyzes all the products and services offered by the Group, and quantifies and qualifies their ability to **provide its customers with performance benefits and to contribute to sustainable development** (see page 30). The Group also targets **industrial excellence,** based on a **continuous improvement** of its processes in order to optimize their performance while protecting the environment.

FINANCIAL AND STOCK PERFORMANCE

The record results achieved in 2021 confirmed that the Group has entered into a new trajectory in terms of performance: above-market sales growth, historic results and margin, high levels of free cash flow and strong value creation for shareholders as a result of rigorous capital allocation (see page 27).

SALES
€44.2 Bn

EBITDA
€6.2 Bn

OPERATING INCOME
€4.5 Bn

RECURRING NET INCOME
€2.8 Bn

FREE CASH-FLOW
€2.9 Bn

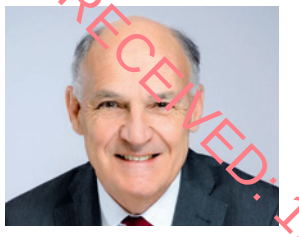
The Group set new annual average financial targets for the 2021-2025 period:

- **accelerating income and cash generation,** with organic sales growth of between +3% and +5%, an operating margin of between 9% and 11%, and a free cash flow conversion rate of over 50%;
- **sustained discipline in capital allocation,** with a return on invested capital (ROCE) of between 12% and 15%, and a "net debt to EBITDA" ratio of between 1.5 and 2;
- **attractive shareholder return policy,** with an annual dividend payout of between 30% and 50% of recurring net income, paid in cash, and a share buyback program amounting to €2 billion for the 2021-2025 period, equivalent to over 30 million net shares bought back on the basis of the recent Saint-Gobain share price.

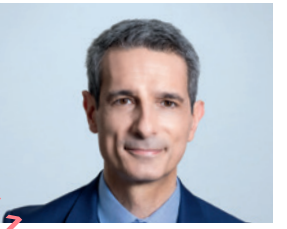
GOVERNANCE BODIES

BOARD OF DIRECTORS

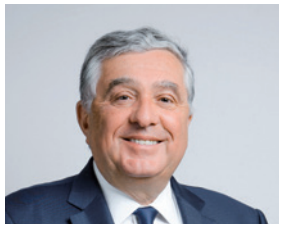
At January 1, 2022, the Board of Directors was composed of the following members:



Pierre-André de Chalendar
Chairman of the Board of Directors of Compagnie de Saint-Gobain



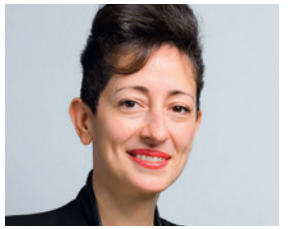
Benoit Bazin
Chief Executive Officer of Compagnie de Saint-Gobain, Director



Jean-François Cirelli
Independent Director, member of the Nomination and Remuneration Committee

Lydie Cortes
Employee Director, member of the Nomination and Remuneration Committee

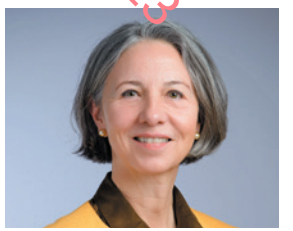
Sibylle Daunis
Director representing employee shareholders



Lina Ghotmeh
Independent Director

Iêda Gomes Yell
Independent Director, member of the Audit and Risk Committee

Anne-Marie Idrac
Independent Director, Chairman of the Nomination and Remuneration Committee, Member of the Corporate Social Responsibility Committee



Pamela Knapp
Independent Director, Chairman of the Audit and Risk Committee

Agnès Lemarchand
Independent Director, Chairwoman of the Corporate Social Responsibility Committee, Member of the Audit and Risk Committee

Dominique Leroy
Independent Director, member of the Nomination and Remuneration Committee

Gilles Schnepp
Director, member of the Audit and Risk Committee

Jean-Dominique Senard
Lead Independent Director, Member of the Corporate Social Responsibility Committee

Philippe Thibaudet
Employee Director, member of the Corporate Social Responsibility Committee

Secretary of the Board of Directors of Compagnie de Saint-Gobain:

Antoine Vignial
Corporate Secretary

THE EXECUTIVE COMMITTEE

At January 1, 2022, the Executive Committee was composed of the following members:

Benoit Bazin
Chief Executive Officer

Noémie Chocat
Vice-President, Corporate Strategy

Patrick Dupin
Senior Vice-President, CEO of the Northern Europe Region

Thierry Fournier
Senior Vice-President, CEO of the Southern Europe, Middle East, Africa Region

Javier Gimeno
Senior Vice-President, CEO of the Latin America Region

Cordula Gudduschat
Vice-President, Marketing and Development

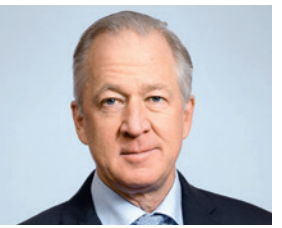
Anne Hardy
Chief Innovation Officer

Benoit d'Iribarne
Senior Vice-President, Technology and Industrial Performance

David Molho
CEO of High Performance Solutions

Claire Pedini
Senior Vice-President, Human Resources and Corporate Social Responsibility

Laurence Pernot
Vice-President, Communications



Mark Rayfield
Senior Vice-President, CEO of the North America Region

Santhanam B.
CEO of the Asia-Pacific and India Region

Ursula Soritsch-Renier
Chief Digital and Information Officer

Sreedhar N.
Chief Financial Officer

Antoine Vignial
Corporate Secretary

The pursuit of lightness is at the heart of decarbonization. Whether as regards plasterboard, glazing or insulation, the R&D departments work to reduce the density of materials and their carbon footprint. Compared to traditional systems, lightweight construction also provides more flexibility and modularity.

2

SAINT-GOBAIN AND ITS ECOSYSTEM

THE WORLD IN WHICH THE GROUP OPERATES

40%

of CO_2 emissions worldwide come from the construction sector.

CLIMATE CHANGE

A CHALLENGE FOR HUMANITY AS A WHOLE

The drastic reduction of CO_2 emissions is at the heart of the global fight against climate change, but the current momentum is far from satisfactory, given GHG (greenhouse gas) emissions reached record levels in 2019. To change things, decarbonization of the economy will be key.

CONSTRUCTION, A VITAL SECTOR

The construction sector plays a key role in this fight, insofar as construction accounts for nearly 40% of CO_2 emissions worldwide. This issue concerns both construction operations and existing buildings, two-thirds of which will still exist and will continue to emit carbon in 2040. Therefore, a "truly systemic" transformation is necessary, in order to bring about profound and immediate changes across the entire sector.

SAINT-GOBAIN, A KEY PLAYER IN GLOBAL TRANSFORMATION

Saint-Gobain, through its unique position in the value chain and its unique portfolio of innovative solutions, contributes to meeting the decarbonization challenge. The solutions sold by the Group in one year made it possible (as measured in 2020) to reduce CO_2 emissions by nearly 1,300 million tons over their entire life cycle – thus far exceeding the Group's total carbon footprint – by improving the energy efficiency of buildings and by avoiding emissions through light construction techniques. Saint-Gobain also plays a key role by contributing to the mobilization of the entire value chain of the construction sector in the pursuit of a common decarbonization objective. The Group is also working to reduce the impact of its own operations in terms of GHG emissions, notably by continuously improving the efficiency of its processes and transforming its industrial facilities. Saint-Gobain is thus investing €25 million in Norway to make its Fredrikstad plant the **world's first carbon-neutral plasterboard plant.**

60%

of energy and natural resources consumption worldwide concerns cities.

DEMOGRAPHICS AND URBANIZATION

CONSTANT LONG-TERM TRENDS

The figures speak for themselves: nearly 10 billion people will live on Earth in 2050, compared to 7.8 billion today. Nearly 70% of the world's population will be living in cities by the same date, representing more than 2 billion additional urban dwellers, mainly concentrated in emerging countries.

These underlying trends are unlikely to reverse and present **a number of complex challenges** for cities. These include developing resilience to the consequences of climate change, notably extreme weather events; providing decent housing for all; meeting the comfort needs of emerging social classes; ensuring efficient waste treatment; limiting the use of natural resources and improving energy efficiency. **To address these challenges, we must accelerate the transformation of the construction sector,** with a **change in construction methods** (from the very structure of buildings to the technologies used in construction operations) and a **massive investment in the renovation** of the existing real estate portfolio, an objective taken head-on by the public authorities, notably in developed countries.

In the same vein, **mobility is reinventing itself** at a sustained pace, with significant investments in the development of efficient and comfortable public transport networks, and a revolution of the private car sector under the effect of regulatory changes, with a rapid electrification of vehicle fleets.

SOLUTIONS TO MEET THE CHALLENGE OF THE REINVENTION OF CITIES

Continued urbanization provides major growth opportunities for Saint-Gobain and underlines its responsibility to have a positive impact. **The Group has a central role to play in meeting the needs of both affordable and sustainable construction,** so that everyone can benefit from decent housing. It also contributes to the **development of new,** smarter and more sustainable **mobility solutions.**

1.75

planets Earth would be necessary to meet the current demand for resources without exceeding their capacity for natural regeneration.

SCARCITY OF NATURAL RESOURCES

A CHALLENGE: LIMITING WITHDRAWALS

The pressure on natural resources is growing strongly, thus generating an **increasingly pronounced gap between needs and available resources.** Here too, buildings play a key role, accounting for 40% of global energy consumption, but also 12% of drinking water consumption, 38% of GHG emissions, and 40% of solid waste production.

The consumption of natural resources has tripled over the last 50 years. Fresh water, an essential and scarce resource (only 0.5% of terrestrial water is usable and available for consumption) is a representative example of this trend: necessary for cities, agriculture and industry, as well as for energy production, its volume is continuously decreasing. It is estimated that 5 billion people will suffer from insufficient access to water by 2050, i.e. more than half of the world's population.

The challenge has therefore been clearly identified: to **systematically promote circularity,** in other words gradually ban linear flows, equally for renovation, for new construction and for industry.

This objective is achievable, not only for products and materials such as glass or gypsum, which can be recycled indefinitely in a closed loop, but also for all solutions provided on the market.

SAINT-GOBAIN, A COMMITTED PLAYER FOSTERING CIRCULARITY

Thanks to its solutions for construction and industry, but also through the improvement of its own processes, Saint-Gobain can and must respond to this challenge. This requires **an acceleration of the transition to a circular economy,** by taking into account the entire life cycle of its products and solutions, in order to limit their consumption of natural resources, extend their lifespan and promote their recycling in order to reduce the production of non-recovered waste. The objective here is to **make the entire value chain virtuous,** by favoring circular flows (see pages 42-43).

More than

15%

of retail sales in the United States are now made online.

DIGITALIZATION

A CONTINUING TREND

Digitalization continues to strongly influence the evolution of all sectors in which Saint-Gobain is present, through the widespread use of data, from its collection (thanks to multiple points of contact) to its analysis. In **distribution,** the expansion of e-commerce has been further accelerated by the health crisis. The priority challenge today is taking into account, comprehensively, the user experience and its personalization, to create a **direct** and privileged **link** between brands and their **customers,** whether they are individuals or craftsmen. In **industry,** digital technology is changing organizational and production processes and methods. Real-time data acquisition and control systems, automation, augmented operators and the interconnection of industrial tools create an ever-increasing volume of information. Once analyzed, data contributes to progress in terms of productivity, agility, production customization, but also of environmental footprint. In the **construction sector,** digital technology is transforming the entire value chain of **construction** and **renovation.** Upstream, building design is increasingly based on digital models, offering an integrated vision of the building during all stages of its life cycle through a "digital twin"; on construction sites, 3D scanning and photogrammetry provide a new understanding of reality. With regard to construction itself, digital technology enables new operating methods such as prefabrication, modular construction and 3D printing. Downstream, wireless monitoring, the interconnection of equipment and home automation also contribute to increasing the comfort of habitat, optimizing the energy consumption of buildings, and improving their safety. In transport infrastructures and high-rise buildings, the mass collection of real-time data also allows precise monitoring of the long-term behavior of structures, conducting predictive analysis, and *in fine* optimizing maintenance and better preventing accidents, which in turn contributes to a better management of the building portfolio throughout its life cycle.

A DRIVER FOR TRANSFORMATION AND PERFORMANCE

For Saint-Gobain, **digitalization is a source of progress and performance improvement, but also a tool for the decarbonization of its industrial processes.** It is a **substantive issue affecting all of the Group's activities,** which has major impacts on customer relations, on recruitment and training, on the innovation process, on market positioning and on social and environmental responsibility.

CHANGING LIFESTYLES

90%

of people's time (in Western countries) is spent indoors.

CHANGING EXPECTATIONS

The generalization of work from home, following successive lockdowns, blurs the boundaries between the private space and the professional environment, redefines expectations regarding residential buildings, and fuels the expansion trend in the housing renovation market. Beyond places themselves, the entire **relationship with work** is being questioned, due to the digitalization of work tools, but also to the increase in geographical mobility, societal changes such as changing family structures, the arrival of new generations on the job market, or workers' demands for a better work-life balance. In terms of building uses, this is part of a **desire for a better quality of life:** beyond thermal and acoustic comfort, it is also about visual comfort, by maximizing access to natural light, and about air quality, by maintaining a ventilated environment free of polluting substances.

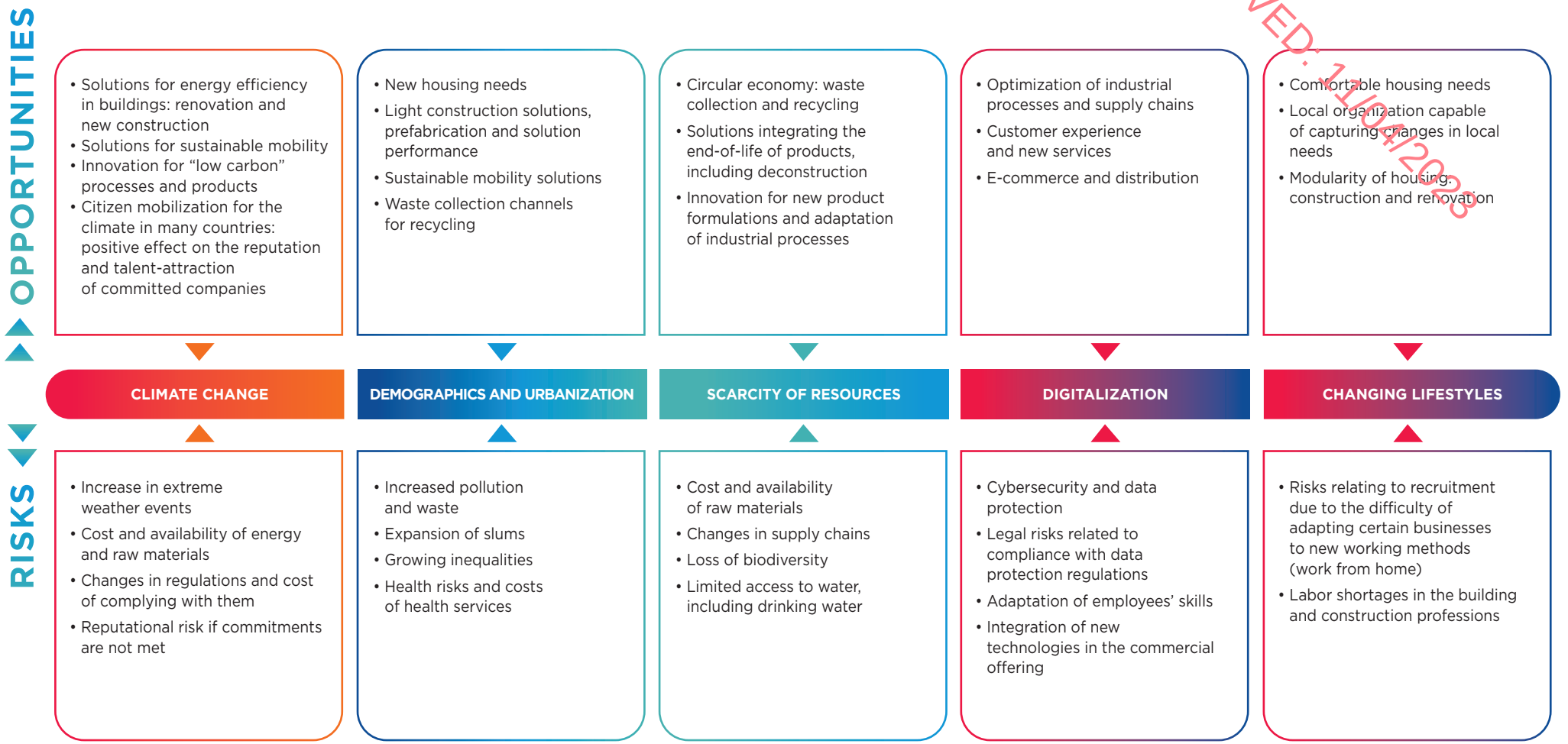
All mega-trends affecting habitat require **more modular and scalable buildings,** in order to facilitate changing building uses and thus to more easily move from office use to residential use, and vice versa, but also ensure their ability to adapt to changing expectations, such as home care needs for the elderly.

Changing lifestyles also have significant impacts on mobility. Globalization and improving living standards worldwide have led to an increase in the mobility of individuals, despite the restrictions brought about by a crisis such as the Covid-19 pandemic. The demand for decarbonization and the densification of residential centers are also leading to the **transformation of public transport networks,** with a view to strengthening them and making them more efficient and environmentally friendly.
With regard to individual vehicles, the transition is now fully underway towards models that emit less GHGs, are more energy-efficient and cleaner, are more comfortable, and are able to interact in real time with other vehicles and with the environment as a whole. In addition to this technological revolution, in some countries we are seeing an evolution in the way the car is represented in the minds of consumers, and as a result, there is a growing preference for use rather than possession.
This underlying trend, which is part of a wider social movement, has very strong impacts in terms of vehicle design.

A DRIVER OF CHANGE IN THE NEW CONSTRUCTION, RENOVATION AND INDUSTRY MARKETS

For Saint-Gobain, changing lifestyles are both an incentive to **closely monitor changes in the expectations of its stakeholders, notably its customers,** through close proximity, and a major lever to transform industry, construction and distribution.

IMPACTS, RISKS AND OPPORTUNITIES



IDENTIFYING OPPORTUNITIES AND RISKS RELATED TO ENVIRONMENTAL, SOCIAL AND SOCIETAL, LABOR AND SOCIETAL CHALLENGES: SAINT-GOBAIN'S APPROACH

In addition to the opportunities and risks related to megatrends, Saint-Gobain carried out a study on the **risks and opportunities related to CSR (**corporate social responsibility) **issues.** This analysis took into account the expectations of its stakeholders.

The analysis methodology made it possible to measure the impact, criticality and level of control of each risk and each opportunity. It was based on the methodology used by the internal control and audit teams but was adapted to non-financial topics.

Thus, nine main topics were identified, representing both opportunities and risks:

- DIVERSITY
- ENERGY EFFICIENCY AND CARBON INTENSITY OF OPERATIONS
- BUSINESS ETHICS
- MANAGEMENT OF SKILLS AND TALENTS
- RESPONSIBLE SUPPLY CHAIN MANAGEMENT
- INTEGRATION OF RECYCLED MATERIALS IN PRODUCTS
- ENERGY AND CARBON EFFICIENCY OF GOODS AND SERVICES
- HEALTH AND SAFETY AT WORK
- PRODUCT SAFETY

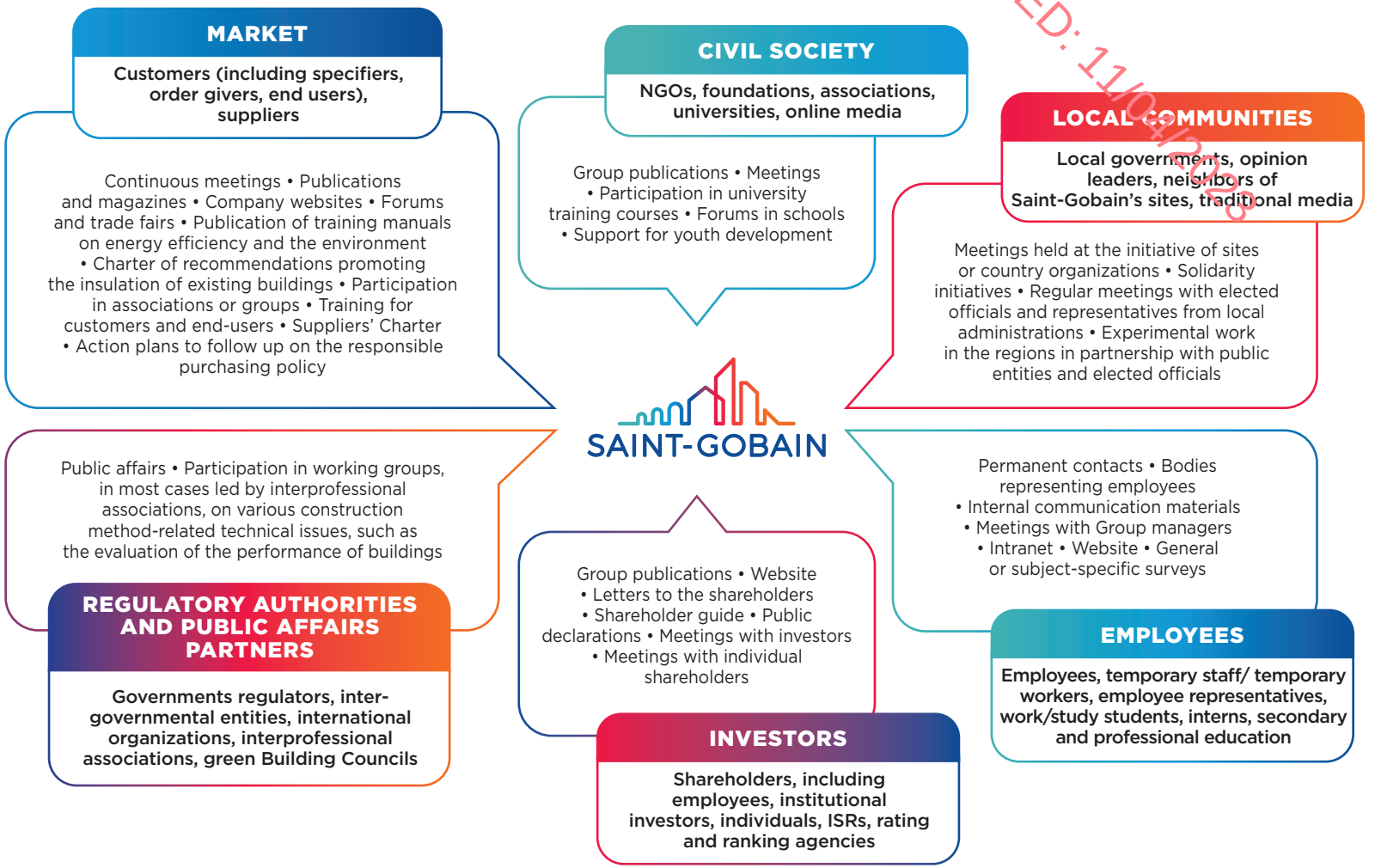
Each pillar of the CSR roadmap includes action plans to manage risks and seize opportunities in relation to these topics.

SAINT-GOBAIN AND ITS STAKEHOLDERS

SAINT-GOBAIN TAKES INTO ACCOUNT THE INTERESTS OF ALL ITS STAKEHOLDERS IN DEFINING ITS LONG-TERM STRATEGY.

The first step is to build dialogue, but also to ensure that this dialogue is transparent and based on mutual trust. Factors such as the size of the Group, its global dimension and the variety of its business lines mean that dialogue must, above all, be organized in a decentralized manner, with each operational entity being responsible for conducting it within its own scope.

Saint-Gobain has mapped its ecosystem by identifying and grouping its stakeholders by category, and by listing the methods by which dialogue is conducted on a daily basis.



A COMMITTED CIVIL SOCIETY PLAYER

In 2021, Saint-Gobain awarded the prizes for the 16th edition of its "Multi Confort" international student competition. Over 200 universities from 38 countries took part in a project to transform the city of Saint-Denis. Created in 2004, this competition, intended mainly for students in architecture, engineering and design, aims to promote the expertise of students around a project based on the real needs of a neighborhood or city, drawing on Saint-Gobain's sustainable construction approach, to create living spaces that respect the planet and the well-being of residents. The prizes were awarded to teams from **South Africa, France, Mexico and Czechia.**

In **Morocco,** through its Academy launched in November 2021, Saint-Gobain aims to facilitate the professional integration of young apprentices by creating an incubator of qualified labor for the implementation of new solutions, and thus become a key player in the Moroccan sustainable development market. The Academy's objective is to train 3,000 professionals by the end of 2022, in three training centers located in Casablanca Ain Sebaa, Dar Bouazza, and Sidi Tiji.

ACTION TAKING MANY FORMS AT THE GLOBAL AND LOCAL LEVEL

In **Thailand,** in 2021, the Saint-Gobain Foundation renovated part of the elementary school in Wat Khao Luak (Pichit province), which is dedicated to the education of students from disadvantaged families living in remote areas.

In the **United Kingdom,** on the occasion of World Mental Health Day, Jewson placed this topic on the agenda. The brand wanted to join the "Big Brew" event organized by the Band of Builders association, to encourage its customers to discuss mental health in construction across its network, create a network of relations, and learn about existing support systems.

The Pontsteiger building, Amsterdam's new gateway, houses 318 apartments. The highest standards in terms of comfort, insulation, and impact and break-in resistance were taken into account. The drywall solutions were entirely designed using BIM (Building Information Modeling) with the help of Saint-Gobain teams.

3

STRATEGY

HOW SAINT-GOBAIN GENERATES SUSTAINABLE AND PROFITABLE GROWTH

STRATEGIC APPROACH

SAINT-GOBAIN'S VISION

ONE AMBITION: GLOBAL LEADERSHIP

Saint-Gobain wants to be the worldwide leader in sustainable construction, which improves daily life for all through its high-performance solutions.

The Group aims to pursue its growth in order to be the leader in most of its markets, by outperforming its competitors. This goal involves, through its values, commitments and actions, **transforming the market and guiding change by becoming a benchmark for all its stakeholders:** its employees, its professional customers in the construction and industry sectors, end consumers, regulators, local communities, the media and citizens. This outlines a value creation model aimed at combining sustainable and profitable growth (opposite page). Being a leader also means being a pioneer and paving the way for others, constantly innovating with and for the entire ecosystem in which Saint-Gobain operates.

THE GROUP'S VALUE PROPOSITION

Saint-Gobain markets alternative solutions to traditional construction, through lighter construction methods and products that are both more sustainable and more efficient. This entails:

Maximizing its virtuous impact across the entire value chain

...for example by enabling a reduction in GHG emissions over the entire life cycle of its solutions, by making it easier to modify, dismantle or repurpose buildings, by allowing gains in all types of comfort, or by increasing the productivity of the Group's customers and all professionals.

Minimizing the footprint of its operations

... notably through the reduction of CO_2 emissions in logistics flows and industrial processes, or through the reduction of the consumption of natural resources and the production of waste.

A STRATEGIC PLAN TO GUIDE MEDIUM-TERM PERFORMANCE

Saint-Gobain's continued growth is achieved through the "Grow & Impact" strategic plan, announced at the end of 2021. It is based on **solid foundations:** the achievement of the objectives of the Transform & Grow plan over the 2019-2020 period made it possible to transform the Group and make it a multi-local and more agile organization, thanks to a simplified structure and governance, enabling faster decision-making. Today, moreover, Saint-Gobain is **clearly market-oriented:** this is reflected in the focus on the customer experience concept.

All aspects of this plan make up an integrated strategy based on two cross-functional levers: **incorporating CSR into all analyses and decisions** (page 26) **and efficiently allocating the Group's financial resources** (page 27).

THE VALUE CREATION MODEL

CONTEXT, RISKS AND OPPORTUNITIES: MEGATRENDS

CLIMATE CHANGE • DEMOGRAPHICS AND URBANIZATION • SCARCITY OF RESOURCES • DIGITALIZATION • CHANGING LIFESTYLES

What relations and resources does Saint-Gobain use?

RESOURCES

HUMAN
- Around 166,000 employees in 75 countries
- Around 120 nationalities
- 26.3% women managers

GLOBAL PRESENCE
- Around 800 industrial sites
- Around 3,500 sales outlets

BRANDS
- A strong Saint-Gobain brand
- A portfolio of recognized brands in the construction and industrial sectors

CAPACITY FOR INNOVATION
- 3,600 researchers
- Over 400 patents filed in 2021
- 50 collaboration projects with start-ups approved in 2021

FINANCIAL RESOURCES
- Sales: €44.2 billion
- Operating income: €4.5 billion
- Recurring net income: €2.8 billion

ENERGY AND RAW MATERIALS
- Recycling helps avoiding the extraction of 9.952 million tonnes of virgin raw materials
- Increasing use of renewable energies

How does the Group's organization generate value?

BUSINESS MODEL

FUNDAMENTALS

CORPORATE PURPOSE

HEALTH, SAFETY, OPERATIONAL PERFORMANCE

PRINCIPLES OF CONDUCT AND ACTION

FINANCIAL PERFORMANCE AND SHAREHOLDER VALUE

MARKETS

RENOVATION

SUSTAINABLE CONSTRUCTION

SUSTAINABLE INDUSTRY

VISION

To be the worldwide leader in light and sustainable construction, which improves daily life for all thanks to its high-performance solutions.

PRIORITIES

Generalize a comprehensive solution approach so as to meet market demands.

Incorporate CSR into all aspects of the model

Efficiently allocate financial resources

Widespread use of data and digital technology

Place the customer at the heart of innovation

Accelerate the technological transformation of construction

Develop human capital through a culture of trust

- Provide Saint-Gobain customers with solutions that combine performance and contribution to sustainable development;
- Act for a decarbonized world (p. 40), a circular economy (p. 42), a safer and fairer world (p. 44).

How is the growth created shared, sustainable and profitable?

VALUE CREATED

CREATE TRUST among stakeholders, contribute to the common good

- A long-term CSR roadmap.
- Taking the SDGs into account (page 49).

ENSURING SUSTAINABLE GROWTH

72% of sales generated through sustainable solutions (in 2020), with a target of 75% by 2025

ENSURING PROFITABLE GROWTH

For the period 2021-2025, Saint-Gobain is aiming for an organic growth of +3% to +5%, an operating margin of 9% to 11%, and a return on invested capital of 12% to 15%

CREATING SHARED VALUE with the Group's stakeholders

Added value: €15.3 billion
Portion held for growth: €4.3 billion

Investments for local communities: €15 million

Shareholder return: €1.2 billion

Employees: wages and other compensations (€8.3 billion); retirement contributions (€610 million)

Taxes and duties: €1 billion

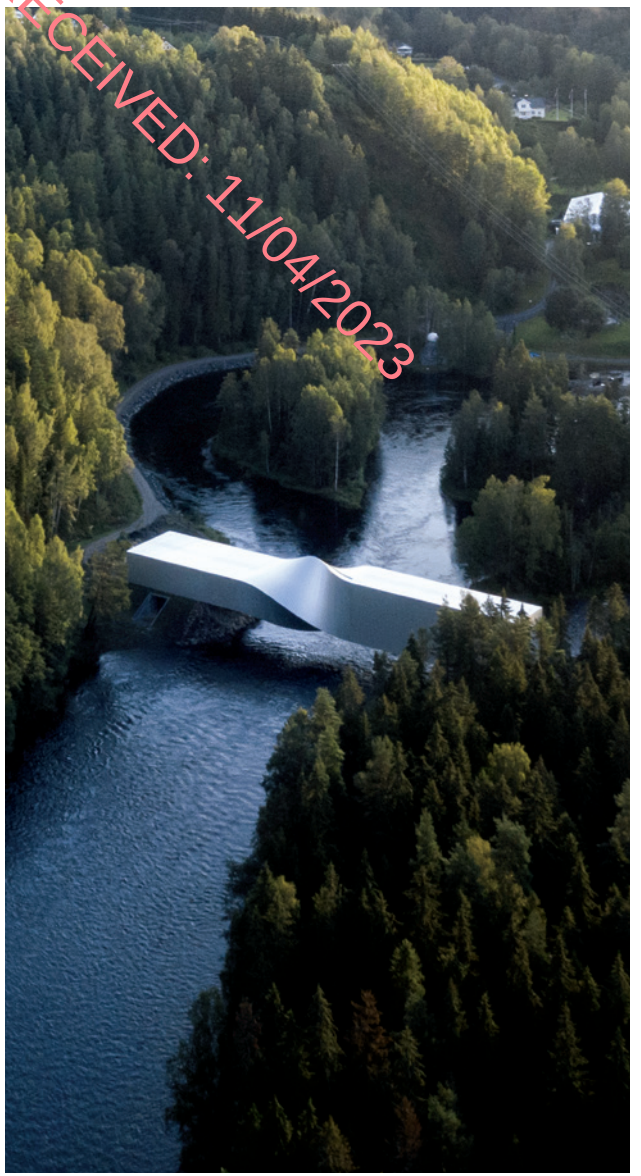
A RESOLUTELY INTEGRATED APPROACH

INCORPORATING CSR IN ALL DIMENSIONS OF THE STRATEGY

For Saint-Gobain, CSR is a long-term commitment and must be understood as a continuous improvement process. In 2003, the signing by the Group of the United Nations Global Compact and the adoption of its code of ethics (see page 45) were the first steps in this direction, followed by other milestones regarding all dimensions of CSR, from compliance to respect for the environment, through commitments on subjects such as diversity or carbon neutrality (see page 40) and through the adoption of a CSR roadmap, which is regularly updated.

In Saint-Gobain's business model, CSR necessarily occupies a cross-cutting place: **the objective is to systematically integrate ESG (environmental, social and governance) criteria into analyses, decisions and actions.** At the highest decision-making level, CSR committees were created in the two governance bodies, the Board of Directors and the Executive Committee. At the local level, it entails accelerating this integration in all action plans – with the same requirements, but in economic and social contexts that vary greatly from one country to another – and ensuring that the growth achieved in the short, medium and long term is always **shared, profitable and sustainable.**

This approach, which considers CSR matters prior to any decision-making, implies an ecosystemic business model approach, integrating the interests of Saint-Gobain's stakeholders in the conduct of its operations (see pages 20 and 47). It also requires the involvement of managers in general and of senior executives in particular, which is why the assessment of their performance now systematically takes into account CSR criteria. The Group also contributes significantly to the reflection on market outlooks in terms of CSR, by collaborating with third parties such as start-ups, professional organizations such as the WBCSD (World Business Council for Sustainable Development), private associations of public interest such as EFRAG (European Financial Reporting Advisory Group), or with NGOs.



ALLOCATING THE GROUP'S FINANCIAL RESOURCES EFFICIENTLY

In terms of the allocation of financial resources, Saint-Gobain's approach aims first and foremost to implement a growth-oriented investment policy. The aim is to seize growth opportunities in key markets. In 2021, in the countries where the **growth of the construction and renovation sectors** is the strongest, the Group announced **a series of massive investments** in its industrial facilities for the production of plasterboard, for example in **Spain** (€40 million invested), in **Brazil**, in **Romania** (€45 million) and in **Norway**. In the **United States,** over $400 million will be invested over the next four years to increase production capacities for roofing, insulation and plaster. This investment drive for industrial development concerns all of the Group's markets, from the production of silica glass (**Poland**) to laminated glass for buildings (**France**), through flat glass for construction and the automotive industry (**Mexico**), fiber cement solutions (**Vietnam**), windshields (**China**) and solutions for construction chemicals and 3D printing (**Malaysia**). Investment priorities also serve to support Saint-Gobain's commitments and its transformation. To meet its commitment to achieving **carbon neutrality** by 2050, the Group has set up a capital investment budget of €100 million per year for all initiatives (including research and development) to **reduce its CO_2 footprint**.

With regard to the management of its **portfolio**, Saint-Gobain's strategy is to pursue value-creating acquisitions on a global scale, in line with the objectives of its "Grow & Impact" plan and its vision (see page 24). In 2021, the Group completed or signed 37 acquisitions representing almost €2 billion in sales. This approach notably addresses Saint-Gobain's goal of being **a leading player in mortars and construction chemicals**, a market currently estimated at between €80 billion and €90 billion, with annual growth of 6 to 8% and which represents an essential lever in terms of the **decarbonization of the building industry** thanks to solutions for concrete with a low carbon footprint or more environmentally-friendly waterproofing resins. The Group, with 272 industrial sites, is one of the main global players in this sector, notably through the acquisition of Chryso (a specialist in admixtures for concrete and additives), the American company GCP Applied Technologies (in progress), or IMPAC (**Mexico**), Duraziv (**Romania**), Z Aditivos (**Peru**) and ABE (**Mauritius**). The acquisition strategy also covered other specialties related to growing markets, such as timber construction systems (**Germany**), gypsum (**Kenya**), distribution (**France**) and stone wool (**India**). With regard to disposals, Saint-Gobain continued its portfolio optimization strategy, aimed at improving the Group's growth and profitability profile, in line with the objectives of the "Grow & Impact" plan and in the light of three decisive criteria: the strategic suitability of the activity in relation to the rest of the Group; its performance with respect to Saint-Gobain's own value creation criteria; and its prospects within the Group's global organization. In 2021, Saint-Gobain completed or signed 20 disposals for €2 billion in sales.

The transformation of mobility involves designing environmentally-friendly, safe, high-tech and comfortable vehicles, as well as making them accessible to as many people as possible. Saint-Gobain has long been committed to this revolution.

4

A CUSTOMER-ORIENTED APPROACH

HOW SAINT-GOBAIN IS ORGANIZED TO ACHIEVE ITS MEDIUM-TERM OBJECTIVES

PROVIDING SOLUTIONS

The sales outlets in the Saint-Gobain distribution network complement the online offering. They provide a human dimension through exchanges with the Group's teams, but also services such as waste recovery.

ANALYZING THE ISSUES FACED BY CUSTOMERS

Saint-Gobain, with its global presence and its differentiating offering, offers market players **a true solution-based approach**, a key component of its "Grow & Impact" **strategic plan**. Beyond the traditional approach consisting in meeting a specific need with a given product, the objective is to offer its customers **end-to-end support as they face complex issues**, modeled as an equal number of "case studies" such as the renovation of an individual house (see page 31) or the construction of a collective residential building (see page 32).

The Group analyzed all of its product and service lines to define four case studies in which it offers **solutions for global markets** (engineering and infrastructure, mobility, industrial markets) and 22 case studies in which it offers **solutions for local markets** (new construction and renovation for residential and non-residential buildings) according to the specific characteristics of the markets: Western Europe, North America, or emerging countries.

Saint-Gobain's organization by country and by market enables it to position itself as close as possible to its customers and thus to anticipate their expectations, taking into account local specificities, whether in terms of architectural styles, construction methods, the climate, standards and regulations, or cultural particularities.

PROVIDING INTEGRATED SOLUTIONS COMBINING A VARIETY OF PRODUCTS, MATERIALS AND SYSTEMS

This approach covers several areas:

- **developing cross-selling,** through joint sales forces that master an entire portfolio of brands, training services for professional customers and end consumers, and specialized sales channels;
- **providing systems;**
- **providing services.**

By capitalizing on its proximity to its customers, combining its skills, inventing new services, strengthening synergies among its business lines, accelerating innovation and the use of data, Saint-Gobain offers **the broadest range of integrated solutions available on the market**. The Group thus better meets the expectations of its customers, by providing them with benefits in terms of both performance and sustainable development.

COMBINING PERFORMANCE AND CONTRIBUTION TO SUSTAINABLE DEVELOPMENT

SOLUTIONS FOR GROWTH, A PROGRAM DESIGNED TO ALIGN THE OFFERING

The "Solutions For Growth" program is driven by Saint-Gobain's goal of **providing solutions that combine performance and contribution to sustainable development**, to meet the expectations of its stakeholders, in particular its customers, and to accelerate progress towards a more sustainable and decarbonized economy.

The objective is to establish a standard method, which is easy to roll out in the organization and which can be adapted according to the markets and local contexts in order to **identify the most relevant solutions and measure the benefits provided**. The impacts of the solutions are assessed throughout the value chain and for the main stakeholders involved, up to the end user.

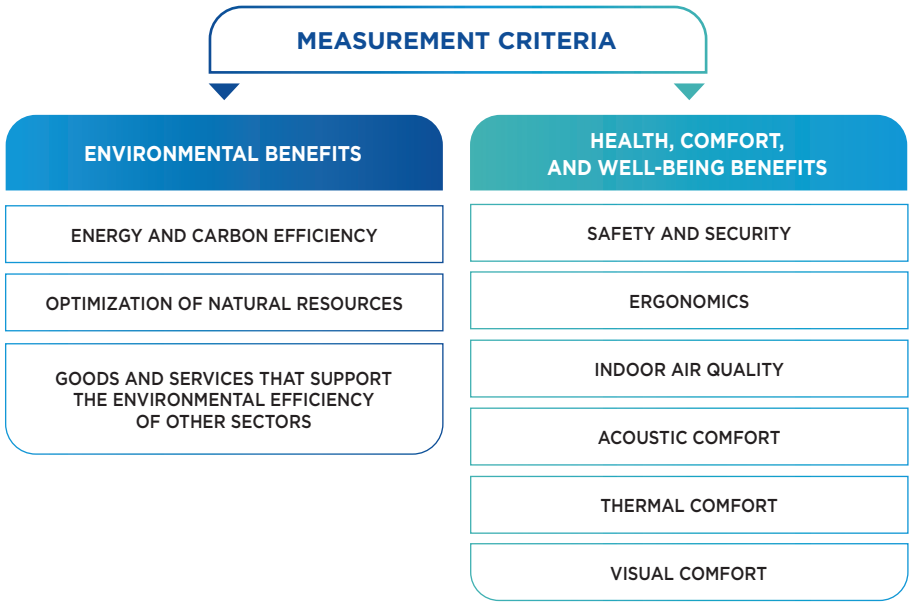
The criteria used to measure the benefits related to sustainable development concern environmental impacts and those related to health and well-being. The measurement of the performance of solutions focuses on increasing economic value and improving the user experience.

In order to **standardize the measurement of impacts** and accelerate the Group's ability to differentiate in the markets, case studies were selected (see previous page). For each case study, local teams identify solutions combining the products and services offered by the brands and distribution networks. The tools developed enable them to measure benefits and therefore to adapt the offering and arguments to the expectations of stakeholders.

75% TARGET PERCENTAGE OF GROUP REVENUE GENERATED BY SUSTAINABLE SOLUTIONS BY 2025

A TWO-FOLD REQUIREMENT APPLIED TO ALL SAINT-GOBAIN SOLUTIONS

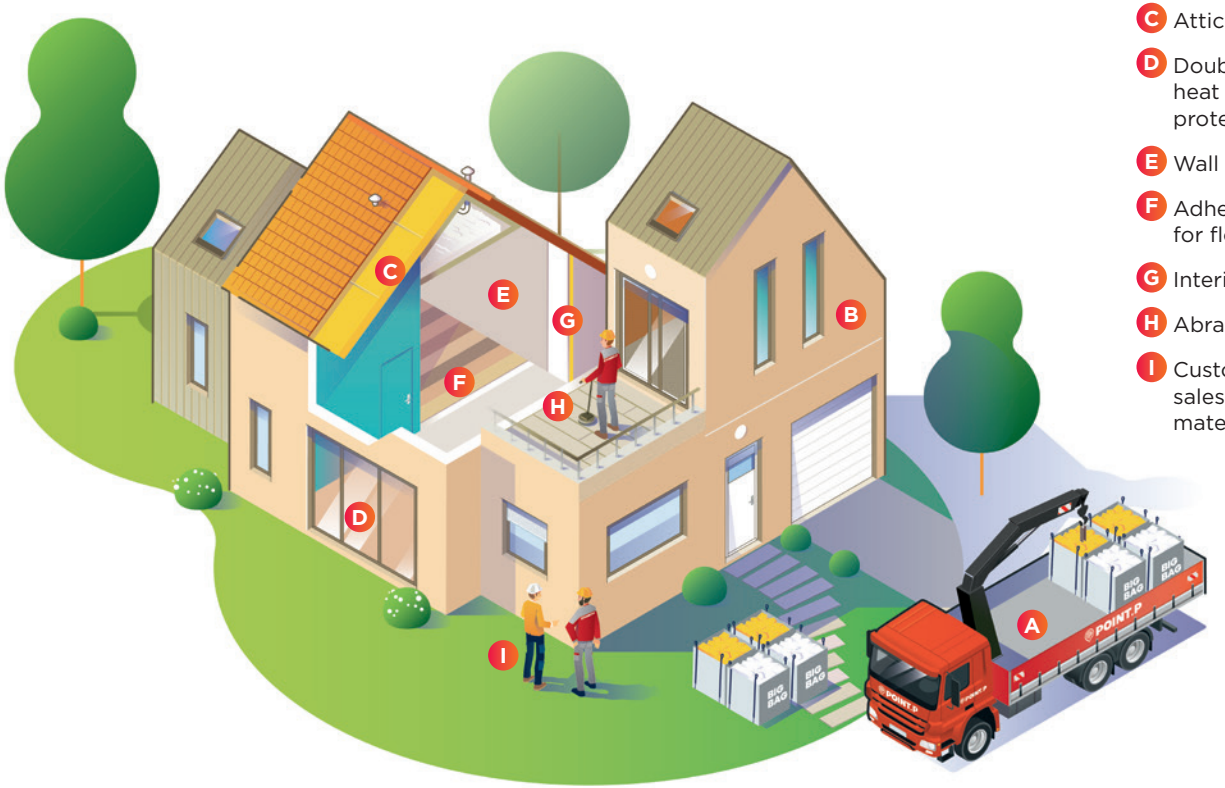
This program **covered over 90% of the Group's sales** and makes it possible to **direct Saint-Gobain's offering towards sustainable construction markets**. The methodology used to identify sustainable solutions is available on the Group's website and was reviewed by an independent third party. The share of sales generated by sustainable solutions amounted to 72% in 2020, with the aim to increasing it to 75% by 2025.



PROVIDING SOLUTIONS FOR RENOVATION

Saint-Gobain produces and distributes complete renovation solutions, with products, materials and services that meet market expectations. In the case study of the renovation of an individual house in France, the Group thus offers, through its brands as a whole, no less than 33 products and services. By combining them, they provide benefits both during renovation operations and in the long term, throughout the building's life cycle.

Examples of products, materials and services offered in this case study



- **A** Materials delivery, construction waste collection service
- **B** Exterior insulation
- **C** Attic insulation
- **D** Double glazing, heat and UV protection films
- **E** Wall coverings
- **F** Adhesive mortars for floor coverings
- **G** Interior partitions
- **H** Abrasives
- **I** Customer advice, sales and delivery of materials to craftsmen

DECARBONIZATION

274
tonnes of CO_2 equivalent emissions avoided over 50 years through improved energy efficiency.

Contribution to the objective of fighting climate change through the reduction of GHG emissions throughout the life cycle of the building (more virtuous techniques and materials, reduction of the use of heating and air conditioning).

PRODUCTIVITY

2,000
sales outlets which are on average less than 10 km from construction sites (in France), saving time and resources.

Improved efficiency and performance for professionals.

ENERGY EFFICIENCY

70%
reduction of the energy bill.

Decrease in ownership and usage costs and increase in property value through the complete renovation of the building.

WELL-BEING

+1.5°C
felt in winter.

-1°C
felt in summer.

Improved visual, acoustic and thermal comfort, and air quality.

PROVIDING SOLUTIONS FOR NEW CONSTRUCTION

Saint-Gobain addresses complex issues relating to the construction of residential and non-residential buildings, with solutions for both interior and spaces distribution; for the building envelope, notably by offering innovative lightweight façade solutions, or by supplying state-of-the-art glass solutions; and for recycling services.
In the case study of the new construction of a collective residential building in Brazil, 13 products and services are thus integrated into the solutions provided by the Group; they provide measurable benefits during the construction phase and throughout the entire life cycle of the building.

DECARBONIZATION
... over the entire life cycle, thanks to construction techniques and the use of recycled materials.

1,055
Tonnes of CO_2 equivalent emissions avoided thanks to the construction methods used.

COMFORT
... in terms of thermal, acoustic and visual comfort and better ambient air quality.

-50%
Noise pollution (-10 dB, divided by 2).

OPTIMIZATION OF THE SURFACE AREA
... taking into account the interests of investors, professionals and occupants.

+2%
surface area thanks to partitions, equivalent to two apartments (for a 20-storey building with six apartments per floor).

REDUCING THE CARBON FOOTPRINT
... thanks to the use of lightweight construction.

-79%
Reduction in the quantity of materials required thanks to the use of lightweight partitions, compared to a traditional construction method.

FAST CONSTRUCTION
... thanks to lightweight façade techniques.

3
months saved on average on construction time.

ON-SITE PRODUCTIVITY
... via a reduction in the number of workers required, and better efficiency of each operator.

-56%
Reduction in the time required to install partitions.

ON-SITE SAFETY
... thanks to solutions that take into account the safety of professionals from the design stage.

PROVIDING SOLUTIONS FOR INDUSTRIAL MARKETS

Whether in the field of construction, mobility or industry, Saint-Gobain provides high-performance solutions to help its industrial customers decarbonize their processes, thanks to its innovation capacity, its proximity to its customers and its use of digital technology and data analysis. These solutions help deliver benefits for industrial customers (in terms of operational and financial performance), for end users (notably in terms of safety, ergonomics and comfort), and for the environment (notably by accelerating the transition towards a circular economy).

1 SUSTAINABLE CONSTRUCTION

2 SUSTAINABLE INDUSTRY

3 SUSTAINABLE MOBILITY

SAFETY • COMFORT • ENERGY EFFICIENCY
PERFORMANCE • DECARBONIZATION

SAINT-GOBAIN'S ASSETS: LIGHT CONSTRUCTION

Scotframe prefabricated houses in the "Raining's Stairs" district of Inverness in the United Kingdom.

BUILDING BETTER, FASTER, MORE VIRTUOUSLY

An alternative to traditional construction methods, which rely heavily on concrete, cement and brick, light construction is based on certain materials such as wood or metal to compose the framework of a building. Already well established in certain markets (in the United States, 90% of individual buildings are based on modular wooden structures), this approach offers a wide range of advantages: **lightness** of structures, **speed** of construction, **productivity** of professionals, thermal and energy **performance**, **ease** and **cost** of deconstruction. It also reduces the environmental footprint. In the case study of the construction of a residential building in Brazil, lightweight construction thus made it possible to save over 1,000 tonnes of CO_2 equivalent, three months of construction time and 79% of materials thanks to lightweight partitions.

Through **prefabrication** (a technique that saves 25 to 50% of worksite time and represents a market of nearly €130 billion worldwide), light construction reduces production costs and therefore makes housing≈construction more affordable, replicable and exportable. Beyond the **direct benefits** provided to builders and occupants of buildings, light construction is a particularly relevant response to the challenges of the rapid urbanization of the population. It also meets the objective of decarbonizing the construction sector over the entire life cycle of buildings, from their construction to their deconstruction, through their use, taking into account their adaptability to changing needs over time. It is therefore one of the priority levers for Saint-Gobain's contribution to a more virtuous economy (see page 40).

ADVANCED SOLUTIONS, COMBINING PRODUCTS, MATERIALS AND SYSTEMS

Saint-Gobain provides a very wide range of expertise and offerings in the field of light construction. To strengthen its position in this promising sector, in 2021 Saint-Gobain acquired Brüggemann, a specialist in turnkey modular timber solutions for new construction and renovation, and Panofrance, a specialist in wood construction systems.

SAINT-GOBAIN'S ASSETS: DATA AND DIGITAL

DIGITAL, A CROSS-CUTTING CHALLENGE

NEW TECHNOLOGIES

Data platforms, collection and analysis, artificial intelligence, cloud

NEW SERVICES NEW BUSINESS MODELS

Building Information Management, circularity, client-centric services and business models

DIGITALIZATION OF OPERATIONS

Industry 4.0, process automation, employee experience

INNOVATION AND AGILITY

Reinforcement of the digital culture, innovation structure, agile working methods

DATA, FUELING NEW BUSINESS MODELS

Digital technology impacts all the business sectors in which Saint-Gobain operates. The Group approaches this subject as **a lever for progress and performance improvement**, which concerns both its internal operations (industrial processes, management, employee engagement), its relations with its suppliers, its customers and its other stakeholders, as well as its corporate social responsibility. **The digital technological revolution is based on a fuel: data**. It is around this gold mine of the twenty-first century, its **collection**, its **understanding** and its **analysis**, that the efforts of all the Group's teams are now reoriented. **This is the key to Saint-Gobain's transformation into a solution provider**, thanks to the intimate knowledge of customers provided by multiple points of contact throughout the value chain.

The roll out of platforms, and innovation in digital services, are **reinventing relations with Saint-Gobain's customers**, while the use of advanced data analysis tools, based on artificial intelligence, notably enables increased sales for the Group's distribution brands.

With regard to **Saint-Gobain's suppliers**, digital technology enables the automation of purchasing processes but also, for example, the monitoring of the suppliers' e-reputation.

3D AND INDUSTRY 4.0, DISRUPTIVE TECHNOLOGICAL REVOLUTIONS

The generalization of 3D is at work in all Saint-Gobain branches, for building markets as well as for industrial markets. The combination of three-dimensional visualization and data science makes it possible to **improve the performance of the solutions offered** by the Group, notably through the modeling of the properties and structure of materials. It also paves the way for **improved productivity** for Saint-Gobain's professional customers, and for monitoring buildings throughout all stages of their life cycle.

Industrial production itself is benefiting from a radical transformation due to the irruption of digital technologies in factories, the interconnection of production equipment, and the collection and use of data through artificial intelligence, which makes it possible to **improve operational efficiency**. Also, digital technology makes it possible to **customize** deliverables further along the value chain and opens up further opportunities for **co-development** with customers.

LEVERS FOR A MORE VIRTUOUS ECONOMY

Data and digital are also essential levers to support the contribution to sustainable development and in particular the **progress towards a circular economy**, by making industrial processes more efficient, by reducing the amount of resources and energy used, or by optimizing logistics flows.

SAINT-GOBAIN'S ASSETS: THE CUSTOMER AT THE HEART OF INNOVATION




CULTIVATING PROXIMITY TO CUSTOMERS

Developing a better understanding of professionals (whether they are architects, engineers, craftsmen, building contractors, developers, building owners) means developing a better understanding of their specific expectations, and thus better **identifying areas for innovation**. This makes it possible for Saint-Gobain to more rapidly identify opportunities to add value, reduce time to market, and optimize returns on investment. This focus on customers takes into account the diversity of situations in each geographical region.

The innovation approach, which is at the heart of Saint-Gobain's model, covers all of the Group's activities, from off-site construction to innovative glass, through rooftop solar panels, light construction and dedicated laboratories to conduct research on the use of residential areas, three-dimensional printing, and **innovation relating to services**.

FOSTERING A SHARED CULTURE OF INNOVATION

Innovating is one of the pillars of Saint-Gobain's managerial culture. Being open-minded and thinking outside the box, taking original paths, questioning practices inherited from the past to suggest and experiment with new ones: these are some of the skills valued as reagards all of the Group's employees. **Saint-Gobain therefore sees innovation as both an objective and a lever that brings together the entire organization around a common mindset**.

This approach resolutely incorporates a goal of openness, by adding to the Group's driving forces an innovation strategy based on **exchanges and partnerships** around the world: with its customers and suppliers, in the context of scientific cooperation and partnerships in the academic world, and **with the start-up ecosystem**. With regard to the latter, nearly 50 **agreements for co-development**, distribution and licensing, and **equity investments** were signed in 2021. **Intrapreneurship** is also encouraged, with Saint-Gobain taking action to support the most promising ideas submitted by its employees, through acceleration and financing initiatives.

SAINT-GOBAIN'S ASSETS: HUMAN CAPITAL

DEVELOPING A CULTURE OF TRUST, EMPOWERMENT AND COLLABORATION

Saint-Gobain's new multi-local organization is based on **trust**, a condition for effective delegation, and on the **development of cross-functional collaboration** among all of the Group's functions and business lines worldwide.

Deployed throughout the Group, the TEC (Trust, Empowerment, Collaboration) approach applies to the **behavioral, organizational and cultural aspects** of life at Saint-Gobain. It represents a **significant change in the corporate culture within the Group, which concerns above all the managerial culture**: it is a question of **adopting, by default, the principle of trust** and thus moving from a traditional vertical scheme to an **open, learning organization, where freedom of decision and action is provided at the local management level** in the various countries where Saint-Gobain operates.

Moreover, the TEC culture aims to foster **greater efficiency in the innovation process, and to promote its alignment with customer needs**, by removing barriers between countries, between business lines (building solutions and industry solutions) and between functions (e.g. between researchers, marketers and technicians).

RECRUITING AND DEVELOPING THE BEST TALENT, FOSTERING EMPLOYEES' ENGAGEMENT

In a context of tension across all functions and business lines offered by Saint-Gobain, the Group is fully committed to the race for talent. Beyond recruitment processes and the attention paid to its brand as an employer, it is **Saint-Gobain's collective ability to continuously train, nurture and develop its talents** that will enable it to make the difference.

Generally speaking, **employee development** involves taking into account individual desires as well as the needs of the organization, through internal mobility and the **widespread and regular measurement of team satisfaction and engagement**. In the end, all the actions undertaken made it possible to achieve a record employee engagement index in 2021, and earned Saint-Gobain the title of "Top Global Employer" for the seventh consecutive year.

PROMOTING DIVERSITY AND INCLUSION

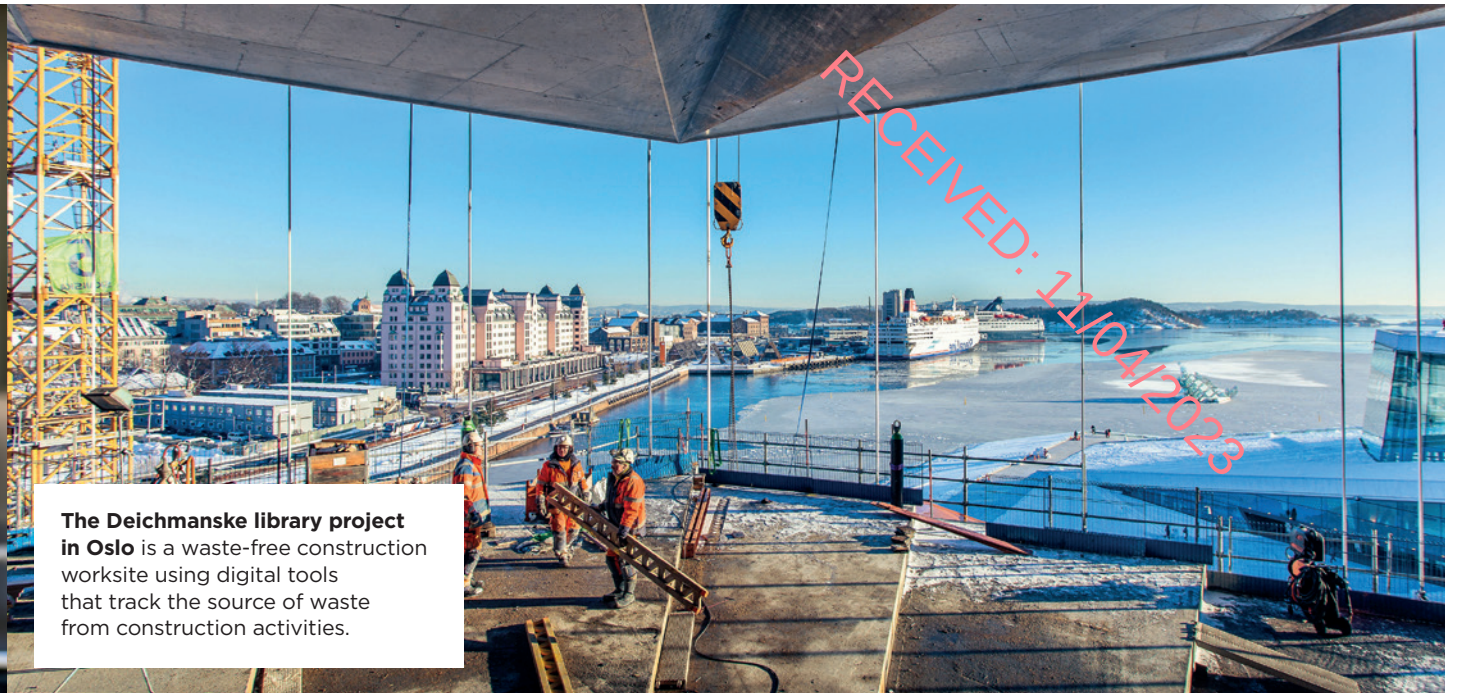
The variety of points of view, experiences, cultures and backgrounds has a positive impact on the working conditions and creativity of teams, on their resilience and their potential for innovation, and on the company's competitiveness and results.

91.1%
DIVERSITY INDEX IN 2021

83%
ENGAGEMENT INDEX IN 2021

The priority objective in terms of human resources is therefore to promote diversity in all its forms, and in particular gender diversity, including on industrial sites.

The Group is committed to maintaining a diversity index of over 90%, as it did in 2021 with a 91.1% level. In this area, Saint-Gobain is making progress thanks to targeted recruitment, the implementation of objectives and performance indicators, and internal awareness-raising campaigns. **Beyond diversity, inclusion is the essential course to follow, ensuring that the contribution of each employee is valued**.



The Deichmanske library project in Oslo is a waste-free construction worksite using digital tools that track the source of waste from construction activities.

5

CONTRIBUTION

HOW SAINT-GOBAIN LOOKS TO THE FUTURE TO CONTRIBUTE TO A MORE VIRTUOUS WORLD

TAKING LONG-TERM ACTION

MEDIUM-TERM

As part of its "Grow & Impact" strategic plan, announced at the end of 2021, Saint-Gobain set itself targets for the 2021-2025 period:

+3% to +5%
ORGANIC GROWTH

9% to 11%
OPERATING MARGIN

12% to 15%
RETURN ON INVESTED CAPITAL (ROCE)

75%
OF THE GROUP'S SALES GENERATED WITH SUSTAINABLE SOLUTIONS
(see page 30)

LONG-TERM

Saint-Gobain set long-term exposure targets for the construction markets (as a percentage of sales). In each of these markets, the Group's value proposition adapts to provide solutions that meet both customer expectations and the challenges posed by megatrends regarding climate, scarcity of resources, urbanization, digitalization, changing lifestyles.

	WESTERN EUROPE	NORTH AMERICA	EMERGING COUNTRIES
Saint-Gobain's long-term exposure target	**50%**	**25%**	**25%**
Major trends and key market growth factors	Changes in regulations, massive public investments to promote energy efficiency, and a better carbon footprint of buildings	Sustained structural demand for new homes, changing expectations	Rapid urbanization, demographic growth, development of the middle class
Responses provided by the Group	Provide a comprehensive range of renovation solutions, products, materials and services; standing alongside professionals from start to finish	Provide solutions for all needs related to the construction of new individual housing, by capitalizing on the importance of light construction on the market	Design and market complete solutions for the sustainable and lightweight construction of collective residential buildings as well as solutions promoting improved comfort

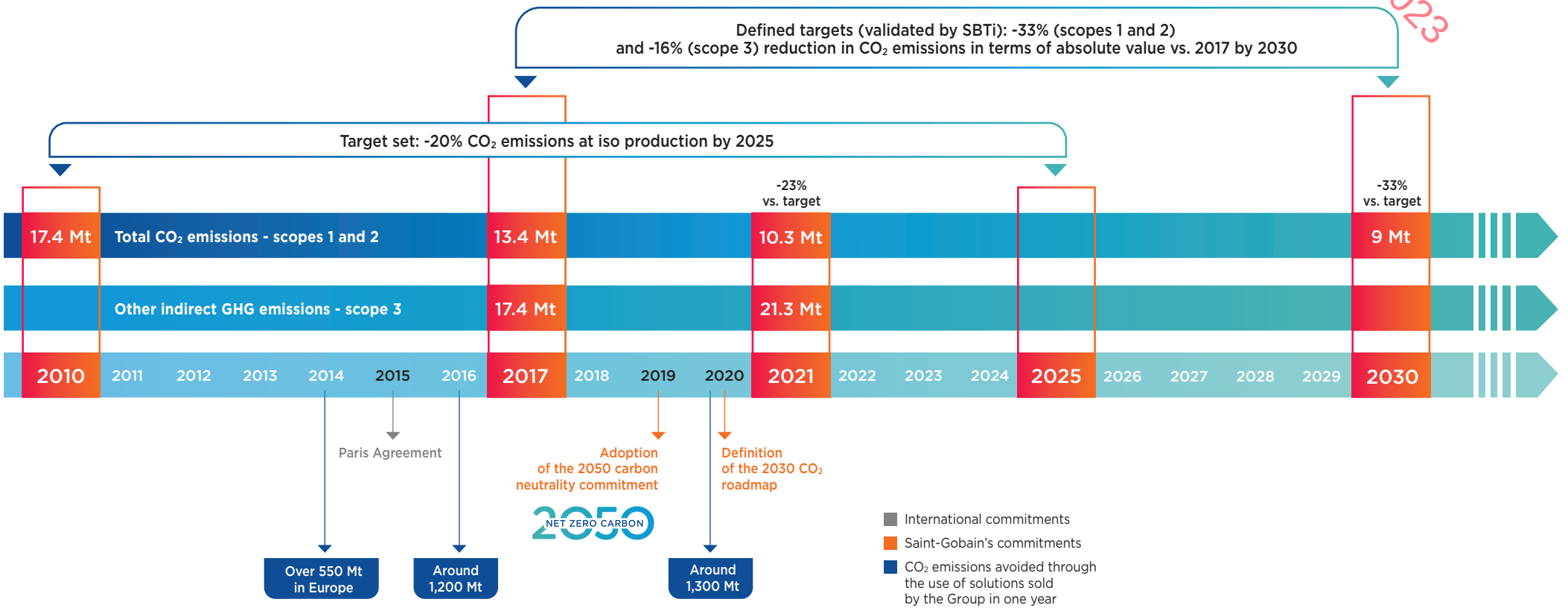
Deliver on the promises of Saint-Gobain's corporate purpose

MAKING THE WORLD A BETTER HOME

Co-design and market solutions that promote performance and contribute to a decarbonized world (p. 42), a circular economy (p. 44), a safe and fairer world (p. 46)

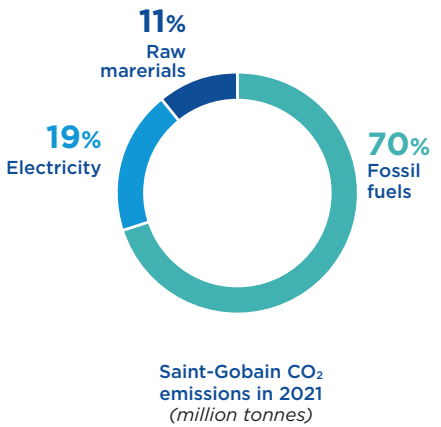
TAKING ACTION FOR A DECARBONIZED WORLD

Saint-Gobain aims to promote the emergence of a fair and sustainable economy which is aligned with the Paris Agreement. The Group supports its customers in reducing their impact by providing low-carbon solutions whose use over their entire life cycle reduces their carbon emissions. Saint-Gobain is committed to achieving carbon neutrality by 2050. Its CO_2 roadmap is based on three levers: optimizing its operations and supply chain; innovating to create "net zero carbon*" plants and low-carbon products; investing to accelerate the transition to a decarbonized economy. The goal is to achieve the greatest reduction possible by acting directly on the value chain without resorting to offsetting measures. CO_2 capture initiatives are being considered in addition to the reduction efforts. Additional information on decarbonization is available on the Group's website: the 2021 Universal Registration Document, the TCFD (Task Force on Climate-Related Financial Disclosures) cross-reference table, and Saint-Gobain's response to the CDP questionnaire on climate change.



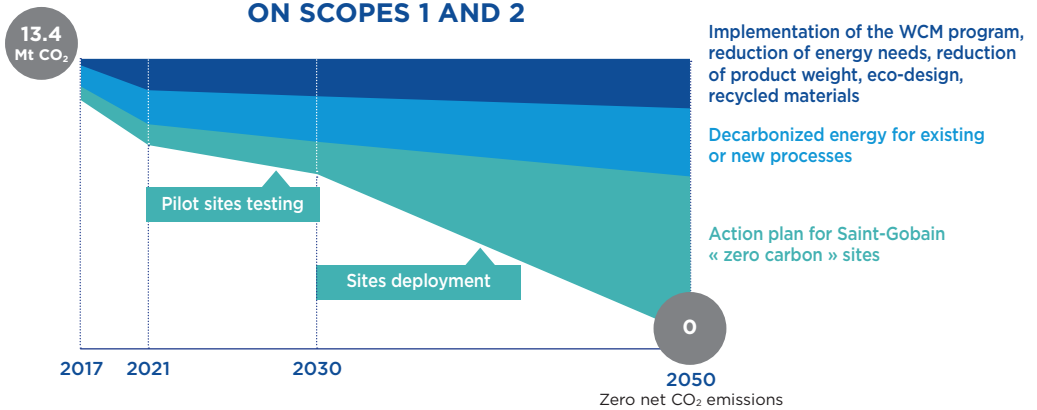
** on scopes 1 and 2*

SCOPES 1 AND 2

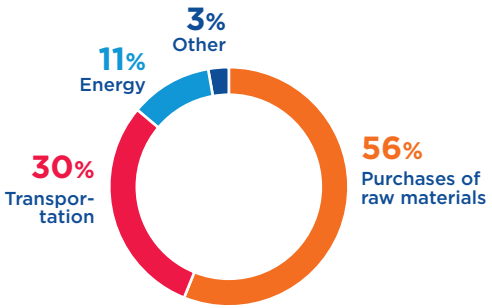


Saint-Gobain CO_2 emissions in 2021
(million tonnes)

GRADUALLY REDUCING EMISSIONS ON SCOPES 1 AND 2



SCOPE 3



Saint-Gobain CO_2 emissions in 2021
(million tonnes)

USING DIFFERENT LEVERS TO REDUCE SCOPE 3 EMISSIONS

PURCHASE OF RAW MATERIALS	TRANSPORTATION AND LOGISTICS	ENERGY
Innovation with suppliers, new formulations and the rise of the circular economy	Logistics optimization and changes in transport methods	In line with the CO_2 roadmap on the carbon impact of energy

CONTINUING TO IMPROVE ASSESSMENT

To improve our scope 3 analysis, we must :

- Extend reporting to the relevant scope of our suppliers
- Improve the quality of information recieved through a strong commitment of our suppliers

ACHIEVING
NET ZERO CARBON BY 2050

In 2019, Saint-Gobain committed to achieving carbon neutrality across all scopes (1, 2 and 3) by 2050.

CONTRIBUTING
TO A DECARBONIZED WORLD

- Generate **growth decoupled** from CO_2 emissions:
  - 2021: 0.23 kg CO_2 /€ revenue and 1.67 kg CO_2 /€ EBITDA
  - 2017: 0.33 kg CO_2 /€ revenue and 3.45 kg CO_2 /€ EBITDA
- Provide **“low carbon” solutions** to decarbonize construction and industry;
- Market **solutions providing carbon benefits** over their life cycle: avoidance of around 1,300 Mt of CO_2 generated by solutions sold over one year, throughout their life cycle.

INVESTING
IN THE GROUP’S TRANSITION

An additional €100 million per year is allocated to CapEx and R&D investments for the 2020-2030 period.

PROMOTING A CIRCULAR ECONOMY

How to preserve the value of resources across the entire model?

Through design and innovation, Saint-Gobain is committed to integrating the circular economy into its value chain (see opposite page). The generalization of circular flows, to the detriment of linear flows, is made possible by improved production processes, the design of resource-saving solutions, and the recovery of buildings, materials and end-of-life products.

SYSTEMATICALLY PROMOTING CIRCULAR FLOWS:

- by reducing the use of raw materials while increasing the use of recycled materials, and by incorporating circularity criteria into product design;
- by sourcing renewable or biosourced raw materials and sustainably managed, recyclable materials and components for solutions and packaging;
- by gradually eliminating linear flows of materials (non-recyclable, non-renewable, non-sustainably managed resources) with particular attention paid to the presence of hazardous substances;
- by designing solutions that consume fewer resources, including by making products lighter, ensuring their recyclability and generating less waste over their life cycle.

In Sweden, for example, Saint-Gobain supplies new glazing for office renovation and recovers the old glazing to reintroduce it into a float* in Germany.

OPTIMIZING PRODUCTION AND DISTRIBUTION PROCESSES:

- by adapting them to the integration of recycled materials, including for packaging;
- by improving them in order to limit final waste from production;
- by offering services to customers to facilitate waste recovery in the value chain.

Within Valoref, Valorwaste recycles refractory waste from production. The Valoref project is expanding in North America, China and India.

DESIGNING RESOURCE-EFFICIENT SOLUTIONS:

- by participating in the public debate to encourage resource-efficient construction methods, such as light construction;
- by promoting renovation, which will allow for an improved use of the building;
- by designing solutions that facilitate the modularity of buildings and/or the optimization of their use;
- by anticipating deconstruction to promote the reuse or recycling of materials.

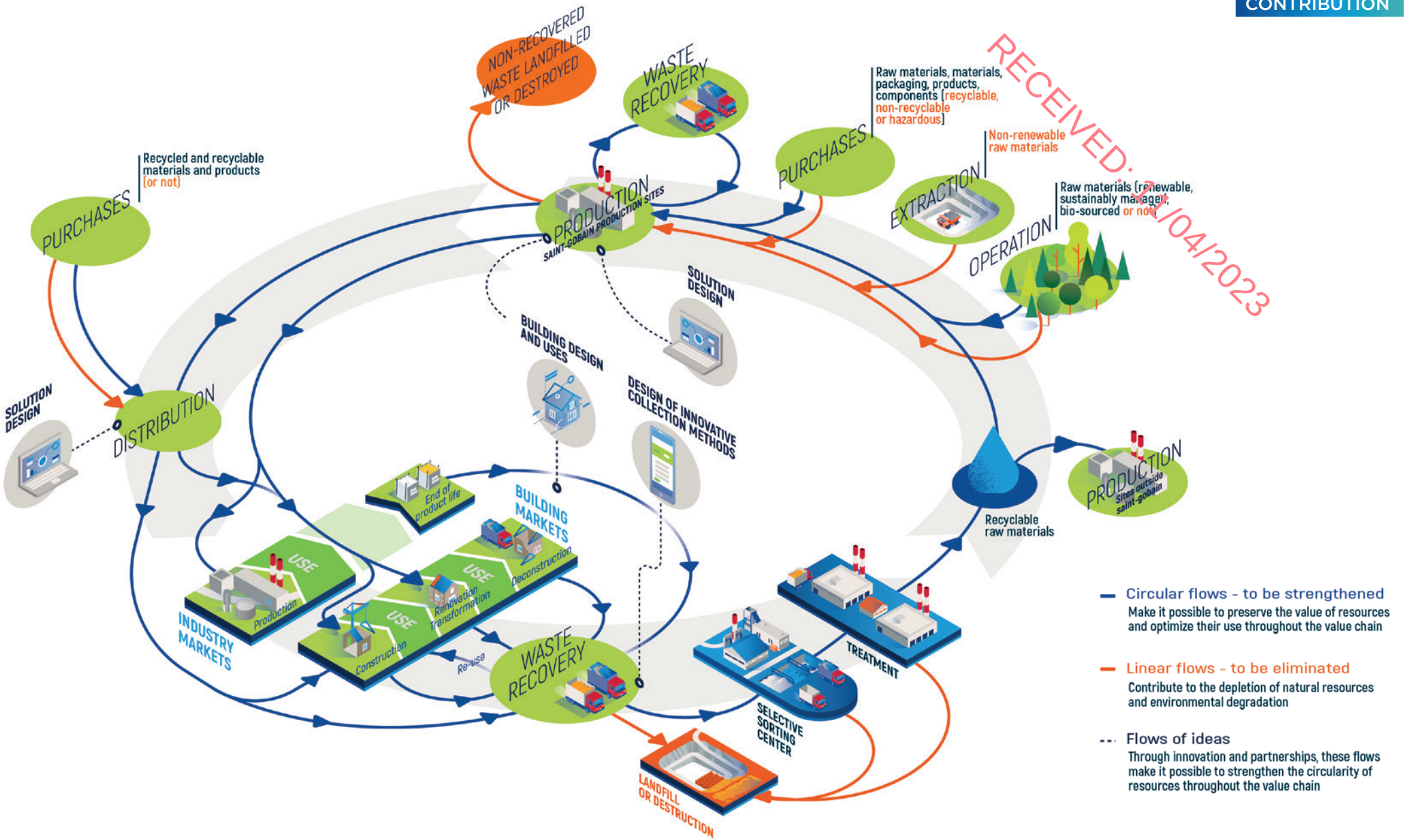
Saint-Gobain participates in the World Business Council for Sustainable Development (WBCSD) working group on circularity in the building sector.

RECOVERING THE VALUE OF BUILDINGS AT THEIR END OF LIFE:

- by preserving the value of resources through recycling channels or partnerships to promote the reuse and recovery of construction waste and its recycling;
- by recovering waste from construction, renovation and transformation sites, and dismantling sites, as well as from distribution collection points or sorting centers for private individuals;
- by sorting waste through treatment sites to facilitate its integration during production, thus reducing landfill and destruction;
- by developing waste treatment technologies to supply recyclable materials for production processes.

In 2021, Saint-Gobain's Distribution branch in France established a partnership with Tri'n'Collect, a start-up organizing the collection, sorting and recycling of construction waste, as well as training and raising awareness among craftsmen in sorting procedures.

** Industrial process known as "float glass" in which a mixture of raw materials is continuously loaded into the melting furnace. When it comes out of the furnace, the glass forms a floating strip on the surface of the molten tin.*



ACTING FOR A SAFER AND FAIRER WORLD

PROTECTING
HEALTH AND SAFETY AND PROVIDING WELL-BEING

Protect health and ensure safety on sites

Health and safety are at the heart of Saint-Gobain's corporate culture, supported by all levels of management and by all employees, temporary workers and subcontractors on site. It is important for everyone to participate in their own safety and the safety of all of their colleagues. The shared objective is to jointly achieve the "zero occupational accidents" and "zero occupational illnesses" objectives. Results show continued progress in this area:

- the accident rate with and without lost time has been divided by four in ten years;
- nearly two-thirds of sites did not report an accident in 2021.

Develop safe products and solutions that provide comfort to the end user

Innovation, production and distribution methods and processes integrate **continuous attention to the quality and safety of products and solutions**; the innovation process includes a checklist to assess potential impacts on health, safety and the environment.

Product compliance is a constantly evolving process.
A program to strengthen the **culture of quality and compliance** of products is rolled out among local teams in each country. In 2021, 66% of sites were covered by a "chemical inventory". Generally speaking, Saint-Gobain's offering focuses on sustainable solutions that include benefits in terms of health, comfort and well-being.

SUPPORTING
GROUP EMPLOYEES AND THEIR FAMILIES

CARE by Saint-Gobain

Launched in 2020, "CARE by Saint-Gobain" is a social protection program for all Group employees and their families. The coverage is defined to meet basic daily healthcare needs but also to support key moments of family life:

- daily medical monitoring and access to care, by covering health costs (doctor visits or hospitalization) at a rate of at least 80%;
- the arrival of a child (including adoption procedures), by paying at least 14 weeks of maternity leave with full pay and 3 days of paternity leave with full pay;
- death, by providing the family with financial capital representing at least one year of the employee's salary.

By early 2023, **all employees**, in all countries where the Group operates, will benefit from these guarantees for themselves and their families. At the end of 2021, 88% of them were already covered.

SHARING
COMMON VALUES WITH STAKEHOLDERS

Respect for human rights at production and distribution sites

Saint-Gobain is committed to respecting human rights wherever the Group operates, and throughout its value chain, based on the United Nations guiding principles on business and human rights. A due diligence process makes it possible to identify risks directly or indirectly related to Saint-Gobain's operations. The main risks identified concern four areas: respect for employee rights, health and safety at work, respect for the environment and anti-corruption. Each of the Group's entities ensures that each employee performs their work on the basis of freely agreed terms of employment according to a shared and accepted document and receives the payment of a fair wage according to the hours worked. Freedom of association is guaranteed at all industrial sites and sales outlets.

Responsible purchasing

Ethical criteria on human rights, working conditions and compliance with standards, health and safety and the environment, are integrated into the purchasing process. The responsible purchasing program – which is based on the ISO 20400 standard – aims to develop long-term relations with suppliers, based on shared improvement plans.

SpeakUp@Saint-Gobain

The ethics and professional whistleblowing system is accessible to employees and all other stakeholders (customers, suppliers, shareholders, trade unions, NGOs, communities and local authorities) to report any breaches of applicable regulations or internal rules and procedures, in particular those related to the code of ethics.

COMMITTING
TO LOCAL COMMUNITIES

Youth training and participation in education

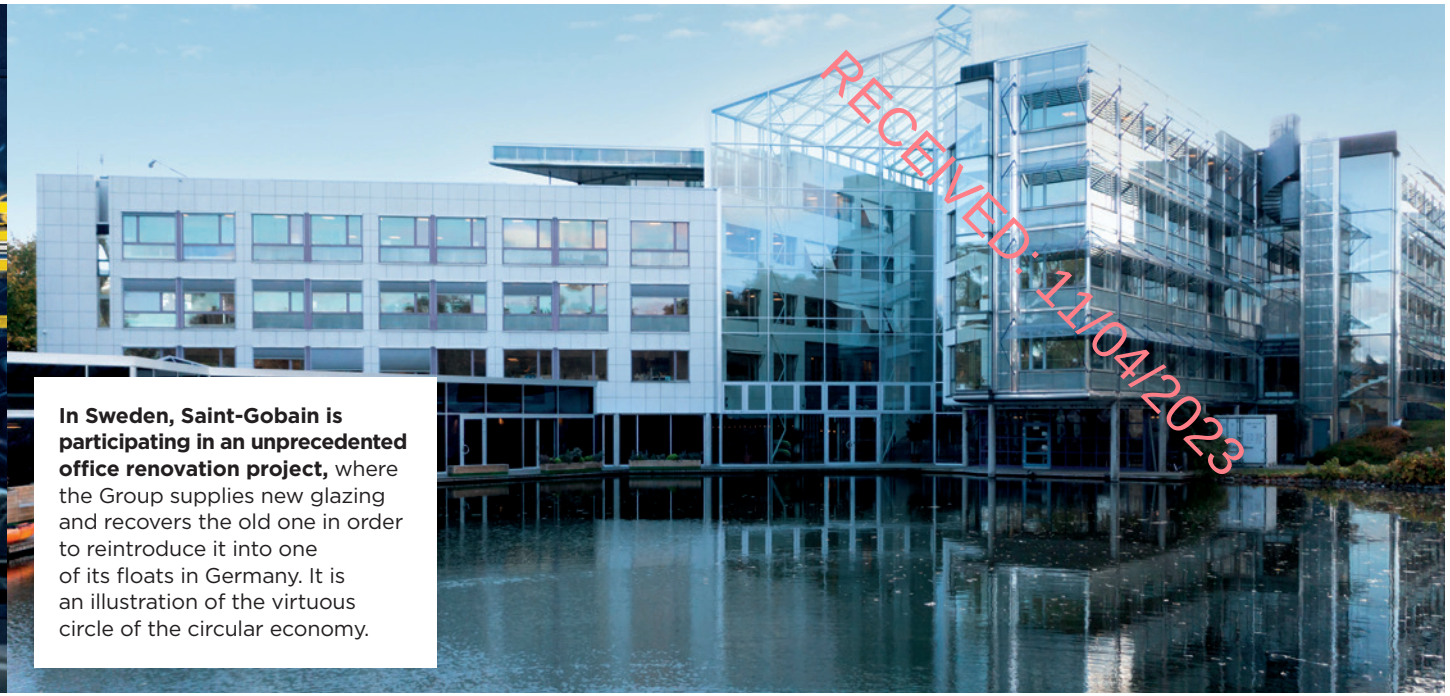
The Group's entities have set up partnerships in a number of countries to train young people in the building professions. These programs are adapted to the needs of communities and developed by local teams.

Among the qualifying training courses related to the building professions, it is worth highlighting three centers created in Morocco, aiming to train 3,000 professionals by the end of 2022, over 1,000 beneficiaries in South Africa, awareness-raising programs on the building professions for young people who dropped out of the education system in North America and England, and two courses at the apprenticeship training center in France.

Support for solidarity projects

Each year, the Saint-Gobain Foundation finances around 40 local projects related to social and sustainable housing or professional integration. Since its creation, it has invested over €16 million and helped improve the living conditions of 280,000 people in 40 countries.

The Foundation finances projects sponsored by Saint-Gobain employees – over 350 active or retired employees, who are directly involved – and relies on local associations.



In Sweden, Saint-Gobain is participating in an unprecedented office renovation project, where the Group supplies new glazing and recovers the old one in order to reintroduce it into one of its floats in Germany. It is an illustration of the virtuous circle of the circular economy.

6

APPENDICES

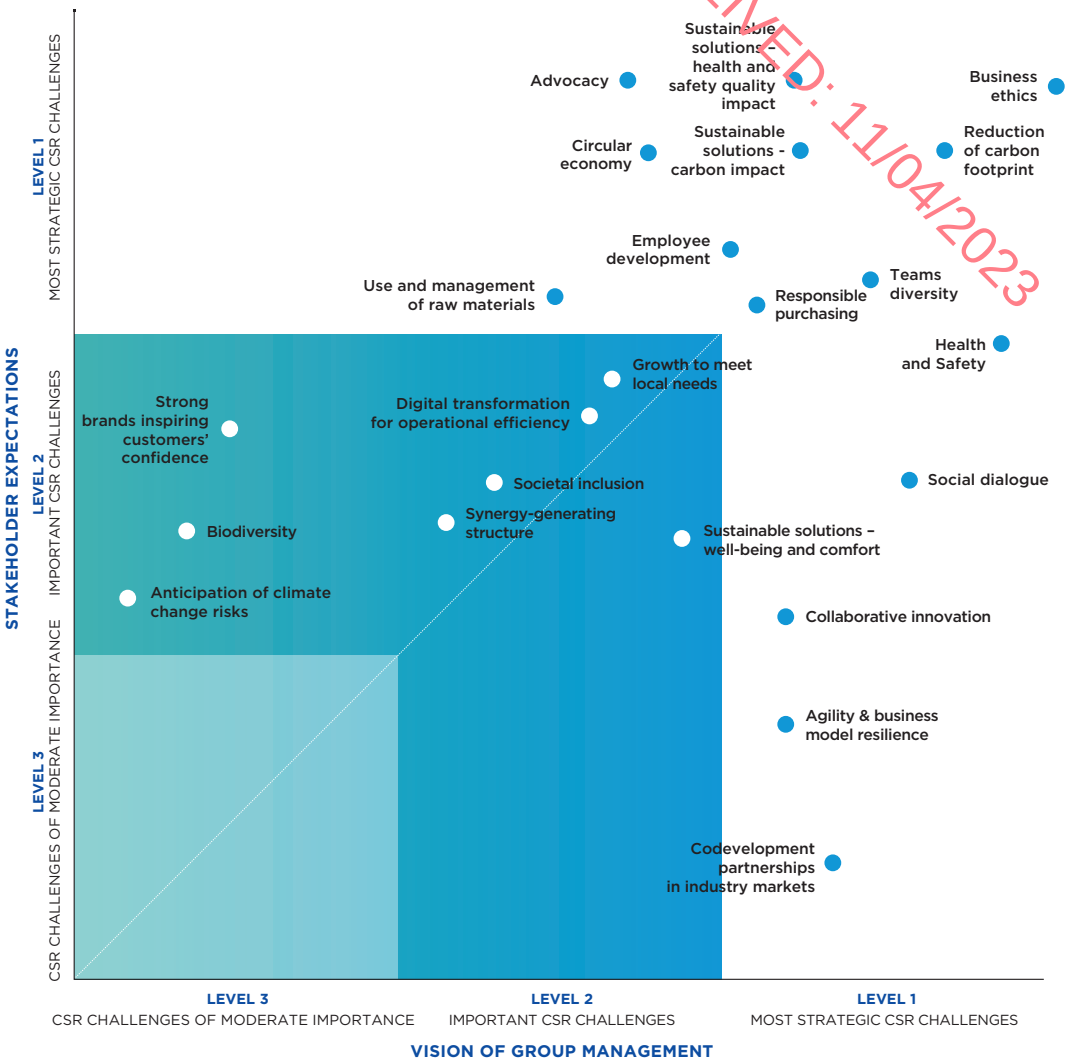
ADDITIONAL DATA AND INFORMATION

MATERIALITY MATRIX

The **materiality matrix** published by the Group was reviewed in 2020 with the assistance of Mazars. The same **methodological principles** were used:

- **identify priority issues**, based on the available documentation concerning the Company, its activities and its environment;
- **share these issues** with its main stakeholders;
- **prioritize these issues** by comparing stakeholders' expectations and the vision of management.

A **methodology note** is available on the Group's website. The assessment is based on information gathered during interviews with experts, customer surveys, employee surveys, minutes of meetings with various stakeholders, and internal interviews. For example, interviews with external stakeholders carried out as part of «the purpose» or the "me@saint-gobain" survey, conducted among Group employees, were included in the analysis.



CSR DASHBOARD

Saint-Gobain's priority CSR topics are associated with risks and opportunities, and take into account the expectations of stakeholders (identified through the materiality analysis) and the environmental, social and societal challenges facing the Group. A CSR roadmap was published in 2019 to serve as a tool for managing Saint-Gobain's CSR strategy. This roadmap demonstrates Saint-Gobain's willingness to assess its performance in terms of the environmental and social impacts of its activities, taking the expectations of its stakeholders into account.

In November 2020, Saint-Gobain implemented its CO_2 roadmap to achieve carbon neutrality by 2050. New targets for reducing carbon emissions in scopes 1 and 2 and in scope 3 from 2017 to 2030 were validated by the Science-Based Targets initiative (SBTi). These targets were therefore included in the dashboard in 2021, replacing the iso-production targets for 2025. This update of the dashboard also includes the action plans implemented as part of the "Grow & Impact" strategic plan.

OBJECTIVES	2021 RESULTS	PROGRESS IN 2021
CLIMATE CHANGE		
To contribute to a just and sustainable transition, aligned with the Paris Agreement		
-33% on scopes 1 and 2 between 2017 and 2030 (in absolute value)	-23% (10.3 $MtCO_2$)	70%
-50% on industrial water withdrawals between 2017 and 2030 (in absolute value)	-14% (48.1 million m^3)	29%
CIRCULAR ECONOMY		
To create value through a circular business model that conserves resources		
-80% non-recovered waste between 2017 and 2030 (in absolute value)	-24% (0.459 Mt)	30%
+30% of virgin raw materials avoided between 2017 and 2030	+1% (9.952 Mt avoided)	3%
HEALTH AND SAFETY ACROSS THE ENTIRE VALUE CHAIN		
To ensure the health and safety of our employees and stakeholders is our first responsibility		
Value of TRAR: 1.5 at the end of 2030	1.9	64%
100% of sites covered by a chemical inventory by 2025	66%	66%
EMPLOYEE ENGAGEMENT AND DIVERSITY		
To create a work environment that enables professional and personal growth, promotes inclusion of all diversities and ensures equity		
Employee engagement rate above benchmark every year	83% vs. 74%	100%
30% of women managers by 2025	26.3%	88%
INCLUSIVE GROWTH		
To create shared economic growth with stakeholders in a spirit of mutual trust and transparency		
100% of countries have a community assistance program by 2025	67%	67%
100% coverage of the CARE program by 2023	88% of employees covered	88%
BUSINESS ETHICS		
To share our values with our stakeholders to build together over the long term		
100% of new managers are trained in the code of ethics in their induction year every year	95%	95% code of ethics 95% corruption 93% competition
100% of responsible timber purchases by 2025	93.4%	93.4%

ROLL-OUT OF THE CSR ROADMAP

To meet its commitments and achieve the ambitious objectives set in its CSR roadmap, Saint-Gobain relies on structured programs designed to be rolled out worldwide. Resources are made available to support local teams, whose own ideas and initiatives can be shared, replicated and adapted.

STRUCTURING PROGRAMS, ROLLED-OUT LOCALLY

WCM BY SAINT-GOBAIN

Program rolled out in **industrial sites** to develop efficiency, competitiveness and customer satisfaction.

ETHICS & COMPLIANCE BY SAINT-GOBAIN

Support **network** for the roll-out of the code of ethics (see page 8) and compliance policies.

It is also worth mentioning TEC (trust, empowerment and collaboration), a program that notably focuses on encouraging a new form of leadership for managers (see page 37), the “environmental framework”, as well as the “Data Protection by Saint-Gobain”, “CARE by Saint-Gobain”, “Water by Saint-Gobain”, and “MWB by Saint-Gobain” programs, among others.

RESOURCES TO SUPPORT LOCAL TEAMS

NOVA BY SAINT-GOBAIN

A specialized team at Saint-Gobain, which identifies innovative start-ups, in particular those working on well-being and sustainable development topics.

SAINT-GOBAIN UNIVERSITY

Program that provides training modules to accelerate the development of skills related to CSR issues.

It is also worth highlighting Unicampus, a program that provides training based on the sharing of experience and which is rolled out on a regional basis; the Saint-Gobain Foundation, which finances local projects supported by employees; the “Boost! by Saint-Gobain” distance learning platform; the Skyline internal communication platform; and the annual €100 million budget allocated, from 2020 to 2030, to actions helping achieve the “net zero carbon” objective.

INSPIRING LOCAL INITIATIVES TO ACCELERATE PERFORMANCE

- Local marketing teams participated in the design of the Solutions for Growth program by sharing their experiences and the expectations of local customers.
- The “environmental emeralds”, “safety diamonds” and “health rubies” Awards reward local initiatives assessed on the benefits provided and on whether they can be implemented in other Group countries or branches.

COMPENSATION INTEGRATING CSR ISSUES

- Long-term compensation plans include a 20% component in relation to CSR criteria, of which 10% corresponds to decarbonization results, 5% to safety and 5% to diversity.
- Annual bonuses are based on 5% on safety results and 5% on decarbonization.

INTEGRATION OF SUSTAINABLE DEVELOPMENT GOALS

To integrate the United Nations Sustainable Development Goals (SDGs) into its CSR approach, Saint-Gobain relies on the materiality analysis (see page 47), its dialogue with its stakeholders, and its knowledge of its value chain (see page 7).
Generally speaking, Saint-Gobain actively follows the debates on SDGs reporting processes, and in particular those of the working group initiated by the Global Compact. Each of the SDGs was classified according to its importance to Saint-Gobain: some of them are aligned with Saint-Gobain's strategy, others only moderately aligned (limited leverage or link to a specific activity) while some are not prioritized. The Group is particularly committed to 14 SDGs, which are integrated into its strategy.

Creating inclusive growth in the countries where Saint-Gobain operates — **SDG 1**

SDG 6 — Ensuring a sustainable management of water resources

Implement actions according to the local context — **SDG 2**

SDG 7 — Using the Group's potential for local consumption to foster the development of local renewable energy networks

Promoting healthy lives and support the well-being of all at all ages — **SDG 3**

SDG 8 — Creating conditions guaranteeing quality jobs for the Group's employees

Promoting learning opportunities throughout life — **SDG 4**

SDG 9 — Engaging Saint-Gobain's innovation at the service of sustainable development and the circular economy

Being inclusive by encouraging equal opportunities — **SDG 5**

SDG 10 — Being inclusive by encouraging equal opportunities

Offering sustainable and affordable solutions that are adapted to the lifestyle changes associated with increasing urbanization — **SDG 11**

SDG 15 — Managing and reducing Saint-Gobain's impact on biodiversity

Changing the way in which the Group designs, produces and distributes its products and solutions to develop the circular economy — **SDG 12**

SDG 16 — Sharing the Group's values with its stakeholders

Contributing to the emergence of low-carbon economies capable of preserving the common good — **SDG 13**

SDG 17 — Behaving like a corporate citizen in each country

Implement actions according to the local context — **SDG 14**

SDGs linked to the strategy
SDGs moderately linked to the strategy
SDGs not a priority

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APPENDIX 1.2

Existing CRAMP March 2021

Saint-Gobain Construction Products (Ireland) Ltd.,

Navan Road, Kingscourt, Co. Cavan

Gypsum Mine Site and Gypsum Processing Facility Decommissioning, Closure and Aftercare Management Plan

Report Date:

24th March 2021

KD Environmental Ltd.

1 Swiftbrook Glen, Virginia, Co. Cavan

Report No 2020/52/02

Table of Contents

1.0 Introduction

KD Environmental Ltd. was commissioned by John McGettigan, EHS Specialist with Saint-Gobain Construction products (Ireland) Ltd. to carry out a review of the Closure Restoration and Aftercare Management Plan (CRAMP) and associated costs for the Saint-Gobain Mining (Ireland) Ltd site in Magheracloone, Co. Monaghan and the Saint-Gobain Construction Products (Ireland) Ltd site at Navan Road, Kingscourt, Co. Cavan.
Saint-Gobain Construction Products (Ireland) Ltd. holds IED licence P0519-03 granted by the EPA for its activities. Saint-Gobain Construction Products (Ireland) Ltd is the parent company of Saint-Gobain Mining (Ireland) Ltd and IED licence P0519-03 covers both the gypsum mining operations and the gypsum processing facility.

This report has been drafted based on information provided by relevant personnel of Saint-Gobain Construction Products (Ireland) Ltd. Site visits were also conducted on 26th August 2020 and 9th March 2021 by David Kelly BSc. MSc. of KD Environmental Ltd. The previous ELRA review was conducted in September 2019 and an annual review is required under condition 12.2.1 of IED licence P0519-03.

Disclaimer:
This report has been drafted based on information provided by Saint Gobain personnel.
KD Environmental Ltd do not warrant the accuracy of this information and will not be responsible for any opinions which KD Environmental Ltd. has expressed, or conclusions which it has drawn, in reliance upon information which is subsequently proven to be inaccurate. All statements and opinions provided in this report have been reported in good faith and are based on the information gained from Saint Gobain key personnel.

Observations and assessments within this report were made in accordance with the following guidance:

- "Guidance on Assessing and Costing Environmental Liabilities" and the "Guidance on Assessing and Costing Environmental Liabilities – Unit Rates for conversion" issued by the EPA in 2014.
- "Guidance on Financial Provision for Environmental Liabilities" issued by the EPA in 2015
- "EPA Approach to Environmental Liabilities and Financial Provision" issued by the EPA in 2019

Activity Details:

Name: Saint-Gobain Mining (Ireland) Ltd
Address: Knocknacran
Carrickmacross
Co. Monaghan

Name: Saint-Gobain Construction Products (Ireland) Ltd
Address: Lisnabow,
Kilmainhamwood,
Kells,
Co. Meath

Licence Number: P0519-03

Activities licenced:

Class 1.3 “The extraction and processing (including size reduction, grading and heating) of minerals within the meaning of the Minerals Development Acts 1940 to 1999, where an activity involves any other operation where either the level of extracted or processed minerals is greater than 200,000 tonnes per annum or the total operational yield is greater than 1,000,000 tonnes, and storage of related mineral waste.

11.1 Waste facility - The recovery or disposal of waste in a facility, within the meaning of the Act of 1996, which facility is connected or associated with another activity specified in this Schedule in respect of which a licence or revised licence under Part IV is in force or in respect of which a licence under the said Part is or will be required.

11.5 Landfills, within the meaning of section 5 (amended by Regulation 11(1) of the Waste Management (Certification of Historic Unlicenced Waste Disposal and Recovery Activity) Regulations 2008 (S.I. No. 534 of 2008) of the Act of 1996, receiving more than 10 tonnes of waste per day or with a total capacity exceeding 25,000 tonnes, other than landfills of inert waste.

Table 1: CRAMP cost comparison with previous plans (Mine & Process Sites combined)

Year	Closure and Restoration/Aftercare Cost
2021	€5,965,811
2019	€5,119,795
2017	€4,919,354

1.1 Process Site History & Description

The company was founded as Gypsum Industries in 1936 and employs 180 people at its Kingscourt operations, now trading as Saint Gobain Construction Products (Ireland) Limited. The gypsum processing facility is situated close to the town of Kingscourt, Co Cavan, eighty five kilometres north of Dublin. In addition to the process site, the 118 acre site contains storage silos, warehouses, workshops, a capped/decommissioned landfill and water lagoon system. The landfill on site is no longer in use was capped in 2018 with the agreement of the EPA.

Gypsum is a non metallic mineral, which is found in rock form. It is composed of Calcium Sulphate di-hydrate. After mining Gypsum is crushed and transported by road to the processing facility where it is calcined and then converted to cement, gypsum plaster boards or builders plaster.

A small stream runs adjacent to the front of the site and this stream is culverted beneath the capped landfill. This stream then resurfaces at the rear of the gypsum processing site and receives stormwater from the roofs and yards on site via a series of settling lagoons.
This stream forms part of the River Lagan catchment area which is a tributary of the River Glyde. All manufacturing activities take place indoors.

A trained emergency response team is located on site. Saint Gobain Construction Products (Ireland) Ltd employ a dedicated environmental team with a high level of expertise and this team will manage and implement all aspects of the facilities decommissioning and closure plan. This team will include the EHS Partner and trained members of the emergency response team. The emergency response team members are trained and equipped to deal with environmental incidents that may occur on site such as oil spillages. Where required, external and specialist contractors may be commissioned to undertake some decommissioning tasks. The fees for specialist contractors have been included in the costs of the CRAMP for the gypsum mining and gypsum processing facilities.

1.2 Mine Site History & Description

Saint-Gobain Mining (Ireland) Ltd operated an opencast gypsum mine in the townland of Knocknacran, Co. Monaghan and currently operates an underground gypsum mine in the townland of Drummond, Co. Monaghan. The setting is rural with other surrounding land use being mainly agricultural with low density residential dwelling. The quarry and mine are situated approximately 7km from the town of Carrickmacross in Co. Monaghan and 7km from Kingscourt, Co. Cavan.

The opencast mine began operation in 1989 following the granting of planning permission (PL18/5/67892) and in 2017 under planning permission P17/217 permission was granted to extend the life of the quarry to the year 2033. The underground mine was opened in 2004 under planning permission P03/578.

The opencast mine site covers a total area of 63.2 hectares of which 44.6 hectares is the area for gypsum extraction. The remaining 20.7 hectares is processing plant, non-extraction areas and administration buildings/car parks. The underground mine was estimated to extend over an area of approx. 33.7 hectares in August 2020.

Figure 1: Opencast Mine Area

The opencast mine is bordered on its western boundary by the R179 Kingscourt to Carrickmacross road. The now disused Drumgossat underground mine forms the majority of the northern section of the site, the active Drummond underground mine lies to the south of the site and the quarried gypsum outcrop lies to the eastern section of the site. The main gypsum mineral reserve lies in the west and south sections of the site.

1.2 Licences/Permitted Activities

Saint-Gobain Construction Products (Ireland) Ltd was issued with an Industrial Emissions Licence (IED) licence P0519-03 by the EPA in July 2015 for their manufacturing and gypsum mining facilities. Saint-Gobain Construction Products (Ireland) Ltd is the parent company of Saint-Gobain Mining (Ireland) Ltd.

Under P0519-03, Saint-Gobain Construction Products (Ireland) Ltd are permitted to carry out the following activity under Section 90(2) of the Environmental Protection Acts 1992 and 2003;

- Class 1.3 "The extraction and processing (including size reduction, grading and heating) of minerals within the meaning of the Minerals Development Acts 1940 to 1999, where an activity involves any other operation where either the level of extracted or processed minerals is greater than 200,000 tonnes per annum or the total operational yield is greater than 1,000,000 tonnes, and storage of related mineral waste.

- Class 11.1 "The recovery or disposal of waste in a facility, within the meaning of the Act of 1996, which facility is connected or associated with another activity specified in this Schedule in respect of which a licence or revised licence under Part IV which a licence under the said Part is or will be required"

Class 11.5 Landfills, within the meaning of section 5 (amended by Regulation 11(1) of the Waste Management (Certification of Historic Unlicenced Waste Disposal and Recovery Activity) Regulations 2008 (S.I. No. 534 of 2008) of the Act of 1996, receiving more than 10 tonnes of waste per day or with a total capacity exceeding 25,000 tonnes, other than landfills of inert waste.

At Knocknacran, Magheracloone, Drummond, Derrynascobe, Derrynaglah, Ballycartlan, Enagh and Carrickmacross, County Monaghan, and at Lisnabow, Kilmainhamwood and Kells, County Meath.

1.3 Closure and Decommissioning Requirements

IED Licence Requirements

Under Condition 10.2 of EPA IED Licence P0519-03, Saint-Gobain Construction Products (Ireland) Ltd. is required to perform a Decommissioning and Residuals Management Plan and review this plan annually;

10.1: Following termination, or planned cessation for a period greater than six months, of use or involvement of all or part of the installation in the licenced activity, the licencee shall, to the satisfaction of the Agency, decommission, render safe or remove for disposal/recovery any soil, subsoil, buildings, plant or equipment, or any waste, materials or substances or other in matter contained therein or thereon, that may result in environmental pollution.

10.2.1: Decommissioning Management Plan (DMP). The licencee shall maintain, to the satisfaction of the Agency, a fully detailed and costed plan for the closure, decommissioning and rehabilitation of the installation or part thereof.

10.2.2: The plan shall be reviewed annually and proposed amendments thereto notified to the Agency for agreement as part of the AER. No amendments may be implemented unless agreed by the Agency.
10.2.3: The licencee shall have regard to the Environmental Protection Agency Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision when implementing Condition 10.2.1 above.

10.2.4: The Decommissioning Management Plan shall include, as a minimum, the following:
(i) A scope statement for the plan
(ii) The criteria which define the successful de-commissioning of the activity or part thereof, which ensures minimum impact to the environment
(iii) A programme to achieve the stated criteria
(vi) Where relevant, a test programme to demonstrate the successful implementation of the de-commissioning plan
(v) A programme to address any remaining licence obligations; and
(vi) Details of costings for the plan and a statement as to how these costs will be underwritten

10.2.5: The licencee shall carry out closure, decommissioning and rehabilitation of the installation in accordance with the plan. No deviation from the plan shall be allowed unless agreed by the Agency.

10.2.6: The licencee shall carry out such tests, investigations or submit such certification, as may be requested by the Agency, to confirm that individual tasks of the plan are being progressed or have been completed.

10.2.7: A final validation report to include a certificate of completion for the Decommissioning Management Plan, for all or part of the installation as necessary, shall be submitted to the Agency within three months of execution of the plan. The licencee shall carry out such tests, investigations or submit certification, as requested by the Agency, to confirm that there is no continuing risk to the environment

Planning Permission

Planning permission granted to Saint-Gobain Mining (Ireland) Ltd by Monaghan County Council also requires for a closure plan to be drafted and submitted under sections 3 and 4 of planning permission P17/217 in the interests of amenities in the areas and the proper planning and development of the area. Under Condition 4 In respect of closure of the mine, the following shall apply:-

(a) The developer shall notify the authority when closure is imminent (at least 12 months prior to closure) and when closure has commenced,

(b) within 12 months of closure and for every 12 month period thereafter, until otherwise agreed in writing with the Planning authority, the developer shall submit a report to the Planning authority containing the following information:-

(c) the nature and extent of rehabilitation work carried out during the past year, the nature and extent of rehabilitation work to be carried out during the coming year, any changes in conditions of the project that may affect the closure plan, and the results of all monitoring described in the closure plan.

(d) In the event of the Planning authority deeming (on the basis of the reports and monitoring) that the mine closure plan is an adequate to properly rehabilitate the site due to changed conditions or, in the event of the developer wishing to amend and/or alter the mine closure plan, the developer shall formally submit detailed proposals for amendments/alterations to the closure plan for the agreement of the Planning authority. The Planning authority shall be empowered to require changes to the proposed amendments/alterations. The mine closure plan shall not be deemed to be altered until the Planning authority formally notifies the developer of the acceptability of the alterations/amendments.

1.4 CRAMP – Scope Statement and Summary

1.4.1 Scope Statement

Scoping for this Closure Restoration and Aftercare Management Plan (CRAMP) has determined that the site will have minimum long-term impacts on the environment and is expected to have no long-term environmental liabilities. A clean closure is envisaged. A closure plan and a restoration/aftercare plan for the Saint-Gobain Mining (Ireland) Ltd site and the Saint-Gobain Construction Products (Ireland) Ltd production facility has been prepared as required under Condition 10 of EPA IED licence P0519-03 and as per EPA guidance.

1.4.2 CRAMP Summary – Gypsum Processing Facility

It is predicted that there are two potential scenarios for site closure of the gypsum processing facility. The first scenario is the transfer of ownership of the facility to another company for mineral ore processing. This is the simplest scenario and an unlikely outcome following cessation of processing by Saint Gobain Construction Products (Ireland) Ltd. Any potential purchaser of the site will be made aware of any potential environmental liabilities associated with the purchase of the facility and would be responsible for any future environmental risk and clean up costs associated with the site. In this scenario, the site will not have to be stripped and fixed plant would not have to be removed. The nature of the plant and buildings used on site lend themselves to processing of mineral ores other than gypsum and may be suitable for other industrial uses. Some low cost decommissioning may have to take place such as removal and decommissioning of unsuitable fixed and mobile plant.

The second scenario is that the gypsum processing facility is fully decommissioned after the site is closed by Saint Gobain Construction Products (Ireland) Ltd. All waste and asbestos will be removed from the site, production buildings and large fixed plant will be decontaminated. Large mobile and fixed plant will be sold and removed from site.

The main office building, technical academy, security building, inwards booth, customer services building, rock shed, mechanical & electrical workshop, plaster mill, board plant & amenities building, car parks, concrete yards and main concreted paths and floor areas will remain in place as this will assist other industrial concerns locating to the site.
This closure scenario is more complex and requires a planned decommissioning. The details of expected requirements under this scenario are presented and costed for in this report.

Total closure and decommissioning costs for the gypsum processing site have been calculated in 2021 as **€3,246,370** which includes a 20% contingency. Saint Gobain Construction Products (Ireland) through their parent company Saint Gobain have in place a financial provision for the amount stated above to cover closure costs of the facility at Kingscourt – see section 9.0.

Full details of decontamination and decommissioning are given in section 3 of this report.

1.4.3 CRAMP Summary – Mine and Opencast Quarry

It is predicted that there are two potential scenarios for site closure of the mine operation. The first scenario is the transfer of ownership of the facility to another company for mineral gypsum extraction. This is the simplest scenario and an unlikely outcome following cessation of processing by Saint-Gobain Mining (Ireland) Ltd. Any potential purchaser of the site will be made aware of all environmental liabilities associated with the purchase of the facility and would be responsible for any future environmental risk and clean-up costs associated with the site. In this scenario, the site will not have to be decommissioned or remediated and fixed plant/machinery will not have to be removed. Some low cost decommissioning may have to take place such as removal and decommissioning of unsuitable fixed plant.

The second scenario is that the gypsum mining operation ceases for good following depletion of the available/suitable gypsum ore and that the site is decommissioned/remediated by Saint-Gobain Mining (Ireland) Ltd with all plant and buildings removed from the site. Production buildings and large fixed plant will be decontaminated, deconstructed, sold and removed from site. The administration building, canteen building, access road to these buildings and carpark will remain in place. The opencast mine area would be remediated. The underground mine will be allowed to naturally flood due to natural groundwater ingress over a 30 year duration. This closure scenario is more complex and details of planned decommissioning and site remediation required under this scenario are given in this report.

Total closure and decommissioning costs for the gypsum mining operations have been calculated in 2021 as **€2,719,441** which includes a 20% contingency. Saint-Gobain Mining (Ireland) Ltd through their parent company Saint Gobain have put in place a financial provision for the amount stated above to cover closure costs for their facility at Knocnacran / Drummond – see section 9.0.

Full details of decontamination and decommissioning are given in section 3 of this report.

2.0 Site Evaluation

2.1 Operator Performance - Compliance

Saint-Gobain Construction Products (Ireland) Ltd. was granted IED licence P0519-03 for their gypsum processing facility and mining operation in 2015. Saint-Gobain Construction Products (Ireland) Ltd. contribute significant resources in order to achieve environmental compliance. On occasion a non-compliance to this IED licence requirements may occur. A full record of environmental non-compliances is available upon request from the environmental office at Saint-Gobain Construction Products (Ireland) Ltd. – a summary for 2020 is given below as reported to the EPA in the Annual Environmental Report.

- Incident History – Gypsum Processing facility
  In 2020, four minor incidents were reported relating to site activities at the gypsum processing facility. Two of these involved minor water monitoring compliance exceedences. Two involved minor operational incidents (small localised spills and leaks etc…) The root cause of all incidents have been addressed with mitigation measures implemented and the incidents are now closed with the EPA.

- Incident History- Mine and Opencast Quarry
  In 2020, four minor incidents occurred relating to site activities at the gypsum opencast quarry and underground mine. Three of these incidents regarded compliance monitoring exceedences with no major detrimental environmental effects recorded. The other incident was a temporary down-time of a stormwater composite sampler.

  In 2018 a major incident occurred at the gypsum mine. A high volume of water ingress into the mine resulted from normal mining activities intersecting an unforeseen fault. As has been normal practice for many years this water was pumped to the old Drumgossat Mine workings to be stored for discharge to the River Bursk during the winter season. The high volume of water meant that the water reached higher levels in the mine than had historically occurred.

  In September 2018, a subsidence event took place in the area of the Magheracloone GAA Facility. Investigation by SRK consultants concluded the subsidence occurred due to a unique and complex set of circumstances with the higher than normal level of water in the old mine workings being one factor. The company investigation was independently reviewed by DCCAE consultants whose report is available on the DCCAE website.
  The R179 Kingscourt to Carrickmacross road also closed for a number of weeks until the risk from further land subsidence could be determined. This has concluded that loss in underground mine stability was localised and that further mine collapse is unlikely.
  The pumping of water to the old Drumgossat mine workings ceased on 28 September 2019.

  It is proposed to continue the current land stability monitoring programme over a 30 year duration as this is the expected time frame for the natural flooding of the Drummond mine to be completed. The current monitoring covers lands and roads in the vicinity of Drummond mine. It is proposed that this will continue twice yearly over the first 10 years and annually after that. The associated costs for subsidence monitoring are detailed in section 7 of this report.

- Compliance History – Both gypsum mine and processing facilities
  In 2020, a total of six compliance limit value exceedences were recorded. Three of these exceedences were due to off site organic loadings of dust which are not related to site

activities. Organic loadings from birds and vegetation were the cause of these exceedences and not dust from Saint Gobain activities.
A further three compliance exceedences regarded minor stormwater emission limit value breaches and had no significant environmental impact.

- Complaints History
  In 2020, nineteen complaints were received. All complaints were investigated and are now closed with the EPA.

- Enforcement Category
  The EPA have confirmed in 2020 that the current risk category for the Saint Gobain process and mine facilities is A1. Under the EPA Licensing and Enforcement Charging Policy issued in 2020, A1 is the highest enforcement category.

2.2 Environmental pathways and sensitivity

2.2.1 Gypsum processing facility – Site Sensitivity

The topography, surrounding land use and location of site operations has not changed in recent years. There are no protected ecological sites within 1km of the site and no sensitive agricultural receptors within 150m of the site. The surrounding topography is an intermediate terrain dominated by drumlin formations.

Surfacewater streams in the vicinity form part of the River Lagan catchment area and receives storm water from the site at location S3. Biological monitoring of the receiving stream by KD Environmental Ltd. in 2018 concluded that the water quality of the stream downstream of the gypsum processing facility was classed as Q2-3 and of being doubtful/poor quality. It is therefore seen as being of Class D sensitivity as it has a poor status. The Streams are not recognized as a Potentially Eutrophic Coastal or Estuarine water.

The site is situated in an area of a locally important aquifer with a moderate aquifer vulnerability rating (Ref: Minerex Ground water report 2010 1632-1224).There are no known emissions to land or groundwater from the gypsum processing facility.

There are No ecological designations or protected areas (SAC, SPA, or NHA) within 1km of the mine site. The nearest protected site is Killyconny Bog Special Area of Conservation (SAC Site Code 000006) approx. 15Km away.

2.2.2 Gypsum mine and quarry – Site Sensitivity

The topography, surrounding land use and location of site operations has not changed in recent years. There are no protected ecological sites within 1km of the site and no sensitive agricultural receptors within 150m of the site. The surrounding topography is an intermediate terrain dominated by drumlin formations. There is some residential housing in the area which is generally confined to linear settlement patterns, mainly along local roads.

The River Bursk receives stormwater (a combination of stormwater from the opencast quarry and hardstand areas and water pumped from the underground mine) from the mine at point MSE1 and surrounding areas. Prior to discharge, this water passes through a series of settling lagoons. The Bursk is a tributary of the River Glyde. The Glyde flows to the sea at Dundalk Bay and although not a designated a salmonid water, this river is known to have salmon run (salmon are listed in Annex II of the Habitats Directive, 92/43/EEC).

Biological monitoring of the River Bursk by KD Environmental Ltd. in 2019 concluded that the water quality both upstream and downstream of the MSE1 discharge has a Q rating of Q3-4 indicating fair to doubtful water quality with slight levels of pollution.
The River Bursk is therefore seen as being of Class C sensitivity. The River Bursk is not recognized as a Potentially Eutrophic Coastal or Estuarine water.

The site is situated in an area of a locally important aquifer with a moderate aquifer vulnerability rating (Minerex 2010 groundwater report).

There are no ecological designations or protected areas (SAC, SPA, or NHA) within 1km of the mine site. The nearest protected site is Killyconny Bog Special Area of Conservation (SAC Site Code 000006) approx. 20Km away.

2.2.3 Gypsum mine and quarry – Hydrogeological Links

In early 2020, Saint Gobain Construction Products Ireland Ltd. commissioned a hydrogeology study of Knocknacran Open Cast Mine and the Underground Mines at Drumgossat and Drummond. This study was conducted by Piteau Associates.

This Piteau Associates report (Ref: Project 4238-R1) is included as Appendix 2 of this CRAMP report.

In summary, no long term costs associated with water management at the mine is expected as the Drummond mine will be allowed naturally flood following cessation of mining activities. Groundwater monitoring will be continued as per EPA licence schedule and these costs are included in the CRAMP.

2.2.4 Drummond mine – Subsidence Management

Drummond Mine has been designed to be self-supporting and not require backfilling.

The mine design is detailed by a third party Rock Mechanic who based on the surveyed geology of the mine and their own inspections, specifies the design of the rooms and pillars. Inspections of the "as built" mine also leads to specific advices where additional specific interventions are required to ensure the safety of the staff who operate within the mine or as a preventive countermeasure to a future subsidence risk.

Regular monitoring of surface levels in the area of Drummond mine has been carried out over many years and continues to be carried out. The data from these level surveys is analysed by a third party specialist and incorporated in the annual subsidence review report. The third party specialist also advises the company of any steps they should take to mitigate any subsidence risks.
This report is issued to Monaghan County Council in compliance with the mines planning permission on an annual basis.
Survey results and subsidence reports are reviewed by the DCCAE at its routine mine review meetings that take place bi-annually. These reviews and any actions arising are reported in the relevant DCCAE mine review reports

2.3 Site processes and activities

2.3.1 Gypsum processing and manufacturing

The main operation at the gypsum process site is the processing of the mineral gypsum into plasterboard and building plaster for use in the construction industry. This involves calcination of the gypsum mineral.

The mineral gypsum occurs naturally and is mined at the gypsum mine at Magheracloone, Co. Monaghan approximately 10 kilometres from the gypsum processing site.
The mineral gypsum is initially crushed to produce a fine powder and heated to remove some of its water content. This forms the product 'Plaster of Paris' and the chemical formula below illustrates this process.

$$CaSO_4.2H_2O \longrightarrow CaSO_4.1/2H_2O$$

The product is further crushed to give a nominal particle size of 150µm before being calcinated at 140 – 170ºC which converts the gypsum to hemihydrate – known commonly as stucco. This stucco material is the raw material of building plaster and plasterboard.
In producing building plaster, process chemicals are added to the stucco to prevent the product from rehydrating too quickly when rehydrated or mixed with water. It is more practical from an end user point of view to have a longer setting duration.

For Plasterboard, the calcinated stucco is mixed with starch, water and air entraining agents to give a fluid consistency. This is then spread onto large sheets of paper and covered with a second sheet of paper to form a plaster sandwich – plasterboard. The plasterboard is dried using a 3 stage gas fired dryer. Plasterboard sheets are then trimmed and cut to desired length.

A flow chart illustrating on site processes at the Saint Gobain Construction Products (Ireland) facility is given below.

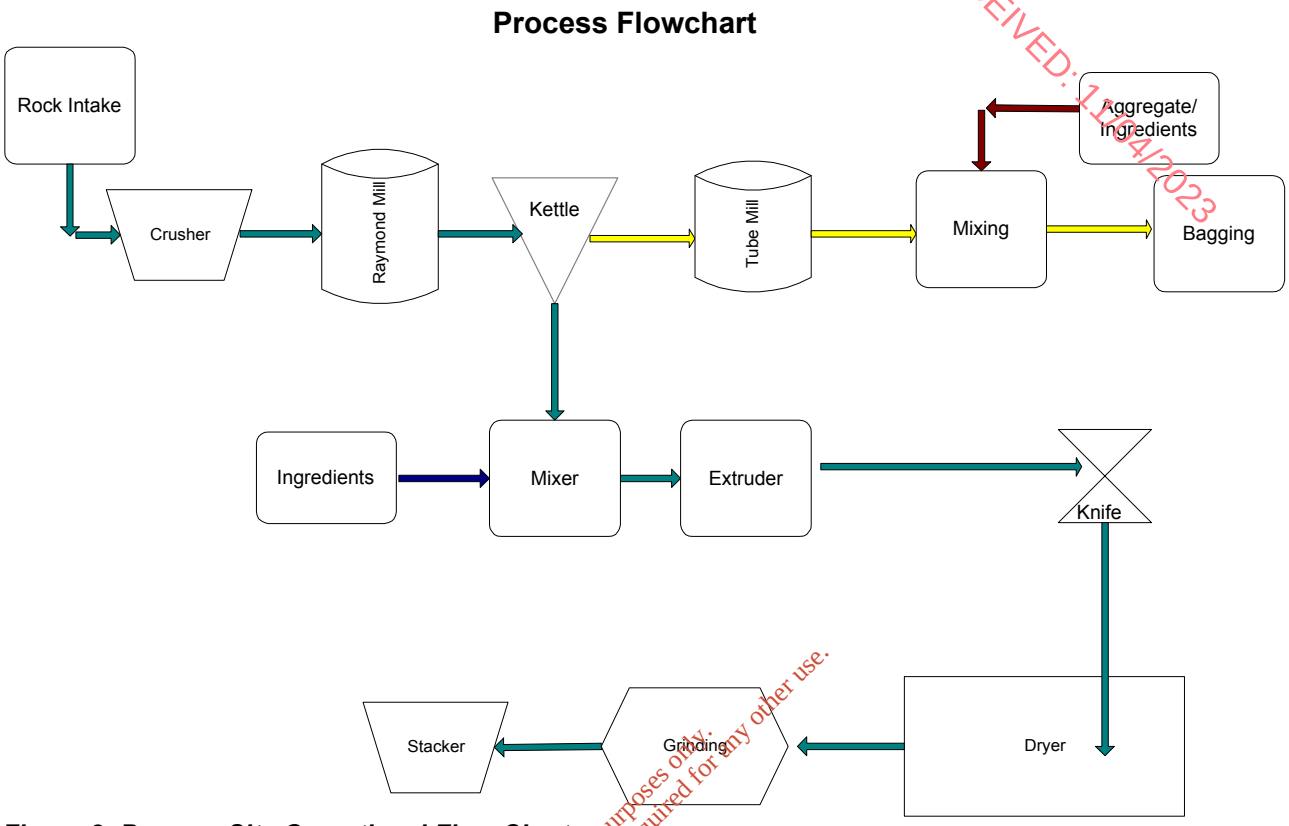


Figure 2: Process Site Operational Flow-Chart

2.3.2 Opencast quarry

Hydraulic excavators and dump trucks are used to remove topsoil, subsoil, and overburden to expose the gypsum rock. The material which has been removed to expose the gypsum is stored on the site. The gypsum is then extracted in a series of benches. Primary breaking is achieved by blasting. Rock breakers are used to carry out secondary breaking, if required. The broken gypsum rock is loaded onto dump trucks using a hydraulic excavator and transported to the surface primary crusher. The surface primary crusher reduces the run-of-mine rock to less than 300 mm. The minus 300 mm rock is transported by conveyor belt to a vibrating grizzly feeder. Material less than 75 mm passes through the feeder and the oversize is directed to the secondary crusher. The secondary crusher reduces the oversize material to less than 75 mm. The rock is then transported by conveyor belt to the stacker-reclaimer (homogenizer) where it is stored under cover awaiting collection either to the plaster and plasterboard factory near Kingscourt or to one of the cement manufacturing companies. Once the entire gypsum mineral has been removed from an area, the area is backfilled using the stored topsoil, subsoil, and overburden.

2.3.3 Underground mining

Gypsum rock is drilled and blasted from a series of tunnels. The tunnels are self-supporting as approx. only 17% of the gypsum is extracted. The remaining 83% is left in the ground to form the roof, floor, and wall support of the tunnel. In areas of poor geology (soft and broken rock) roof support is installed in the form of rock bolts and mesh. The tunnels are laid out in a grid pattern to form rooms (where the gypsum has been removed) and pillars (where the gypsum has been left in place). The rock is loaded onto dump trucks using rubber-tyred loaders and transported to the underground primary crusher. The underground primary crusher reduces the run-of-mine rock to less than 300mm. This material is then transported to surface on a conveyor belt, where it joins the surface processing plant at the secondary crusher.

All mining operations are carried out within the confines of the gypsum deposit therefore no waste material is extracted. This eliminates the need for spoil heaps or dumps.

A flow chart illustrating on site processes at the Saint-Gobain Mining (Ireland) Ltd mine and mining facility is given below.

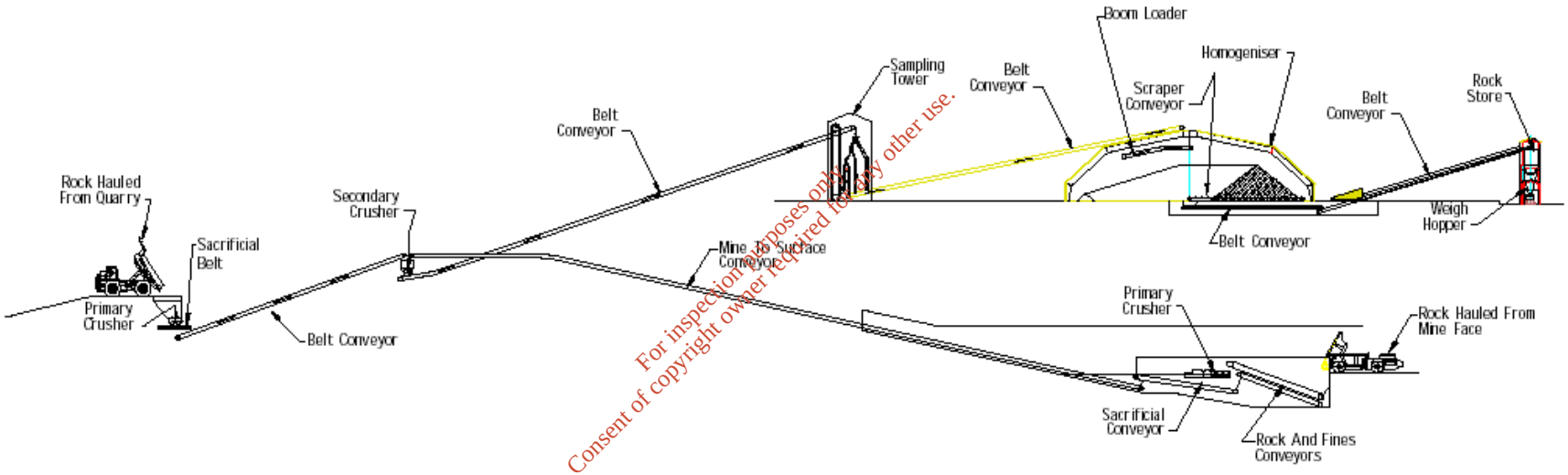


Figure 3: Mine Facility Operational Flow-Chart

2.4 Inventory of buildings, plant and equipment

2.4.1 Inventory of buildings, plant and equipment – Gypsum Processing Site

Table 2. Inventory of Processing Facility Plant and Equipment

Plant description	Number on site
Belted Conveyors	20
Ingredients Bins	60
Processing screws	70
Product elevators	17
Raymond Mills	5
Submerged combustion kettles	3
Conical Kettle	1
Tube Mills	3
Expanders	2
Baggers	2
Plasterboard dryer	1
Storage bins	10
Paper stations	4
Palletiser	2
Mixer	1
Grinder	1
Rotary Kiln	2
Lathe lines	2
Foiling conveyors	6
Compressors	3
Passenger/goods lift	1
Transformer rooms	9
Main stack & dust cyclone	1
Electric Cabinets	202
Mobile plant	**Number on site**
Shovels	2
Tractors	3
Caterpillar	1
Teleporter	1
FLT	20
Bobcat	1

2.4.2 Inventory of buildings, plant and equipment – Gypsum Mine Site

Table 3. Inventory of Mine Site Plant and Equipment

Plant description	Number on site
Crushers	3
Wheel wash	1
Weigh Bridge	1
Homogeniser	1
Lorry Loader	1
Conveyors	7
Autosampler	1
Ventilation fan stations	2
Substations	3
Electric Panels	17
Pump station	3
Dumpers	4
Excavators	3
Water Tanker	1
Tractors	1
Diesel Bowser	1
4 x 4	7
IT (FLT)	1
Telescopic Handlers	2
Front End Loader	3

Table 4. Inventory of Process Facility Buildings & Structures

Buildings & Structures
Plaster mill – 4 storey manufacturing building surrounded by a single storey warehouse and raw material store
Board Plant – Single storey building (95%). Three storey in one section; raw material additive area. This is adjoined to the amenities building (cloakrooms) and meeting room
Mechanical and electrical workshop (2 storey at rear) connected to the board plant and accessories stores
Accessories stores and engineering stores
Office/ admin building: 2 storey
Technical Academy: 2 storey
Rock intake: Single storey
Heavy machinery store : Single storey

All production buildings associated with gypsum processing comprise block base, steel supports with metal cladding. Older buildings on the processing site have asbestos cladding. Smaller buildings, e.g. offices, laboratory etc. are of block construction.

Table 5. Inventory of Mine Site Buildings & Structures

Buildings & Structures
Rock Shed
Offices/ Administration
Workshop/Garage
Laboratory (Within Admin Building)
Car Park x 1
Surface water lagoons x 4
Surfacewater Holding Tanks
Oil Storage Bunds
Homogeniser Building
Sample Tower
Primary & Secondary crusher buildings
Emergency station (mine rescue)

All production buildings associated with the Saint-Gobain Mining (Ireland) Ltd. facility comprise of either concrete block built structures or steel supports with metal cladding.

2.5 Inventory of raw materials, products and wastes

2.5.1 Inventory of raw materials, products and wastes – Process Site

The following table is a detailed inventory of raw materials used at the gypsum processing and production facility:

Table 6. Inventory of Raw Materials/Chemicals (Processing Site)

Material	Max. Volume Stored	Storage
Oxyacetylene	6 cylinders	Storage cage
Oxygen	8 cylinders	Storage cage
Argon	2 cylinders	Workshop
Propane	2 Cylinders	Storage cage
Aquagrip 25268	8 tonnes	Bunded in BP
Aquagrip 27871	3 tonnes	Bunded in BP
Esacol 506E	2 tonnes	Raw materials warehouse
Microsilica	27 tonnes	Raw materials warehouse
Fibre Glass (wet chopped)	28 tonnes	Raw materials warehouse
SCP700C Ink	152 litres	Chemstore
Nansa	2 tonnes	Raw materials warehouse
Cerestar 05483	52 tonnes	Raw materials warehouse
SCP700 cleaner	6 litres	Chemstore
Steol (Manro)	27 tonnes	Bunded at BP
Borresperse	34 tonnes	Bunded at BP
NCH Belt Grip	12 x 400 ml	Chemstore in stores
NCH Foam Cleaner	12 x 400 ml	Chemstore in stores
NCH Cut Tapping Oil	12 x 400 ml	Chemstore in stores
NCH Galvanic Spray	12 x 400 ml	Chemstore in stores
NCH Jet Air	12 x 400 ml	Chemstore in stores
NCH Klentec 207	12 x 400 ml	Chemstore in stores
NCH Grease Spray	12 x 400 ml	Chemstore in stores
Klubersynth CH2-100N	400 litres	Bunded
Castrol Alpha SP150	400 litres	Lubrication store
Castrol Alpha SP320	400 litres	Lubrication store
Castrol Mollub 936	165 Kg	Lubrication store
Castrol Hyspin AWS32	208 litres	Lubrication store
SCP60 Ink	20 litres	Chemstore
SCP60 Cleaner	12 litres	Chemstore
Perlite Ore	30 tonnes	Plaster Mill
Poval	4 tonnes	Plaster Mill
Rapid Aged Fines	7 tonnes	Plaster Mill
Silipon P	4 tonnes	Plaster Mill
Tartaric Acid	24 tonnes	Plaster Mill
Tylose E	1 tonne	Plaster Mill
Vermiculite	28 tonnes	Plaster Mill
Vinnapas	1 tonne	Plaster Mill
Castrol Spheerol LEP2	500 litres	Bund
Castrol Alpha 220	400 litres	Lubrication store
Castrol AWS 46	400 litres	Lubrication store
Plast Retard PE	2 tonnes	Plaster Mill
HRA Accelerator	3 tonnes	Plaster Mill
Diesel	10,000 litres	Double skin tank in yard
Bluestar (Silicone oil)	7,000 litres	Board Plant bund
Keratin	6 tonnes	Plaster Mill

Material	Max. Volume Stored	Storage
Lock n Pop	600 litres	Plaster Mill on bund
Foil (Metalised Polyester)	6 tonnes	Board Plant
Almaredge Lube	60 litres	Lubrication Store
EON 9000SP Oil	60 litres	Lubrication Store
Propylene glycol	200 litres	Lubrication Store
Vectron 15W40 Oil	40 litres	Lubrication Store

All chemicals, cleaning materials and oils used at the facility are stored within a chemstore cabinet, on a suitable bund or a designated storage warehouses as required. Some bottled flammable gases are stored on site such as Propane, Acetylene and Argon. Use and storage of these pressurised gases is controlled through operating procedures at the workshop and throughout the site.

No hazardous waste is stockpiled on site and is disposed of as produced – E.g. Waste Oils, WEEE, and Solid Oily Wastes.

2.5.2 Inventory of raw materials, products and wastes – Mine Site

The following table is a detailed inventory of raw materials used at the gypsum mine and opencast quarry:

Table 7. Inventory of Raw Materials/Chemicals (Mine Site)

Name	Type	Quantity	Location stored
Castrol 15w/40	Engine oil	200L Barrels x 2	Main oil store at w/shop(bunded)
Castrol AWS 46	Hyd oil	200L Barrels x 2	Main oil store at w/shop(bunded)
Castrol Tection mono 10W	Engine oil	200L Barrels x 2	Main oil store at w/shop(bunded)
Castrol Tection mono 20W	Engine oil	200L Barrels x 2	Main oil store at w/shop(bunded)
Castrol tribol 47447-220HT	Grease	250 kg in 50kg drums	Main oil store at w/shop(bunded)
WD-40 general	Lubricant spray	450ml cans x 10	Aerosol locker in workshop
WD-40 Contact cleaner	Cleaner spray	450ml cans x 10	Aerosol locker in workshop
Sulphur free diesel	Diesel	27000L Tank	Main diesel tank at w/shop
Adblue	Adblue	1000L IBC tank	Adblue storage area W/Shop(on bund)
Waste oil	Waste oil	1750 L Tank (bunded)	Storage tanks @ Workshop (Bunded)
Hydraulic oil 46	Hydraulic oil	2740L tank (bunded)	Storage tanks @ Workshop (Bunded)
Hydraulic 10W	Hydraulic oil	1750 L Tank (bunded)	Storage tanks @ Workshop (Bunded)
Heating oil tank	Green diesel	2740L tank (bunded)	Storage tanks @ Workshop (Bunded)
Engine oil 15/40W	Engine oil	1750 L Tank (bunded)	Storage tanks @ Workshop (Bunded)

All chemicals, cleaning materials and oils used at the facility are stored on a suitable bund as required. There have been no documented incidences of major chemical or fuel spills at the facility.

3.0 Decommissioning / Closure Tasks & Programs

3.1 Gypsum Processing Facility Closure Plan Synopsis

The closure scenario considered is a permanent cessation of operations on site and a complete clean closure of the facility. A plan for this scenario is covered in this report as it requires a more extensive plan than selling the site as an on-going mineral ore processing facility. A clean closure is envisaged for the process site due to high level of operational controls and procedures on site. To date, there have been no major environmental or polluting incidents on site. Therefore no aftercare and restoration management will be required to obtain a clean closure.

It should also be noted that this closure plan does not include the landfill site adjacent to the gypsum process facility. This landfill has for many years ceased receiving waste from the gypsum processing facility and capping of this landfill was completed in 2018. The aftercare and restoration of the landfill is not considered within this report and is covered by a separate decommissioning and aftercare plan.

The lagoon system to the rear of the processing facility currently receives leachate from the landfill site and site surface runoff from the process site. The volume of leachate from the landfill entering the lagoons has and will continue to decrease as the landfill capping is now complete.
The gypsum processing facility will be still in operation after 2021 and for many years to come. Stormwater from the facility will flow to the lagoons after the landfill is capped. Therefore, the decommissioning of the lagoons is included is the decommissioning and closure plan for the processing facility and not considered in the closure plan for the landfill.

Upon cessation of activities at the gypsum processing facility and subsequent decommissioning, no remaining environmental liabilities are expected. The following must be considered in order to achieve clean closure at the facility:

- Before decommissioning activities commence, a site closure application will be prepared and submitted to the Agency.
- While it is considered that the operations at the installation will not lead to any deterioration of the environmental conditions on or under the site, Saint Gobain Construction Products (Ireland) Ltd. is committed to ensuring that, as far as practicable, the decommissioning returns the site to a neutral condition and it is carried out in a manner that minimises any impact to the environment and as agreed with the Agency.
- Saint Gobain Construction Products (Ireland) Ltd. is committed to ensure that proper decontamination of on site plant and equipment takes place.
- Saint Gobain Construction Products (Ireland) Ltd. is committed to ensure that proper recovery or disposal of wastes generated during the decommissioning process takes place.

3.2 Mine Site Closure Plan Synopsis

The closure scenario considered is a permanent cessation of operations on site and a complete clean closure of the mine facility. Following the cessation of operations at the underground and opencast mines, all mobile and fixed plant will be removed from the site. The site will be decontaminated and decommissioned.

On verification by the EPA that this has been completed, it is planned that the final stage in the mine closure is to allow the groundwater table to recharge to its natural levels by turning off the pumps currently used to pump water from the opencast and underground mine floor. On closure and cessation of site activities and following the decommissioning and removal of all plant and equipment from the underground mine, ground water will be allowed to flow into the mine at a controlled rate.

Storm water and groundwater ingress will over time fill the opencast quarry with water to form a small lake.

Groundwater flow into the underground mine can be extracted if required by utilising submersible pumps to extract water to the current lagoons system for discharge as the permitted MSE1 discharge into the River Bursk.

The area around the newly formed lake will have where required soil and topsoil applied and these areas will be reseeded and planted with native species.

A detailed plan for this scenario is covered in this report as it requires a more extensive plan than selling the site as an on-going gypsum mineral mining facility. Upon cessation of activities at the mine and subsequent decommissioning, no remaining environmental liabilities are expected. The following must be considered in order to achieve clean closure at the facility:

- Before decommissioning activities commence, a site closure application will be prepared and submitted to the Agency.
- While it is considered that the operations at the installation will not lead to any deterioration of the environmental conditions on or under the site, Saint-Gobain Mining (Ireland) Ltd. is committed to ensuring that, as far as practicable, the decommissioning returns the site to a neutral condition and it is carried out in a manner that minimises any impact to the environment and as agreed with the Agency.
- Saint-Gobain Mining (Ireland) Ltd. is committed to ensure that proper decontamination of on-site plant and equipment takes place.
- Saint-Gobain Mining (Ireland) Ltd. is committed to ensure that proper recovery or disposal of wastes generated during the decommissioning process takes place.

3.3 Plant and equipment decontamination requirements

3.3.1 Gypsum Processing Facility decontamination requirements

The most likely scenario is that notification of closure is received in advance of closure and all closure activities are completed by Saint Gobain Construction Products (Ireland) staff, however in line with the EPA's guidance document costings are based on closure by a third party.

Building structures, bunding, fixed plant, mobile plant and other structures within the gypsum processing facility will be decontaminated prior to removal from the site. Dry deposit contaminants will be initially removed by mechanical methods such as scraping, sweeping and vacuuming. A decontamination and decommissioning team made up of existing staff may be retained on site for the duration of the decontamination and deconstruction phase of the site closure to perform and assist with required tasks. An external cleaning company may also be sought if required.

Residual contaminants not removed by initial mechanical cleaning will be removed using compressed air and steam cleaning. Compressed air will be used as a preference where possible to reduce volumes of contaminated wash water resulting from steam cleaning and power hosing. Wash water produced will be collected in the stormwater drains in the main yard areas and pass to the storm water lagoons at the rear of the site, before being discharged to the receiving stream on passing discharge parametric analysis.

3.3.2 Gypsum Mine Site decontamination requirements

Building structures, bunding, fixed plant, mobile plant and other structures within the gypsum mine facility will be decontaminated by Saint-Gobain staff prior to removal from the site before being sold. Dry deposit contaminants will initially be removed by mechanical methods such as scraping, sweeping and vacuuming to limit the generation of wash water on site. Given the specialised nature of the mining industry, familiarity with the mine site and for health and safety reasons, a decontamination and decommissioning team made up of Saint-Gobain staff will be established and will be retained on site for the duration of the decontamination and deconstruction phase of the site closure to perform required tasks.
Residual contaminants not removed by initial mechanical cleaning will be removed using compressed air and steam cleaning. Compressed air will be used as a preference where possible to reduce volumes of contaminated wash water resulting from steam cleaning and power hosing. Wash water produced will be collected in the surface water drains and pass to the surface water lagoons, before being discharged to the receiving river on passing discharge emission limit values as per IED licence P0519-03.

3.4 Plant and equipment decommissioning requirements

At the processing facility, Kettle 6 is a conical kettle, whereas the remainder of the kettles (3, 4, & 5) are continuous kettles (older technology). Kettle 6 will be reused within the Saint-Gobain group and therefore be shipped to another site in either France or the UK. The remainder of the fixed and mobile plant will be sold on the open market or can be sold as scrap if there is no other option.

The gypsum mine site fixed plant may be shipped to other sites within the Saint Gobain group in either France or the UK or sold on the open market. If no buyer can be sought it will be sold as scrap.

3.5 Demolition

3.5.1 Process Facility demolition requirements

The main office building, technical academy, security building, in booth, customer services building, rock shed, mechanical & electrical workshop, plaster mill, board plant & amenities building, car parks, concrete yards and main concreted paths and floor areas will remain in place as this would assist in allowing other industrial facilities to locate to the site. All asbestos will be removed from the site and the buildings will then be surveyed and rendered safe. In the event that certain buildings cannot be rendered safe in situ, these buildings will be deconstructed and removed from site following decontamination.

Materials produced as a result of building and structures deconstruction include:
1. Metal framing and Cladding
2. Construction & Demolition materials (blocks, concrete, plaster etc…)
3. Electrical cabling
4. Piping and ducting
5. Plastics
6. Wood
7. Glass
8. Asbestos

Materials will be sold as scrap or recovered materials as a preference. Materials will be recycled if not sold or disposed of by licenced contractors that presently remove waste from the site. At present, there is some asbestos panelling and cladding on site and there is currently a program implemented to remove a set amount of asbestos from the site each year. It is hoped that all asbestos will be removed from the site at time of facility closure. If however, some asbestos remains on site, this will be removed by a licenced contractor as part of the first stage of site decommissioning.

3.5.2 Mine site demolition requirements

The administration building, canteen building, access road to these buildings and carpark will remain in place. Production buildings such as the homogeniser building, structures and large fixed plant will be deconstructed, sold and removed from site following decontamination.

Materials produced as a result of building and structures deconstruction include:

1. Metal framing and Cladding
2. Construction & Demolition materials (blocks, concrete, plaster etc…)
3. Electrical cabling
4. Piping and ducting
5. Plastics
6. Wood
7. Glass

Materials will be sold as scrap or recovered materials as a preference. Materials not sold will be recycled or disposed of by licenced contractors that presently remove waste from the site.

3.6 Consumables

It is expected that at least 3 months' notice of site closure will be available to Saint-Gobain Construction Products (Ireland) Ltd for both the gypsum mine and processing facilities. On receiving notification of site closure, Saint-Gobain Construction Products (Ireland) Ltd will cease ordering or reduce quantities ordered of consumables to allow stock on site to be used up in the last months of activity. Mining will be reduced or cease at the Saint-Gobain Mining (Ireland) Ltd facility on notification that the site is to close. On final closure, any consumables that remain on site will be either removed by their suppliers at a neutral cost or transferred to other Saint-Gobain facilities in Ireland or the UK for use.

3.7 Production Materials & Finished Product

It is expected that at least 3 months notice of site closure will be available to Saint Gobain Construction Products (Ireland) Ltd. On receiving notification of site closure from Saint-Gobain, Saint Gobain Construction Products (Ireland) Ltd will cease ordering or reduce quantities ordered of consumables and raw materials to allow stock on site to be used up in the last months of production. Any remaining consumables and raw materials will either be returned to suppliers for credit or shipped to similar Saint-Gobain companies in the UK, or as a final option returned to suppliers as a free return.

Production will be reduced or cease at the gypsum processing facility on notification that the site is to close. On final closure, any finished product on site will be removed and shipped to similar Saint-Gobain companies in the UK. From here, products will be sold and distributed. A warehouse facility could also remain at the Kingscourt site until all stock of finished product has been sold.

3.8 Chemicals and Wastes

Before the plant decommissioning starts, all chemicals, oils or cleaning products will be removed from the gypsum mine and processing facilities either by selling to third parties, transferring to other Saint Gobain group sites or removal by licenced waste contractors.
All wastes on site will be removed as currently performed by licenced waste contractors.
All wastes produced during decommissioning will also be removed from site by licenced waste contractors.

3.9 Contaminated land treatment, removal and/or disposal

There may be heaps of spoil, rubble and C & D waste on site from infrastructural works. Any such spoil heaps that are on site in the event of closure will be sampled and analysed for Total Pollutant Content and waste acceptance criteria in order to determine if the material can be classed as inert, stable non-reactive or hazardous under the Landfill Directive of 1999.
Such stockpiles will be removed from site and treated or disposed of accordingly by licenced waste contractors and facilities as agreed with the EPA.

3.10 Soil and Groundwater Monitoring

3.10.1 Gypsum Processing Facility Soil & Groundwater Monitoring

There have been no incidents of soil contamination as a result of gypsum processing operations on site since the granting of an IPPC licence in 2002.

The processing areas on site are almost entirely covered by hard-stand and it is proposed to leave the hard-stand in place after closure of the site. There will not, therefore, be any soil to be removed from the site. Soil Contamination is not considered to be a potential problem. In terms of site history, there have been no significant spills to date. In the event of any spill in the future, (prior to closure) spills will be dealt with efficiently due to the presence on site of an Emergency Response Team. There are spill containment procedures in place and spill clean-up material readily available.

Groundwater monitoring results have to date not indicated any site contamination.
As required under Schedule C.5 of IED licence P0519-03, Saint Gobain Construction Products (Ireland) perform ground water sampling and analysis from 15 groundwater boreholes on the process site. This is performed on a quarterly basis and will continue to be done throughout and following the closure of the facility to a timeframe as agreed with the EPA. No ELV (Emission Limit Values) are specified for groundwaters in IED licence P0519-03, however, trigger limits have been set for each groundwater parameter based on published IGV (Interim Guideline Values) and analysis results during and following the facility closure will continue to be compared to these trigger limit values as a measure of compliance.

Table 8: Process Facility Groundwater monitoring requirements

Analysis	Frequency	Method
Water Level	Quarterly	Dip meter
pH	Quarterly	pH meter
Conductivity	Quarterly	Conductivity meter
COD	Quarterly	Standard method
Calcium	Quarterly	Standard method
Sulphate	Quarterly	Standard method
Ammonia	Quarterly	Standard method
Chloride	Quarterly	Standard method
Manganese	Quarterly	Standard method
Barium	Quarterly	Standard method
Other*	Quarterly	As agreed with the EPA

* Other parameters may be required by the EPA

3.10.2 Gypsum Mine Site Soil & Groundwater Monitoring

As a condition of the licence, Saint-Gobain Mining (Ireland) Ltd has taken biannual samples of groundwater for analysis from all groundwater boreholes at the mine site. These are reported in the AER as per IED licence P0519-03 and table 5 below.

Soil Contamination is not considered to be a significant issue in terms of site closure. There have been elevated levels of petroleum hydrocarbons (TPH) at two groundwater monitoring boreholes recorded at the mine. The TPH levels have been reported to the EPA in the Annual Environmental Report and an investigation into the cause of the elevated TPH levels is currently ongoing. If oil spills occur on site they will be dealt by the on-site Emergency Response Team. There are spill containment procedures in place and spill clean-up material readily available. Groundwater monitoring results have to date not indicated any site contamination.

As required under Schedule C.8 of IED licence P0519-03, Saint-Gobain Mining (Ireland) Ltd. performs ground water sampling and analysis from 12 groundwater boreholes on the mine site. This is currently performed on a biannual basis. All 12 groundwater boreholes will continue to be monitored on a biannual basis following decommissioning and flooding of the underground mine and opencast quarry. It is estimated it will take 30 years to complete flooding of the underground mine and opencast quarry. Therefore, groundwater monitoring has been costed for a duration of 32 years following cessation of mining activities (2 years decommissioning plus 30 years controlled flooding).

Trigger limits have been set for each groundwater parameter and analysis results during and following the facility closure will continue to be compared to these trigger limit values as a measure of compliance.

Table 9: Mine Site Groundwater monitoring

Parameter	Frequency	Method
Water Level	Biannually	Dip meter
pH	Biannually	pH meter
Conductivity	Biannually	Conductivity meter
Calcium	Biannually	Standard method
Sulphate	Biannually	Standard method
Ammonia	Biannually	Standard method
Chloride	Biannually	Standard method
Nitrate	Biannually	Standard method
Manganese	Biannually	Standard method
Sodium	Biannually	Standard method
Potassium	Biannually	Standard method
Magnesium	Biannually	Standard method
Other*	Biannually	As agreed with the EPA

3.11 Surface water Monitoring

3.11.1 Gypsum Processing Facility Surfacewater Monitoring

Surface water monitoring results have to date indicated that there has been no significant pollution instance on site. As required under Schedule C.2.2 of IED licence P0519-03, groundwater monitoring results has to date not indicated any site contamination. Saint Gobain Construction Products (Ireland) perform stormwater discharge sampling and analysis of receiving waterbodies in the vicinity of the gypsum processing site. This monitoring program has been costed in section 6.

3.11.2 Gypsum Mine Site Surfacewater Monitoring

The controlled flooding of the underground mine and opencast quarry will over time allow for storm water and groundwater recharge to form a lake on the footprint of the Saint-Gobain Mining (Ireland) Ltd mine and quarry. The Environmental Impact Statement for the Saint-Gobain mining facility concluded that the lake will cover an area of approx. 25.4 hectares. It is estimated that approx. 30 years will be the time required for groundwater rebound to flood the underground mine and for storm water to fill the excavated area of the opencast quarry.
Post flooding, in the event of overflow from the newly formed lake, any overflow water from the lake will flow through gravity into the existing westward flowing stream close to MSW1. It is proposed that during flooding and for a period of 2 years after flooding is completed, quarterly analysis of the receiving water downstream on the stream will be performed for the current MSW1 licenced parameters. The westward flowing stream that receives storm water at MSW1 is a tributary of the Kingscourt River and forms part of the River Lagan catchment area.

There are no licenced ELV's (Emission Limit Values) for MSW1 in licence P0519-03, however, surface water analysis results during and following the facility closure will continue to be compared to the 2009 surface water regulation good water quality values as a measure of compliance. Warning and control limits for the monitoring point downstream of MSW1 may be set and agreed with the EPA prior to site closure.

This monitoring program has been costed in section 6.

Table 10: Surfacewater monitoring at MSW1

Analysis	Frequency	Method
pH	Quarterly	pH meter
BOD	Quarterly	Conductivity meter
Sulphate	Quarterly	Standard method
Calcium	Quarterly	Standard method
Conductivity	Quarterly	Standard method
Total Nitrogen	Quarterly	Standard method
Total Phosphorus	Quarterly	Standard method
Other*	Quarterly	As agreed with the EPA

3.12 Mine Site Ground and Stormwater Management

It is planned that the final stage in the mine closure is to allow the groundwater table to recharge to its natural levels by turning off the pumps currently used to pump water from the opencast and underground mine floor.

On closure and cessation of site activities and following the decommissioning and removal of all plant and equipment from the underground mine, the controlled natural flow of groundwater ingress into the mine will occur. Storm water and groundwater ingress will over time fill the opencast quarry with water to form a small lake.

Groundwater flow into the underground mine can be extracted if required by utilising submersible pumps to extract water to the current lagoons system for discharge as the permitted MSE1 discharge into the River Bursk.

Two mass concrete bulkheads were installed in the underground mine at locations E1South and E2South to control groundwater ingress into the underground mine from this area. No maintenance of bulkhead at Drummond mine is required as there is no current or planned build up of water behind the bulkhead. The current water flow from behind the bulkhead is not under pressure however monitoring of water flow volume is ongoing. There is no cost associated with monitoring water flow as it is now part of the routine dewatering management system for Drummond mine. The future plan for the ongoing operation of the bulkhead is to allow no build up of water pressure behind the bulkhead hence there are no long term costs involved.

3.13 Mine Site Land Rehabilitation and Planting

During the lifespan of the opencast mine at Knocknacran, Saint-Gobain Mining (Ireland) Ltd practiced grading, contouring and landform remodelling whilst extracting mineral gypsum. This allows for acceptable sloping and fall in gradient that lends itself to successful reseeding and planting of the opencast mine area. The use of mounding and grading also assists the creation of microclimates that encourage plant growth and can help in the reduction of erosion.

On closure of the mining operation and following the creation of a small lake through the controlled flooding of the mine, the area around the lake will in some sections require soil and topsoil applied. These areas will be reseeded and planted. Phased planting will be undertaken throughout the closure plan timeframe to create a landscape that blends into the surrounding countryside.

A map illustrating rehabilitated land and newly formed lake is included as Appendix 1 of this report. It is estimated that 23.9 hectares of land will need rehabilitation. This will require 59,750m^3 of topsoil, of which there are 26,700m^3 available on site. Other required topsoil will be source from a certified green field site and subject to inspection before use as fill material on site.

The guiding principles for the rehabilitation of land at the mine site are as follows:

- Establish an ecological and landscape structure that creates habitats of local value
- Allow natural plant succession in conjunction with the planting of indigenous tree and shrub species
- Achieve a high level of ecological diversity within the site establishing a high quality mixture of coniferous and deciduous planting
- Achieve a strong nature conservation theme
- Improve visual and physical connections with surrounding land uses

It is proposed to seed areas of the site with a range of seed mixes to increase the cover and to improve the habitat value of the site. The use of a variety of grass mixes will allow various use areas of the site to be defined.

The first planting of pioneer grass species will occur following the final contouring of the opencast mine slopes and after grass seeding has been established. Planting will be used to facilitate a long term process of succession and colonization in order to create a diverse ecological habitat. The first phase of planting will be birch and alder. These species tolerate harsh and exposed conditions and will create shelter for other tree species to be planted such as oak and maple.

An understory of hawthorn, hazel and dogwood will be planted. Woody plants such as these encourage bird species to establish in wooded areas and this assists with the dispersal of seeds and the natural plantation of the site. Tree and hedge plantations will be placed to create links with existing hedgerows creating corridors for fauna to move from area to area. They will also create habitat islands which will help in the dispersal of seed.

An estimate of the quantity of soil and topsoil has been calculated based on the area to be rehabilitated, the current soil and topsoil available on site and the required depth of soil in each section of the opencast mine perimeter – see Appendix 1. Costings for the purchase and application of the required soil and of reseeding/replanting these areas are included in section 6 of this report.

3.14 Programme and timeframes for delivery

3.14.1 Gypsum Processing Facility Programme and timeframes for delivery

A maximum timeframe for completion of tasks set out in the closure plan, of approximately one year is expected.
This is the duration in which all tasks listed in section 6 – Costings, must be complete. Following the plan, waste disposal and decontamination of plant and equipment will be the first tasks completed as disassembly and shipping of plant and equipment cannot be performed until this is done. It is planned that all waste will be removed from the site within 3 months of notification of facility closure.
Following completion of all closure tasks, an external closure plan audit will be conducted by an environmental consultant agreed with the EPA. A period for ongoing monitoring of ground and surface waters will also be agreed with the EPA following closure.

A Gantt chart illustrating closure plan timeframes is given below

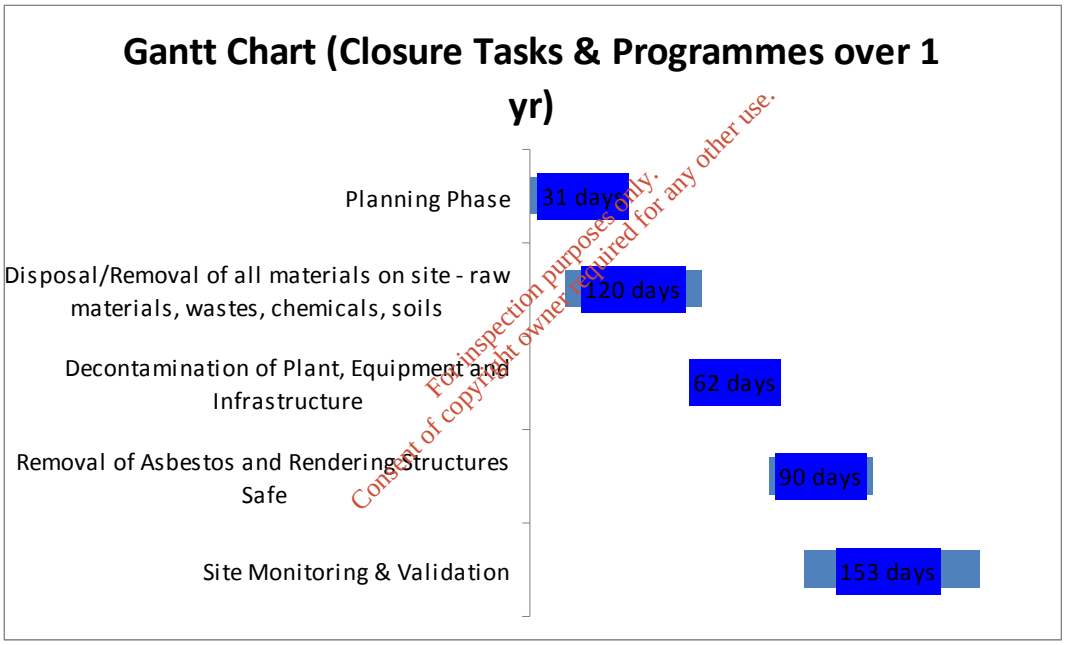


Figure 4: Closure Plan Tasks Process Site

The planning phase will involve the development of a procurement management plan for the phases of the shutdown project. It will also involve refinement of project scope and schedule and the definition of procedures. It is estimated that it will take three months to dispose and remove raw materials, wastes and chemicals/oils on site.

Decontamination of plant, structures and equipment is expected to take two months to facilitate the subsequent decommissioning of the site. Deconstruction and removal is estimated to take three months due to the large size and volume of key processing equipment. Site monitoring will take place over a period of five months with validation at the end of that five month period. Following the facility closure and site decommissioning,

Saint Gobain Construction Products (Ireland) Ltd. will continue to perform surface and ground water sampling and analysis as per IED licence P0519-03 for a duration agreed on consultation with the Environmental Protection Agency – costs are estimated for 10 years in this report.

Dust monitoring will also continue as per IED licence for an agreed duration.
Air monitoring will discontinue as no production processes will be performed and therefore no emissions to atmosphere will be made.

3.14.2 Gypsum Mine Site Programme and timeframes for delivery

Closure of the Saint Gobain gypsum mine will be completed in 2 phases. The 1st phase is the intermediate closure plan which will take place 2 years after cessation of gypsum rock extraction from the opencast quarry. The 2nd phase is the closure of the underground mine and will occur when all the economically extractable reserve of gypsum mineral has been removed from the mine area unless permission has been obtained to extend the underground mining area. The possible closure date for Drummond mine is therefore difficult to accurately predict as it will depend on market demand. The planning phase will involve the development of a procurement management plan for the phases of the shutdown project. It will also involve refinement of project scope and schedule and the definition of procedures.
It is estimated that it will take three months to dispose and remove raw materials, wastes and chemicals/oils on site.

Phase 1 refers to the closure of the opencast quarry. Phase 1 includes the removal and decontamination of materials and equipment associated with the operation of the opencast quarry. This does not include equipment required for pumping or environmental monitoring. Phase 1 will include surface contouring, landscaping of the extension area, thinning and final planting. The decontamination of plant, structures and equipment is expected to take two months to facilitate the subsequent decommissioning of the site. Deconstruction and removal is estimated to take three months due to the large size and volume of key processing equipment.

Step 1. Removal of all equipment from the opencast quarry area with the exception of the pumping station. (Year 1)

Step 2. Site contouring, Restoration of topsoil cover & grass seeding. (Year 1 – 2)

Step 3. Planting of pioneer species and initial landscaping, installation of access where appropriate. (Year 2 – 3)

Step 4. Thinning of species, planting of final cover species. (Year 7 – 8)

Phase 2 refers to the closure of the underground mine. It includes the decommissioning, decontamination and removal of equipment / materials used for the operation of the underground mine and site contouring.

Step 1: Removal of all fixed and mobile plant from underground (except pumping and ventilation equipment).

Step 2: Removal of all oils and greases from underground storage areas.

Step 3: Installation of telemetry system linking subsidence monitoring points at key locations to surface. (Year 1) with Land subsidence monitoring performed Year 1 - 30.

Step 4: Removal of all surface fixed plant and production buildings. (Year 1 – 2)

Step 5: A 250 mm diameter borehole will be installed to intersect the Drummond mine workings at approx. -20 m O.D. A 150 mm submersible pump will be installed prior to all underground pumping equipment being removed from the mine. The existing Drumgossat submersible pumping system will also be maintained.
In the event of stability issues arising during the flooding process, it will be possible to halt and reverse the flooding process by activating the submersible pumps.

Step 6: Remove pumping equipment from deepest locations and monitor rate of flooding. When water level reaches -10m O.D., the pumping system in the opencast quarry can be removed, allowing the depression to fill. (Year 1 – 10)

Step 7: Remove all remaining equipment from the underground mine. Seal declines to portal at both Drummond and Drumgossat. (Year 10)

Step 8: Complete site contouring, restoration of topsoil cover, grass seeding, boundary treatment in mineral processing area. (Year 2)

The flooding of the underground mine and opencast quarry with ground and storm water will take a considerable amount of time. Information from the Environmental Impact Assessment completed for the Saint-Gobain gypsum mine and quarry, estimates that in excess of 30 years will be the time required for groundwater rebound to flood the underground mine and for storm water to fill the excavated area of the opencast quarry. To monitor land stability in the vicinity of the underground mine during this natural flooding, it is proposed to continue the current land stability monitoring over a 30 year duration. The current monitoring covers lands and roads in the vicinity of Drummond mine. It is proposed that this will continue twice yearly over the first 10 years and annually after that.

Groundwater and surface water monitoring will continue as specified in section 3.7 during this period. Storm water monitoring downstream will be performed during the period of controlled flooding of the quarry and underground mine and for a further 2 years after flooding is complete.

As outlined in the closure plan, waste disposal and decontamination of plant and equipment will be the first tasks completed as disassembly and shipping of plant and equipment cannot be performed until this is done. It is envisaged that all waste would be removed from the site within 3 months of notification of the mine facility closure.

Following completion of all closure tasks, an external closure plan audit will be conducted by an environmental consultant nominated by Saint-Gobain Construction Products (Ireland) Ltd. and agreed with the EPA.

A period for ongoing monitoring of ground and surface water waters will also be agreed with the EPA following closure.

Only following verification from the EPA that decontamination and decommissioning of the site has been completed will the underground mine and quarry be allowed to fill with groundwater and storm water.

Two Gantt charts illustrating the timeframe for the completion of both phases of the closure plan are provided below.

The total duration for completion of CRAMP for the Saint-Gobain Mining (Ireland) Ltd mine is estimated at being 34 years. This consists of 2 years of plant and building decommissioning, landscaping and land rehabilitation; 30 years of controlled flooding, ground and surface water monitoring with a further 2 years of surface water monitoring.

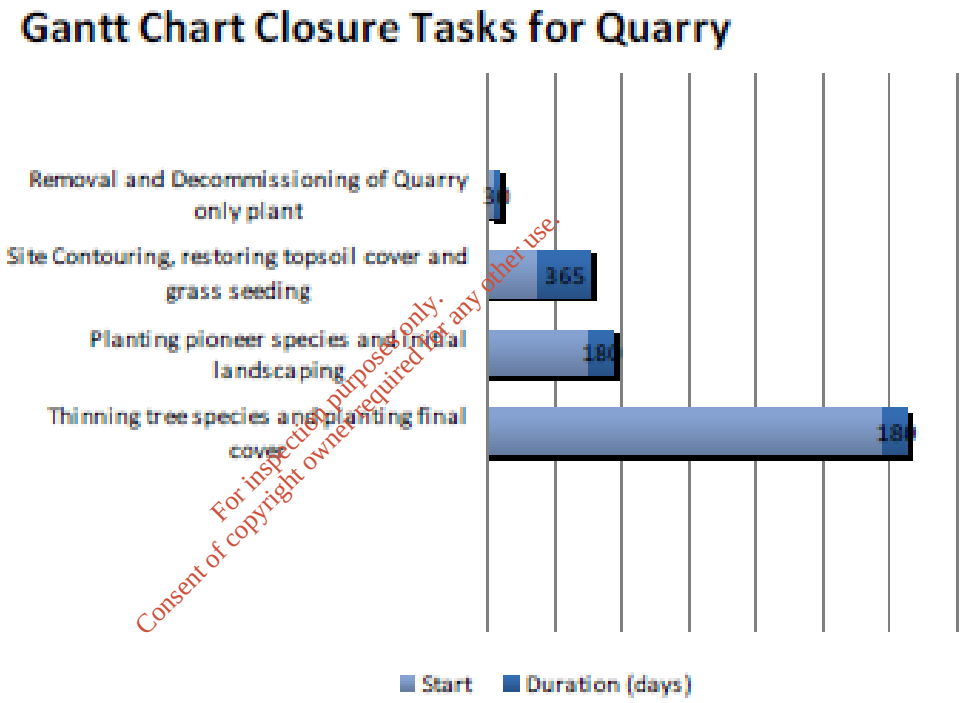


Figure 5: Closure Plan Tasks Opencast Mine

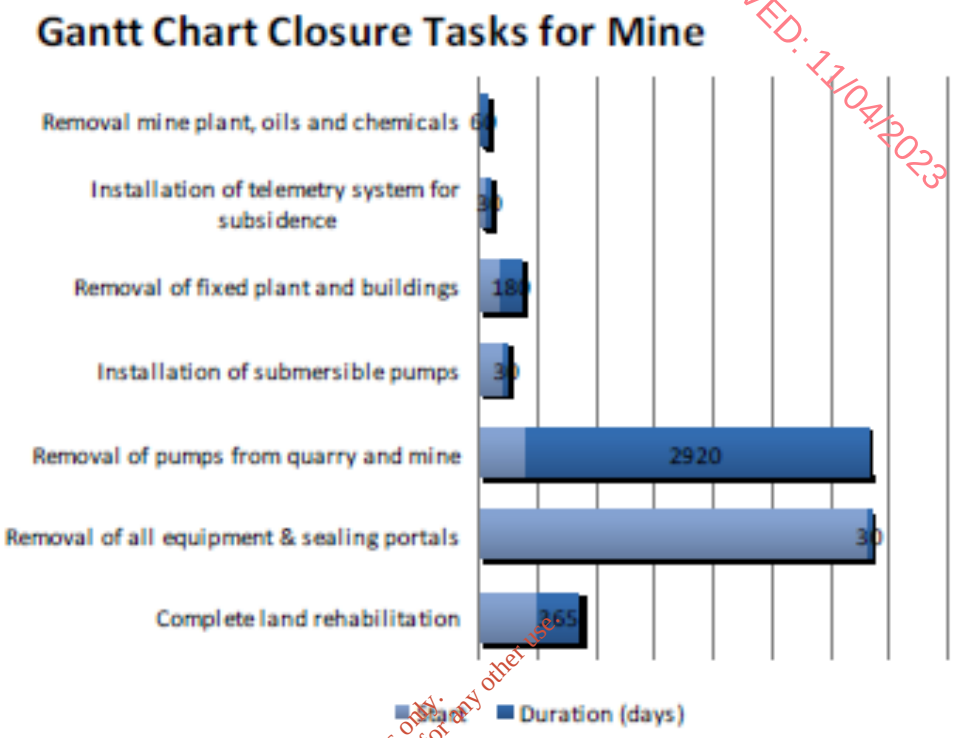


Figure 6: Closure Plan Task Drummond Mine

4.0 Criteria for Successful Decommissioning

Successful clean closure will be achieved when it can be demonstrated that there are no remaining environmental liabilities at the Saint Gobain gypsum processing and mining facilities. The criteria for successful clean site closure will be as follows:

1. Ensuring sufficient resources are made available so that the site closure is carried out to plan and within a reasonable timescale.
2. All plant safely decontaminated/decommissioned using standard procedures and authorised contractors.
3. All wastes handled, packaged, temporarily stored and disposed or recovered in a manner which complies with regulatory requirements.
4. All relevant records relating to waste and materials transfer or disposal were managed and retained throughout the decommissioning/closure process.
5. There is no soil or groundwater contamination at the site. This has been verified using monitoring data, site incident and pollution records and groundwater assessments conducted at the time of site closure. The criteria for evaluating whether the soil or groundwater is contaminated will be that samples are assessed against the Dutch Guideline Criteria (soil), the EPA's Interim Guideline Values (groundwater) and trigger limits set for each borehole location (groundwater) by Minerex Environmental Consultants.
6. The Environmental Management System will remain in place and continue to be implemented during the closure period by designated Saint-Gobain personnel.

5.0 Decommissioning Plan Validation

Prior to commencement of the implementation of the CRAMP, it will be reviewed by an appropriately qualified independent consultant. This consultant will be nominated by Saint-Gobain Construction Products (Ireland) Ltd. and agreed with the EPA at the time.

Throughout the implementation of the Plan, the consultant will monitor progress and advise on the proper implementation of the Plan. After the Plan has been implemented and all associated works have been carried out, the consultant will conduct a Decommissioning and Closure Audit. This audit will verify that all equipment and materials have been properly disposed of and that the site has been rendered free from potential liabilities. A report on the Decommissioning and Closure Audit will be prepared for the EPA, and will form part of the validation certification for the Plan. The audit will ensure the following:

1. All actions as detailed in the CRAMP are carried out.
2. Timescales are as agreed in the decommissioning/closure plan.
3. All waste and recycled materials have been transported off site to contractors as agreed in the plan.
4. Evidence is available of all consignments transported off site.
5. There is no evidence of environmental impact on soil or groundwater arising from the activities associated with the decommissioning/closure plan.

6.0 Gypsum Processing Facility Decommissioning & Closure Costings

The tables below details estimated costs based on up to date pay rates and contractor rates. Heavy end estimates have been used to give higher region costs. Costs in 2021 have been determined by applying a 2.5% per annum increase to 2019 prices to allow for annual inflation.

Table 11: Decommissioning and Closure Costs – Process Site

Task	Description	Quantity	Unit	Unit Rate €	Cost €	Source of Rates
Decontamination of main site plant & equipment	Removal of gypsum from main plant & equipment	4,704	Man hours	€22.73	€106,908.45	Spick N Span cleaners
Decontamination of Buildings and Structures	Removal of gypsum from main buildings & structures	6,302	Man Hours	€22.73	€143,226.45	Spick N Span cleaners
Decontamination of Fuel Tanks	Emptying, Cleaning & removal of fuel tanks (Assuming all tanks half full)	10,500	Litres	€56.82	€596.76	Rilta
Render safe Buildings & Structures	Render safe Plaster Mill & Board plant, engineering workshop, stores & accessories	25,208	m^2	€1.82	€47,741.45	Cass Roofing
Removal of fixed plant Inc. electrics & services (excl Kettle 6)	Removal of fixed plant	9,280	Man Hours	€45.45	€421,815.43	Industry Standard
Removal of Kettle 6	Transport of fixed plant for transport to either the UK or France	1	Kettle	€0.00	€0.00	Cost covered by Saint-Gobain receiving site
Disposal of Plant	Broken or damaged plant that is not transported for further use is metal fabricated and will be sold as scrap. This is cost neutral.			€0.00	€0.00	Local metal recycling company with WCP permit.
Staffing Costs (includes Administration Costs)	1 x Environmental Manager as part of full time role covering process site, landfill, & Mine site.	1	Per Annum	€17,045.34	€17,045.34	Current Salary Rates
Staff Costs	Annual Leave cover for 2 years	40	Days	€139.78	€5,602.98	Current EHS Salary
Security Costs	Netwatch Annual Contract	1	Year	€28,408.90	€28,408.90	Current Net watch rate
Monitoring (1 year @ Factory site only)	Monthly Surface Water Monitoring	12	Per Month	€681.81	€81,817.42	Current costs for 10 years
	Annual Surface Water Monitoring	1	Per Annual Event	€244.38	€2,436.40	Current costs for 10 years
	Ground Water Monitoring of nine wells (Not including landfill wells)	2	Per Event	€1,647.72	€32,953.90	Current costs for 10 years
	Dust Monitoring	12	Per Month	€34.09	€1,704.11	Current costs
	Noise Monitoring	1	Per Event	€852.27	€852.06	Current costs

Task	Description	Quantity	Unit	Unit Rate €	Cost €	Source of Rates
Draining and Cleaning of SW lagoons at rear of site if contaminated during decontamination	Sludge testing / research	3	Sample	€568.18	€1,704.11	Minerex
	Design & planning	4	Lagoon	€284.09	€1,136.78	Minerex
	Management & site work / supervision	12	Man day	€568.18	€6,818.56	Minerex
	Reporting	1	Report	€454.54	€454.92	Minerex
	Pumps, generator, hosing, pipe stoppers.	6	Day	€284.09	€1,704.11	Minerex
	Hire of Dumper truck, Long reach excavator & JCB & Labour	6	Day	€909.08	€5,454.85	Wills Bros
Filling in and seeding of lagoons if required	Purchase of fill materials and soil. Landscaping and reseeding at lagoon areas in compliance with recommendations from the habitat survey for the processing site.	30,000	m^3	€30.59	€917,826.00	Wills Bros
Planting of trees, grasses and plants for ground rehabilitation	Land rehabilitation of opencast quarry areas	5	Hectares	€0.00	€0.00	Cost Neutral Greenbelt Project
Removal of solid wastes	Lagoon Sludge	1,600	Per Tonne	€329.54	€527,268.76	Rilta
	C&D Waste	1,000	Per Tonne	€37.50	€37,499.96	AES
	Municipal solid waste	60	Per Tonne	€27.27	€1,636.87	AES
	Mixed dry recyclables	100	Per Tonne	€4.55	€4,545.00	AES
	Paper/ cardboard/ packaging	19	Per Tonne	€261.36	€4,966.30	AES
	Wood	24	Per Tonne	€34.09	€818.44	AES
	Chemicals/ paints / Ink & associated packaging	5	Per Tonne	€1,136.36	€5,681.78	Rilta
	WEEE - hazardous	2	Per Tonne	€272.72	€545.27	Irish Lamp
	Metal	11	Per Tonne	€0.00	€0.00	Charlie Byrne
	Waste Oils & Solid oily waste	40	Per Tonne	€2,045.44	€81,817.42	Rilta
Asbestos Removal [Note 1]	Asbestos Removal & Disposal	9,300	m^2	€12.84	€119,400.38	Cass Roofing
External consultation	Closure plan audit to ensure criteria for successful closure	5	Days	€852.27	€4,261.34	Industry standard / current provider
Closure Plan Audit & EPA Report	Closure plan audit to ensure criteria for successful closure	3	Days	€852.27	€2,557.22	Industry standard / current provider
Insurance Costs	Site insurance costs including environmental liabilities, personal injury, vehicular etc…	1	Year	€22,629.39	€22,629.41	Current Insurance Provider
Utilities	Water used for cleaning/decommissioning and electricity supply to power decommissioning equipment for up to 6 months	365	Days	€113.64	€41,476.57	Estimated quantity and current costs
Licence enforcement (1 year)	EPA Licensing costs for P0519-03	1	Year	€19,416.92	€19,416.60	Current EPA Cost

Additional Cost included in 2020 Review – see below						
External consultation	Environmental Impact Assessment prior to infilling of stormwater lagoons (if required to be filled) at the gypsum process site	3	Days	€852.27	€2,657.22	Industry standard / current provider

Total Costs

Total Closure and Decommissioning Costs: €2,705,309
20% Contingency: €541,062
Total Cost plus Contingency: **€3,246,270**

**Note 1: Funds would be transferred from the asbestos removal budget already in place to the closure plan budget. Figure based on 50% of asbestos remaining on site at time of closure*

7.0 Mine and Quarry Decommissioning & Aftercare Costings

The tables below details estimated costs based on up to date pay rates and contractor rates. Heavy end estimates have been used to give higher region costs. Costs in 2021 have been determined by applying a 2.5% increase per annum to 2019 prices to allow for annual inflation increases.

Table 12: Decommissioning and Aftercare Costs – Mine

Task	Description	Closure/ Aftercare	Quantity	Unit	Unit Rate €	Cost €	Source of Rates
Decontamination of main site plant & equipment	Removal of gypsum from main plant & equipment	Closure	488	Man hours	€22.29	€10,877.12	Spick N Span cleaners of EHS members
Decontamination of Buildings and Structures	Removal of gypsum from main buildings & structures	Closure	976	Man Hours	€22.29	€21,755.29	Spick N Span cleaners or EHS members
Deconstruction of Production Buildings & Structures	Demolition of Lorry load conveyor shed, the homogeniser building, the engineering workshop and bund structures	Closure	652	Man Hours	€33.43	€21,799.42	Cass Roofing
Removal of fixed plant	Removal of fixed plant	Closure	976	Man-hours	€55.73	€54,387.70	Industry Standard
Decommissioning & cleaning of Diesel tanks	Cleaning out tanks with total capacity of 23m^3 (Assuming all tanks half full). Cost includes tank decontamination, transport of fuel for recovery/recycling, contractor labour and tank decommissioning/disassembly. Cost plus 20% as there are a number of large tanks (5) on site at the mine	Closure	23	M^3	€55.68	€1,281.76	Rilta
Cleaning interceptor	Cleaning interceptor	Closure	1	Event	€1,716.33	€1,716.72	Rilta current cost
Disposal of Plant	Broken or damaged plant that is not transported for further use is metal fabricated and will be sold as scrap. This is cost neutral	Closure			€0.00	€0.00	
Staffing Costs (includes Administration costs)	1 x Environmental Manager as part of full time role covering process site, landfill, & Mine site. €15,000 for mine site only.	Aftercare	1	Per Annum	€16,717.55	€16,717.55	Current Salary Rates
Staff Costs	Annual Leave Cover over 2 years	Aftercare	40	Days	€55.68	€5,483.21	Current EHS Salary
Monitoring	Surface Water Monitoring	Aftercare	34	Years	€1,716.33	€16,596.72	Current costs
	Ground Water Monitoring (12 Boreholes)	Aftercare	32	Years	€1,838.93	€58,845.51	Current costs
	Dust Monitoring	Aftercare	34	Per Month	€133.74	€4,547.11	Current costs
	Noise Monitoring	Closure	2	Per Event	€835.88	€1,671.54	Current costs
	Land Subsidence monitoring *See Note 1	Aftercare	34	Years	€3,919.18	€133,355.83	Current costs
Soil and topsoil required for ground rehabilitation	Landscaping of areas above flood level of opencast mined area	Closure	33,050	M^3	€30.09	€994,526.88	Wills Bros

Task	Description	Closure/ Aftercare	Quantity	Unit	Unit Rate €	Cost €	Source of Rates
Application of soil and subsoil to required areas	Landscaping of areas above flood level of opencast mined area	Closure	33,050	M^3	€3.56	€117,869.62	Wills Bros
Purchase of trees and plants for land rehabilitation	Land rehabilitation of opencast quarry areas	Closure	23.9	Ha	€0.00	€0.00	Cost Neutral Greenbelt Project
Planting of trees, grasses and plants for land rehabilitation	Land rehabilitation of opencast quarry areas	Closure	23.9	Ha	€0.00	€0.00	Cost Neutral Greenbelt Project
Draining and Cleaning MSE1 lagoons at rear of site if contaminated during decontamination	Sludge testing	Closure	3	Per sample	€557.25	€1,671.54	Minerex
	Design & planning	Closure	2	Per lagoon	€278.63	€556.83	Minerex
	Management & site work / supervision	Closure	6	Man Day	€557.25	€3,343.09	Minerex
	Reporting	Closure	1	Per Report	€445.80	€445.47	Minerex
	Pumps, generator, hosing, pipe stoppers.	Closure	3	Per day	€278.63	€836.30	Minerex
	Hire of Dumper truck, Long reach excavator & JCB & Labour	Closure	4	Per Day	€668.70	€2,674.89	SG Rates
Filling in and seeding of MSE1 lagoons (if required)	Purchase of fill materials and soil. Staff costs to operate JCB and truck. Reseeding at lagoon areas in compliance with recommendations from the habitat survey for the processing site	Closure	6,253	M^2	€11.15	€69,690.06	SG Rates
Removal of solid wastes	C&D Waste	Closure	5,000	Per Tonne	€36.78	€183,893.00	Midland Waste
	Municipal solid waste	Closure	60	Per Tonne	€26.75	€1,605.36	Midland Waste
	Mixed dry recyclables	Closure	100	Per Tonne	€4.45	€445.47	Midland Waste
	Paper/ cardboard/ packaging	Closure	19	Per Tonne	€256.33	€4,870.70	Midland Waste
	Wood	Closure	24	Per Tonne	€33.43	€802.68	Midland Waste
	Chemicals/ paints / Ink & associated packaging	Closure	5	Per Tonne	€1,114.50	€5,572.52	Rilta
	Interceptor chambers	Closure	5	Per Tonne	€284.19	€1,421.50	Rilta
	WEEE - hazardous	Closure	2	Per Tonne	€267.48	€534.77	Irish Lamp
	Metal	Closure	1,000	Per Tonne	€0.00	€0.00	Charlie Byrne
	Waste Oils & Solid oily waste	Closure	40	Per Tonne	€2,006.11	€80,244.64	Rilta
	External consultancy, advice and validation of closure plan steps	Closure	5	Days	€835.88	€4,179.39	Industry standard
Purchase of Submersible pumps	Controlled flooding of underground and opencast mine areas	Closure	2	Per pump	€11,145.03	€22,290.06	Clarke Rewinds
Installation and commissioning of submersible pumps	Controlled flooding of underground and opencast mine areas	Closure	2	Per pump	€390.08	€780.61	Clarke Rewinds

Task	Description	Closure/ Aftercare	Quantity	Unit	Unit Rate €	Cost €	Source of Rates
Annual preventative maintenance of submersible pumps	Controlled flooding of underground and opencast mine areas over 30 years	Aftercare	30	Per annum	€390.08	€11,701.86	Clarke Rewinds
Utilities – water and electricity	Water used for cleaning/decommissioning and electricity supply to power decommissioning equipment for up to 6 months.	Closure	182	Days	€111.45	€20,284.42	Estimated
External consultation	Closure plan audit to ensure criteria for successful closure	Closure	3	Days	€835.88	€2,507.84	Industry standard
Licence enforcement charges (34 years)	EPA Licensing costs for P0519-03 (licensing cost divided by 2 and multiplied for total duration of CRAMP – decreasing by 1/24th year on year)	Aftercare	34	Years	€6,087.42	€206,972.07	As per EPA guidance
Insurance Costs	Site insurance costs including environmental liabilities, personal injury, vehicular etc…	Closure	2	Year	€22,194.21	€44,388.91	Current Insurance provider
Additional Cost included in 2021 Review – see below							
Security Management / Health & Safety	Maintenance of security fence to ensure No public access or trespass *See Note 2 Netwatch system for security cameras*See Note 2	Aftercare Aftercare	34 34	Years Years	€1,025 €2,562.50	€34,850 €87,125	Current Provider and cost
Groundwater Management	Maintenance of bulk head in the underground mine*See Note 3	Aftercare	34	Years	€0	€0	Current cost
External Consultation	Environmental Impact Assessment prior to infilling of stormwater lagoons (if required to be filled) at the gypsum mine site	Closure	3	Days	€852.27	€2,557.38	Current provider cost
External Consultation	External verification that CRAMP is completed and liaising with the EPA on surrender of IED licence	Aftercare	10	Days	€852.27	€8,522.67	Current provider cost
Total Decommissioning & Closure Costs						€1,690,006	
Total Aftercare costs						€576,195	
Total Estimated Decommissioning & After Care Costs						€2,266,201	
Contingency 20%						€453,240	
Total Funds Required including Contingency						€2,719,441	

Note 1 * Land Subsidence: ***It is proposed to continue the current land stability monitoring over a 30 year duration as this is the expected time frame for the natural flooding of the Drummond mine. The current monitoring covers lands and roads in the vicinity of Drummond mine. It is proposed that this will continue twice yearly over the first 10 years and annually after that. This will cost €1400 per monitoring event. Currently land stability in the vicinity of Drumgossat mine costs €1400 per monitoring event and it is planned to have an open cast mine over the main footprint of the old Drumgossat mine. Land stability on the roads over Drumgossat will continue twice yearly over the first 10 years and annually after that. Total cost €112,000 spread over 30 years***

Note 2 *Security: ***Every 6 months a security fence inspection is performed at a cost of €300. Maintenance costs are as they occur i.e. if a fence needs repair. A maintenance budget of €34K over 34 years is expected to be sufficient. The ongoing security camera monitoring is expected to be €2.5K per annum over 34 years. (Total €85K)***

Note 3* Bulk Head Maintenance: ***No maintenance of bulk head at Drummond mine required as there is no current or planned build up of water behind the bulk. The current water flow from behind the bulk head is not under pressure however monitoring of water flow volume is ongoing however, there is no cost associated with monitoring water flow as it is now part of the routine dewatering management system for Drummond mine. The future plan for the ongoing operation of the bulk head is to allow no build up of water pressure behind the bulk head hence there are no long term costs involved.***

Note* See table 14 below for breakdown of Inflationary increases over a 34 year period.

Table 13: Projection of Future Cost Estimates Accounting for Inflation of 2.5% per Annum

Year	Aftercare Costs	Decommissioning Costs
2021	€691,434	€2,028,007
2022	€708,720	€2,078,707
2023	€726,438	€2,130,675
2024	€744,599	€2,183,942
2025	€763,214	€2,238,540
2026	€782,294	€2,294,504
2027	€801,851	€2,351,866
2028	€821,898	€2,410,663
2029	€842,445	€2,470,930
2030	€863,506	€2,532,703
2031	€885,094	€2,596,020
2032	€907,221	€2,660,921
2033	€929,902	€2,727,444
2034	€953,149	€2,795,630
2035	€976,978	€2,865,521
2036	€1,001,403	€2,851,071
2037	€1,026,438	€2,922,347
2038	€1,052,099	€2,995,406
2039	€1,078,401	€3,070,291
2040	€1,105,361	€3,147,048
2041	€1,132,995	€3,225,725
2042	€1,161,320	€3,306,368
2043	€1,190,353	€3,389,027
2044	€1,220,112	€3,473,753
2045	€1,250,615	€3,560,596
2046	€1,281,880	€3,649,611
2047	€1,313,927	€3,740,852
2048	€1,346,775	€3,834,373
2049	€1,380,445	€3,930,232
2050	€1,414,956	€4,028,488
2051	€1,450,330	€4,129,200
2052	€1,486,588	€4,232,430
2053	€1,523,752	€4,338,241
2054	€1,561,846	€4,446,697
2055	€1,600,892	€4,557,864

Note: 20% contingency cost added to initial 2021 figures for aftercare and decommissioning

8.0 Decommissioning and Closure Plan Review & Update

The Decommissioning and Closure Plan for the gypsum processing facility and the gypsum mine/quarry will be reviewed annually and updated where necessary. Details of the review and any updates will be reported in the AER.
In the event of closure of the facility, the EPA will be notified in writing that the mining operations are ceasing and that the mine will be closing.

This plan will then be implemented in a phased manner as described previously. Throughout the closure, the site's EMS will remain in place and it will be ensured that there are no uncontrolled releases to the environment. Saint-Gobain Construction Product (Ireland) Ltd. management will liaise with the EPA over the period to determine when it would be appropriate to apply for the surrender of the licence.

9.0 Closure Plan Funding

The combined decommissioning and aftercare costs of the Saint-Gobain Mining (Ireland) Ltd mining facility in 2021 are calculated at €2,719,441.
The combined decommissioning and closure costs of the Saint-Gobain Construction Products (Ireland) Ltd gypsum processing facility in 2021 are calculated at €3,246,370.

The combined closure and aftercare management cost for the gypsum mine site and the gypsum processing facility is €5,817,940. This figure includes a 20% contingency.

For the gypsum mine and quarry site, the total aftercare costs have been calculated over a 34 year period to allow for inflation increases at 2.5% per annum.

In May 2018 the capping of a disused landfill on site was completed as per the EPA specifications for landfill decommissioning. The old landfill site is now four years into its planned aftercare. RPS completed the CRAMP for the old landfill (RPS Ref: MGE0451RP0007) which was approved by the EPA before commencement of capping works. Wills Bros. completed capping works. Following the completion of capping works, the EPA signed off on the closure of the old landfill site. RPS costed the capping works at €2,777,098 and this works was funded by the Saint Gobain group. The total aftercare costs for the capped landfill were calculated by RPS to be €1,451,797 giving an annual aftercare cost of €40,533 over 30 years.

The total CRAMP costs for the capped landfill, the gypsum mine/quarry and the gypsum processing facility is:

Landfill Aftercare	€1,451,797
Process Facility CRAMP	€3,246,370
Mine Site CRAMP	€2,719,441
Total:	**€7,417,608**

Saint Gobain have a bank guarantee in place for the inevitable CRAMP costs relating to the environmental restoration and aftercare of the mine, quarry and landfill. The current guarantee amounts to €6,251,447.

Saint Gobain also have a 'Parental Company Guarantee (PCG)' which is in place to cover up to €1.5m of non inevitable costs from CRAMP reports, such as factory closure costs, environmental liabilities etc should SGCPIL go insolvent or fail to fix an issue.

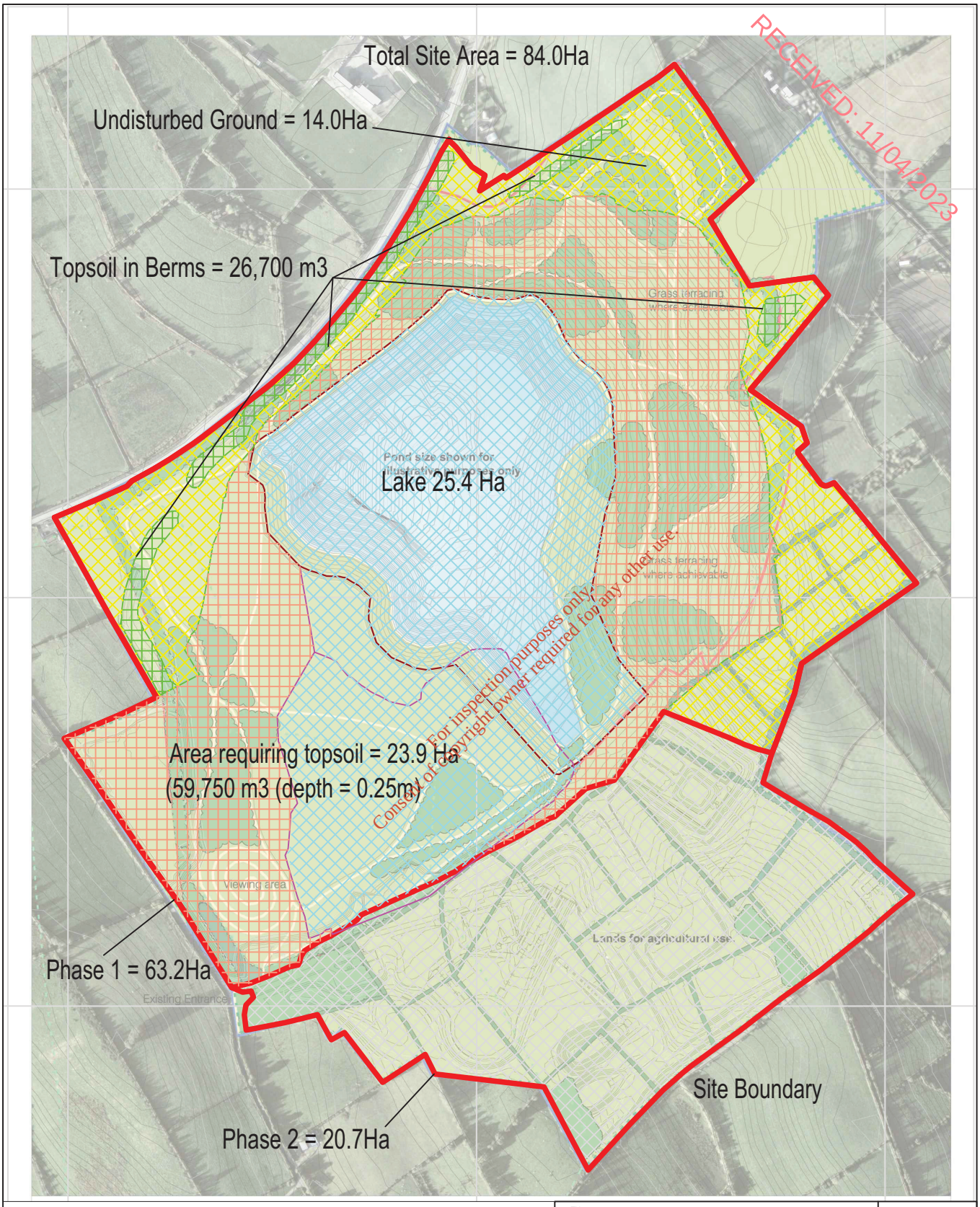
Therefore Saint Gobain have in place sufficient funding to meet the total closure and aftercare costs of the gypsum mining/quarry, the gypsum processing facility and the aftercare costs for the decommissioned landfill.

David Kelly BSc. MSc.
Director & Technical Manager
KD Environmental Ltd.

24th March 2021

Appendix 1

Mine Site Topsoil Requirement & Layout



Topsoil Required = 59,750 m3
Topsoil Available on Site = 26,700 m3
Difference = 33,050 m3

ref drg: Closure Plan 5621_DR-301-02 Jan 2010

Title

Knocknacran Opencast Mine

Topsoil Requirement for Closure Plan

Surveyed	01-09-17
Drawn	09-09-17
Grid	National
Datum: O.S.Poolbeg +1000m	

SCALE 1:2500

GYPSUM INDUSTRIES PLC
KNOCKNACRAN OPENCAST

Kingscourt,Co Cavan,Ireland

Drawing No.

350b-24-14

Appendix 2

Piteau Associates – Hydrogeology Report

PITEAU ASSOCIATES
Geotechnical and Water Management Consultants

HYDROGEOLOGY STUDY OF KNOCKNACRAN OPEN CAST AND DRUMGOOSAT AND DRUMMOND UNDERGROUND MINES

Prepared for

SAINT-GOBAIN MINING IRELAND (LTD.)

February 2020
PROJECT 4238-R1

Piteau Associates
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Shrewsbury
SY2 5DE
United Kingdom

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1. INTRODUCTION

1.1 BACKGROUND

This report has been prepared by Piteau Associates for Saint-Gobain Mining Ireland (Ltd.) (SGMI). It describes the assessment undertaken to develop a conceptual hydrogeological model for the infiltration of surface water and the flow of groundwater around and into the Drumgoosat and Drummond underground mines and Knocknacran open cast, Co Monaghan.

The study includes all available geology, groundwater and surface water information for the sites, including the information contained in reports by Minerex (2019), SLR (2019), SGMI (2019) and SRK (multiple dates).

Monaghan County Council (MCC) has requested that a hydrogeological report is prepared according to a scope defined by ARUP consulting which collates all relevant hydrogeological information for Drumgoosat and Drummond underground mines, and the existing Knocknacran open cast mine. This report has been prepared according to the ARUP scope.

The report was presented in draft to MCC, EMD and the EPA at a meeting in the MCC offices on 10th December, 2019. The PowerPoint presentation was distributed to all attendees after the meeting. Verbal and written comments from the agencies have been incorporated into this final version of the report.

1.2 SITE DESCRIPTION

1.2.1 Climate

Precipitation records from the site between 1990 and 2019 show that the annual average rainfall is 955 mm. Dunsany synoptic station (45 km south of the site) has an annual average potential evapotranspiration of 515 mm (2016 to 2019).

Table 1-1 presents the monthly mean values for precipitation and evaporation. As is typical in Ireland, the wettest months coincide with the months of lowest potential evapotranspiration (October to January). The driest months with highest potential evapotranspiration are May and June.

1.2.2 Topographic setting

The topography of the area is gently undulating with a general fall from west to east. The area of the site has an elevation of between 40 and 50 maODM (metres above Ordnance datum, Malin) which is also typical of the area to the east. The elevations gradually increase to the

west, to a ridgeline (and surface water catchment divide) which reaches around 250 maODM about 8 km to the west of site.

The lowest topography close to the study area occurs around the River Bursk (between 25 and 32 maODM). The River Lagan near the south end of the Drummond mine is about 30 maOD, which is considered to be the hydrogeological base level for the mining district.

Table 1-1 Monthly mean precipitation and potential evapotranspiration

Month	Precipitation (mm/mon)	Potential Evapotranspiration (mm/mon)
January	94.9	11.3
February	74.9	17.7
March	72.8	32.3
April	66.1	49.2
May	64.4	78.1
June	67.9	84.9
July	73.3	87.1
August	77.3	67.3
September	64.4	45.6
October	96.5	25.2
November	98.8	9.1
December	103.6	9.4
Total	**954.9**	**514.5**

1.2.3 Surface water drainage

The three primary local surface water courses are (Figure 1.1):

- Magheracloone Stream which runs north to south along the western boundary of the site;
- River Bursk (also known as River Rahans) which runs north to south along the eastern boundary and which receives discharge from the site;
- River Lagan (also known as the River Glyde) receives water from both the Maghercloone and Bursk and flows from west to east to the south of the site.

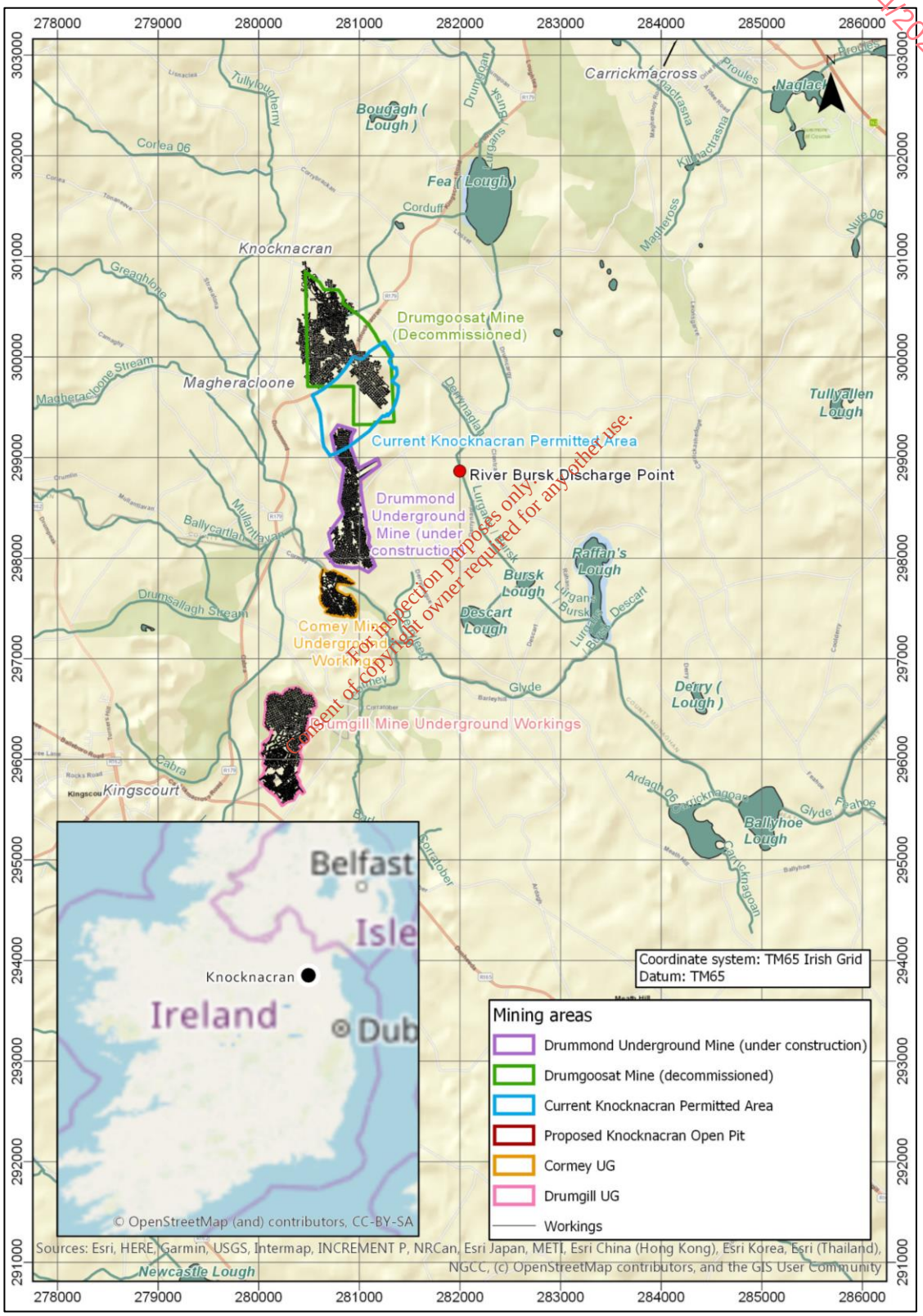
The Corduff Stream also rises in the area above the Drumgoosat mine and flows north to Lough Fea, about 2 km northeast of site (Figure 1.1). Lough Fea is part of the River Bursk catchment. The Bursk flows south into Bursk Lough, then Rahans Lough, and then into the River Lagan. Bursk Lough is also fed by Descart Lough.

The Bursk drainage area is low lying, the loughs along its course have the following areas and elevations:

- Lough Fea is 30 ha in area, elevation of 32 maODM;
- Bursk Lough is 2 ha in area, elevation of 25 maODM;

- Rahans Lough is 17 ha in area, elevation of 24 maODM;
- Descart Lough is 6 ha in area, elevation of 26 maODM.

Figure 1.1: Site location.



1.2.4 Mining

The main area of study includes two operational mines and one closed underground mine. The mines have a general north-south alignment along the strike of the Kingscourt gypsum formation (Figure 1.1). The key features of each mine are as follows:

- Drumgoosat underground mine is located in the north of the study area. It was operational between 1963 and 1989. It is up to 100 mbgl depth and has an aerial extent of around 1,700 m × 800 m (80 ha). Pumping records for the mine during operations indicate groundwater inflows were seasonally variable between 20 m³/d in September to 870 m³/d in March. The mine was used to temporarily store excess water from the Drummond underground mine up to the time of the subsidence event on 23/24 September 2018. The northeast part of the Knocknacran open cast is underlain (and quarries into) the southern-most workings of the Drumgoosat underground.
- Drummond underground lies in the southern part of the study area. It has been operational from 2006 to 2008, and from 2013. It extends to about 155 mbgl depth and currently has an aerial extent of around 1,300 m × 300 m (38 ha). Inflows to the Drummond mine have historically been between 1,400 and 2,200 m³/d. In June 2018, the mine workings intersected a fault one, known as the 'June 2018 mine fault'. Inflows from the fault were initially estimated to be around 12,000 m³/d but reduced quickly, and have since reduced to around 1,200 m³/d.
- Knocknacran open cast is in the centre of the mining area. Geological strata exposed in the open cast include overburden, the Upper Gypsum Member, bands of dolerite, mudstone and the Lower Gypsum Member (see Section 2.1). The mine has been operational since 1988 and includes excavation into the southeast third of the Drumgoosat workings. It is currently about 70 m deep (lowest floor elevation about -3 maODM) and has an aerial extent of around 1,110 m × 500 m (55 ha). A general view looking north is shown in Figure 1.2. Sump pumping rates from the mine are not recorded but estimates indicate that they range seasonally between about 10 m³/d in September (low groundwater flow only) and 950 m³/d in April (mostly surface water runoff).

In addition to the three mines within the main area of study, there are two historic underground mines located to the south of the existing Drummond mine. The Cormey mine was worked between 1952 and 1961. It included two shafts, both of which are now capped, but monitoring of water levels can be carried out in '1998 – Cormey Shaft'. Further to the south, the Drumgill mine was worked in the middle part of last century.

Inflows to the current two operating mines are pumped into the site water management system. Some of the higher flows were pumped for storage in the Drumgoosat workings. A well into the Drumgoosat workings is operated to maintain water levels in the interconnected mine area.

All water from the site is pumped to the 'southeast lagoons' from where it is discharged to the River Bursk at the licensed discharge point to the southeast of Knocknacran open cast (Figure 1.1). The license states that a maximum of 12,240 m³/day can be discharged. The discharge of

mine water is automatically adjusted depending on the available flow and assimilative capacity in the river to ensure that water quality standards are not exceeded.

Figure 1.2: General view of Knocknacran open cast (looking north)

1.3 OBJECTIVES

This report details the review of available geological and hydrogeological information alongside the water monitoring database (water levels, surface water and groundwater quality) to:

- Develop a conceptual hydrogeological model for the infiltration of surface water and the flow of groundwater in the mining district;
- Evaluate groundwater conditions to support an assessment of the future stability of the portion of the closed Drumgoosat mine that lies below the R179 and L4900 roads.
- To address issues from the EPA email of 19th December

1.4 AVAILABLE INFORMATION

The information used to compile this report has included mapping datasets, timeseries monitoring data and reports. The key data are summarised as follows:

- SGMI mapping of geological structures;
- Geological Survey of Ireland (GSI) online mapping datasets;
- Location of third-party wells (Golder 2019 survey);

- Environmental monitoring wells – location and geological zone of monitoring, monthly water level data and monthly water chemistry data;
- Drummond pumping log – daily flow data from January 2010 to November 2019; and
- Drumgoosat dewatering well – spot flow measurements from October 2017 to November 2019.

Several pertinent reports are available for the area. Key reports and their conclusions are summarized as follows:

- Drummond Mine Environmental Impact Statement (2003) and Knocknacran Environmental Impact Statement (2017).
    - Geology and water chapters outlining the current and anticipated conditions at the site in relation to previous development projects
- Minerex, 2019a. Annual Groundwater Monitoring Report for Mine and Processing sites for 2018.
    - Presentation of the data collected through 2018 and its interpretation as part of the SGMI environmental permit conditions.
- Minerex, 2019b. Drummond Mine Water Ingress: Assessment of Impact on Groundwater Resources -Rev 1, June 2019. Doc. Ref.: 1632-2093 (Rev 3).
    - Presentation of the data collected in relation to the intersection of June 2018 mine fault in 2018, revaluation of the conceptual model and recommendations regarding management of the water.
- SLR, 2019. Drummond Mine Dewatering Plan (2019 to 2020) SLR Ref: 190311.501.00545.0004.
    - Water management plan for the SGMI site (not only Drummond mine) including dewatering projections, storage and treatment requirements.
- CCC, 2011a. Cavan County Council. Establishment of groundwater source protection zones – Kingscourt Water Supply Scheme, Mullantra Borehole (May 2011).
    - Hydrogeological conceptual model and groundwater supply source zone definition.
- CCC, 2011b. Cavan County Council. Establishment of groundwater source protection zones – Kingscourt Water Supply Scheme, Descart Boreholes (April 2011).
    - Hydrogeological conceptual model and groundwater supply source zone definition.

2. GEOLOGY

2.1 STRATIGRAPHY

The geology of the district has a strong north-south strike, as illustrated in Figure 2.1. The study area is located on the Kingscourt Outlier, a half-graben structure formed of Carboniferous and Permo-Triassic rocks. The Kingscourt Fault forms the western boundary of the Kingscourt Outlier.

Extensive underground mining has historically taken place in the gypsum deposits of the Kingscourt Outlier. The mines extract gypsum from the Permian-age Kingscourt Gypsum Formation, which consists of mudstone with gypsum and anhydrite. The gypsum deposits occur within a north-south striking band, approximately 1.2 km wide and 12 km long. The sandy mudstones and red-brown mudstones of the formation are up to 550 m in thickness and contain two distinct beds of gypsum and anhydrite in the lower portion. These deposits form a cap on the north-south trending Carboniferous outlier within the Lower Palaeozoic Longford Down Massif.

The study area contains five primary stratigraphic units. These are summarised (from youngest to oldest) as follows:

- **Kingscourt Sandstone Formation** – outcrops to the east of the Kingscourt Fault and is the youngest formation of the sequence. This part of the sequence comprises a siltstone member (between 80 to 100 m in thickness), conformably overlain by Lower Triassic red-beds sandstone (up to 300 m thick), which typically comprises deep beds with parallel and cross lamination.
- **Kingscourt Gypsum Formation** – is a mudstone unit with two distinct mineralised beds. The provenance of the gypsum suggests deposition of sediments when arid deserts were occasionally encroached upon by the sea, which then evaporated to precipitate thick deposits of evaporite minerals. Figure 2.2 presents the stratigraphy of the formation which is typically divided into five units.
    - *Lower Mudstone Member* is a transitional mudstone which grades up into the Lower Gypsum from 50% gypsum to good quality gypsum.
    - *Lower Gypsum Member* and anhydrite bed is up to 35 m in thickness and is grey in colour. Above the transition zone with the Lower Mudstone, it comprises a thickly bedded, high quality white to grey nodular gypsum that has been the target of underground mining. This, in turn, transitions upwards into good quality, light brown laminated gypsum with rhythmic banding, which gradually changes to creamy pink or red further up the succession. Next are banded magnesium-rich gypsum layers which can be high in carbonates and show signs of being heavily leached by groundwater. Massive white gypsum is the upper-most section of the Lower Gypsum unit. Sub-outcrop of the Lower Gypsum Member

underlies the Knocknacran open cast area, from the settlement ponds in the east to the extent of Drumgoosat underground workings in the north.

- *Middle Mudstone Member* is a band of mudstone that separates the upper and lower gypsum members. It varies between 6 and 12 m in thickness. The member consists of reddish, micaceous, plastic mudstones, with frequent green reduction spots and laminations near the base.
- *Upper Gypsum Member* is a massive, fine grained, grey-brown to red pure gypsum. It is typically red and is thinner than the lower bed, ranging between 6 and 10 m in thickness. Moving upward in the sequence from the massive red gypsum is inter-banded gypsum and red siltstone, coarse gypsum and finally massive gypsum containing very pure and fine grained grey or cream laminated mineral. The Upper Gypsum subcrop only underlies the western side of the Knocknacran open cast and is well exposed in this location.
- *Upper Mudstone Member* the Upper Gypsum is overlain by the Upper Mudstone, which is between 26 and 36 m in thickness.

- Namurian sandstones of the **Cabra Formation, Corratober Bridge Formation, Clontrain Formation and Carrickleck Formation** – underlying the Kingscourt Gypsum formation and outcropping to the east of eastern-most fault within the graben structure. The formations comprise Namurian-age (Carboniferous) sandstones and interbedded shales. These are poorly cemented and typically very weathered. This tends to result in increased permeability.
- **Carrickleck Sandstone Member** – the basal member of the sandstone sequence. It is distinguishable from the Carrickleck Formation as being buff-coloured ferruginous sandstone.
- **Milverton Group** – Underlying the Carrickleck Sandstone Member and outcropping further to the east, the Milverton Group comprises Dinantian pure bedded limestone. The limestone within this group is extensively karstified with numerous features including caves, enclosed depressions, springs, swallow holes and turloughs.
- **Dolerite and basalt sills** are also present in the Kingscourt sequence. The sills are have been described as being conduits for water, having been hydrothermally altered during intrusion, making them susceptible to weathering and incompetent in places. The primary intrusion is a fine grained homogeneous basalt between the upper and lower gypsum beds, in the Middle Mudstone. The intrusion reaches a maximum thickness of 60 m. It has undergone extensive near-surface lateritic weathering and hydrothermal alteration, and is weathered to a fine grained sand in places. The dolerite sill chiefly occurs to the east of the orebody and thins out towards the west, with the dip of the gypsum beds. There is a secondary intrusion (8 m in thickness) that is typically confined to the Lower Mudstone.
- **Castlerahan Formation** outcrops to the west of the Kingscourt Fault. This Silurian-aged massive quartzo-greywacke has been thrust upwards along the Kingscourt Fault to juxtapose the Permian Kingscourt Sandstone Formation.

- **Westphalian Shales** outcrop to the north of the site are consisting of grey to black shale and carbonaceous or pyritous, thin bedded siltstones and fine grained sandstones. In addition, minor thin beds of coal may be present.

Figure 2.1: GSI bedrock geology of the study area (with half-graben cross section)

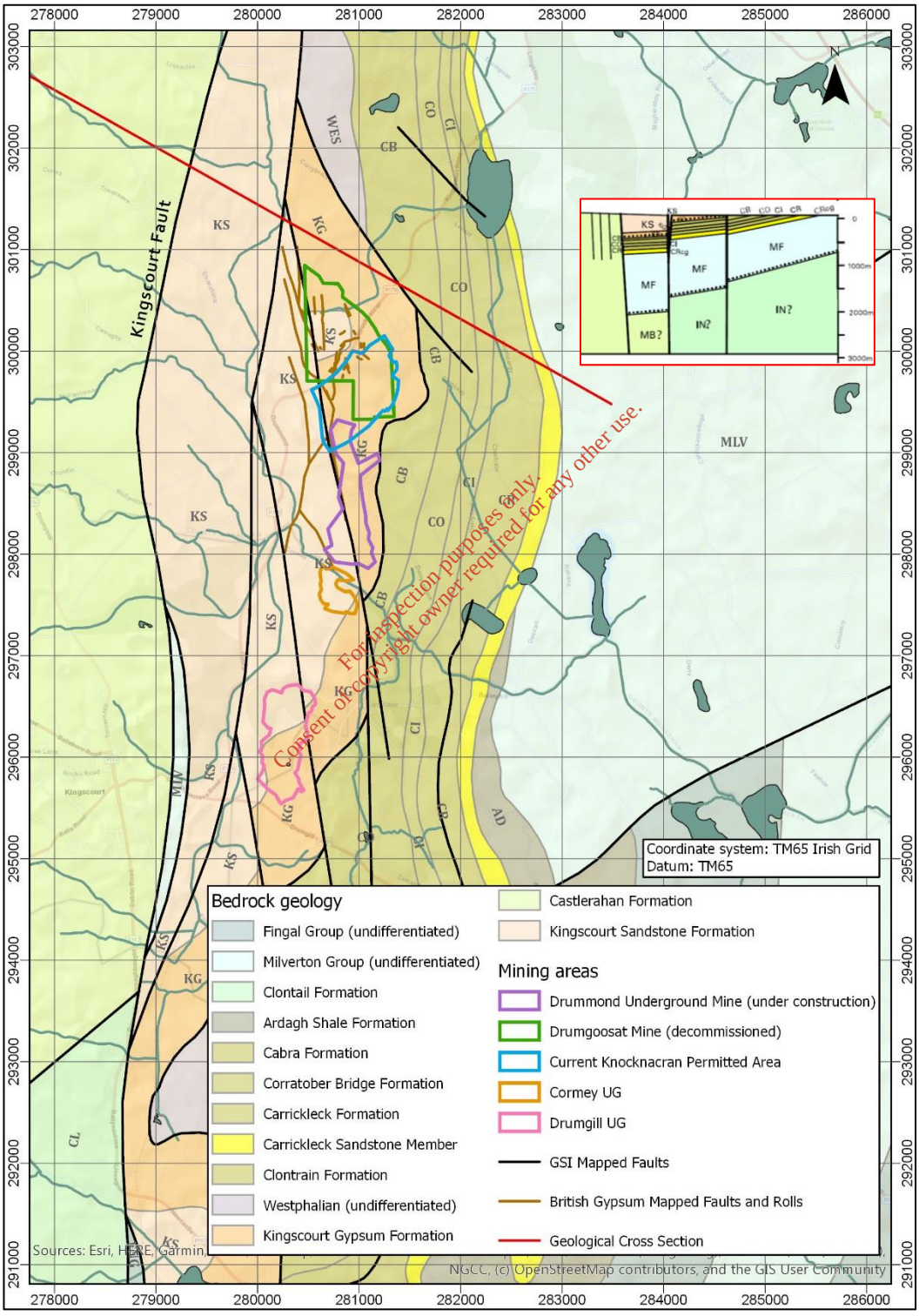
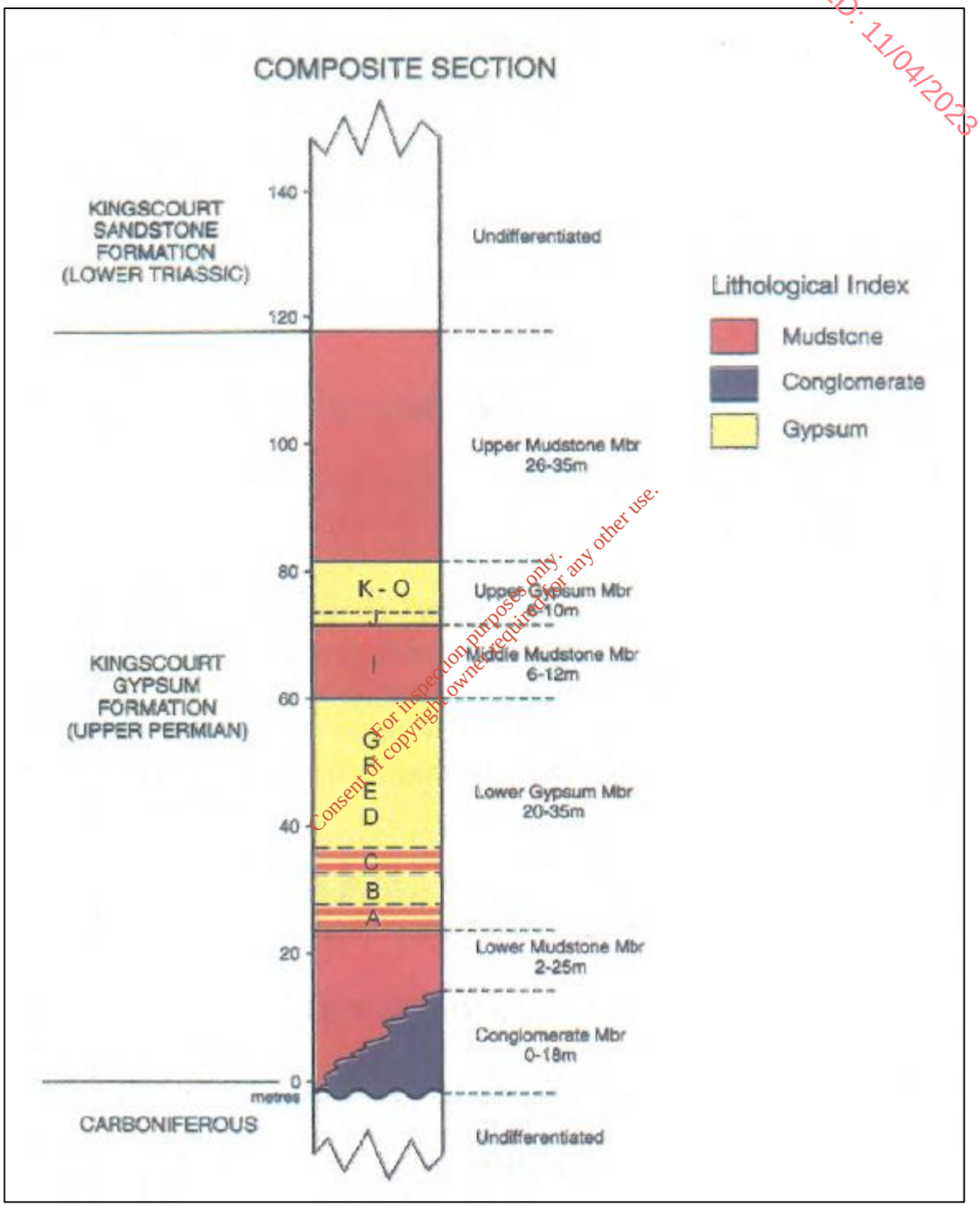


Figure 2.2: Stratigraphy of the Kingscourt Gypsum Formation (Source: Gardiner and McArdle[1])



[1] Gardiner, P.R.R. and McArdle. P., 1992. The geological setting of Permian gypsum and anhydrite deposits in the Kingscourt district, Counties Cavan, Meath and Monaghan. in Bowden, Earls, O'Connor & Pyne (eds.) 1992. The Irish Minerals Industry 1980-90. IAEG, pp 301-316.

2.2 SUPERFICAL DEPOSITS

The area surrounding the site is principally underlain by till (also known as Boulder Clay) which is predominantly derived from the Lower Palaeozoic sandstones and shales that comprise the underlying bedrock (Figure 2.3). The thickness of the superficial deposits is variable across the area. Thicker till layers are observed at the higher points of the terrain (drumlins), with overburden thickness reaching about 50 m. Away from the drumlins, the overburden can be as thin as 1 m, with areas of bedrock outcrop seen to the east of the site (i.e. there is no overburden present). The average overburden thickness is 13 m according to drill hole logs and the Geological Survey of Ireland (GSI) National Well Database.

To the east, the till is derived from limestones and, to the southeast, tills originating from Namurian sandstones and shales dominate (reflecting the different underlying bedrock geology). Grey brown podzolic and associated gley soils typically comprise the upper portion of the overburden, especially in areas of limestone glacial till (according to the National Soil Survey). Drumlin landscapes are typically characterised by drier mineral and organic soils.

The till layers are traversed by glaciofluvial sand and gravel deposits that follow the channels of local watercourses. These deposits are notable along the course of the Magheracloone Stream, running north to south along the western border of the site, and in the channel of the River Lagan, to the south of the site. Some areas of peat are also present in topographic lows, along with some minor pockets of lacustrine sediments throughout the area.

2.3 GEOLOGICAL STRUCTURE

2.3.1 Regional structures

The dominant structural trend in the area is north to south, consistent with the strike of the main stratigraphical units. The Permo-Triassic bedrock occurs in a series of open folds trending in this orientation, and the strata dip with an angle of between 10° and 30° towards the Kingscourt Fault.

The Kingscourt Fault is located about 1.5 km to the west of the site and makes up the western boundary of the Kingscourt Outlier (half-graben). Several other major faults in the sequence also trend north-south but have opposite throws (up to approximately 150 m) which, in combination, form graben-like structures.

Geophysical interpretation by Young (1975)[1] found two major geophysical trends; a north-south and an approximately northeast-southwest or "caledonoid" direction. These geophysical trends are typically consistent with the mapped geological structure in the Kingscourt Outlier.

Mapping by British Gypsum shows a set of north-south striking faults, corresponding with the major structural orientations of the area. Two major faults have been observed around the Knocknacran open cast. Both have a north-south trend and appear to extend at least as far as the Cormey workings to the south. One underlies the pit along its southwestern margin. The other occurs approximately 500 m to the west. The faults are believed to downthrow the Upper and Lower gypsum beds by around 10 m and 30 m, respectively. Discontinuous groundwater levels have been identified between exploration holes on either side of the fault that underlies the south western margin of the pit. This suggests that the fault acts as a low permeability barrier to groundwater flow.

Roll and fault information for the Drumgoosat area also shows structures primarily following the north-south orientation although some rolls are orientated in a northeast-southwest direction.

Mapping data for the Knocknacran open cast and a number of underground pillar faces has also identified minor faults that appear to form a dendritic pattern through the centre of the pit. Analysis of the data found that the major discontinuities in the gypsum are near vertical and strike north-south and east-west, with less dominant features striking northeast-southwest and northwest-southeast. The shaley units within the gypsum exhibit well developed bedding, with a regional bedding trend between 15° and 30° to the east.

There is no evidence from the underground workings at Drummond or Drumgoosat to suggest the major north-south trending graben structures are important water-bearing features. Rather, the available data suggests they are barriers to groundwater flow across their strike plane.

2.3.2 Palaeokarst

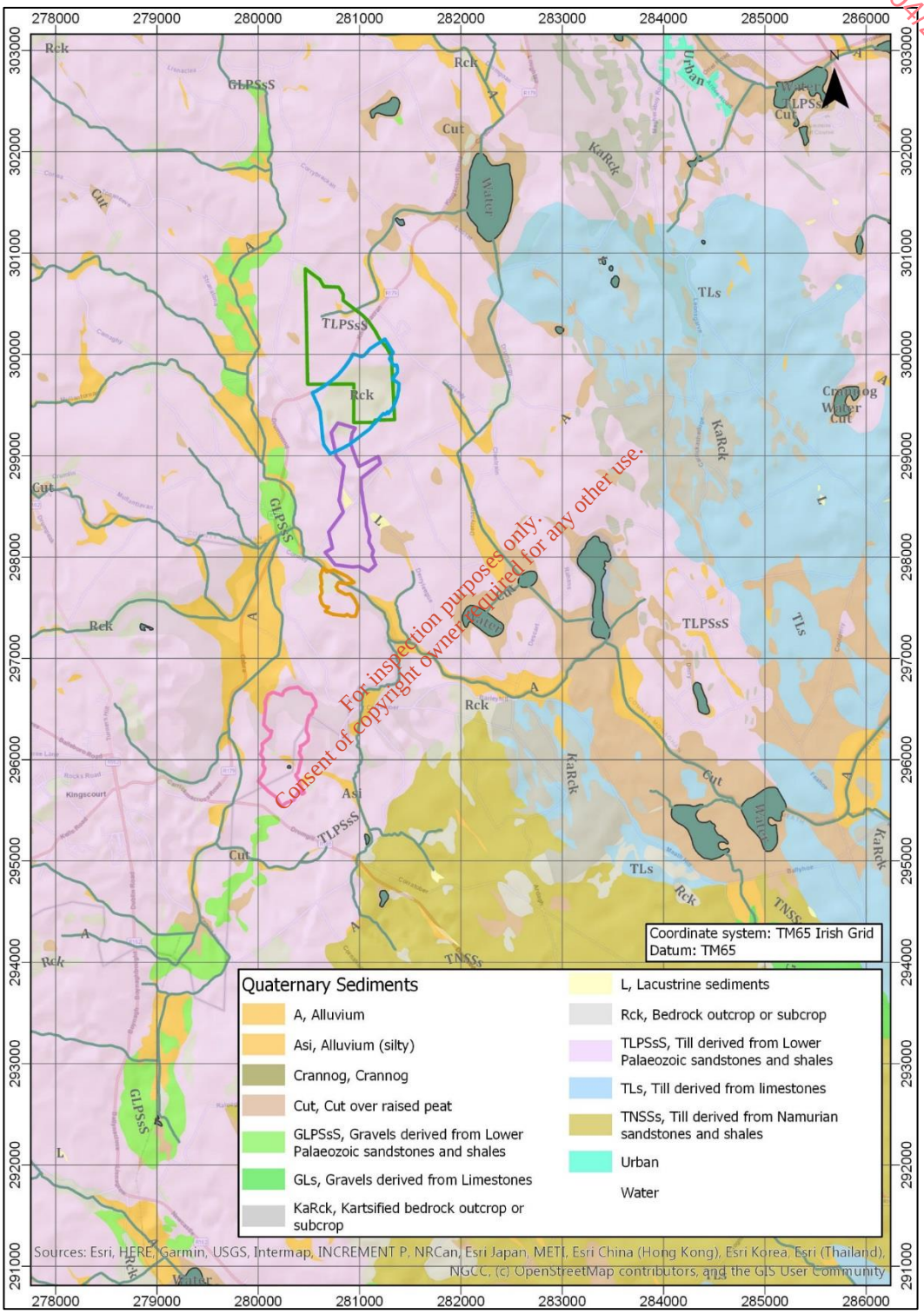
Palaeokarst surfaces are evident on the surfaces of the gypsum beds, with post-depositional solution seen particularly where the existing open cast mine has exposed them to the east of the deposit. The karst surfaces are often mantled by Palaeocene dolerite lava flows of the Antrim Lava Group. Vaughan[2] suggests that a karst surface and associated cave drainage

[1] Young DGG (1976) A Geophysical interpretation of the Structural Development of the Kingscourt Graben. Proceedings of the Royal Irish Academy.

[2] Vaughan APM, Dowling LA, Mitchell, Lauritzen S-E, McCabe AM and Coxon P (2004) Depositional and post-depositional history of warm-stage deposits at Knocknacran, Co. Monaghan, Ireland: implications for preservation of Irish last interglacial deposits. Journal of Quaternary Science Vol 19, pp577-590.

developed in the Permian gypsum before Palaeocene times, however major cave systems have not been observed during mining.

Figure 2.3: GSI overburden mapping of the study area



3. HYDROGEOLOGY

3.1 MAIN AQUIFER UNITS

GSI has carried out aquifer mapping to characterize the groundwater units around the study area (Figure 3.1). According to their interpretation, the principal bedrock aquifer units in the area are:

- **Kingscourt Sandstone Formation** – Permo-Triassic sandstones to the west of the site which are locally important aquifers ("bedrock which is generally moderately productive");
- **Namurian sandstones** and **Carrickleck Sandstone Member** – Namurian sandstones to the east of the site have also been classified as a locally important aquifer;
- **Milverton Group** – Dinantian pure bedded limestones east of the Namurian sandstones are considered to be a regionally important karstified aquifer.

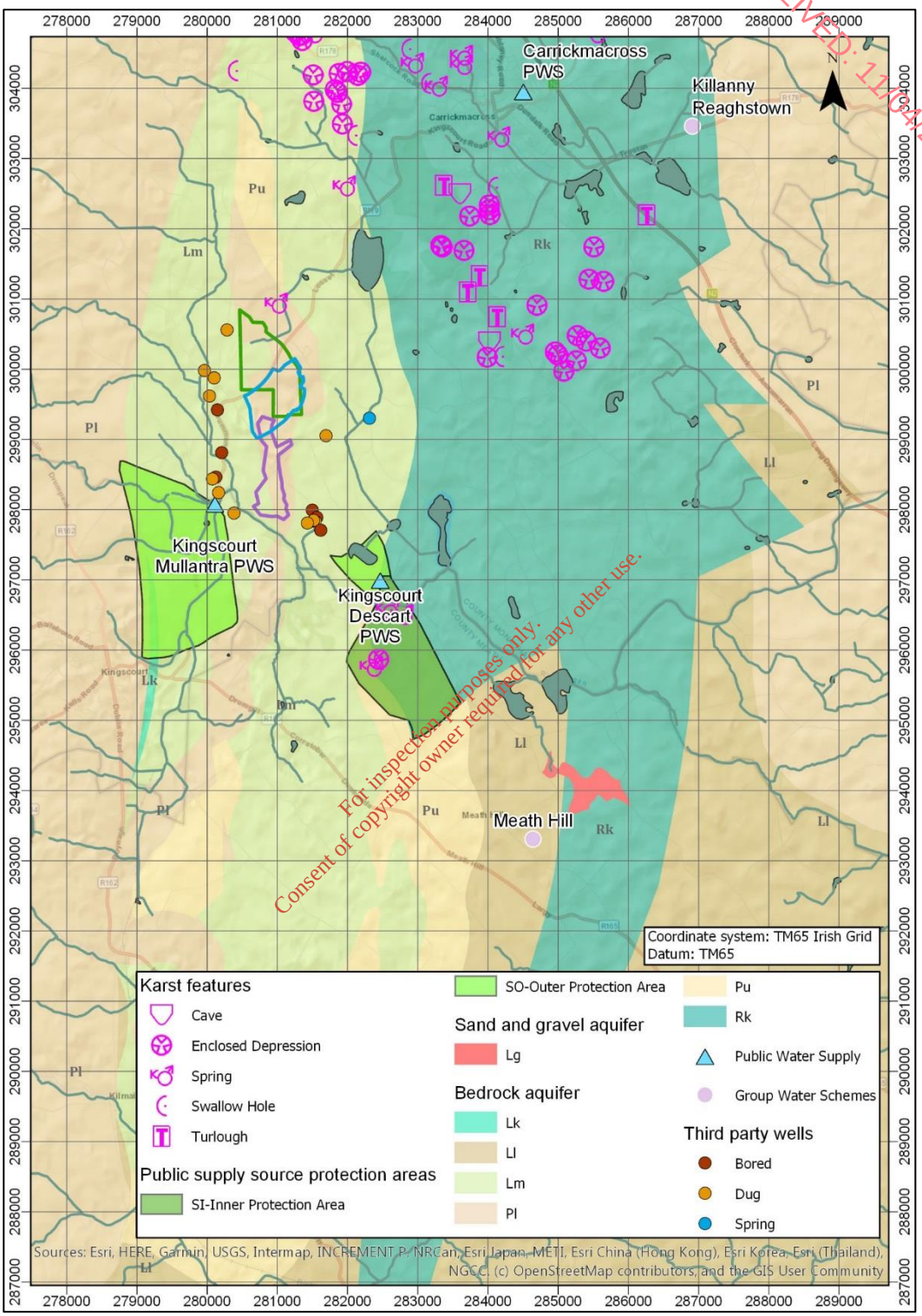
The **Kingscourt Gypsum Formation** (central to the site) and the **Westphalian Shales** to the north are both considered poor aquifers. The GSI describes these as "bedrock which is generally unproductive except for local zones".

Hydrogeological characterisation of the SGMI mine complex (Minerex, 2019[3]) also describes the Kingscourt Gypsum Formation gypsum and mudstone members as 'aquicludes'. Their low permeability restricts the flow of water between aquifer units, despite the evidence of karstification in the gypsum. The dolerites of the formation are considered to be 'aquitards', which are characterised by low permeability and low flow rates.

The **Castlerahan Formation** is classified as a poor aquifer and the **Dolerite sills** do not have a designation but have been described as being conduits for water, having been hydrothermally altered during intrusion, making them susceptible to weathering and incompetent in places.

[3] Minerex, 2019. Annual Groundwater Monitoring Report for Mine and Processing sites for 2018.

Figure 3.1: GSI bedrock aquifer units and groundwater supplies



3.2 GROUNDWATER VULNERABILITY AND RECHARGE

DELG/EPA/GSI[4] state that groundwater that readily and quickly receives water (and contaminants) from the land surface is considered to be more vulnerable than groundwater that receives water (and contaminants) more slowly and in lower quantities. The travel time, attenuation capacity and quantity of contaminants are a function of the following natural geological and hydrogeological attributes of the area:

- The sub-soils that overlie the groundwater;
- The type of recharge - whether point source or diffuse;
- The thickness of the unsaturated zone through which the contaminant moves.

All levels of groundwater vulnerability status are observed in the area surrounding the site, as shown in Figure 3.2. Areas of low subsoil permeability provide a protective layer to the groundwater and correspond to a “low” vulnerability designation. Much of the Kingscourt Sandstone Formation to the west of the site shows a “moderate” to “high” designation, with localised areas of “extreme” vulnerability associated with alluvial deposits. The karstified Milverton Group limestones are prevalent to the east of the site and have mostly been assigned “moderate” to “extreme” vulnerability status, with large portions of the area comprising of “rock at or near surface or karst” making it highly vulnerable.

Groundwater recharge in the area is mostly derived from infiltration of precipitation and local runoff. The national groundwater recharge map indicates that natural recharge may locally range between 1 and 800 mm per year (Figure 3.3). This is based on rainfall datasets held by the GSI that include annual rainfall, actual evapotranspiration, soil drainage, subsoil permeability, groundwater vulnerability and bedrock aquifer class.

According to the GSI maps, the recharge within the footprint of the mine area is typically 100 to 200 mm/yr, decreasing to less than 50 mm/yr above Drummond underground. The western margin of the Kingscourt Sandstone Formation is associated with higher recharge, between 350 to 550 mm per year, with small areas of higher (601 to 700 mm) recharge to alluvial gravels.

Recharge in Ireland primarily occurs between October and March when rainfall exceeds evapotranspiration (i.e. when the soil water is at field capacity). From March to October, the opposite is often true when the soil moisture is in deficit. A typical seasonal cycle of the soil moisture balance and recharge may be as follows:

[4] DELG/EPA/GSI, 1999. Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland. Misstear, B. D., Banks, D., and L. Clark. 2006. Water Wells and Boreholes. Wiley & Sons Ltd. ISBN-13: 978-0- 470-87989-7.

- Summer: high rate of evapotranspiration and soil water removal; increasing soil moisture deficit; rainfall events cause near-surface infiltration, but the water is quickly removed from the soil profile by evapotranspiration. Little or no recharge.
- Autumn: high soil moisture deficit, which has been gradually built up over the summer months; infiltration from rainfall events is stored in the near-surface soils, even though evapotranspiration rates are low; little water percolates downward below the extinction depth to recharge.
- Winter: the soil moisture deficit that was built up during the summer months becomes progressively replenished by on-going infiltration due to precipitation events. At some point, the soil moisture deficit is used up, breakthrough occurs, and the percolating water moves downward below the capture zone of the root system. The water is able to move downward below the extinction depth and become recharge to the groundwater system.
- Spring: the soils are fully saturated, and any rainfall or snowmelt is transmitted rapidly downward below the root zone to become recharge. This may also be the period of high water availability, so most or all of the annual recharge may occur during this period. As ambient air temperatures increase, so evapotranspiration rates also rise, and the soil moisture deficit starts to build up as summer approaches.

It should be appreciated that both the annual rainfall amounts, and the seasonal pattern of rainfall, are inherently variable, depending on seasonal precipitation events and longer term cycles. There have been a number of significantly dry or wet periods over recent years. In any one year, the actual recharge is likely to be significantly different from the annual average. Low rainfall in winter may lead to lower than average recharge while a wet spring may produce a large amount of recharge.

Figure 3.2: GSI aquifer recharge mapping

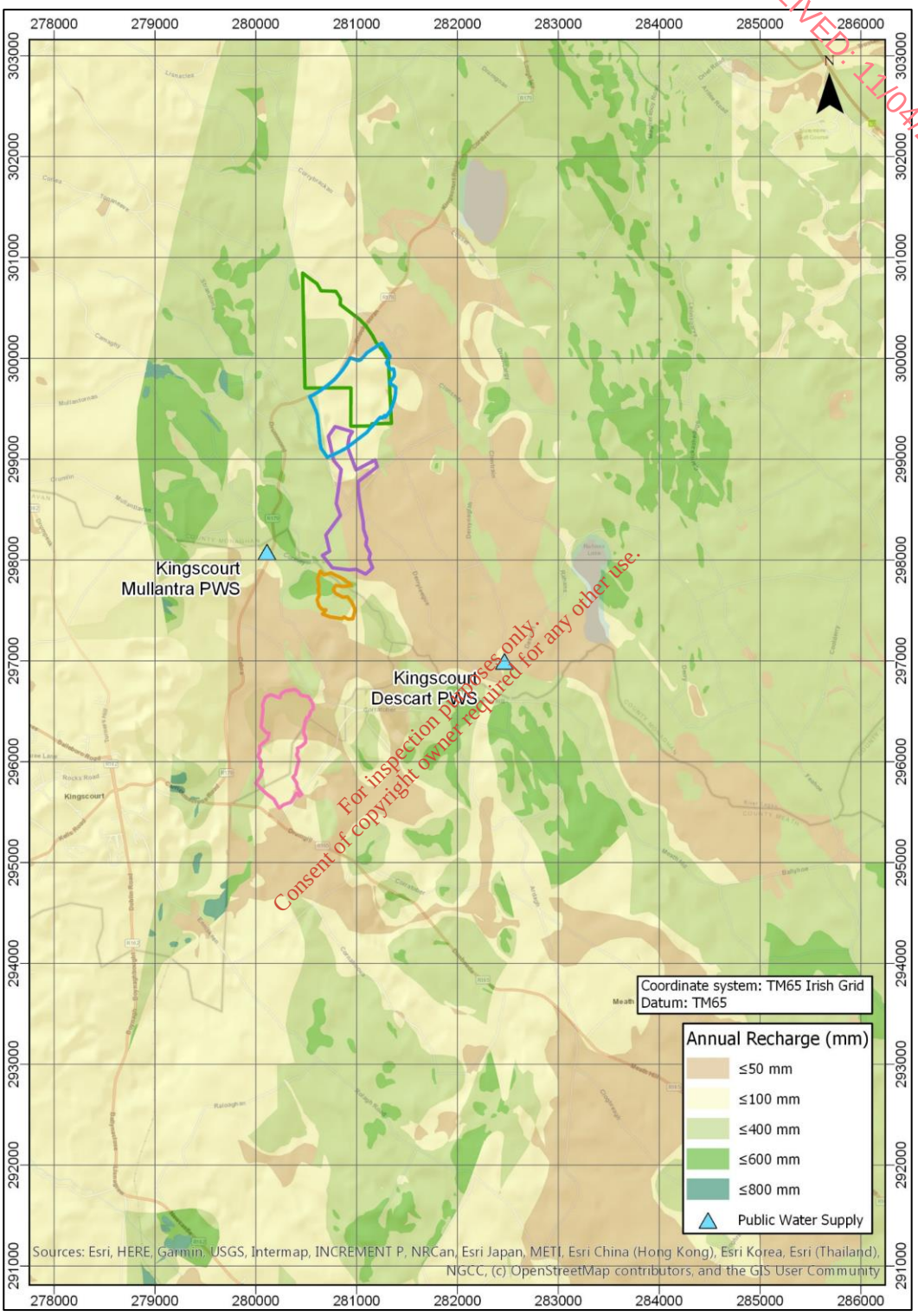
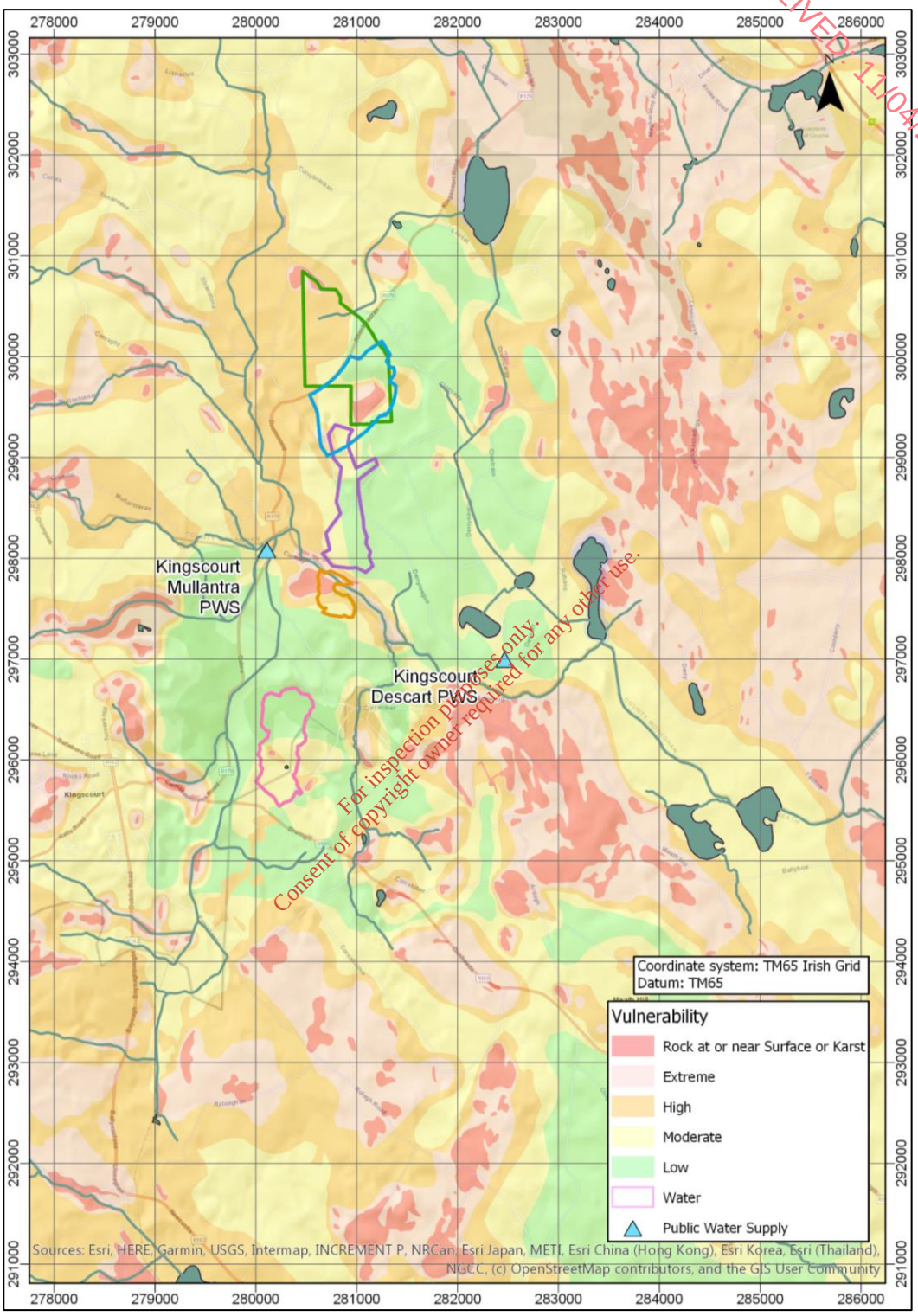


Figure 3.3: GSI aquifer vulnerability mapping



3.3 GROUNDWATER USERS

3.3.1 Public groundwater supplies

Three public groundwater supplies (PWS) are located within 7 km of the study area:

- Kingscourt Mullantra PWS (well name BW01);
- Kingscourt Descart PWS (well names BW02 and BW03);
- Carrickmacross PWS (well names Monanny borehole and Nafferty spring and borehole).

The location of the boreholes and Nafferty spring are shown on Figure 3.1.

Kingscourt Mullantra PWS

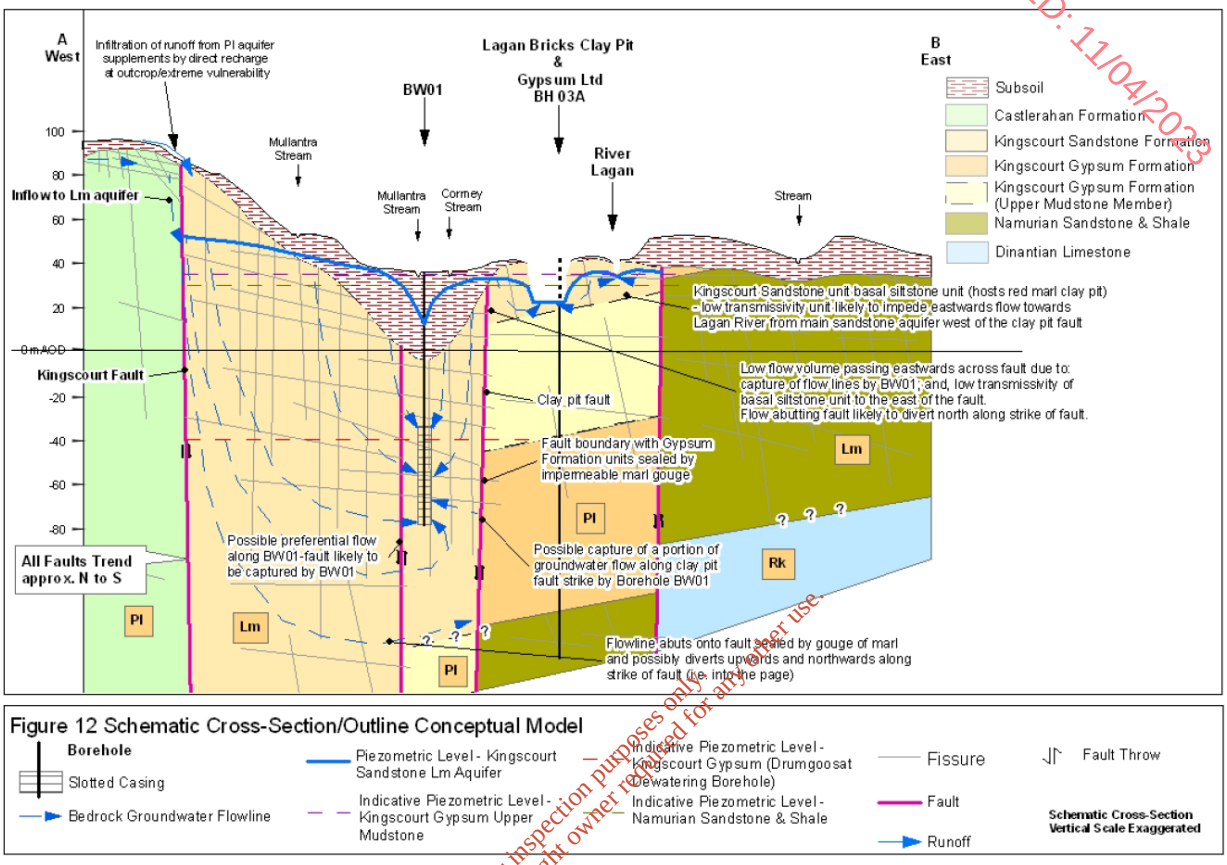
Well BW01 is located about 2 km to the southwest of the study area. Based on the source protection zone report[5], it is drilled to a depth of 120 m, with screen between 71 and 113 mbgl. A diagrammatic cross section through the well is shown on Figure 3.4.

BW01 has a typical abstraction rate of around 375 m³/d from the Kingscourt Sandstone Formation. The source zone protection report says that the majority of the sandstone aquifer footprint is confined by the overlying low and moderate permeability subsoil deposits. It is mainly recharged at areas of bedrock outcrop and extreme vulnerability along the Kingscourt Fault scarp to the west of the borehole. This suggests that the borehole is not abstracting water from the area of the mine and the mine dewatering does not affect water levels within the well.

The isolation from the mining areas is further supported by the statement in the report that the sandstone aquifer appears to be *hydraulically isolated from the gypsum aquifer by the low permeability basal layer of the sandstone and upper strata of the gypsum. Where the two aquifers are juxtaposed by faulting, the gypsum appears to be sealed off by a low permeability "gouge" of marl.*

[5] CCC, 2011[a]. Cavan County Council. Establishment of groundwater source protection zones – Kingscourt Water Supply Scheme, Mullantra Borehole (May 2011).

Figure 3.4: Diagrammatic cross section through the Kingscourt Mullantra PWS (reproduced from CCC, 2011a)



The nature of the geology and presence of fault barriers suggests that BW01 is hydraulically isolated from any mining activities

Kingscourt Descart PWS

BW02 and BW03 are located around 3.5 km southeast of the study area. A diagrammatic cross section showing the wells is shown in Figure 3.5. Based on the source protection zone report[6], the wells are drilled to depths of 19 and 91 m, respectively. Their static groundwater levels are at, or above, ground level (i.e. they are artesian).

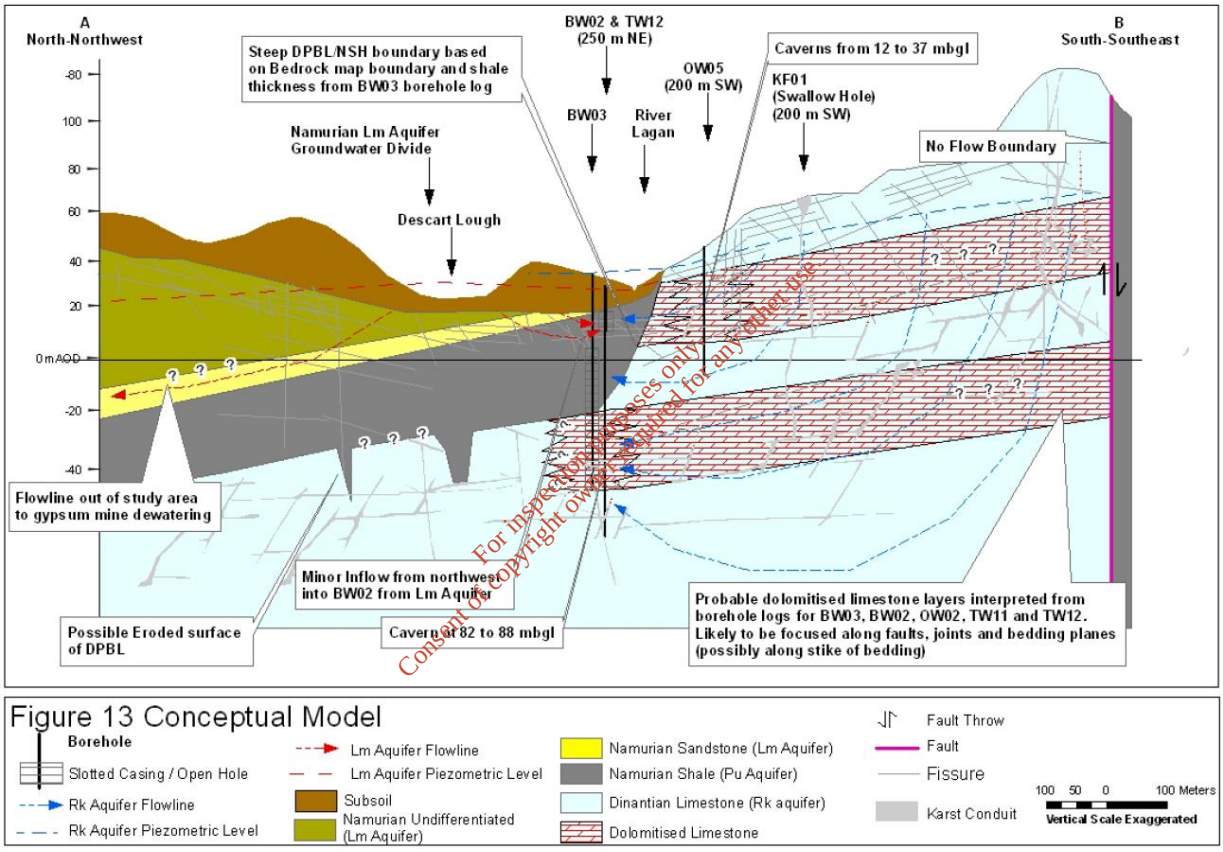
Pumping test results show that both wells have potential yields of around 1,000 m³/d or greater from the dolomitised Milverton Group limestone. The source protection zone report says that the limestone unit is karstified and mainly recharged at bedrock outcrop and through karst features on Barley Hill, and where the overlying subsoils are thin. Barley Hill is to the south of

[6] CCC, 2011[b]. Cavan County Council. Establishment of groundwater source protection zones – Kingscourt Water Supply Scheme, Descart Boreholes (April 2011).

the wells, so groundwater flow is northwards towards the wells and discharges in the Lagan River.

The nature of the geology and discussion in the source protection zone report suggests that the boreholes are not abstracting water from the mining area and are located within a hydraulically disconnected groundwater system. It therefore appears unlikely that any current or planned future mining activities could affect the wells.

Figure 3.5: Diagrammatic cross section through the Kingscourt Descart PWS (reproduced from CCC, 2011[b])



The nature of the geology is such that the wells are likely isolated from any mining activities

Carrickmacross PWS

The Monanny borehole and Nafferty spring and borehole are located over 6 km to the northeast of the study area. The supplies do not have source protection reports but the EPA states that Monanny borehole is 97 m deep and both supplies abstract water from karstified limestone (the Milverton Group). As outlined above, boreholes (and springs) of the Milverton Group do not abstract water from the mining area and are located within a hydraulically disconnected groundwater system.

3.3.2 Group water supply schemes

In addition to the public water supplies, there are three group water schemes (GWS) within 10 km of the study area (Figure 3.1).

- Magheracloone GWS sources its water from Greaghlone Lough, 6 km northeast of the site. The lough is underlain by low permeability tills and Castlerahan Formation which is a poorly productive bedrock aquifer based on GSI mapping. The mine is within a separate hydrogeological block and therefore does not have any hydraulic connection with the lough. Most of the properties in the vicinity of the mine which do not have private supplies are connected to the Magheracloone GWS water supply network.
- Meath Hill GWS is a groundwater source located 7 km to the southeast (beyond Kingscourt Descart PWS). The borehole is located within the Tobercolleen and Lucan Formation (Carboniferous limestone) which forms an isolated 'locally important' aquifer between the 'poor' Ardagh Shale Formation to the west and 'regionally important' Milverton Group to the north and west. This would suggest that there is no hydraulic connection with the mine.
- Killanny Reaghstown GWS abstracts groundwater from two boreholes in the regionally important Milverton Group aquifer around 7 km to the northeast of the site. As outlined in the source protection plan for the Kingscourt Descart PWS wells above, boreholes of the Milverton Group do not abstract water from the mining area and are located within a hydraulically disconnected groundwater system.

3.3.3 Domestic groundwater supplies

Based on a survey completed in September 2019, there are 23 third-party wells and groundwater sources within 500 m of Drumgoosat workings. Locations for nineteen of these have been surveyed and are shown in Figure 3.1. Locations with surveyed coordinates also have water level data available. A total of fourteen are listed as being in use but none are currently monitored regularly. Most are used to supply water to local housing and farms; eight are boreholes, eleven dug wells and four are springs. One publicly accessible healing spring is also recorded.

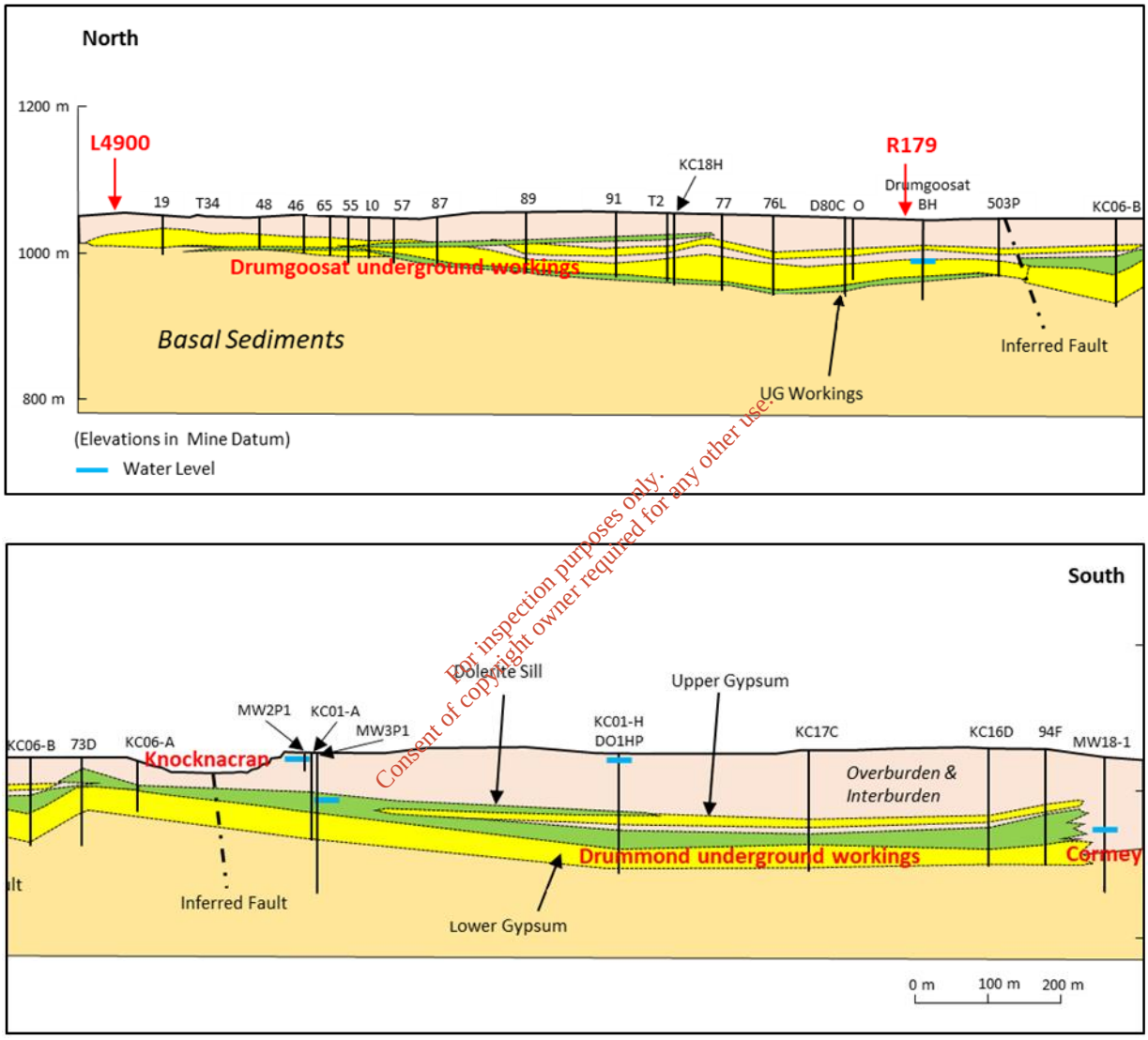
The majority of the known supply sources occur in the outcrop area of the Kingscourt Sandstone (to the west of the Kingscourt Fault) or to the east of the faults that define the eastern side of the graben. Only one of the supplies are located close to the mining areas or above the subcrop area of the Kingscourt Gypsum sequence.

3.3.4 Mine water storage

The decommissioned Drumgoosat underground mine reaches a maximum depth of around 100 mbgl to the north and northwest of the Knocknacran open cast (Figure 3.6). The underground workings have historically been used to store mine water as part of the water management plan for the Drummond underground mine and the Knocknacran open cast. Water

was stored during times of low flow in the River Bursk. Water is discharged when the flow rate in the river could assimilate the sulphate content of the mine water release to the river in line with the conditions in the EPA licence for the site.

Figure 3.6: Schematic North-South section through all mines. The figure shows the location of the R179 and L4900 roads



3.4 GROUNDWATER LEVELS

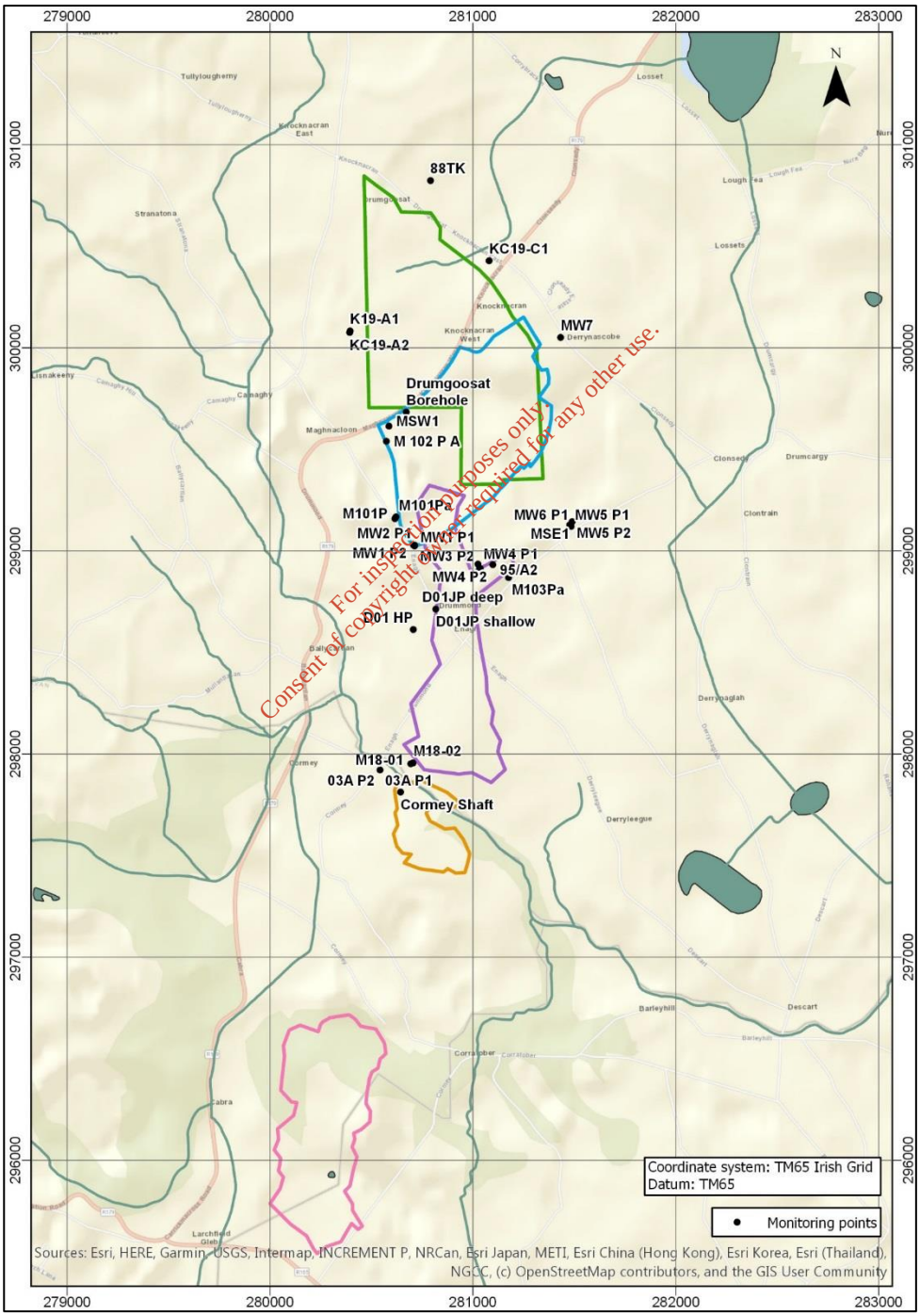
3.4.1 General

Groundwater level monitoring data have been compiled by Minerex and are available for a 38 year period (1981 and 2019). Data for the 29 wells with multiple years of data were analysed. The locations of the wells are shown in Figure 3.7. Of these:

- six wells are in “clay” superficial deposits (till);

- seventeen wells are in the Kingscourt Gypsum Formation (five in Upper Mudstone; four in Upper Gypsum; six in Middle Mudstone; two in Lower Gypsum; and none in Lower Mudstone); and
- six wells are in the Namurian Sandstone Formation, including the well drilled into the Drumgoosat underground workings to control water levels in the interconnected mine area.

Figure 3.7: Groundwater monitoring well locations



The wells are colour-coded by stratigraphic position by Minerex (Figure 3.8). Recent groundwater levels (May 2019) are shown on Figure 3.9 and in Table 3-1.

Table 3-2 shows water levels for monitoring points in the South Drummond area only. Groundwater hydrographs between January 2013 and June 2019 are shown in Figure 3.10 to Figure 3.15.

Figure 3.8: Groundwater monitoring well stratigraphical positions (Source: Minerex, 2019)

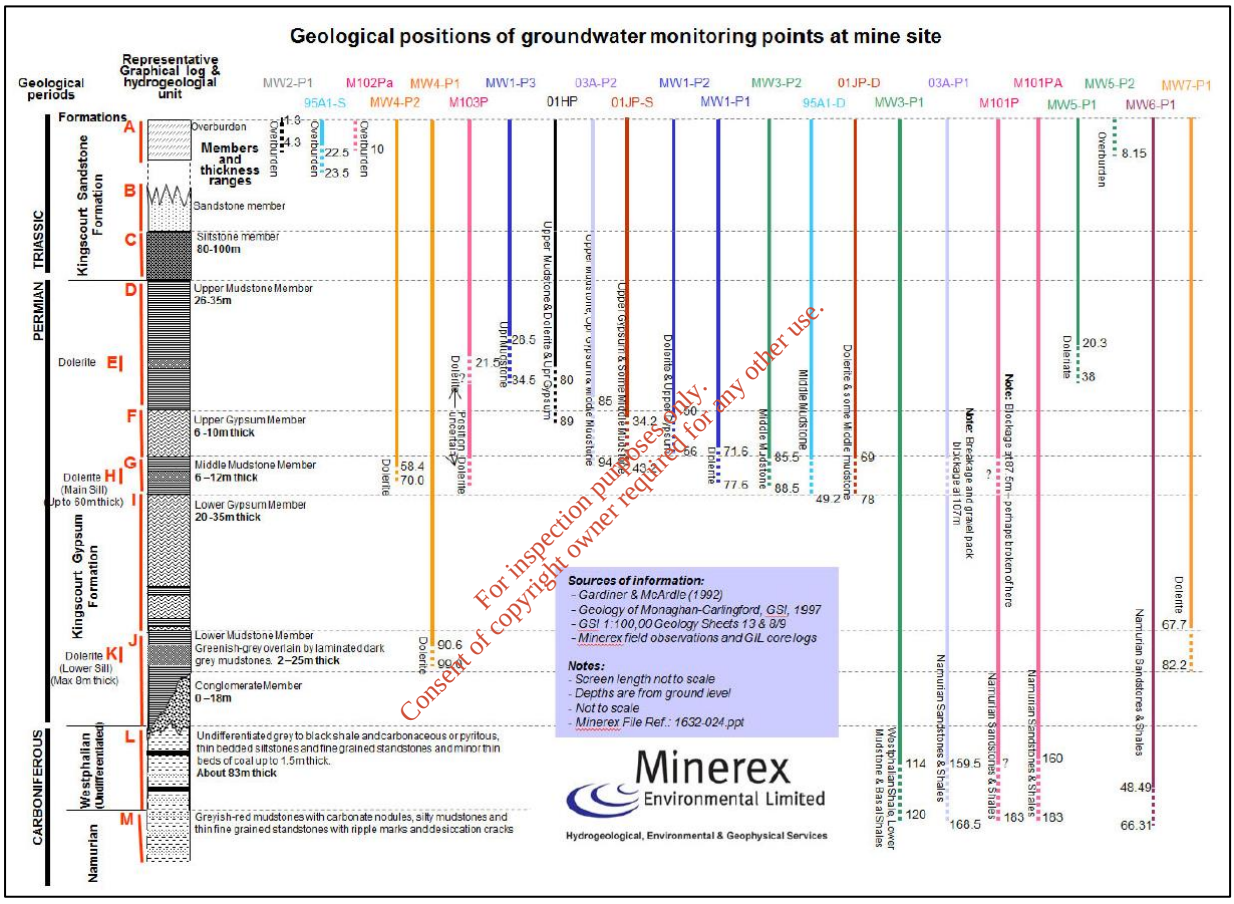
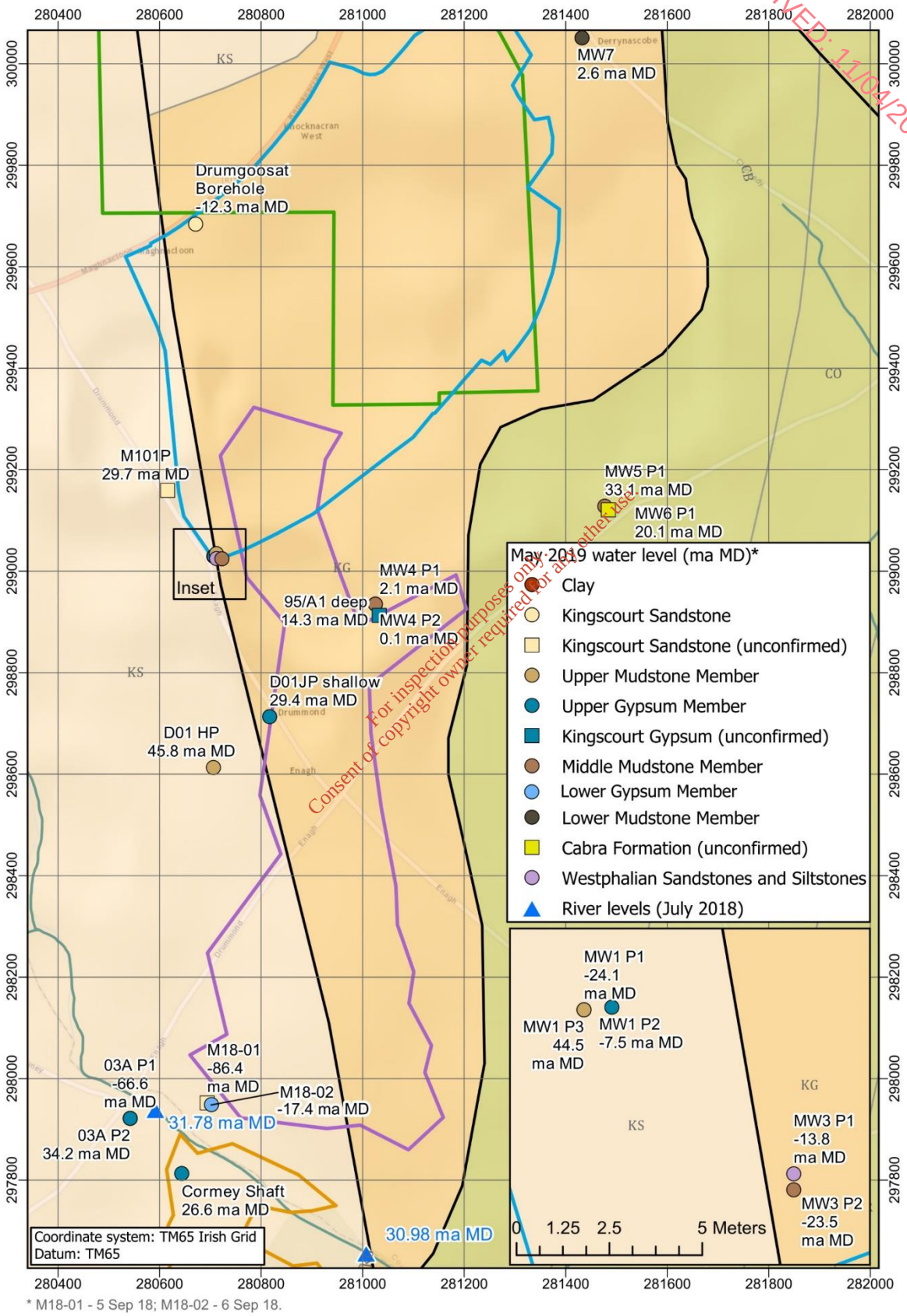


Figure 3.9: Currently recorded groundwater levels (November 2019)



* M18-01 - 5 Sep 18; M18-02 - 6 Sep 18.

Table 3-1 Recent groundwater levels in all available monitoring wells

Monitoring Point	Hydrogeological Unit	Date	Water level elevation (maODM)	Inferred Drawdown from Baseline
1 H P	Upper Mudstone Member	01 May 19	45.8	0
1 J P Shallow	Upper Gypsum Member	01 May 19	29.4	33.0
1998 - Cormey Shaft	Upper Gypsum Member	01 May 19	26.6	5.0
95 A 1 Deep	Middle Mudstone Member	01 May 19	14.3	19.1
95 A 1 Shallow	Clay	01 May 19	36.4	0
Drumgoosat dewatering well	Kingscourt Sandstone	01 May 19	-12.3	-29.3
M 101 P	Kingscourt Sandstone	01 May 19	29.7	14.7
M 102 P A	Clay	01 May 19	39.2	0
MW 1 P 1	Middle Mudstone Member	01 May 19	-24.1	68.5
MW 1 P 2	Upper Gypsum Member	01 May 19	-7.5	51.9
MW 1 P 3	Upper Mudstone Member	01 May 19	44.5	0
MW 2 P 1	Clay	01 May 19	46.5	0
MW 3 P 1	Westphalian Sandstones and Siltstones	01 May 19	-13.8	58.2
MW 3 P 2	Middle Mudstone Member	01 May 19	-23.5	67.9
MW 4 P 1	Lower Mudstone Member	01 May 19	2.1	60.4
MW 4 P 2	Middle Mudstone Member	01 May 19	0.1	62.3
MW 5 P 1	Middle Mudstone Member	01 May 19	33.1	15.3
MW 5 P 2	Clay	01 May 19	50.3	0
MW 6 P 1	Cabra Formation	01 May 19	20.1	28.3
MW 7 P 1	Lower Mudstone Member	01 May 19	2.6	45.8
O3A P 2	Upper Gypsum Member	01 May 19	34.2	-2.8
MW 18 2	Upper Gypsum Member	06 Sep 18	-17.4	79.8
MW 18 1	Lower Gypsum Member	01 Sep 18	-86.4	148.8
O3A P 1	Namurian Sandstone	01 Sep 18	-66.6	100.0
Drummond E 4	Lower Gypsum	01 Aug 18	-79.6	77.0
Drummond E 7	Lower Gypsum	01 Aug 18	-70.7	68.1
1 J P Deep	Middle Mudstone Member	01 Apr 14	43.8	18.6
M 101 P A	Lower Mudstone Member	01 May 10	49.1	-11.7
M 102 P	Clay	01 Apr 09	39.2	-2.8
95 A		01 Nov 05	64.9	-2.5
96 A		01 Nov 05	75.8	-3.4
95 A 2	Clay	01 Oct 05	38.5	-11.1
M 103 P	Upper Mudstone Member	01 Aug 05	29.8	4.6
506 P	Upper Mudstone Member		31.6	-3.2
507 P	Upper Mudstone Member		30.4	-5.0

Table 3-2 Water levels for South Drummond area monitoring points

Monitoring Point	Hydrogeological Unit	Water level elevation (maODM)
River		31.8
O3A P2	Upper Gypsum Member	34.2
1998 – Cormey Shaft	Upper Gypsum Member	26.6
MW 18 2	Upper Gypsum Member	-17.4
O3A P 1	Namurian Sandstone	-66.6
MW 18 1	Lower Gypsum Member	-86.4

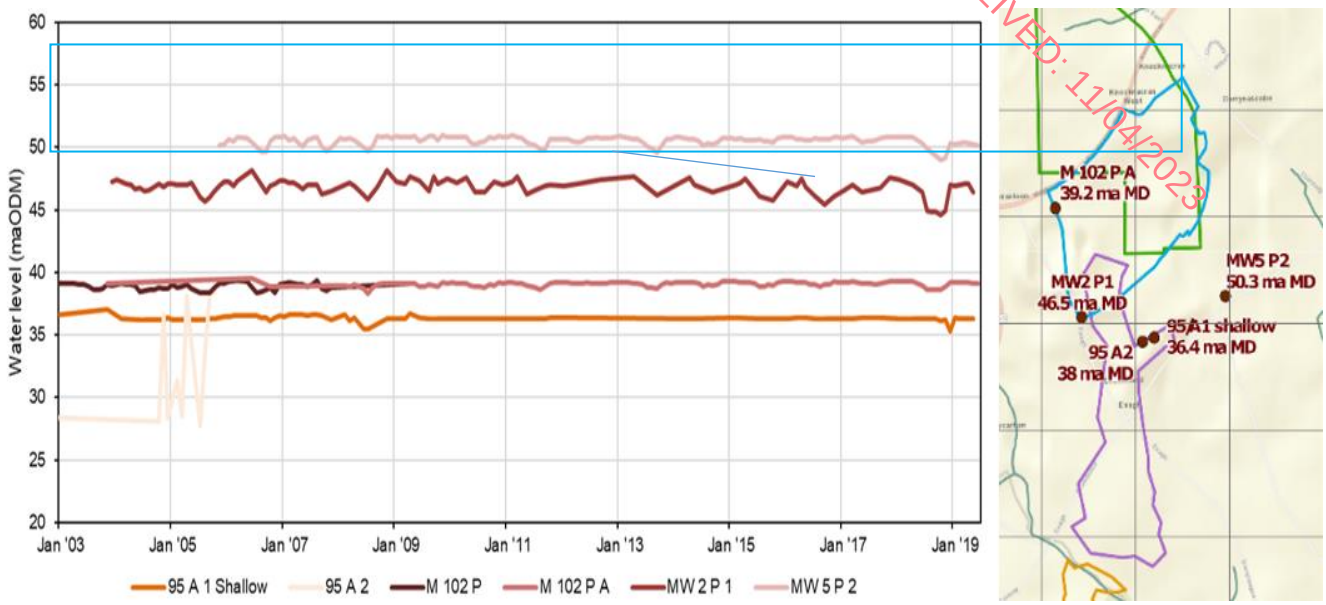
3.4.2 Superficial deposits

Figure 3.10 shows the hydrographs for the six wells believed to be representative of superficial deposits (mostly till). The observed water levels range between 28 maODM (95 A2) and 50 maODM (MW5 P2). The water elevation typically reflects the local topography and the elevation of the well collar. The depth to water in the wells is typically in the range of 0.5 to 2 m. All wells show a seasonal fluctuation, except for 95 A 1.

The largest seasonal fluctuation is typically seen in MW2 P1, located close to the northern margin of the Drummond underground mining area. This showed a water level reduction of about 3 m during the dry summer of 2018; recovering during the recharge period towards the end of the year. It does not appear to show any correlation with the recent increased inflows to the Drummond workings. There are no trends that would indicate long term drawdown or changes due to the mining operations.

As is seen in other mining districts in Ireland (and worldwide), the behaviour of water levels in superficial deposits tends to be mostly independent of conditions in the underlying bedrock formation. The data from the six wells in the study area are consistent with this. The underlying mine workings do not significantly affect the near-surface water balance in the superficial deposits. The seasonal fluctuation in MW2 P1 appears to be related to natural climatic cycles.

Figure 3.10: Hydrographs for wells thought to be screened in superficial deposits (till)



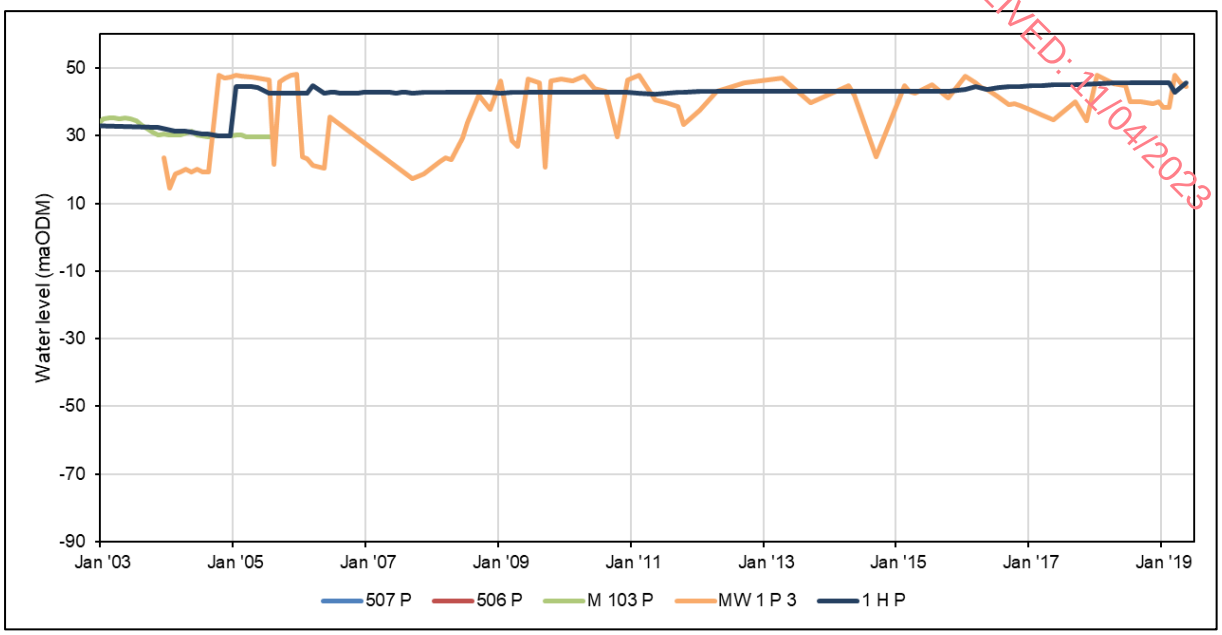
3.4.3 Kingscourt Gypsum Formation

Upper Mudstone Member

Monitoring data are available for three wells screened in the Upper Mudstone Member with records between January 2003 and June 2019 (Figure 3.11). Groundwater levels are above the inferred hydrogeological base level. There is no apparent influence of recent or historical mining activities.

The record for M103 P ceased in mid-2005 but closely matched 1HP when concurrent data were available. Levels in 1HP have typically remained around 43 maODM since January 2005 and have shown a slight increase in the recent years. MW1 P3 shows a much broader range in level than MW1 P3, which is screened in the same unit. The reported groundwater elevation shows significant fluctuation between 15 maODM and 50 maODM since 2003, with greatest peaks correlating to wet winter periods. It is not apparent why the early water levels fluctuate.

Figure 3.11: Hydrographs for wells screened in the Upper Mudstone Member



Upper Gypsum Member

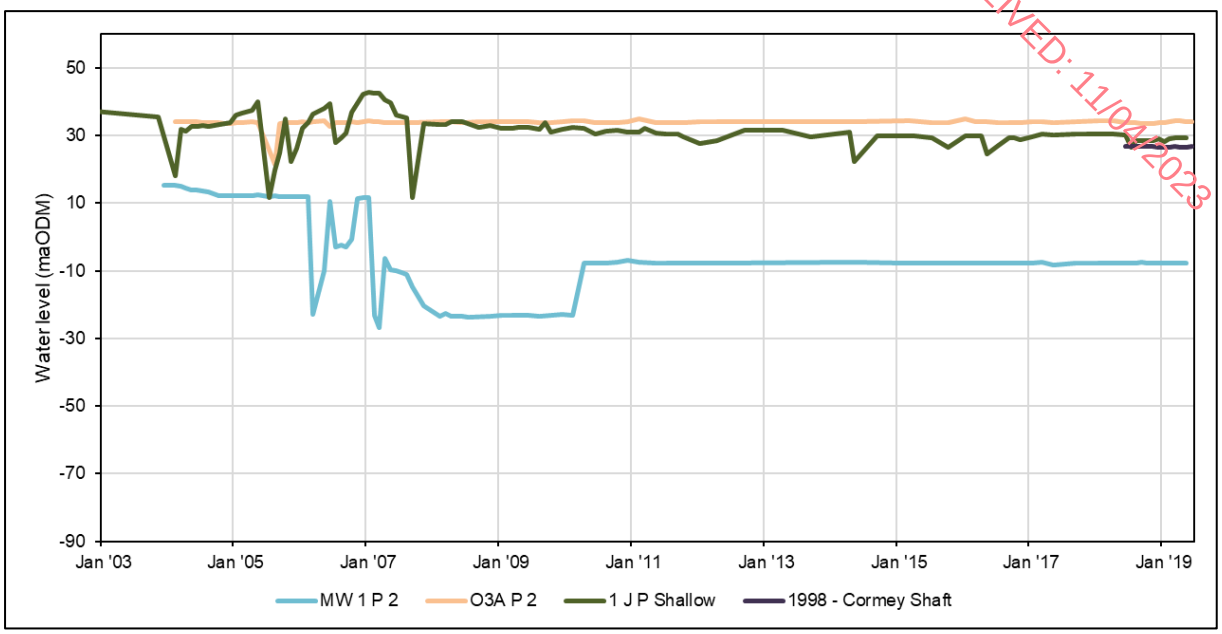
There are four observation wells monitoring the Upper Gypsum Member (Figure 3.12). These typically have water levels around 10 m lower than the Upper Mudstone Member wells. This suggests a downward hydraulic gradient and indicates that significant downward groundwater flow does not occur.

O3A P2 has remained stable since monitoring began, with the exception of a sharp drop in level in July 2009 which corresponds to a similar drop in 1J P Shallow. Overall levels in these two wells have been similar since 2009, but 1J P Shallow has decreased by approximately 4 m in that period and shows stronger fluctuations than O3A P2.

Groundwater levels observed in MW1 P2 are about 35 m lower than in the other Upper Gypsum Member wells. The level was recorded at 18 maODM when monitoring began in February 2004 in this well. The drawdown may have been a response to early underground development in Drummond. Further drawdown occurred during 2006 and early 2007. The reason for the reported recovery in 2010 and the stable water level since June 2010 (-8 maODM) is unclear, although it continues to be influenced by mining.

Monitoring data for the Cormey shaft have shown a slight downward trend since 2007 but the shaft appears to be mostly isolated from the Drummond underground mine. There was a drop of about 1 m which appears to be coincident with the increase in mine inflows in June 2018.

Figure 3.12: Hydrographs for wells screened in the Upper Gypsum Member

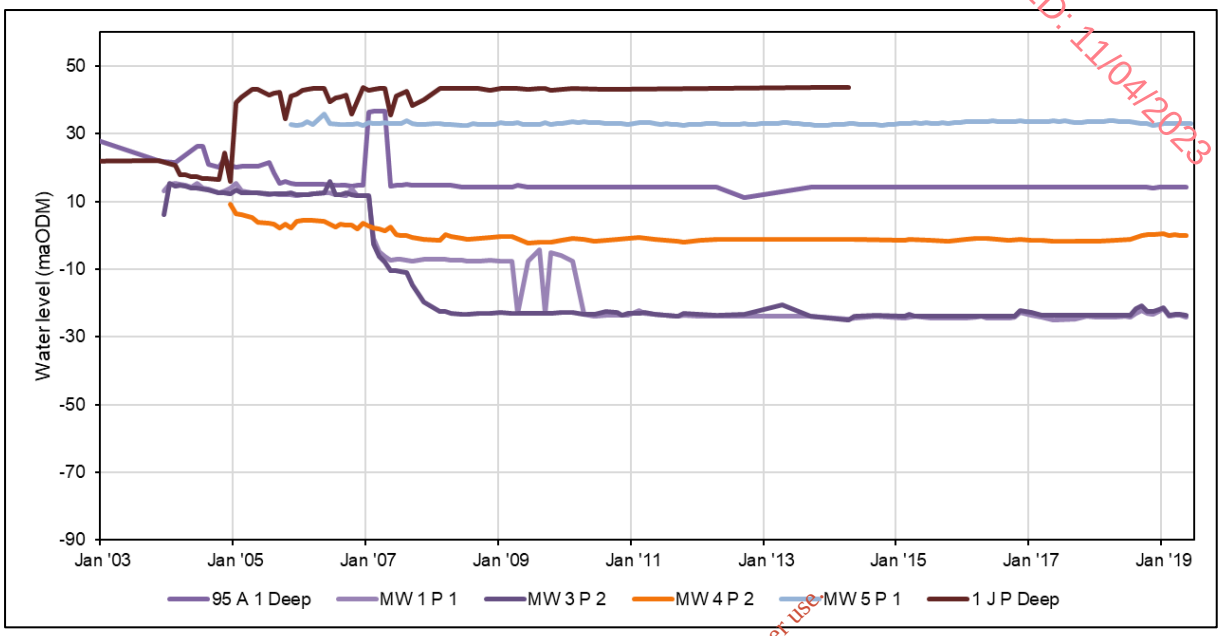


Middle Mudstone Member

Observation wells in the Middle Mudstone Member are shown in Figure 3.13. Overall, water levels show a much wider range than those seen in the upper units. This is due to proximity to mine workings and associated dewatering. All but two of the observation points (MW 5 P1 and 1 JP Deep) are below the hydrogeological base level. Key observations are as follows:

- Levels in MW5 P1 have remained stable at around 33 maODM since monitoring began in 2006 and do not appear to be impacted by mining;
- 1JP Deep increased from 22 maODM in November 2003 to 43 maODM in May 2005, where it has remained since;
- 95A1 Deep and MW4 P2 have shown similar trends, with levels declining gradually up until 2008 when they stabilised, and a slight rise in water level is seen in late 2018;
- M1 P1 and MW3 P2 have decreased in level by around 17 m and 35 m respectively, with the main drop occurring in January 2007 (consistent with MW 1 P2 in the upper gypsum and M 101 P in the Numurian – albeit a more subdued response);
- M1 P1 and MW3 P2 have approximately the same reported groundwater level of around -23 maODM since January 2007.

Figure 3.13: Hydrographs for wells screened in the Middle Mudstone Member (including dolerites)

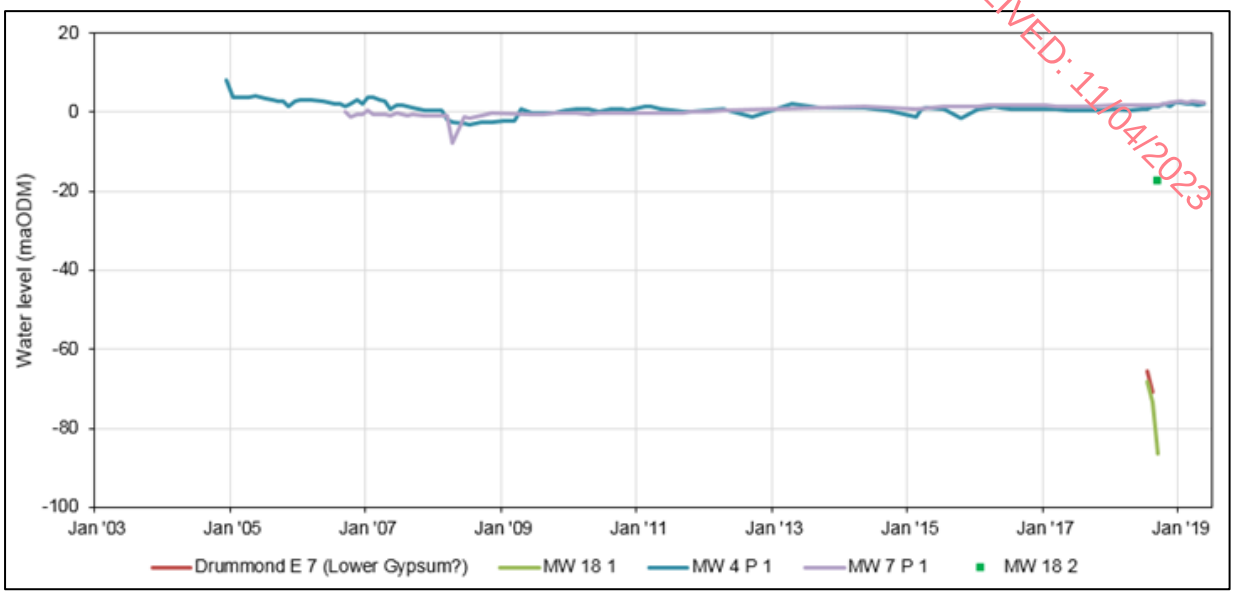


Lower Gypsum Member

Observation wells in the Lower Gypsum Member (Figure 3.14) have shown little variation since monitoring started in about 2005. Reported water levels in MW4 P1 and MW7 P1 are very similar, but MW7 P1 fluctuates less than MW4 P1. Both wells have a reported water level of around 0 maODM which is significantly below the hydrogeological base level. However, neither well responds to the increase in Drummond Mine inflows in 2018.

Drummond E7 and MW18 2 are believed to be open in the Lower Gypsum member. The level in Drummond E7 is approximately -65 maODM and the single water level measurement for MW 18 2 was 17 maODM in September 2018. Borehole logs for MW 18 1 shows it is open in a faulted interval of the Lower Gypsum Member. The water level was between -70 and -90 maODM in late 2018.

Figure 3.14: Hydrographs for wells screened in the Lower Gypsum Member



3.4.4 Namurian sandstone and Westphalian shale

The Drumgoosat dewatering well is screened in Namurian sandstone. The monitoring data indicate that pumping maintained the water level at between -50 and -30 maODM until June 2018 (Figure 3.15), when water levels increased to around -10 maODM as a result of the increased inflow of water pumped from the Drummond Mine (see Section 4.3). The Drumgoosat dewatering well levels are approximately 80 m below the regional water levels reported for the Namurian sandstone, and the hydrograph shows a strong seasonal signature. Well levels have typically varied by around 10 m between seasons, but levels during the 2018 winter period exceeded those previously reported.

In addition to the Drumgoosat well, there are two observation wells screened in the Namurian sandstones (M101 P and MW6 P1). These are below their expected hydrogeological base level but show relatively little variation over the past 10 years (Figure 3.15). Between early January 2007 and January 2009, a decline in water level was observed in M101 P, from around 35 to 29 maODM. This response was not observed in MW6 P1, but was also seen in MW 3 P 1 which is screened in the Westphalian Shales.

Water levels in MW 3 P 1 (-10 to -20 maODM) are at least 30 m lower than the expected hydrogeological base level at that location, but remain relative stable from 2009 until early 2017, when a further reduction in level of around 3 m was observed. MW 3 P1 also shows a subdued response to the recent increase in water level in the Drumgoosat well.

Water levels in O3A P1 have shown little variation since monitoring started in about 2005 until the 6 month period between April 2018 and October 2018 when a steep drop from 30 maODM

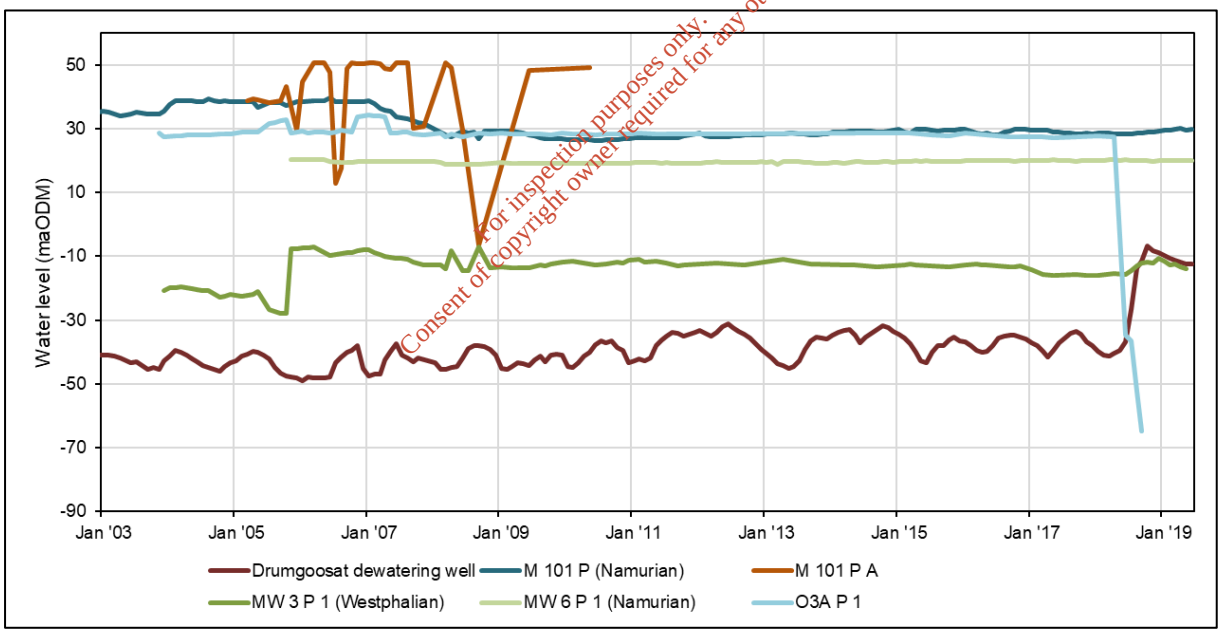
to -60 maODM occurred. This can be correlated with mining into a fracture zone associated with the June 2018 mine fault (see Section 4.3).

There are no further apparent correlations between the water levels in the dewatering well and water levels in the observation wells. It is inferred that all three observation wells have been influenced by historical mining to some degree, but only MW 3 P1 responds (by a minor amount) to recent mining activity.

Due to the hydraulic layering and poor connectivity of the geological units in the area, it is apparent that some lower units have become dewatered to variable degrees, while units above them remain unimpacted by mining. This is most notable with regards to the superficial deposits, but it also occurs in the bedrock due to the layering of the units with the Kingscourt Gypsum sequence and the presence of the dolerite sills.

Furthermore, below the Kingscourt Gypsum sequence, there are high groundwater levels in some of the underlying Namurian sandstone units compared to overlying gypsum sequence.

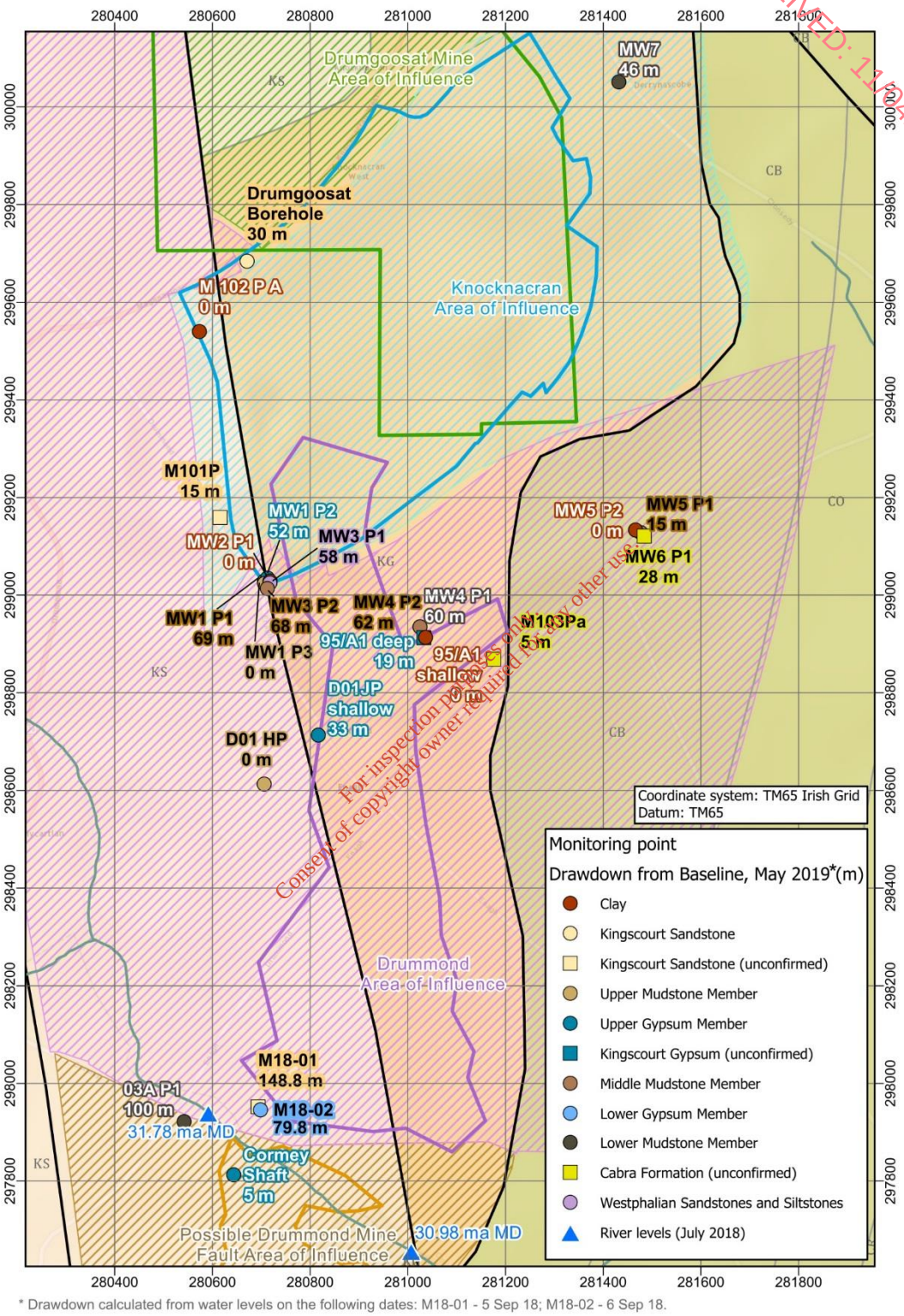
Figure 3.15: Hydrographs for wells screened in Namurian sandstone



3.4.5 Drawdown

Using the long-term water level records, the drawdown from original baseline for each monitoring well has been estimated as shown in Figure 3.16. Drawdown is greatest within the mudstone and gypsum members, as would be expected because these are the units where mine workings are present. There is some localised drawdown in the Kingscourt Sandstone and Namurian Sandstone units, some of which can be related to the penetration of the hydraulic barriers caused by the faults and lithological contacts (see Section 5.5).

Figure 3.16: Interpreted monitoring well drawdown from baseline conditions



* Drawdown calculated from water levels on the following dates: M18-01 - 5 Sep 18; M18-02 - 6 Sep 18.

Beneath the R179 and L4900 roads, about 70 m of drawdown has occurred within the Kingscourt Gypsum Formation as a result of historical mining and dewatering of the Drumgoosat Mine. Figure 4.5 shows the strata dip away from the R179. The interpreted pre-mining groundwater level was likely around 40 maODM below the alignment of the road. It appears that the pumping from Drumgoosat underground has maintained dewatered conditions beneath the roads. It is expected that pumping from the Knocknacran open cast and the Drumgoosat well will cause groundwater levels beneath the roads to remain low during the period of active operations. Any potential seasonal variation in groundwater level would be limited provided pumping from the workings is continuous.

All bedrock drawdown is relatively local to the mining areas. There is no indication of any regional-scale drawdown.

There is no apparent drawdown or influence of mining on the superficial deposits.

3.5 GROUNDWATER CHEMISTRY

The Minerex 2018 Annual Monitoring Report[7] presents water quality plots for all monitoring wells to the end of 2018. The plots are included in Appendix A. The monitoring well locations and depths are presented in Figure 3.7 and Figure 3.8. In general terms, the groundwater of the area is near-neutral pH; with high chloride and sodium and moderate sulphate and calcium. Table 3-3 provides a summary of the sample results.

Each monitoring location tends to have at least one parameter which is an exception to these generalisations. There does not appear to be any correlation with regards to lithology, depth or location (except MW1 and MW3), suggesting that groundwater quality is localised and is primarily controlled by local flow conditions and the interaction of the specific combination of lithologies in that area.

Alkalinity is mostly high but is also variable between sampling stations. For samples that have high alkalinity, the sulphate and calcium are relatively low, suggesting that the water has not had significant residence time within any of the gypsum horizons. Samples that have high sulphate also tend to show high calcium (this is expected) and sodium which suggests the water has had contact with gypsum and other evaporite lithologies. The high pH values (> pH8) indicate an external influence, possibly cement from the well construction.

Any groundwater that comes into contact with gypsum will, in principle, cause gypsum to dissolve, provided the water is under saturated. The rate of dissolution is dependent on the extent of under saturation and also the pH of the water (lower pH = faster dissolution). Most

[7] Minerex, 2019b. Annual Monitoring Report 2018 Rev 0, May 2019. Doc. Ref.:1632-2089.

groundwater samples from monitoring wells appear to be under saturated with respect to gypsum. Therefore, there is the potential for dissolution of gypsum to occur, even though the pH is typically neutral. Superficial groundwaters tend to have the lowest pH, so the greatest potential for dissolution is where these waters have contact with gypsum such as in the wall of the open cast or in the Upper Mudstone or Upper Gypsum members above the roof of the underground mining areas. However, most of the local superficial (till) deposits are of low permeability, so percolation rates are relatively low. There is more potential for on-going gypsum dissolution below natural or mining-induced surface depressions where infiltration and percolating water may become concentrated.

The ability for gypsum dissolution to cause mechanical changes to the formation is more likely to be a function of kinetics (physical movement) and not of thermodynamics (degree of under-saturation and pH). The kinematics of crystalline gypsum dissolution in Palaeozoic and Mesozoic rocks is typically slow and tends to be associated with water movement rather than thermodynamics. If flow through the wall rock or void space is sufficiently slow, gypsum will dissolve, reach equilibrium and then begin to re-precipitate.

The data show a significant change in groundwater quality of MW1-P3 as a result of the inflows related to the June 2018 mine fault. The water in the monitoring well goes from having relatively low concentrations of all parameters and elevated pH (unlike any other water type), to being similar to MW1-P1 and MW3-P2 (i.e. with relatively high sodium, calcium and sulphate). Reported values of calcium are 500-600 mg/l with 1,400-1,900 mg/l sulphate, showing near gypsum saturation. Recent samples from the inflow water from the mine fault show lower sulphate values and under saturation with respect to gypsum (Table 3-4).

Table 3-3 Summary of groundwater quality

Lithology	Unit	Well	pH	Alkalinity	Chloride	Sodium	Calcium	Sulphate	Comment
Dolerite	Lower Mudstone	MW4-P1	7 to 8	100 to 400	10 to 20	50 to 70	100 to 200	400 to 500	Comparable to M102-PA
Dolerite	Middle Mudstone	MW1-P1	7 to 8	100 to 400	40	50 to 70	500 to 600	1400 to 1900	Comparable to MW3-P2
Dolerite	Upper Mudstone	MW5-P1	7 to 8	400 to 1000	10 to 20	10 to 30	100	100 to 200	
Mudstone	Middle Mudstone	95A1-D	11 to 13	400 to 1000	10 to 20	10 to 30	Variable	Variable	
Mudstone	Middle Mudstone	MW3-P2	7 to 8	100 to 400	40	50 to 70	500 to 600	1400 to 1900	Comparable to MW1-P1
Mudstone	Upper Mudstone	MW1-P3	8 to 10	<50	10 to 20	10 to 30	<100	100 to 200	Pre-June 2018
			7 to 8	100 to 400	40	120	500 to 600	1400 to 1900	Post-June 2018
Till	Overburden	M102-PA	7 to 8	100 to 400	10 to 20	50 to 70	100 to 200	400 to 500	Comparable to MW4-P1
Till	Overburden	MW2-P1	6 to 7	500	60	10 to 30	200	100 to 200	
Till	Overburden	95A1-S	11 to 13	100 to 400	10 to 20	10 to 30	100 to 200	10	
Till	Overburden	MW5-P2	7 to 8	100 to 400	10 to 20	10 to 30	100	10	Comparable to MW6-P1
Mudstone & Gypsum	Upper Mudstone	01JP-S	7 to 8	400 to 1000	10 to 20	10 to 30	500 to 600	Erratic	
Sandstone	Namurian sandstones	MW6-P1	7 to 8	100 to 400	10 to 20	10 to 30	100	100 to 200	Comparable to MW5-P2
Sandstone	Namurian sandstones	MW3-P1	7 to 8	100 to 400	10 to 20	50 to 70	500 to 600	1400 to 1900	

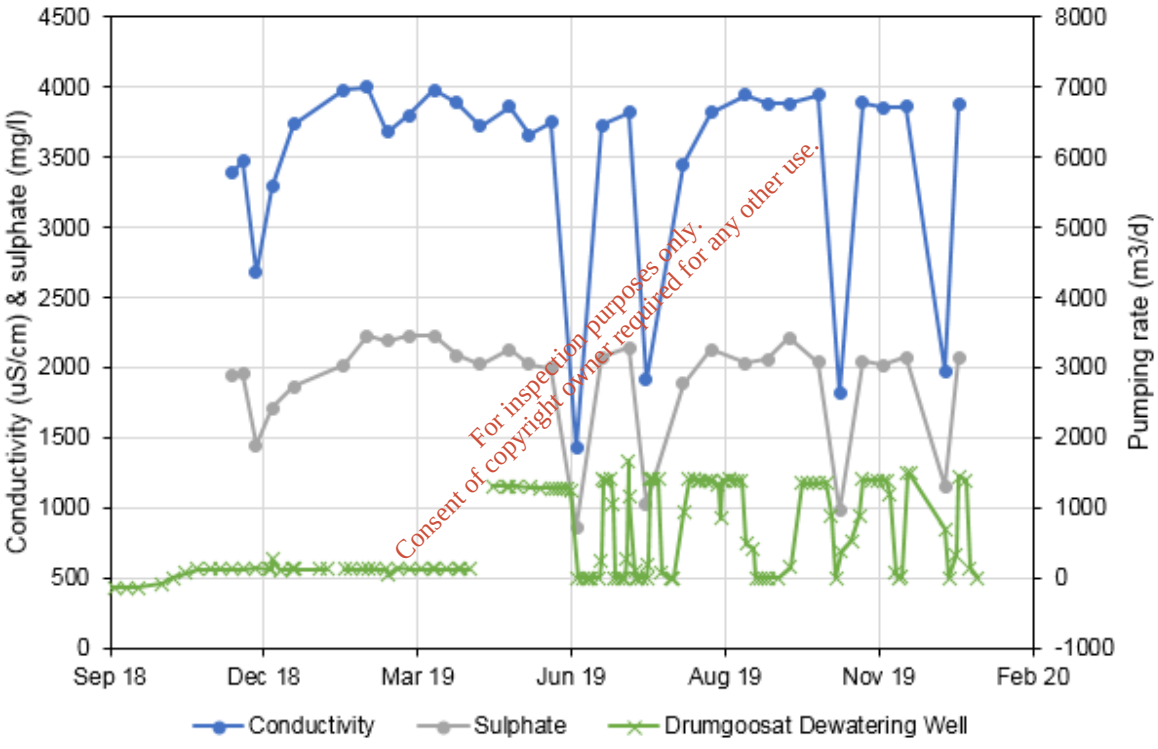
Note: higher than typical values are highlighted in orange and lower than typical in green.

Table 3-4 Sample results from the Drumgoosat well and the south mine inflow water

	No. of Samples	Sulphate (mg/l)			pH (pH units)			Conductivity (µS/cm)		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Drumgoosat well	31	1900	863	2227	8	7.08	7.98	3482	1424	3995
Drummond south inflow	2	545	532	558	-	-	-	1331	1328	1333

Samples from the Drumgoosat well typically show near-saturation with respect to gypsum (Table 3-4) but with some samples showing lower parameter values (Figure 3.17). The lower values may be related to samples taken following the pumping of water into the well.

Figure 3.17: Time series plot of Drumgoosat well chemistry



Note: positive pumping rate indicates water pumped to lagoon, negative pumping rate indicates water pumped to workings.

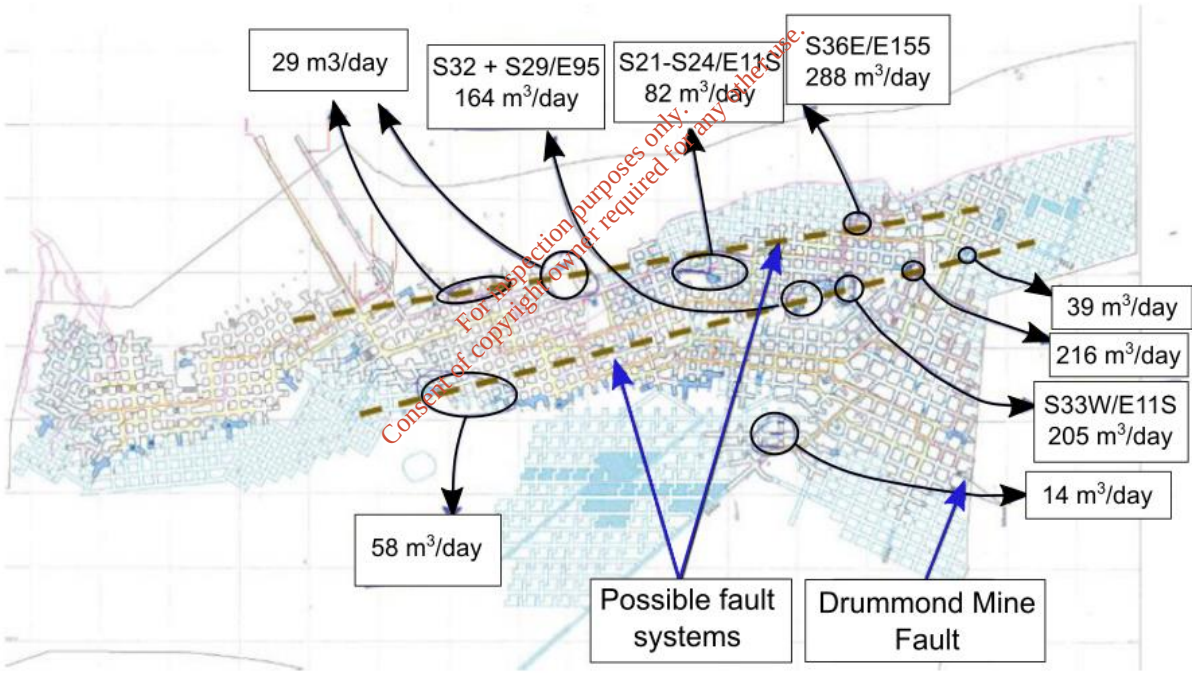
4. MINE WATER MANAGEMENT

4.1 INFLOW SOURCES

4.1.1 Drummond Mine

All inflows to the active Drummond Mine are derived from groundwater. Historical inflows were between 1,400 and 2,200 m³/d. Current inflows are a little over 2,000 m³/d, with about 50% of this derived from the 2018 mine fault zone. The remainder of the inflows are derived from joints and fracture zones, as mapped on Figure 4.1, with much of the hydraulic connection thought to be from the Upper Gypsum unit and/or the dolerite sill. There is a strong correlation between the mapped inflows and the position of inferred fault zones.

Figure 4.1: Sketch map showing inflows to the Drummond mine (November 2019)



4.1.2 Knocknacran open cast

Inflows to Knocknacran open cast mine are mostly derived from incident precipitation onto the pit walls and floor, with a minor amount of local groundwater inflow. Estimated sump pumping rates range between about 10 m³/d in September (groundwater flow only) and 950 m³/d in April (mostly surface water runoff).

The water in Knocknacran open cast is collected in a sump on the pit floor and is pumped up to the settlement lagoons. Mining and water management appears to be well executed, with plating of the bench faces to reduce erosion and piping (Figure 4.2).

Figure 4.2: Good surface runoff management practices at the Knocknacran open cast, including plating of the bench faces and drainage of the benches

4.1.3 Drumgoosat workings

Inflows to Drumgoosat workings are derived from groundwater, plus water pumped into the workings as part of the site water management strategy. Pumping records for the mine during active operations indicate groundwater inflows were low, but seasonally variable, between 20 m³/d in September to 870 m³/d in March.

The seasonal nature of the pumping records suggests that much of the water would likely have been derived from surface infiltration, potentially focused on natural or mining-induced surface depressions, and particularly in the central section of the mine where the Upper Gypsum and mine workings are within 50 m of the ground surface.

Additional groundwater is likely to have entered the workings from the north, along the strike of the Kingscourt Gypsum Formation.

4.2 PUMPING AND WATER MANAGEMENT

Groundwater inflow to Drummond Mine is routed to a central sump in the mine, from where it is pumped to the settlement lagoons. A bulkhead was installed following the inflow that occurred in June 2018 as a result of mining into the June 2018 mine fault (see Section 4.3.5). Water from behind the bulkhead is also routed to the central sump.

Water from Drumgoosat Mine is pumped from a borehole in the old mine workings up to the settlement lagoons.

SLR, 2019[8] prepared the Drummond Mine Dewatering Plan (2019 to 2020). It includes surface water runoff from the areas around the above-ground infrastructure at the workshop, office and car park. The runoff is also directed to the settlement lagoons. Runoff around the workshop hard stand area is directed to a hydrocarbon separator and then to the settlement lagoons. The surface water volumes are small compared to the overall volume of water from the Drummond, Drumgoosat and Knocknacran mining areas.

The existing water management system collects the water from the various sources, and routes it through the treatment facility to the discharge point on the River Bursk. All waters from the site are treated in the settlement ponds for the removal of suspended solids. The water from the various sources at the site is relatively low in suspended solids so does not require significant settlement time (SLR, 2019[8]). There is no process water used at the site.

The water from the final settlement lagoon is pumped to the River Bursk via the infrastructure at MSE-1 located in the south eastern corner of the site (Figure 1.1). MSE-1 infrastructure comprises two large holding tanks, a v-notch weir for measuring discharge flow and continuous monitoring instrumentation for measurement of electrical conductivity (to allow the estimation of sulphate).

SGMI monitor the flow and electrical conductivity in the River Bursk in real time. The discharge of mine water is automatically adjusted depending on the available flow and assimilative capacity in the river. The discharge is controlled in order to ensure compliance with a sulphate value of 200 mg/L at a compliance point (CP1) in the river. CP1 is 70 m downstream of the discharge point (Figure 1.1).

Historically, SGMI has stored the excess mine water in Drumgoosat Mine when discharge to the River Bursk would have exceeded the CP1 compliance value. The mine workings provided a buffer for water storage when there was insufficient assimilative capacity in the River Bursk. Water was released during higher river flows when there is adequate assimilative capacity.

Following the subsidence event at Drumgoosat on the 23rd/24th September 2018, SGMI commenced the discharge of mine water directly to the existing settlement lagoons and the River Bursk as part of emergency measures which went into force on 28th September.

[8] SLR, 2019. Drummond Mine Dewatering Plan (2019 to 2020) SLR Ref: 190311.501.00545.0004.

4.3 WATER BALANCE MODEL

4.3.1 Reported flows

Within the current mine water management system, three flows are recorded on a regular basis:

- 'Effluent monitoring' – daily monitoring of total mine site discharge from MSE-1 to the River Bursk [April 2004 to September 2019];
- 'Drummond pumping log' – spot flow meter readings of water pumped from Drummond underground to the surface lagoon (sum of BS2400 #2 Flowmeter from Ritz 8", Ritz pumps to Lagoon and #1 Sub from Ritz 8") including water from the June 2018 mine fault [January 2010 to November 2019];
- 'Drumgoosat pump' – spot flow meter readings of the well abstracting water from the Drumgoosat workings to the surface lagoon (negative numbers), or injecting water from the lagoon to the workings (positive numbers) [January 2018 to November 2019].

In addition to these flows, scanned paper records are available of pumping hours from Drumgoosat at various points in time between 1981 and 1992.

4.3.2 Estimated flows

The available flow records above were used to help support the development of a water balance model for estimating the following flows which are not recorded:

- June 2018 mine fault inflow;
- Additional lagoon water which reports to Drumgoosat workings;
- Drumgoosat groundwater inflow;
- Knocknacran groundwater inflow;
- Knocknacran and mine surface infrastructure area runoff.

The water balance includes:

<u>Drumgoosat inflows</u>

- Infiltration from above through superficial deposits
- Lateral groundwater flow within Kingscourt Gypsum from north
- Water pumped in from storage

<u>Outflows from Drumgoosat</u>

- Water pumped out of the dewatering well

<u>Drummond inflows</u>

- Infiltration from above through Upper Gypsum and Dolerite

- Lateral groundwater flow within Kingscourt Gypsum from south
- Inflow from the 2018 mine fault

Outflows from Drummond

- Water pumped out of the Central sump

Knocknacran inflows

- In-pit runoff due to incident precipitation on the pit walls
- Minor groundwater inflow from superficial deposits
- Lateral groundwater flow within Kingscourt Gypsum from south and south (currently none because of mines to north and south)

Outflows from Knocknacran

- Water pumped out from sump

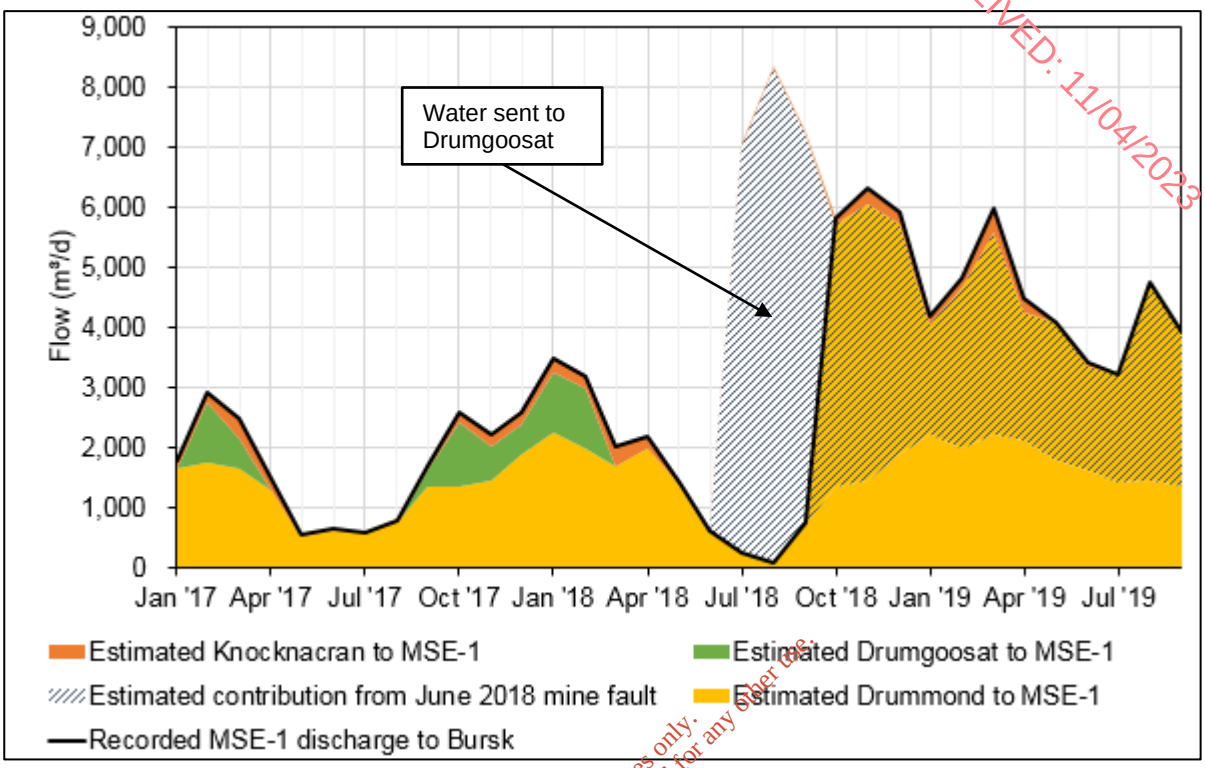
The monthly water balance is presented in Appendix B and the components of flow making up the MSE-1 discharge are shown in Figure 4.3. The following subsections describe the water balance for each of the mining areas.

4.3.3 Drumgoosat underground

Scanned copies of hand-written pumping hour records are available from the period when Drumgoosat was being mined. The record was not continuous but included dates between 1981 and 1992. 1991 provided the best record and had pump capacity estimates so flows could be derived from the pumping hours record. It showed that a total of 92,691 m³ was pumped from Drumgoosat between 9th January and 5th December 1991, giving an average flow of 281 m³/hr. However, flows were strongly seasonal ranging from 20 m³/d in September to 870 m³/d in March. This reflects the normal seasonal recharge pattern.

For the purposes of this study, and to take a conservative approach, it has been assumed that all water pumped was groundwater (i.e. no water service water was pumped back underground for drill rigs or dust suppression). The monthly total flows for Drumgoosat were used directly in the water balance model, with two thirds of the flow being attributed to the current Drumgoosat underground and one third to the Knocknacran open cast pit (which has mined into the southeast portion of the Drumgoosat workings). These flows are presented in Table 4-1.

Figure 4.3: Estimated mine water balance 2017 to 2019



Colour blocks show cumulative components of MSE-1 flow

4.3.4 Drummond underground

Figure 4.1 shows that the dewatering rate from Drummond underground was seasonally variable between (1,400 and 2,200 m³/d) in 2017 and early 2018. These flows are consistent with the groundwater point-source inflow mapping (Figure 4.1) which indicates inflows of around 760 L/min (1,094 m³/d). The point source inflows appear to occur along linear features as indicated in Figure 4.1. This would be expected in this environment where faults act as barriers to groundwater flow (and in some cases flow may also be slightly enhanced parallel to their strike).

Additional inflows to the Drummond workings after June 2018 are not recorded directly or as part of the 'Drummond pumping log'. However, the Drummond flow record increases significantly from June 2018 reflecting the changing of the water management system to handle the new inflows. In general, there appears to be a slight incremental rise in groundwater inflows through late-2018 and early-2019, but continuing to display a seasonal variation. Estimated inflows between October 2018 and September 2019 (excluding June 2018 mine fault) are between 1,600 and 2,300 m³/d.

Table 4-1 Estimated groundwater inflows to the Drumgoosat Workings based on 1991 records

Month	1991 Drumgoosat pumping record (m³/month)	Estimated current Drumgoosat groundwater inflow (m³/month)	Estimated current Knocknacran groundwater inflow (m³/month)
January	11 351	7 567	3 784
February	10 885	7 257	3 628
March	26 786	17 857	8 929
April	17 037	11 358	5 679
May	1 437	958	479
June	1 879	1 253	626
July	1 426	950	475
August	1 511	1 007	504
September	672	448	224
October	8 240	5 494	2 747
November	14 101	9 401	4 700
December	12 726	8 484	4 242
Total (m³/yr)	**108 049**	**72 033**	**36 016**

4.3.5 Drummond south end inflow

A significant groundwater ingress to the Drummond Mine occurred on 21st June 2018 after the advancing development for the galleries encountered a fracture zone in the rock (Minerex[9]). Initially, the ingress was not apparent and remained unnoticed when the mine staff left the site in the evening. However, the inflow increased substantially during the night and the mine galleries were found partially flooded the next morning.

It was postulated that that the inflow increased from its initial low rate as a result of local-scale gypsum dissolution. However, a more plausible explanation may be flushing out of fault gouge material from the fault zone. The early water inflow to the mine from the ingress was estimated to be around 12,000 m³/d. After a number of weeks, this had reduced to around 4,000 m³/d. The current inflow at this location is now around 1,200 m³/d.

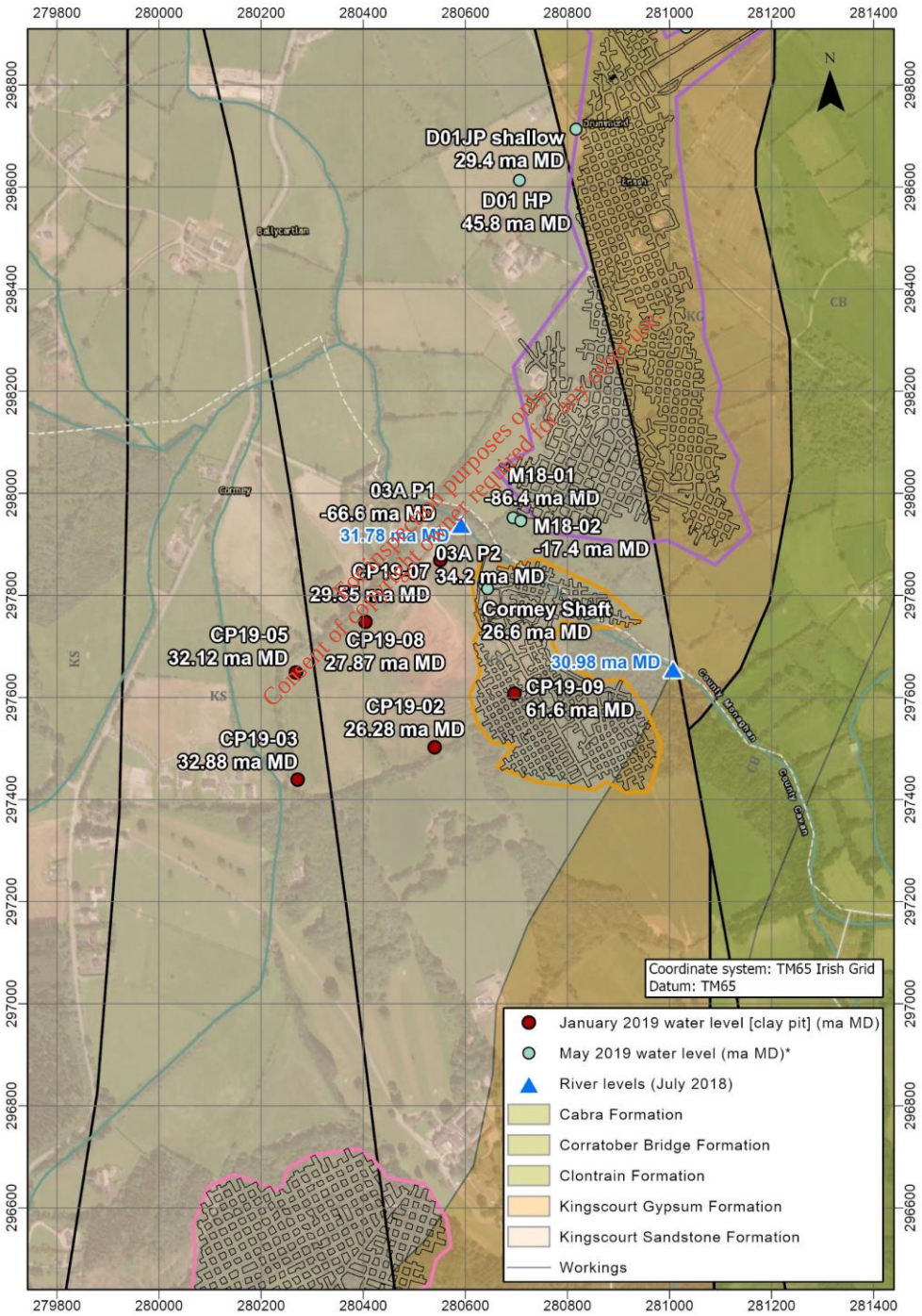
The inflow had a notable impact on monitoring well O3A P 1 (in the Lower Mudstone). The rapid change in water level suggests a limited source of groundwater storage in the locally interconnected fracture network. The reduced inflow rate in 2019 is likely because: (i) much of the groundwater storage has been discharged from the fault; and (ii) July is a seasonal low for

[9] Minerex, 2019a. Drummond Mine Water Ingress: Assessment of Impact on Groundwater Resources - Rev 1, June 2019. Doc. Ref.: 1632-2093 (Rev 3).

recharge to the groundwater system (and so low groundwater inflow). Recent water samples show the inflow waters are under-saturated with respect to gypsum.

Figure 4.4 shows the current water levels in the area around the south end of the Drummond mine. The map includes available groundwater monitoring data, including the monitoring wells drilled around Cormey brick quarry, plus low flow river spot heights.

Figure 4.4: Current groundwater levels around the south end of Drummond mine



The map shows strongly depressed groundwater levels in M18-02 and 03A P1 due to the 2018 mine inflow, and also reduced water levels in M18-02. Water levels in the Cormey shaft, CP19-02, CP-19-07 and CP19-08 are about 3 to 5 m below the level of the river, indicating they are below their hydrogeology base level and effected by the mine workings or by local groundwater inflow to Cormey brick quarry. The water level in OPA P2 is slightly higher than the river, as are water levels in CP19-02 and CP19-05, which appear to occur to the west of a mapped fault zone.

Figures 4.5 and 4.6 show north-south and east-west cross sections through the south end of the Drummond mine area. The alignment of the cross sections is shown on Figure 4.7. The inferred north-south fault penetrated by the workings in June 2018 is shown on Figure 4.6. The low groundwater levels occur immediately to the west of the fault. The reported water level in MW18-02 appears to coincide with the level of the Upper Gypsum unit. It should be noted that the old Cormey mine workings are located within the Upper Gypsum unit which occurred within about 30 to 40 m below the level of the alluvium below the River Lagan. All the Drummond Mine workings are within the Lower Gypsum unit.

Figure 4.5: North-south cross section through the south end of Drummond mine

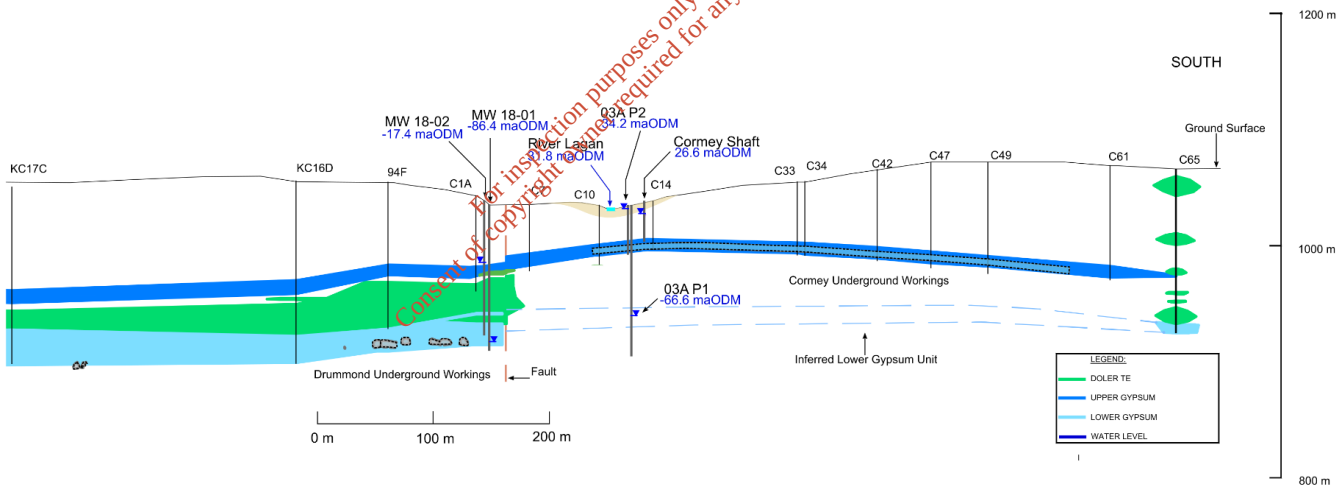


Figure 4.6: East-west cross section through the south end of Drummond mine

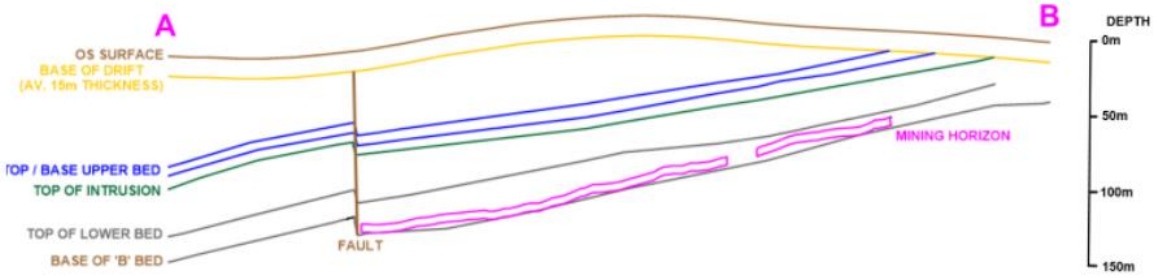
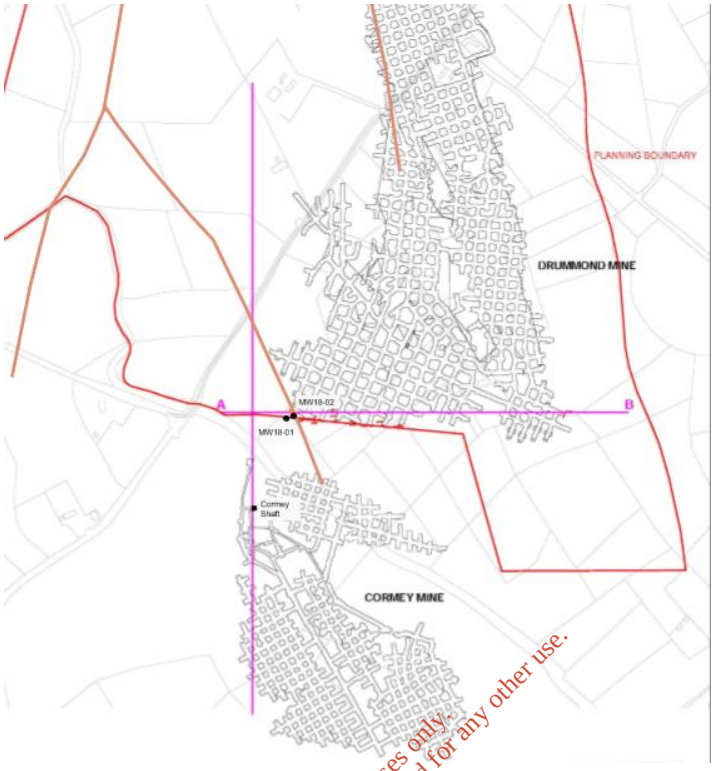


Figure 4.7: Location of the cross sections at the south end of Drummond mine



The following conclusions can be inferred from the available data:

- The area of high drawdown resulting from the Drummond 2018 inflow is localized and limited in aerial extent. The high drawdown area is potentially bounded to the west by sub-parallel north-south trending faults and bounded to the north and south by lithological contacts
- The Lower Gypsum is hydraulically isolated from the Upper Gypsum apart from locally around the fault zone. The Upper Gypsum unit remains saturated (or partially saturated) above the south end of the Drummond workings, below the River Lagan, and within the flooded Cormey workings.
- The superficial deposits around the river remain saturated, with groundwater levels similar to the surface water levels in the river
- The groundwater entering the south end of the Drummond mine likely follows a diffuse flow pathway, as follows:
    - Ultimately, the recharge is derived from the alluvium beneath the river.
    - There is likely a reasonably good hydraulic connection between the alluvium beneath the river and the Upper Gypsum unit (potentially occurring through a dolerite sill).
    - As the percolating water moves downwards through the Upper Gypsum unit, the levels of dissolved calcium and sulphate increase, but the water remains under saturated with respect to gypsum.

- The connection between the Upper Gypsum and the Lower Gypsum (and the Drummond Mine workings) is related to the fault (or the footwall of the fault) but remains relatively weak.

4.3.6 Knocknacran open cast

Water pumped from the Knocknacran open cast is not currently metered. Surface runoff to the sump has also been estimated based on the precipitation record of the site and assuming an average runoff coefficient of 0.3. This produces a runoff contribution of up to 20,000 m³/mon (650 m³/d) in the winter months. Based on the Drumgoosat groundwater inflow assessment shown in Table 4-1, the groundwater inflows to Knocknacran are estimated to be between 200 m³/month in September and 9,000 m³/month in April. However, the actual groundwater inflows may be lower than these estimates because of the relatively small recharge area.

5. CONCEPTUAL GROUNDWATER MODEL

5.1 SUMMARY OF MINE INFLOWS

Groundwater inflows to the existing underground workings are typically low. Inflows to the Drumgoosat mine are estimated to be seasonally between 20 and 870 m³/d. In the Drummond mine, inflows excluding water from the June 2018 mine fault are between 1,600 and 2,300 m³/d, with an additional 900 to 2,100 m³/d derived from the June 2018 mine fault.

5.2 RECHARGE

Precipitation records from 1990 to 2019 show that the site has an annual average precipitation of 955 mm. Dunsany synoptic station (45 km south of the site) has an annual average potential evapotranspiration of 515 mm (2016 to 2019). Assuming actual evapotranspiration is 95% of potential, the effective rainfall for the area is around 466 mm/yr.

The GSI national groundwater recharge map indicates that recharge within the footprint study area is typically 100 to 200 mm/yr. This represents 10 to 20% of mean annual precipitation and 22 to 42% of the effective rainfall, which is considered to be slightly high given the local topography, but is reasonable for planning purposes. It represents a conservative estimate for predicting on-going recharge to the underground mining areas.

5.3 NEAR-SURFACE WATER TABLE

The natural water table is typically within the range 0.5 to 2.0 mbgl across much of the mining area. Groundwater levels in the superficial deposits typically show a seasonal variation of less than 2 m (apart from well MW2 P1). The seasonal variation is due to recharge from October to

March (increasing levels) and limited recharge between April and September as groundwater is removed from the system through evapotranspiration and discharge to local diches or small streams.

All superficial observation wells are above or very close to mine workings but there are no declining trends in any of the superficial groundwater monitoring points, which suggests that any leakage from the alluvium to the dewatered underground mining areas would represent only a small part of the near-surface water balance. Other underground mines in Ireland have not seen any noticeable change in the near-surface water balance of the superficial deposits caused by mining.

5.4 GROUNDWATER FLOW

Based on the available monitoring results, it can be inferred that the north-south strike of the stratigraphical contacts exerts a significant influence on groundwater flow. Most of the groundwater movement within the strata of the Kingscourt Gypsum Formation occurs under fracture flow conditions through structures (faults, or occasionally karst within the gypsum units) or within the dolerite sills which are thought to be locally altered and more potentially permeable than the surrounding gypsum and mudstone units.

The observed geological discontinuities within the strata means there is limited lateral or vertical groundwater flow within the Kingsland Gypsum Formation on a site scale. The layered nature of the strata impedes the downward flow of groundwater to the mine voids and creates strong vertical hydraulic gradients.

The north-south strike of many of the major faults helps to reinforce the groundwater compartmentalisation. The Kingscourt Gypsum Formation is located within the Kingscourt Outlier, which is a half-graben feature, approximately 1.2 km wide (east-west) and 12 km long (north-south). During mine dewatering, the boundaries of the half-graben have helped to localise the area of drawdown. The western limit of drawdown is a fault within the Kingscourt Sandstone Formation.

The geology information and available water level data suggest that the area of drawdown influence from the mining is anisotropic in a north-south direction. This is illustrated in Figure 3.16, where the relatively low groundwater inflow rates to Drumgoosat and Knocknacran produce highly localised areas of drawdown, primarily defined by north-south trending faults. Penetration of the June 2018 mine fault by mining extended the area of influence by a small amount to the south and west.

The groundwater inflows to the Drummond Mine are around an order of magnitude larger than Drumgoosat and Knocknacran combined due to the proximity of saturated alluvial deposits below River Lagan. The saturated alluvium crosses the north-south trending sub-crop areas of

the Kingscourt Gypsum units. The saturated alluvial deposits that underlie the river cause on-going recharge to the Upper Gypsum unit.

5.5 HYDROGEOLOGICAL BOUNDARIES

The total area of drawdown for Drumgoosat, Knocknacran and Drummond is estimated to be less than 4.5 km². The inferred hydrogeological boundaries are illustrated in Figure 3.16 and can be described as follows:

- Western boundary: a fault within the Kingscourt Sandstone Formation. Mine workings have not penetrated this fault. The area of drawdown is unlikely to extend beyond it.
- Northern boundary: the inferred geological interpretation shows the gypsum pinching out, which would support the relatively localised northward extent of the drawdown, potentially further constrained by a northwest-southeast trending fault mapped by the GSI. Current indications are that drawdown extends no more than about 0.5 km from the northern part of the workings.
- Eastern boundary: the graben-stepped faulting determines the maximum distance which any drawdown can extend to the east. Where mining into the Namurian Sandstone has occurred (Drummond and the southeast portion of Drumgoosat/Knocknacran), the area of drawdown may locally extend outside of the Kingscourt Gypsum Formation.
- Southern boundary: drawdown to the south appears to have been limited, potentially by offsets in the Kingscourt Gypsum strata. Recharge from the saturated alluvial deposits below the River Lagan also creates a recharge boundary between the Drummond Mine and the old Cormey workings.

Following the intersection of the fault by the underground development in the southwest part of the workings, the initial inflow was around 12,000 m³/d. The inflow has now reduced to around 1,200 m³/d. The inflow is sustained by recharge (as opposed to groundwater storage) which is ultimately derived from the alluvial deposits below the River Lagan, with the percolating water passing through the Upper Gypsum Unit and through a weak sub-vertical hydraulic connection into the Drummond Mine workings (Lower Gypsum unit).

There are a number of examples of underground mines in Ireland and elsewhere that have encountered additional groundwater inflows as a result of penetrating hydraulic boundaries caused by lithological contacts or faults. Groundwater levels in the surrounding bedrock units typically show very little variation until the hydrogeological boundary is penetrated. At Drummond, there was a rapid fall in water level in OPA P 1 level once mining had penetrated the hydrogeological boundary, indicating limited storage within the Lower Mudstone Member outside of the boundary. The slight fall in water level in the Cormey shaft monitoring point indicates re-equilibrium of the system as a result of the increased mine inflows.

5.6 IMPLICATIONS FOR THE R179 AND L4900 ROADS

Prior to June 1998, the groundwater level in the Kingscourt Gypsum beneath the R179 was about -30 maODM, which represents about 70 m of drawdown from its original pre-mining groundwater level. Pumping water into the Drumgoosat well following the June 2018 Drummond inflow event caused the water level beneath the road to rise to a maximum of about -5 maODM (995 mine level; Figure 5.1). Figure 5.2 shows the extent of inundation of the lower seam for water levels of -37 and -6 maODM. The current groundwater level beneath the road is about -15 maODM.

Figure 5.1: Water levels in the Drumgoosat workings from January 2018 to June 2019 (note that water levels on the y-axis are mine level – maODM plus 1,000 m)

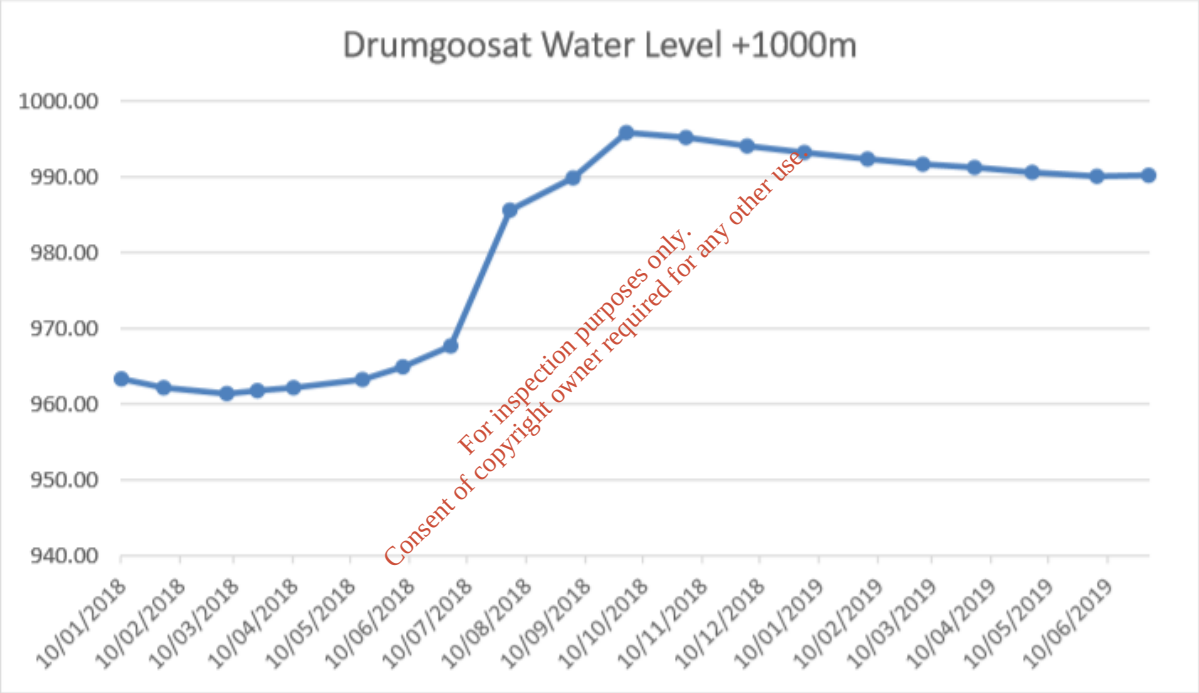
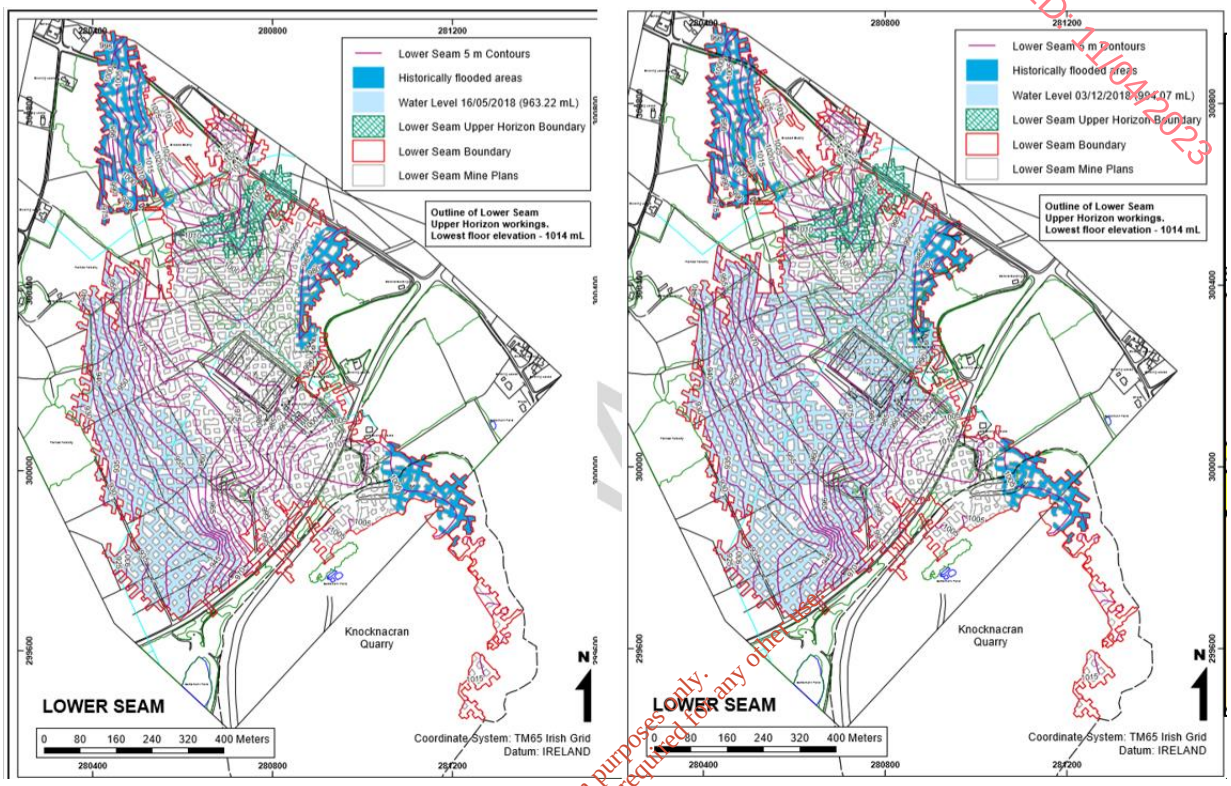


Figure 5.2: Extent of inundation in the Lower Seam close to the R179 with a water level of -37 maODM (left) and -6 maODM (right)



While mining is on-going in Knocknacran open cast and pumping from the Drumgoosat well is being continued, it can be expected that groundwater levels will remain at or below their current level beneath the R179 and L4900.

The available data indicate that seasonal fluctuations are unlikely to affect groundwater levels beneath the roads.

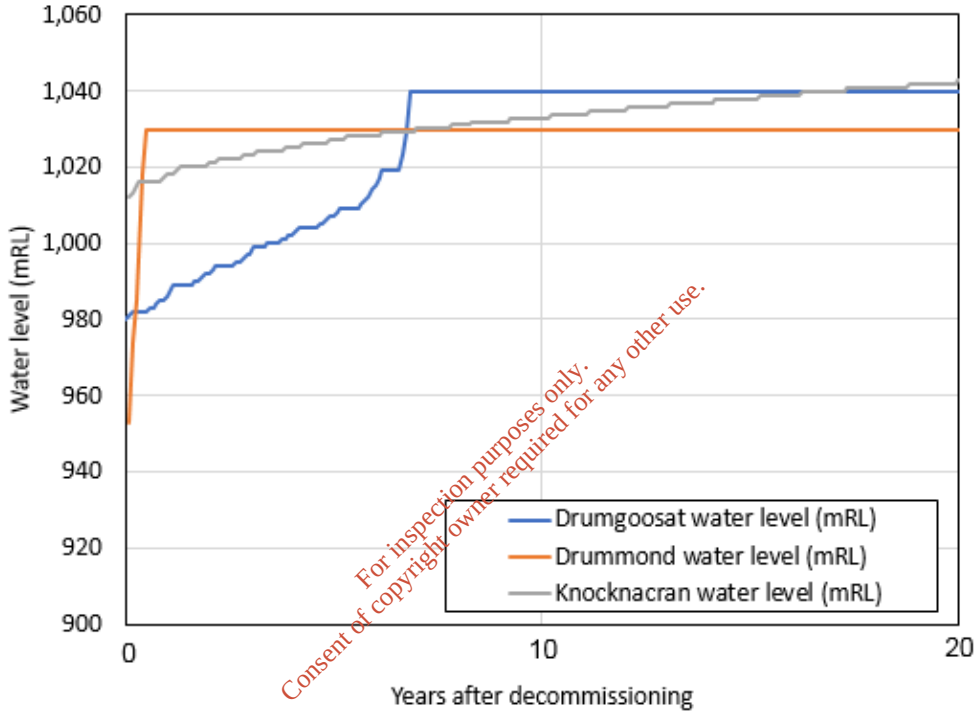
5.7 IMPLICATIONS FOR THE EVENTUAL CLOSURE OF THE SITE

Upon closure of the mine and final shut down of the pumping in Knocknacran, Drumgoosat and Drummond, a lake will form in the area of the Knocknacran open cast and all underground workings will flood. The rate of water level rise in lake will be controlled by the incident precipitation and runoff onto the area of the open cast and the groundwater interconnection with Drummond underground workings.

The water balance model has been used to make a preliminary prediction of the post mining rise in water levels. The model indicates that the Knocknacran lake will rise to about 44 maODM within a period of about 10-15 years following shut down of the pumps (Figure 5.3) and that the lake would create a small surface water overflow at the low point on its western margin. The actual rate of water level rise would depend on the climatic conditions and the amount of rainfall that occurred during the post-closure period.

Figure 5.3 also shows that flooding of the Drummond workings would occur much more rapidly than the lake because of the high rate and groundwater inflow and the low void space of the underground workings relative to the open cast void. The preliminary model indicates that the Drummond workings would flood to about the 33 maODM elevation within a year. There may be some groundwater transfer from the Drummond workings to the lake during the early period of recovery. Potential outflow from the lake to Drummond may also affect the timing of the final stages of the lake recovery, once the lake level rises above about 33 maODM.

Figure 5.3: Water balance model results showing post-mining water level recovery



The Drumgoosat underground is isolated from the Knocknacran open cast by backfill material placed against the North wall of the Knocknacran pit. The backfill will minimize the likelihood of groundwater outflow at the south end of Drumgoosat. Groundwater levels within the Upper and Lower Gypsum beneath the R179 and L4900 roads would initially rise at a slower rate than the lake, but the rate of water level rise would increase once the underground void space is totally flooded. The water level about the flooded workings would rise to above 40 maODM within about 4-6 years. Transfer of groundwater beneath the roads will be limited because of the presence of the backfill material. This will help limit the amount of future gypsum dissolution that can occur beneath the R179.

Final post-mining groundwater levels around Knocknacran are expected to be slightly higher than pre-mining. The final groundwater flow system across the site area can be expected to be similar to pre-mining. Groundwater recharge will occur due to rainfall and runoff on the lake and due to minor natural recharge above the flooded underground mines. Groundwater

discharge from the site will occur across the boundaries of the hydrogeological block defined in Section 5.5. Bulkheads are planned near the south end of the Drummond Mine to minimize the potential for outflow to occur across the fault zone in the southwest part of the workings.

6. SUMMARY AND ACTION PLAN

6.1 HYDROGEOLOGY

The principal control of the hydrogeology of the gypsum mining district is the north-south alignment of the geological strata. This is further enforced by the similar north-south trend of the main regional geological structures. The general low permeability nature of the strata within the Kingscourt Gypsum Formation means that groundwater inflows to the mining areas are mostly low.

The current study includes the inactive Drumgoosat underground, the active Knocknacran quarry (open cast) and the active Drummond underground mine. The available data indicate that all three mining areas are contained within a broad hydrogeological block. Although there are some internal boundaries to the block, the three mining areas appear to be hydrogeologically connected along the strike of the Kingscourt Gypsum Formation.

The hydrogeological block is bounded to the west by a fault within the Kingscourt Sandstone Formation, and to the east by the faults that form the eastern boundary of the half graben. Based on pumping records from the Drumgoosat underground, the extent of dewatering influence to the north appears to be limited, likely no more than 0.5 km to the north of the existing underground mine workings. The available geology data suggest that the gypsum strata may pinch out or become offset.

Saturated alluvial deposits of the River Lagan cross the north-south trending sub-crop of the Kingscourt Gypsum strata between the south end of the Drummond Mine and the historical (flooded) Cormey Mine. Recharge to Upper Mudstone and Upper Gypsum units from the alluvium created mining difficulties during Cormey operations (which mined the Upper Gypsum seam) and has lead to higher inflows into the Drummond Mine than are observed at either Drumgoosat or Knocknacran.

6.2 POTENTIAL IMPACTS

All local public water supplies are located outside the boundaries of the hydrogeological block and are not affected by the mining operations. Source zones for the water supplies are remote from the mining areas.

There is no apparent influence of mining on the groundwater table in the superficial deposits that overlie the mine workings, except very locally around the Knocknacran open cast. This is consistent with observations around mining areas elsewhere in Ireland.

While mining is on-going in Knocknacran open cast and pumping from the Drumgoosat well is being continued, it can be expected that groundwater levels will remain low beneath the R179 and L4900 roads. There may be a minor seasonal variation in groundwater level, but this would be limited provided pumping from the workings is continuous. The available data indicate that seasonal fluctuations are unlikely to affect groundwater levels beneath the roads.

6.3 EVENTUAL SITE CLOSURE

When mining is completed in the Knocknacran open cast, and the pumps are shut down in the open cast sump and in the Drumgoosat dewatering well, a lake will begin to form in the area of the open cast. The rate of water level rise will be controlled by the incident precipitation and runoff onto the area of the open cast and the groundwater connection with the Drummond Mine.

The water balance model indicates that the Knocknacran lake will rise to about 44 maODM within a period of about 20-25 years following shut down of the pumps. Flooding of the Drummond workings to about the 33 maOAD elevation will occur within a year. The backfill material placed against the north wall of the Knocknacran pit will help prevent the possibility of groundwater outflow at the south end of Drumgoosat. The water level about the flooded workings would rise to above 40 maODM within about 4-6 years. Transfer of groundwater beneath the R179 and L4900 roads will be limited because of the presence of the backfill material. This will help limit the amount of future gypsum dissolution that can occur beneath the R179.

6.4 PLAN GOING FORWARD

6.4.1 Key issues

The current study has defined a number of key issues that require on-going monitoring. These are:

- The water level in the Drumgoosat workings
- The water balance of Knocknacran
- The inflow at the south end of the Drummond Mine
- Groundwater levels around the south end of Drummond

6.4.2 Monitoring plan

Going forward, the following needs to be considered for on-going monitoring:

- Continuation of daily monitoring of total mine site discharge from MSE-1 to the River Bursk
- Instantaneous and cumulative flow measurement of the water pumped from Drummond underground
- Instantaneous and cumulative flow measurement of the water pumped from the Drumgoosat well.
- Daily and cumulative flow measurement of the water pumped from the Knocknacran sump
- Daily (or continuous) water level measurements in the Drumgoosat well
- Daily (or continuous) water level measurements in the Cormey shaft
- Quarterly water level measurements in all current monitoring boreholes
- Quarterly water quality sampling of the water pumped from the Drumgoosat well
- Quarterly water quality sampling of the south Drummond inflow

6.4.3 Additional studies

An improved understanding is required to assess the interaction of the Ehagh bog with the mine area, including the swallow hole at Enagh. A walk-over survey of the area is planned for March 2020. A hydrogeology study will be scoped at that time. The study will consider the implications of closure and flooding of the Drummond Mine workings.

7. LIMITATIONS

Piteau Associates has exercised reasonable skill, care and diligence in obtaining, reviewing, analysing and interpreting the information acquired during this study, but makes no guarantees or warranties, expressed or implied, as to the completeness of the information contained in this report. Conclusions and recommendations provided in this report are based on the information available at the time of this assessment.

In preparing the recommendations contained herein, Piteau Associates has relied on information and interpretations provided by others. Piteau Associates is not responsible for any errors or omissions in this information. This report is comprised of text, tables, figures, photos and appendices, and all components must be read and interpreted in the context of the whole report. The report has been prepared for the sole use of Saint-Gobain Mining Ireland (Ltd.), and no representation of any kind is made to any other party.

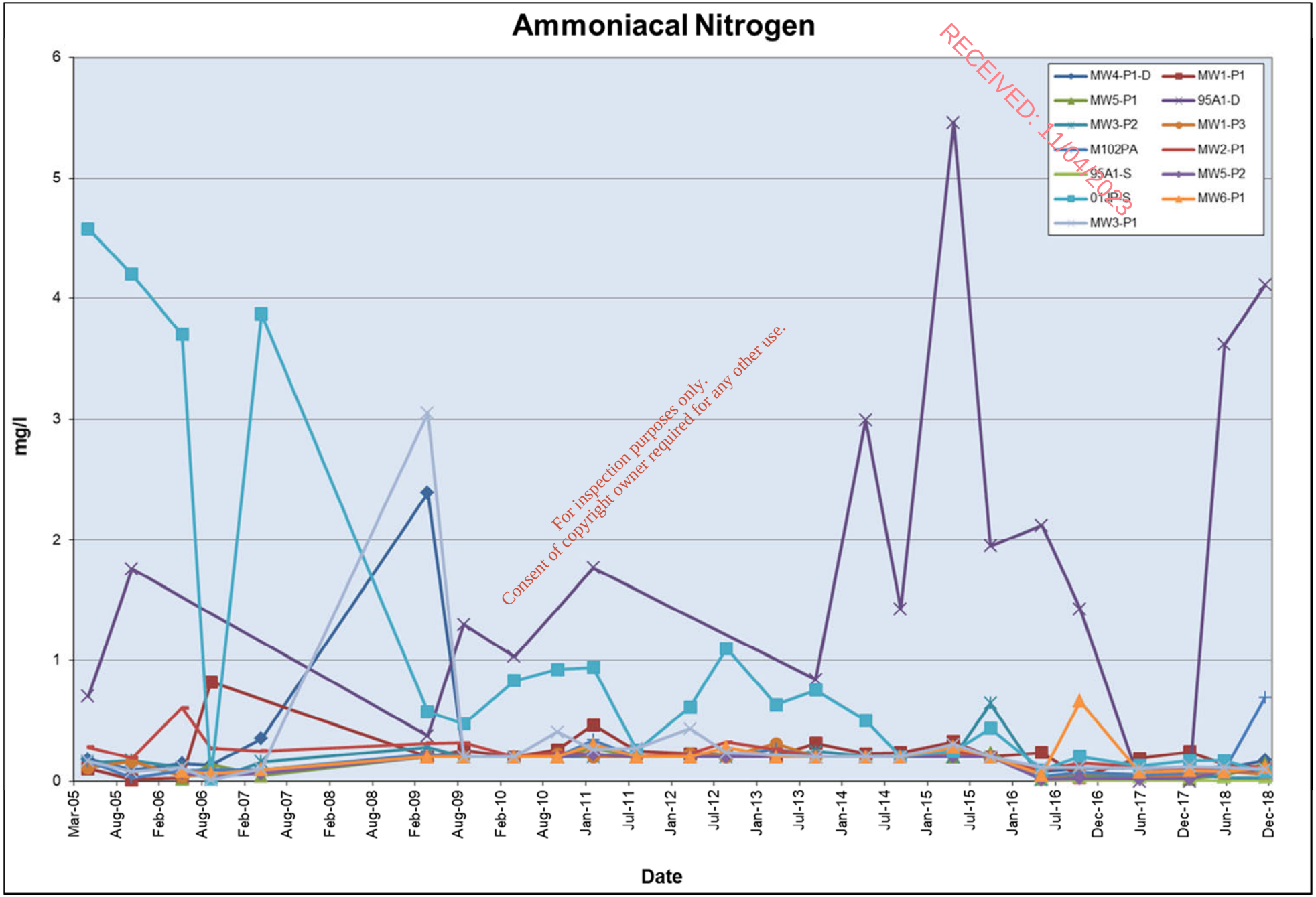
Respectfully submitted,

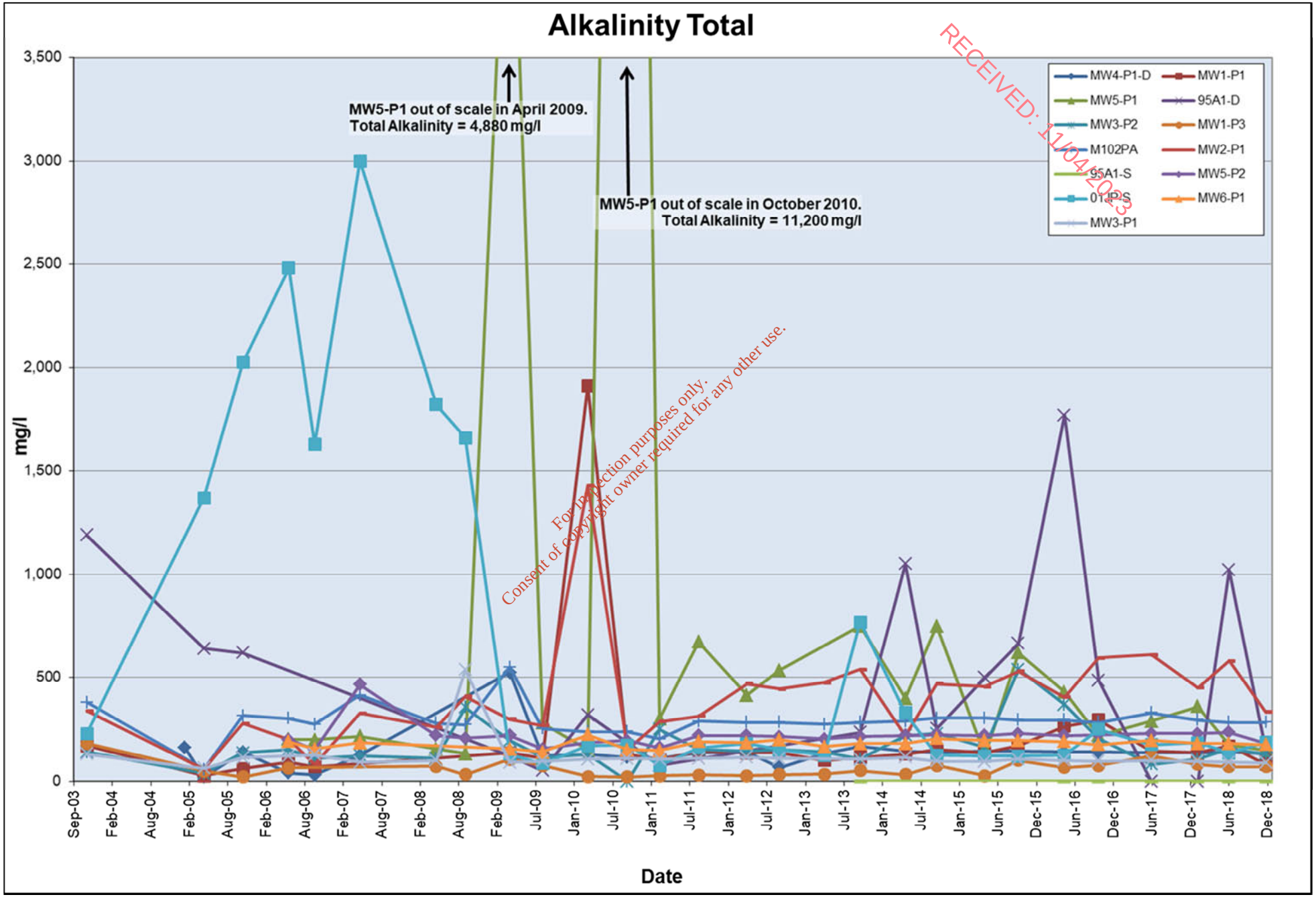
PITEAU ASSOCIATES.

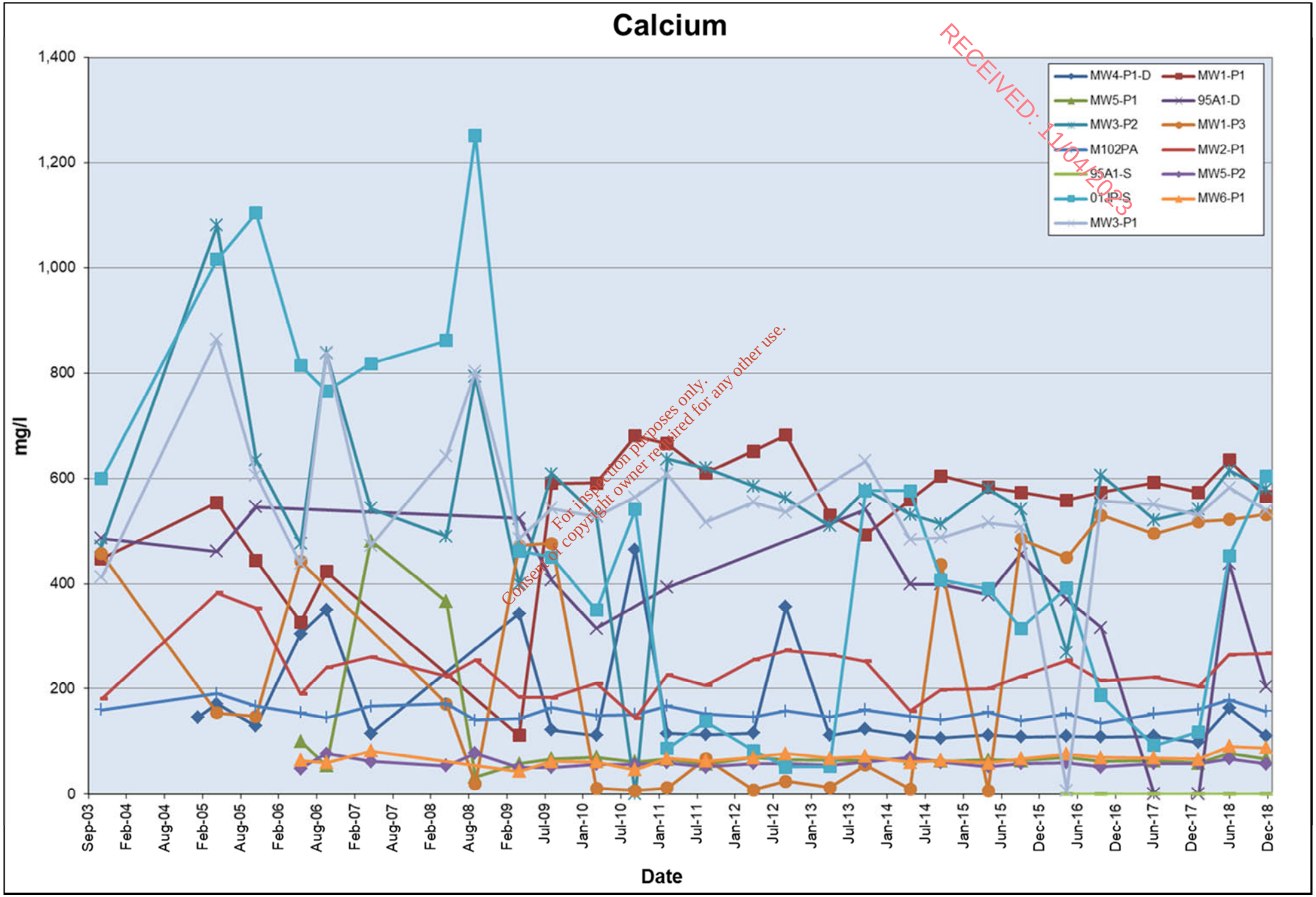
Geoff Beale
Principal

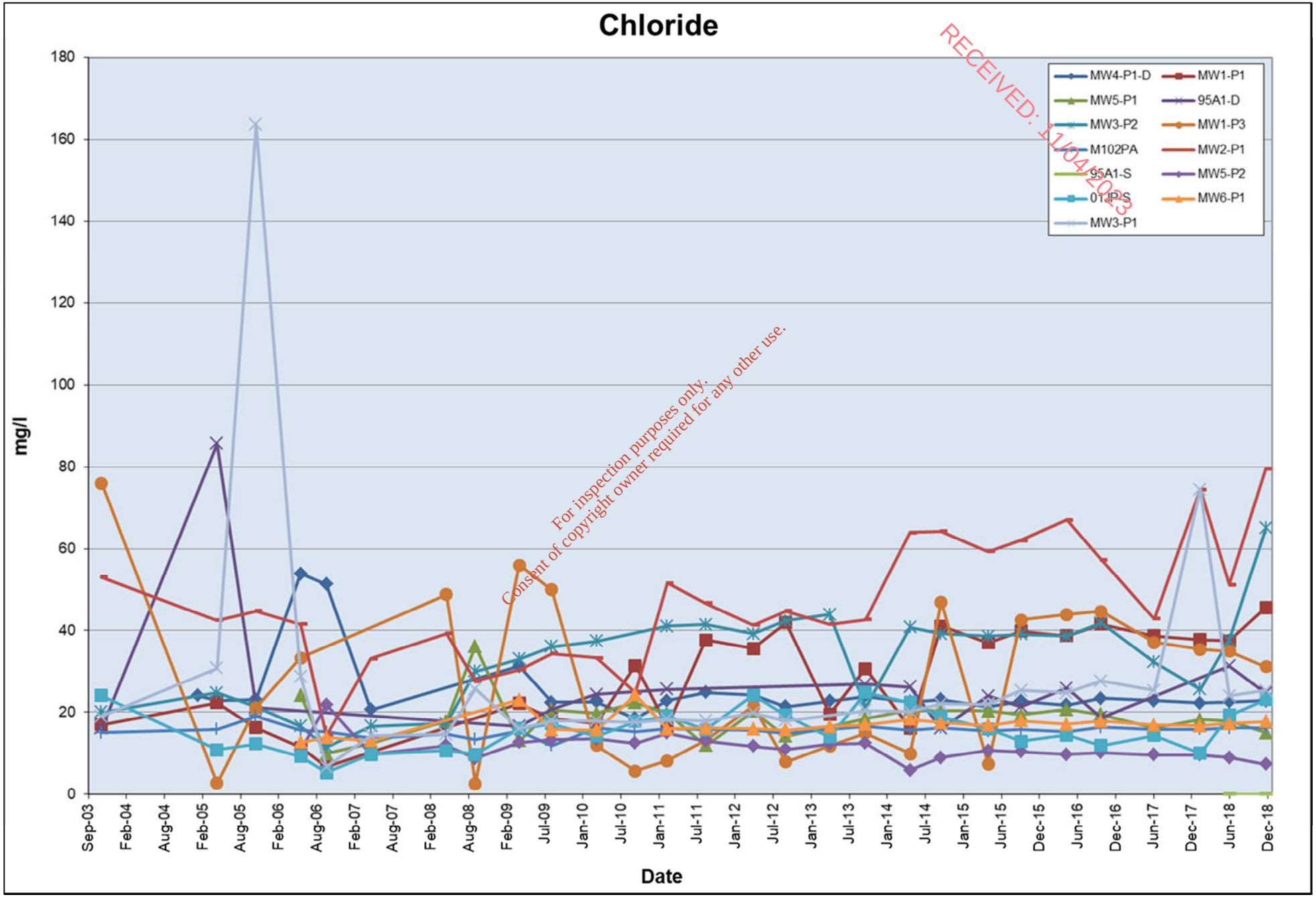
APPENDIX A

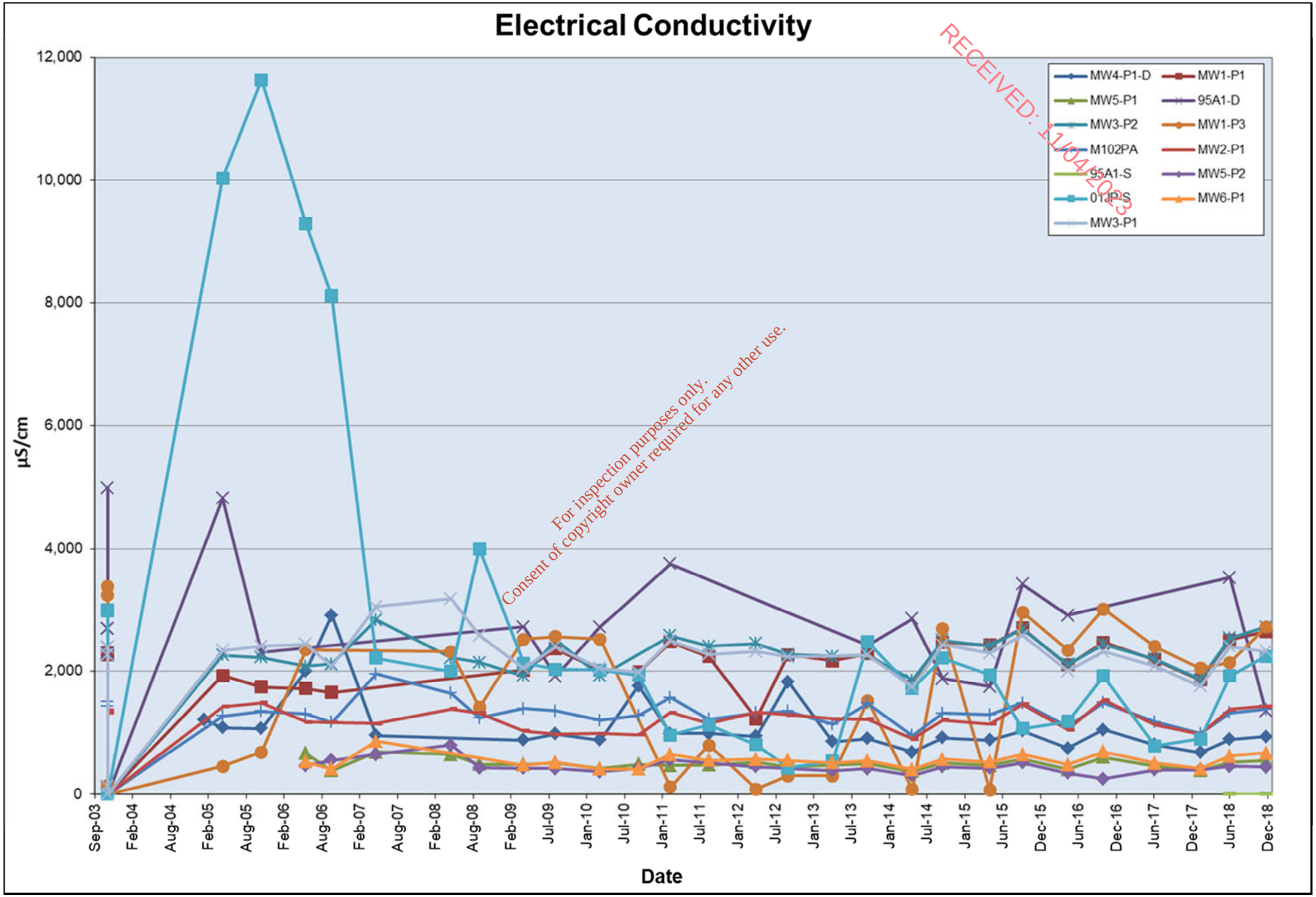
Minerex 2018 Annual Monitoring Report

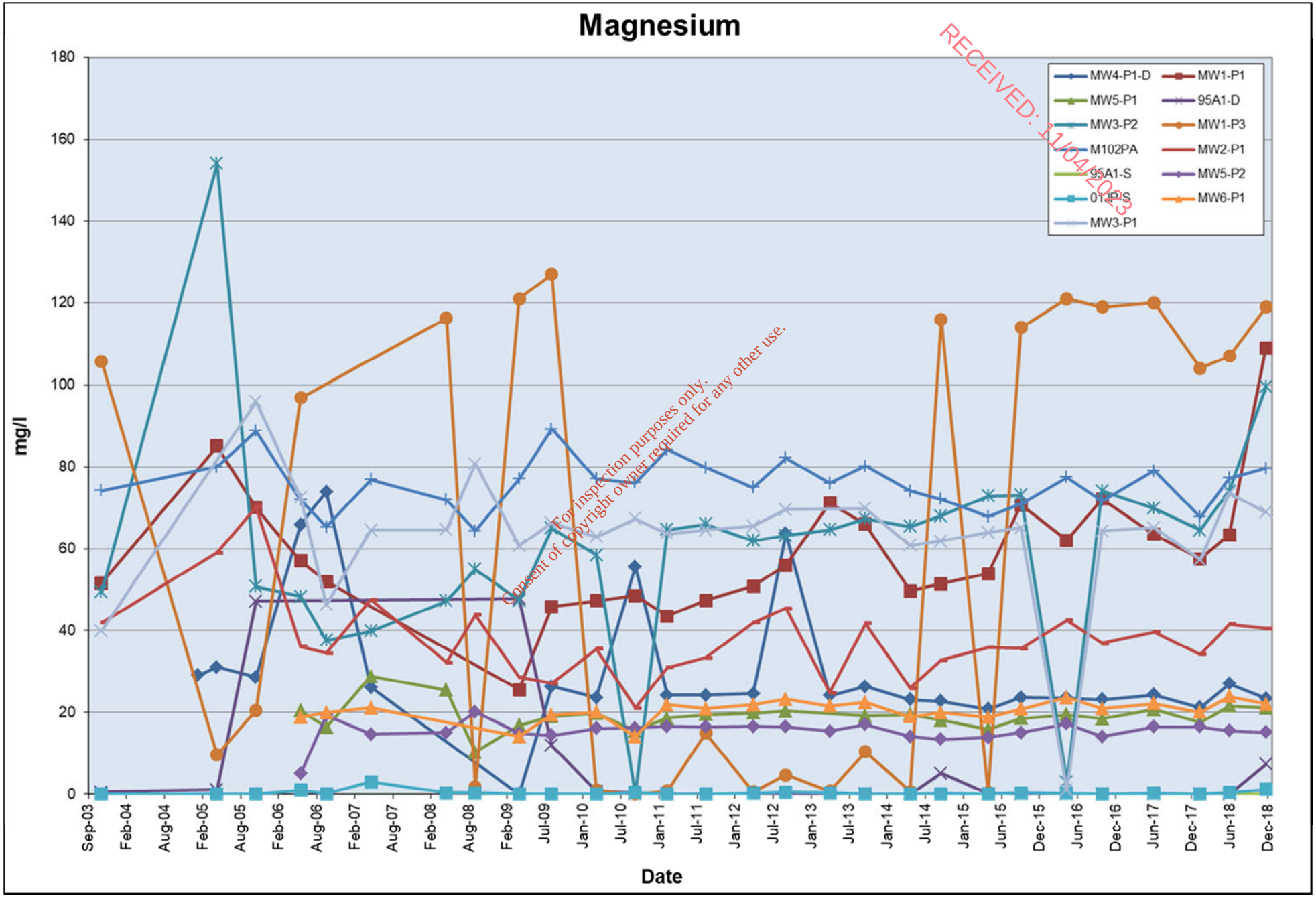


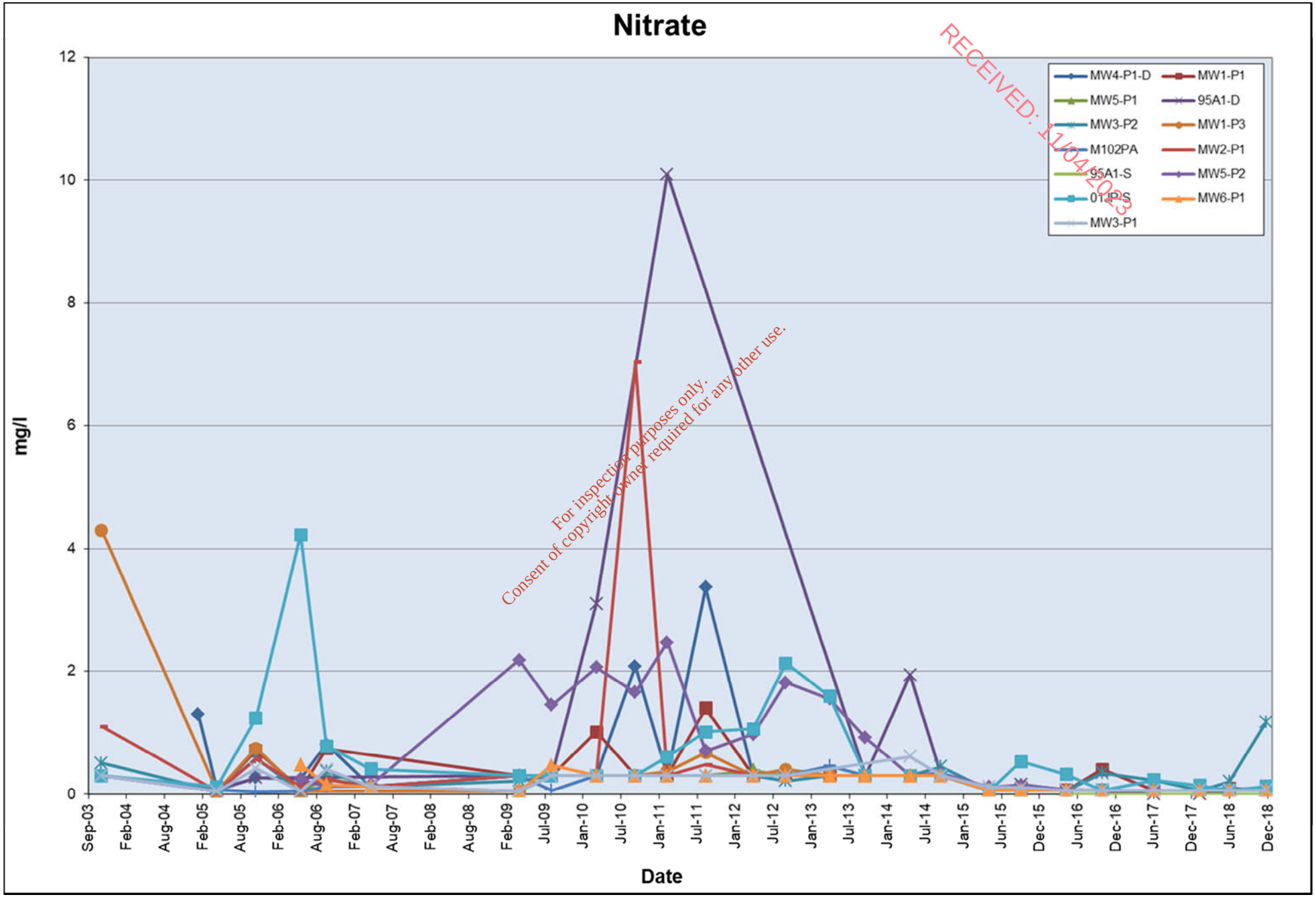


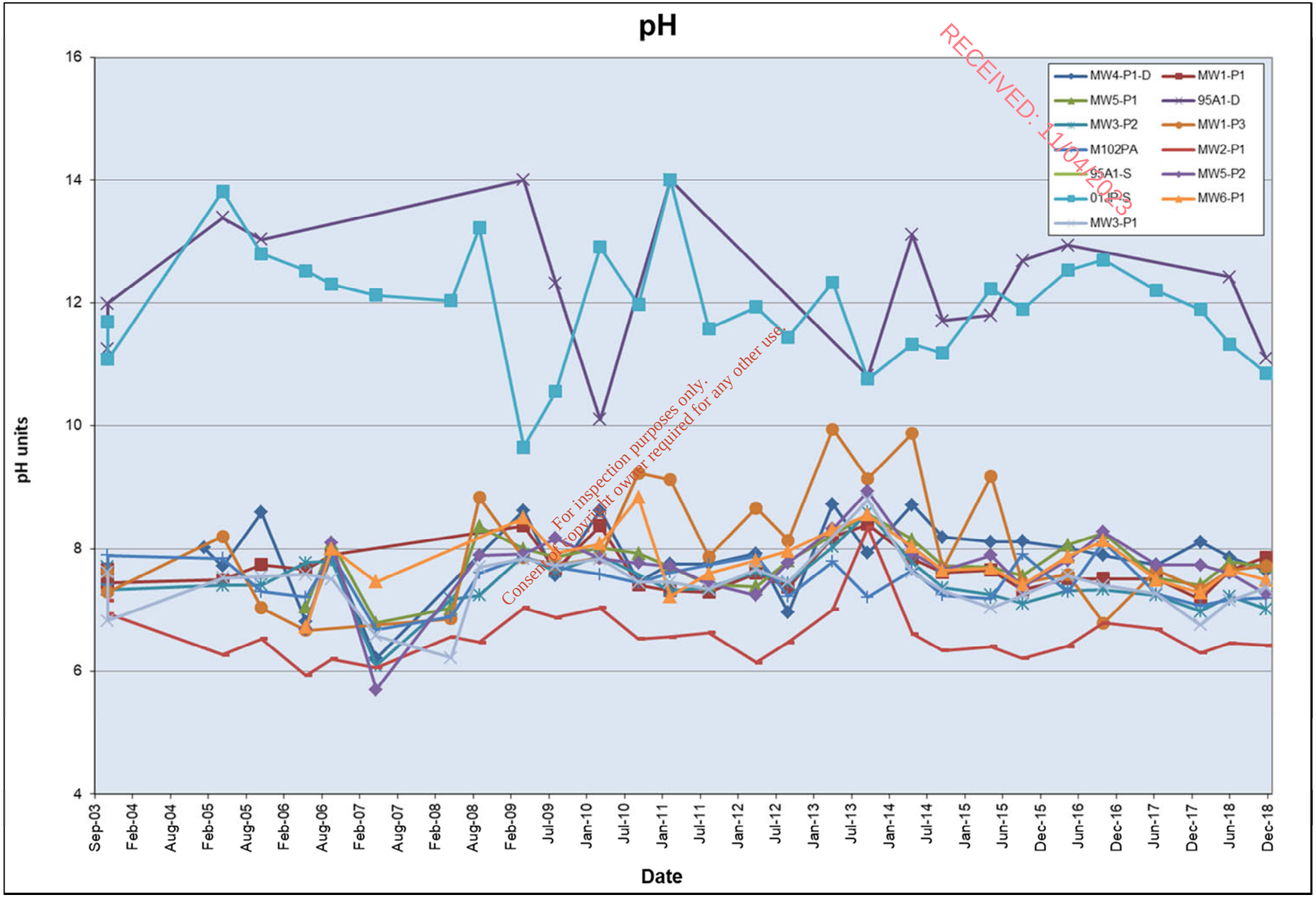


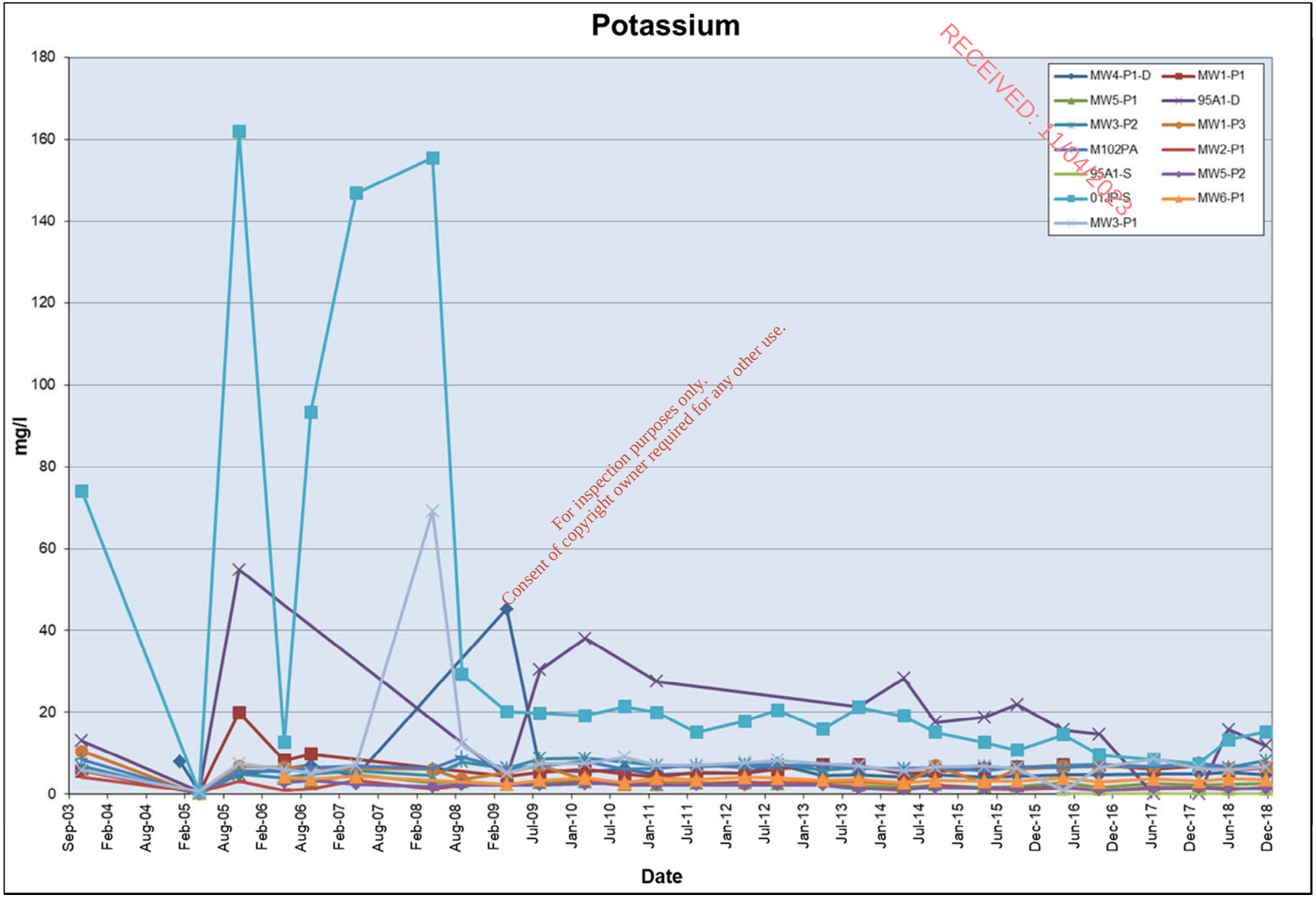


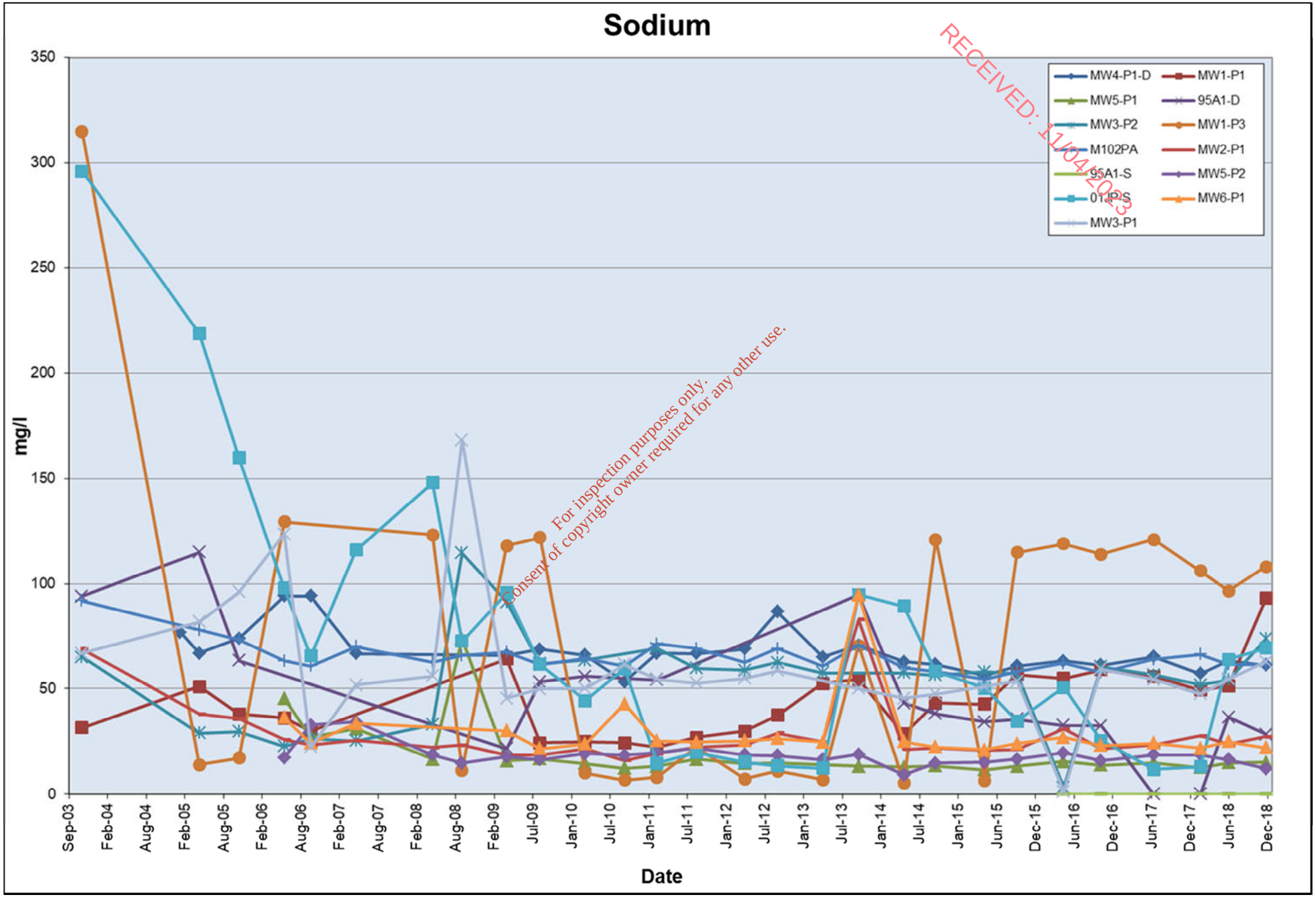


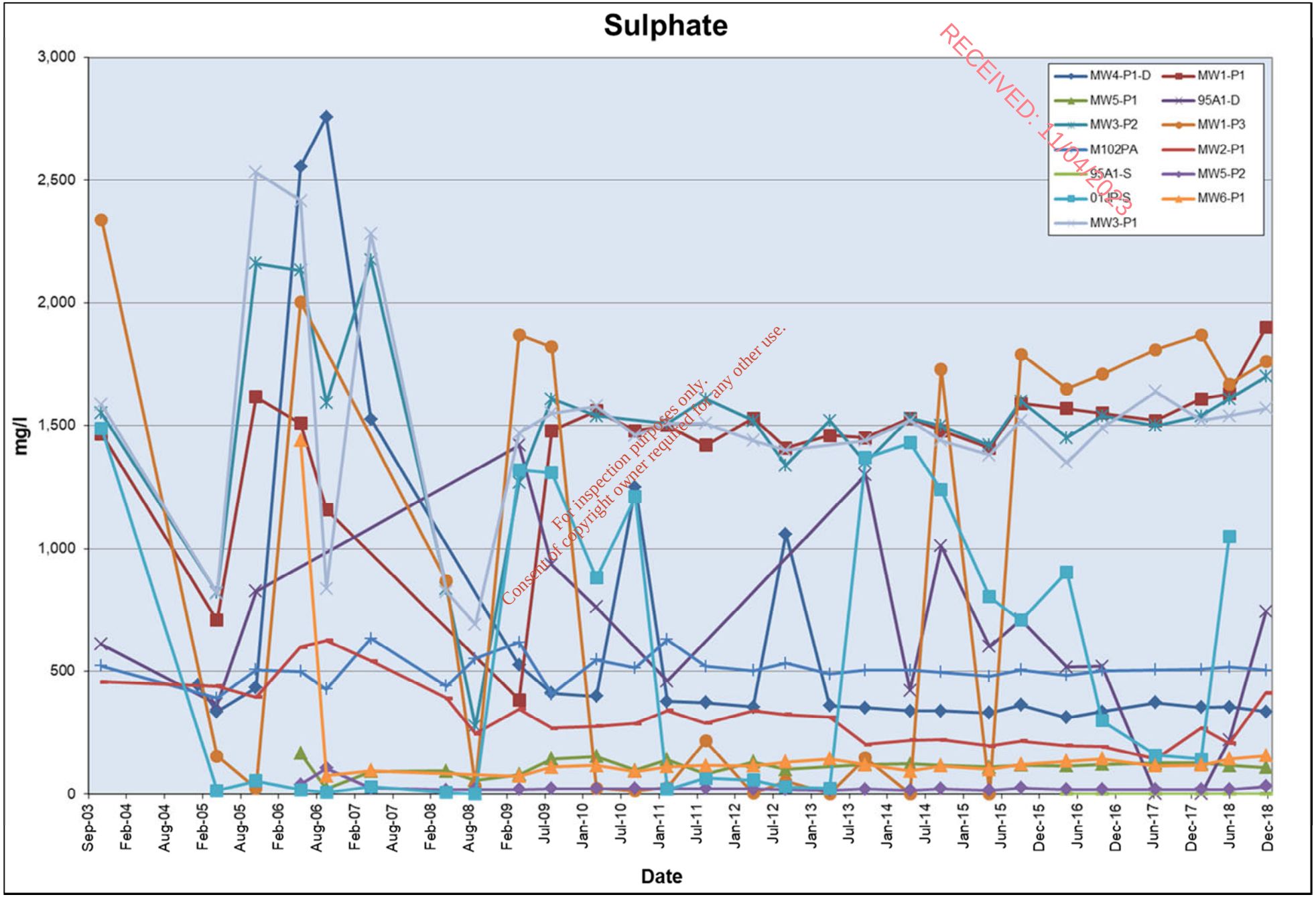












APPENDIX B

Preliminary mine site water balance 2017 to 2019

Month	m³/d														mm/d			mRL
	Recorded MSE-1 discharge to Bursk	Recorded Drummond to Lagoons	Estimated Drummond to MSE-1	Estimated contribution from June 2018 mine	Estimated contribution from June 2018 mine	Drumgoosat groundwater	Recorded Drumgoosat Well	Additional to Drumgoosat	Estimated Drumgoosat to MSE-1	Knocknacran groundwater	Knocknacran runoff	Estimated Knocknacran to MSE-1	Site runoff to MSE-1	Total Discharge	Precipitation	PET	Effective Ppt	Recorded water level
Dec-16																		966.6
Jan-17	1,776	1,876	1,636	0	0	244	0	241	0	122	18	140	0	1,776	0.0010	0.0003	0.0007	966.4
Feb-17	2,927	1,736	1,736	0	0	259	0	-998	998	130	63	192	0	2,927	0.0028	0.0006	0.0023	965.5
Mar-17	2,480	1,645	1,645	0	0	576	0	-497	497	288	50	338	0	2,480	0.0028	0.0010	0.0018	963.9
Apr-17	1,479	1,921	1,290	0	0	379	0	631	0	189	0	189	0	1,479	0.0023	0.0016	0.0000	961.8
May-17	535	1,608	520	0	0	31	0	1,088	0	15	0	15	0	535	0.0022	0.0026	0.0000	961.6
Jun-17	650	1,611	613	0	0	42	0	998	0	21	16	37	0	650	0.0032	0.0027	0.0006	964.1
Jul-17	589	1,422	563	0	0	31	0	859	0	15	11	26	0	589	0.0029	0.0027	0.0004	966.5
Aug-17	786	1,459	754	0	0	32	0	705	0	16	16	32	0	786	0.0026	0.0021	0.0006	967.8
Sep-17	1,686	1,343	1,343	0	0	15	0	-271	271	7	63	71	0	1,686	0.0037	0.0014	0.0023	969.1
Oct-17	2,569	1,357	1,357	0	0	177	0	-1,058	1,058	89	66	154	0	2,569	0.0031	0.0008	0.0024	968.9
Nov-17	2,210	1,442	1,442	0	0	313	0	-558	558	157	53	210	0	2,210	0.0022	0.0003	0.0019	967.3
Dec-17	2,576	1,864	1,864	0	0	274	0	-513	513	137	61	198	0	2,576	0.0025	0.0003	0.0022	965.6
Jan-18	3,477	2,220	2,255	0	0	234	34	-1,009	975	122	126	248	0	3,477	0.0050	0.0004	0.0046	963.8
Feb-18	3,167	1,972	1,972	0	0	638	0	-1,019	1,019	130	47	176	0	3,167	0.0023	0.0006	0.0017	962.2
Mar-18	2,005	2,228	1,673	0	0	366	0	555	0	288	44	332	0	2,005	0.0025	0.0009	0.0016	961.3
Apr-18	2,169	2,115	1,974	0	0	32	0	141	0	189	6	195	0	2,169	0.0018	0.0017	0.0002	962.0
May-18	1,405	1,788	1,389	0	0	40	0	399	0	15	0	15	0	1,405	0.0012	0.0026	0.0000	962.8
Jun-18	600	1,991	579	0	0	32	0	1,412	0	21	0	21	0	600	0.0000	0.0035	0.0000	964.4
Jul-18	245	7,017	230	0	6,787	32	0	6,787	0	15	0	15	0	245	0.0014	0.0031	0.0000	967.7
Aug-18	92	8,311	64	0	8,246	14	0	8,246	0	16	11	28	0	92	0.0025	0.0022	0.0004	985.4
Sep-18	729	7,226	718	0	6,508	183	0	6,508	0	7	4	11	0	729	0.0017	0.0016	0.0001	989.9
Oct-18	5,817	6,411	1,357	4,363	0	303	59	691	0	89	8	97	0	1,453	0.0011	0.0009	0.0003	995.8
Nov-18	6,319	5,303	1,442	4,613	0	283	137	0	0	157	107	263	0	1,706	0.0044	0.0005	0.0039	995.2
Dec-18	5,928	4,843	1,864	3,845	0	234	144	0	0	137	83	219	0	2,083	0.0034	0.0004	0.0030	994.1
Jan-19	4,174	4,136	2,220	1,818	0	576	112	98	0	122	14	136	0	2,357	0.0009	0.0004	0.0005	993.3
Feb-19	4,801	4,446	1,972	2,666	0	406	124	0	0	130	33	163	0	2,135	0.0019	0.0007	0.0012	992.4
Mar-19	5,963	4,750	2,228	3,337	0	31	131	0	0	288	110	398	0	2,626	0.0051	0.0011	0.0040	991.8
Apr-19	4,465	4,013	2,115	2,133	0	42	884	0	0	189	27	216	0	2,331	0.0026	0.0017	0.0010	991.2
May-19	4,095	3,901	1,788	2,291	0	31	1,292	0	0	15	0	15	0	1,803	0.0013	0.0023	0.0000	990.6
Jun-19	3,407	3,449	1,611	1,747	0	34	399	91	0	21	28	49	0	1,660	0.0035	0.0026	0.0010	990.0
Jul-19	3,222	3,440	1,422	1,779	0	14	449	239	0	15	6	21	0	1,443	0.0030	0.0029	0.0002	990.2
Aug-19	4,739	3,663	1,459	3,257	0	177	1,171	0	0	16	6	23	0	1,482	0.0025	0.0024	0.0002	990.1
Sep-19	3,912	3,968	1,343	2,557	0	313	588	68	0	7	4	12	0	1,355	0.0017	0.0016	0.0002	989.4
Oct-19		3,661					891									0.0008		988.4
Nov-19																		986.7
Dec-19																		

Green = monitored value, orange = derived value