Water Impact Assessment 2023 - 2024

MINERALS FOR A SUSTAINABLE FUTURE

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WATER IMPACT ASSESSMENT FOR THE ENGEBØ PROJECT, NORWAY

Prepared For

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EXECUTIVE SUMMARY
WATER IMPACT ASSESSMENT FOR THE ENGEBØ PROJECT, NORWAY

A water impact assessment has been undertaken for the Engebø Project in Norway which aims to evaluate the potential impacts of the project on local water resources, including surface water and groundwater. The scope of the study encompasses the identification and analysis of key water related receptors and stakeholders within the surrounding catchments, assessment of potential impacts from the project on water quality and quantity, and the development of mitigation measures to minimise potential adverse effects, ensuring compliance with relevant environmental regulations and standards.

The approach followed in this study involves a combination of desk-based research, field investigations, and data analysis. The study incorporates updated baseline monitoring of surface water flows, groundwater levels and water quality. Data analysis is conducted to assess the current status of water resources, identify potential sources of contamination, and evaluate the potential impacts of the project on water quality and quantity.

The study demonstrates that, with various suggested controls in place, risks to water receptors in the catchments surrounding the Engebø Project can be managed. Three key water risks were identified in the water risk assessment that require additional consideration and management. These are as follows:

Arsenic concentrations in discharge from the sedimentation pond to the fjord. Arsenic concentrations discharging from the sedimentation pond are predicted to be remain within the "Moderate" classification for coastal waters and within the baseline monitoring range, until at least the end of Phase 1. However, during Phase 2, arsenic concentrations in the sedimentation pond discharge are predicted to exceed the baseline range (albeit staying within the "Moderate" water quality class), assuming no dilution in the fjord. This allows time during the Phase 1 of the operation to refine the current predictions with additional monitoring and to develop suitable mitigation controls, if required. ERG will develop a Water Management Plan (WMP) which includes proposed monitoring and planned responses to deviation from expected concentrations. During Phase 1, appropriate site-specific water quality limits (SSWQLs) for the fjord adjacent to the project site should be developed in collaboration with the regulator, Miljødirektoratet, and in accordance with the Water Framework Directive, considering naturally occurring baseline concentrations in the fjord as well potentially considering mixing zones, where appropriate. Regular monitoring will allow comparison of actual versus modelled chemistry and validation of the model predictions. With these additional controls in place, and with a monitor and mitigate type approach as the project develops through Phase 1 of operations, it is considered unlikely that the fjord would be impacted by poor quality water runoff from the site.

Reduction in flows in the Grytaelva. The summer low flow is predicted to reduce in an adjacent stream, the Grytaelva, which has potential implications in terms of aquatic life ecosystems. The WMP will include monitoring and planned responses to deviation from expected flows. Installation of continuous flow monitoring instrumentation will allow the development of a rating curve for flow monitoring sites such that water level changes can be predicted and the potential impact on aquatic ecosystems can be accurately assessed. ERG also plan to assess the implications of the sensitivity to water level changes at key locations where sensitive aquatic life has been identified and explore options for buffering any potential water level changes and improving the eel and trout habitat in general, such as through the creation of additional pools in the stream that hold water throughout the summer period. With these additional controls in place, the risk of an impact to aquatic life from a reduction in flows in the Grytaelva due to the project is expected to be low.

Reduced groundwater availability. There is a risk of reduced groundwater availability in water wells associated with groundwater near the lower reaches of the Grytaelva due to a reduction in flow. Any potential impact will be monitored and ERG will provide alternative supply for an wells where a measurement reduction in water availability is observed.

Based on the outcomes of this WIA in terms of the key potential water impacts and identified potential management controls, SRK recommendations for further work to be considered by ERG as the Project progresses include:

- Produce a Water Management Plan which outlines a framework for managing water during construction and operations of the Project in order to minimise impacts to surrounding water receptors. It should build on, and be informed by, this document.
- Continuation and improvement of baseline surface water and groundwater monitoring including a local meteorological station, continued monthly spot flow measurements and installation of automatic continuous stage monitoring devices development of rating curves, continued monthly baseline surface water quality monitoring and in the fjord, continued baseline groundwater monitoring.
- Initiation of regular operational water monitoring and sampling e.g. from the in-pit and ex-pit sumps, and the sedimentation pond.

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ABBREVIATIONS AND UNITS I

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WATER IMPACT ASSESSMENT FOR THE ENGEBØ PROJECT, NORWAY

1 INTRODUCTION

1.1 Background

SRK Consulting (UK) Limited ("SRK") is an associate company of the international group holding company, SRK Consulting (Global) Limited (the "SRK Group"). SRK has been requested by Engebø Rutile and Garnet AS ("ERG", hereinafter also referred to as the "Client") to undertake a Water Impact Assessment ("WIA") for the Engebø project ("the Project" or "Engebø") located in Vestland, Norway.

The Project involves the development of an open pit together with a waste rock dump (WRD), ore stockpiles, underground crusher, processing plant, stacking and loading facilities and deep-water port. Tailings will be disposed of undersea, in the fjord to the south.

The mining development has the potential to impact surface water flows, surface water quality and fjord water quality as well as, to a lesser extent, groundwater levels and quality. Hence, there is a need to identify and quantify potential impacts on sensitive receptors in the vicinity of the site, as well as to inform the development of appropriate monitoring and mitigation plans, via a WIA.

Previous studies include Asplan Viak (2022), which provides a qualitative assessment of potential water impacts to surface water as part of the environmental permitting process. The preliminary WIA (SRK, 2023) built on this work to provide a more comprehensive assessment of potential water impacts, including a quantitative assessment of flow and water quality discharging from the site.

This 2024 update incorporates an additional year of baseline monitoring data to build on the preliminary WIA and remove the 'preliminary' designation. The scope of the update is outlined in the below sections.

1.2 Objective and Scope

This WIA has been produced in response to specific funding conditions as well as commitments made by ERG in respect of international best-practice in water management and stewardship.

The specific funding conditions required to be addressed are as follows:

1. Include a full year of measurements for the site wide water balance finalisation (May 2023 – May 2024);
2. Demonstrate compliance with the Discharge Permit, the Norwegian Discharge Standards and EU Water Framework Directive;

3. Provide assurances that contact water will not be discharged into Gryta Creek; and
4. Identify all events and circumstances that may affect the site wide water balance and options to mitigate the impact of discharges from the Project if such discharges are found to have contaminants of concern that exceed the permitted discharge levels under or otherwise not in compliance with (i) the Discharge Permit, and/or (ii) the Norwegian Discharge Standards, for which options must be set out in a proposed workplan and schedule.

Although this WIA addresses aspects of all of these items, a Water Management Plan (WMP) has also been produced which is complementary and should be read in conjunction with this WIA. The WIA focusses on the more theoretical prediction of potential impacts and controls. The WMP focusses on i) the practical management actions required to ensure compliance and ii) the actions required to manage any unwanted events, or manage circumstances where flow or water quality impacts exceed those predicted.

1.3 Study Aims

The principal objectives of the WIA update are to:

1. Characterise the baseline groundwater and surface water flow and water quality conditions within the local water resource catchment.
2. Assess potential operational phase impacts of the proposed mining operation on the surrounding water resources and water dependent ecosystems, including:
    - Impacts on surface water flows and water quality in the Grytaelva;
    - Impacts on water quality in the fjord adjacent to the site; and
    - Impacts on groundwater levels and quality.
3. Evaluate and optimise potential management controls and set out recommendations for ongoing monitoring.

1.4 Report Structure

This report outlines SRK's key findings from the WIA, the main sections of which are described as follows:

- **Section 2:** Project description;
- **Section 3:** current relevant legislative and regulatory context;
- **Section 4:** the current baseline conditions from which potential impacts can be assessed;
- **Section 5:** the sources, potential pathways and receptors in the vicinity of the Project, including an initial scoping of potential water-related impacts, where justification is made as to whether these impacts can be considered qualitatively or whether further, more detailed, quantitative assessment is required;
- **Section 6:** the quantitative impact assessment methodologies for potential impacts to surface water and groundwater;
- **Section 7**: the results and analysis from the above, including an assessment of potential mitigation options;

- S**ection 8:** the findings from the WIA in terms of the key potential water impacts and any controls required, as well as recommendations for monitoring in the form of a water impact risk assessment**.**

2 PROJECT DESCRIPTION

2.1 Background and Location

The Project comprises a mining and processing operation that will produce high grade rutile and garnet products. The Project is expected to use open pit and underground methods, with a production rate of 1.5 million tonnes per annum (Mtpa) of ore for an anticipated life of mine (LoM) of around 39 years.

The Project is located in Naustdal, in the Sunnfjord Municipality, Vestland County on the west coast of Norway. The Project site is situated on the northern side of the Førde Fjord, approximately 20 km west of the town of Naustdal and 30 km west of the town of Førde.

2.2 Project Layout

The main Project components include an open pit mine, underground mine, mine service area, WRD, ore stockpiles, sedimentation pond, a processing area, and a water treatment plant (WTP). Tailings disposal will be undersea via a pipeline to the south into Førde Fjord. The proposed general layout of the Project is shown in Figure 2-1.

The layout broadly consists of two areas:

1. Open-pit, workshops and waste rock dump (WRD) area; and
2. Processing plant area including an existing deep-water quay and submarine tailings disposal area.

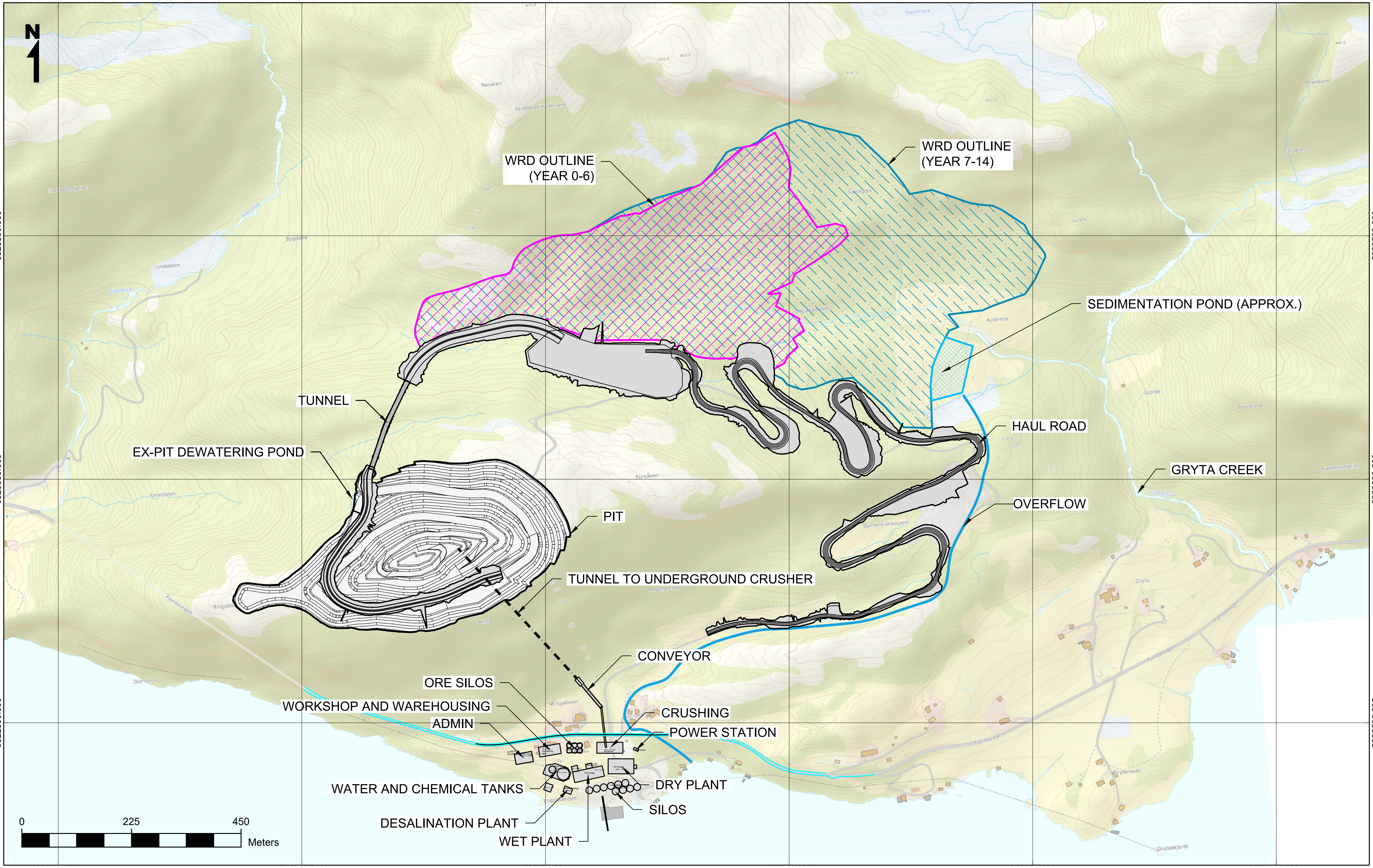
Both areas are located within the regulated extent of the approved zoning plan for mineral extraction and processing at Engebø.

Fresh water for the process plant will be generated by desalination of sea water. The raw water supply from the desalination plant will discharge into a 600 m^3 raw water storage tank.

2.3 Schedule

For the purposes of this study, the development of the waste rock dump (WRD) during mining operations has been split into two main phases, the footprints of each are shown in Figure 2-1, below:

- Phase 1: up to year 6 of mine development.
- Phase 2: from years 7 to 14 of mine development.



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SEPTEMBER 2024	32082	Engebø Water Impact Assessment	1:7500
srk consulting		Project Layout	Figure 2-1

2.4 Site Water Management

2.4.1 Introduction

The sections below outline proposed water management concepts for each of the key Project components.

2.4.2 Open Pit

All water run-off in the open pit mining perimeter, including snowmelt, will drain to an in-pit sump. Groundwater inflows to the final open pit are expected to be minimal and precipitation and run-off will constitute the dominant source of pit water requiring dewatering.

Water will be pumped from the in-pit sump to an intermediate ex-pit dewatering pond on the pit rim. Water will be pumped from the intermediate pond via a discharge pipeline through the haul road tunnel, to be discharged into a drainage ditch connected to the sedimentation pond.

Surface run-off from surrounding areas unaffected by mining activities will be diverted away from the pit by means of temporary drains or berms. These drains and berms will be positioned as required and repositioned whenever the open pit perimeter or other mine infrastructure is extended.

2.4.3 Underground Crusher and Conveyor

Water ingress into the workings around the underground crusher and conveyor will occur from water seepage from run of mine (RoM) feed material stored in the vertical ore pass and hydrogeological seepage of water into the tunnels and chambers, although this latter source is expected to be limited.

Provision has been made for three sumps in the main underground working areas. Drainage channels will drain water to the sumps. Spillage pumps, connected to a common discharge pipeline, will be used for the pumping of water from these sumps to the process plant area.

2.4.4 Waste Rock Dump

A series of cut-off drains, berms and channels will be constructed and maintained to segregate clean run-off (“non-contact water”) from upstream catchments running towards the WRD from run-off on the active stockpile (“contact water”). The berms and channels will be adjusted in stages to keep pace with the extension of the active waste stockpile area. During operations, these will be designed to manage flows associated with a 200-year design storm event.

2.4.5 Sedimentation Pond

Contact surface water from within the mine catchment (including runoff from the WRD, haul roads, laydown/service and equipment parking areas, as well as some natural ground catchment areas that cannot be practically diverted) will be directed to a sedimentation pond constructed downstream of the WRD to allow for the settlement of suspended solid matter in run-off water. Settled solids from this pond will be removed periodically and placed back on the WRD.

The sedimentation pond discharge will be connected to an open drainage outlet that will channel water through an open channel running alongside the haul road and discharge it into the fjord adjacent to the process plant area. It is not anticipated that contact runoff from the WRD will require treatment (other than settlement) prior to discharge.

2.4.6 Raw Water

Fresh raw water will be used for process water top-up (to make up for water loss in tailings disposal and dryers), underground operations (dust suppression, wash down), potable water, and fire water. The majority of the fresh raw water supply for the Project will be obtained from a package-type desalination plant located on the southwest side of the process plant site. Water will be sourced from the Førde Fjord via water intake pumps.

3 LEGISLATIVE AND REGULATORY CONTEXT

3.1 Overview

Norway is a member of The European Economic Area (EEA) and policies and regulations are compliant with those of the European Union (EU). EU regulations such as the Water Framework Directive (WFD), REACH (regulations for use of chemicals) and the Mining Waste Directive are implemented in Norwegian environmental legislation, as are the Equator Principles and the IFC's Performance Standards and Guidelines.

A summary of relevant water legislation is provided below to provide the context in which this study has been undertaken.

3.2 Water Framework Directive

The EU WFD was entered into force in Norway in 2008. The general objective of the WFD is to ensure that all water bodies in member states reach at least a “good” status by 2027. The directive requires that member states undertake the following, for surface water:

- Undertake water management based on river basins;
- Define what constitutes a “good” status by setting Environmental Quality Standards (EQSs);
- Identify the characteristics of river basin districts;
- Assess existing water quality;
- Identify and implement necessary pollution control measures; and
- Continually monitor and review progress.

It also states the following requirements for groundwater:

- Prevent and limit groundwater pollution;
- Ensure that a sufficient quantity of good quality water is available for people's needs, the economy, and the environment;
- Sustainably manage groundwater resources and preserve the natural ecosystems dependent on them; and

- Assess groundwater bodies with the aim of achieving good chemical and quantitative status.

The WFD is implemented in Norway through a corresponding national water regulation, "Vannforskriften", outlined in Section 3.3 below.

3.3 Vannforskriften

The Vannforskriften is the Norwegian water regulation used to implement the WFD. In line with the WFD, Norwegian water management planning is divided into 11 River Basin Districts (RBDs). It also shares part of five international RBDs with neighbouring Finland and Sweden. In Norwegian the RBDs are referred to as "Vannregioner".

For surface water, the Vannforskriften classifies water bodies based on chemical, physical and biological parameters. There are five classes ranging from 'very good' to 'very bad'. The Regulations state that all water bodies must achieve or maintain at least good ecological and chemical status, except for water bodies defined as "heavily modified".

A 'good' water body status implies a certain degree of impact but no greater than to allow the water dependent ecosystems to continue functioning as they should and that use of water can be seen are sustainable. 'Moderate' or worse water body status implies impacts that have impacted the natural functioning of water dependent ecosystems in that water body. Water quality limit values for the classification of both freshwater and coastal water are defined in document M-608 produced by the Norwegian Environment Agency (Miljødirektoratet, 2016).

The project site is located in the Vestland RBD and is located within the Jølstra/Førdefjorden (084) river basin, covered in the Vestland River Basin Management Plan for 2022 to 2027 (Klima- og miljødepartementet, 2022[1]). Three classified water bodies are located on or near the project site:

- **Førdefjorden-ytre**, coastal water, water body ID: 0281010202-C. This is the outer section of the Førdefjorden which forms the southern land boundary of the project site and to which all runoff from the site eventually drains. It is described in more detail in Section 4.4.
- **Gryta**, river, water body ID: 084-259-R. This is the main surface water course draining from the project catchment and includes the Engjabødalen tribuary flowing from the project site. The Grytaelva and Engjabødalen are described in more detail Section 4.5.
- **Elver Førdefjorden nord**, river, water body ID: 084-260-R. This is a collection of surface water courses along the coast to the west of the project catchment, including the Stølselva which is the adjacent catchment to the west of the project site. The Stølselva is described in more detail Section 4.5

Groundwater is classified as 'good' or 'bad' based on the chemical condition of the groundwater and hydrological condition of the aquifer, i.e., sustainable abstraction rates. There is no consideration of ecological health in determining the groundwater classification.

[1] www.vannportalen.no/sharepoint/downloaditem/?id=01FM3LD2QPOUM2ETVRH5BIDY5Z66B5EJJR

3.4 Regulatory Approvals and Consents

The Environmental Discharge Permit is governed under The Pollution Act, and the responsible authority is the Norwegian Environment Agency (Miljødirektoratet). The Environmental Discharge Permit covers licences to discharge solids, gas and fluids to the air, water or ground and licences for vibration and noise pollution, and requirements for environmental monitoring and reporting.

This study does not include a detailed description of all the various regulatory obligations associated with the Project under the existing Environmental Discharge Permit. However, some key aspects of the environmental obligations that relate to this study are as follows:

- Run-off from the open pit mining area must be secured by means of a sedimentation basin with the appropriate capacity; and
- In order to provide a safeguard against run-off from the waste rock disposal site into the Grytaelva, a sedimentation pond with sufficient capacity must be established, as must a drainage ditch to carry water to and alongside the works road down to the process plant site and discharge into he fjord.

3.5 Guidance for Impact Assessment Methodology

Guidance on the requirements for content of an impact assessment is provided in the handbook on impact assessment of climate and environment (document M-1941; Miljødirektoratet, 2023[2]).

There are a number of different steps defined in a full impact assessment including; description of project and alternatives, acquisition of knowledge and methodologies, setting values, assessing impact on degradation, and evaluating consequences. However, the preliminary WIA outlined in this study focuses only on the "assess impact on degradation" phase of the full impact assessment described in the guidance. It is assumed that the WIA described herein will supplement previous impact assessment studies undertaken in support of the environmental licence and therefore represents an update rather than a standalone impact assessment in line with M-1941.

The methodologies described for assessing impact and potential degradation in M-1941 involve the definition of a baseline condition combined with predicted effects because of implementing the proposed Project. The guidance outlines a scale for the definition of potential consequences; from positive consequences, through negligible consequences, up to very serious consequences. A hierarchy of mitigation measures should therefore be described where potential impacts are considered material.

The selection of mitigation measures should follow the typical hierarchy of measures comprising: avoid, limit damage and restore; with compensation as a last resort. Mitigation measures should be accompanied with associated investigations to support the viability of their implementation. The guidance also provides guidelines around consideration of monitoring arrangements.

[2] https://www.miljodirektoratet.no/ansvarsomrader/overvaking- arealplanlegging/arealplanlegging/konsekvensutredninger/

It should also be noted that the guidance specifically calls for the use of an assessment of uncertainty in the characterisation and, if appropriate, in the implementation of mitigation measures. The WIA methodology followed in this study takes specific account of uncertainty when protecting potential impacts and evaluating mitigation controls.

3.6 Water Quality Standards

3.6.1 Surface Water

Environmental quality standards for prioritized substances and prioritized hazardous substances in freshwater and coastal waters are defined by the Ministry of Climate and Environment (Klima- og miljødepartementet, 2007[3]). Prioritized substances are limited to a range of hydrocarbons plus cadmium, lead, mercury and nickel. Water quality standards for inorganic species are summarised in Table 3-1. The WIA considers potential for generation of poor quality water due to water-rock interactions and therefore excludes hydrocarbons.

Table 3-1: Environmental quality standards for prioritized substances and prioritized hazardous substances (Klima- og miljødepartementet, 2007)

Parameter	Unit	Average annual limit value for fresh and coastal water	Maximum value for fresh and coastal water
Cadmium and cadmium compounds (classes depending on the hardness of the water, see note 1)	µg/l	Freshwater: ≤ 0.08 (class 1) 0.08 (class 2) 0.09 (class 3) 0.15 (class 4) 0.25 (class 5) Coastal water: 0.2	≤ 0.45 (Class 1) 0.45 (Class 2) 0.6 (Class 3) 0.9 (Class 4) 1.5 (Class 5)
Lead and lead compounds	µg/l	Freshwater: 1.2 Coastal water: 1.3	14
Mercury and mercury compounds	µg/l		0.07
Nickel and nickel compounds	µg/l	Freshwater: 4 Coastal water: 8.6	34

Note 1 - class 1: < 40 mg CaCO3/L, class 2: 40 to < 50 mg CaCO3/L, class 3: 50 to < 100 mg CaCO3/L, class 4: 100 to < 200 mg CaCO3/L and class 5: ≥ 200 mg CaCO3/L

The Norwegian Environment Agency (Miljødirektoratet) defines reference values and class limits in document M-608 (Miljødirektoratet, 2020[4]) for the following:

- Certain metals, including arsenic, lead, cadmium, copper, chromium, mercury, nickel, and zinc;
- pH;
- Total phosphorus; and
- Total nitrogen.

Reference values and class limits for fresh water and coastal water are summarised in Table 3-2 and Table 3-3, respectively.

[3] https://lovdata.no/dokument/SF/forskrift/2006-12-15-1446/KAPITTEL_16#KAPITTEL_16

[4] https://www.miljodirektoratet.no/globalassets/publikasjoner/M608/M608.pdf

Table 3-2: Reference values and class limits for freshwater (Miljødirektoratet, 2020)

Parameter	Unit	Class I Background	Class II Good	Class III Moderate	Class IV Bad	Class V Very bad
Arsenic	µg/l	0 – 0.15	0.15 – 0.5	0.5 – 8.5	8.5 - 85	> 85
Lead	µg/l	0 - 0.02	0.02 - 1.2	1.2 - 14	14 - 57	> 57
Cadmium (see note 1)	µg/l	0 - 0.003	≤ 0.08 (class1) 0.08 (class 2) 0.09 (class 3) 0.15 (class 4) 0.25 (class 5)	≤ 0.45(class1) 0.45 (class 2) 0.60 (class 3) 0.9 (class 4) 1.5 (class 5)	≤ 4.5(class1) 4.5 (class 2) 6.0 (class 3) 9.0 (class 4) 15 (class 5)	>15
Copper	µg/l	0 - 0.3	0.3 - 7.8		7.8 - 15.6	> 15.6
Chromium	µg/l	0 - 0.1	0.1 - 3.4			> 3.4
Mercury	µg/l	0 - 0.001	0.001 - 0.047	0.047 - 0.07	0.07 - 0.14	> 0.14
Nickel	µg/l	0 - 0.5	0.5 - 4	4 - 34	34 - 67	> 67
Zinc	µg/l	0 - 1.5	1.5 - 11		11 - 60	> 60
pH	-	6.7 – 6.2	6.2 – 5.6	5.6 – 5.0	5.0 – 4.7	< 4.7
Total Phosphorus	µg/l	1 - 8	8 - 15	15 - 25	25 - 55	>55
Total Nitrogen	µg/l	1 - 250	250 – 425	425 – 675	675 – 1,250	>1,250

Note 1 - class 1: < 40 mg $CaCO_3$/L, class 2: 40 to < 50 mg $CaCO_3$/L, class 3: 50 to < 100 mg $CaCO_3$/L, class 4: 100 to < 200 mg $CaCO_3$/L and class 5: ≥ 200 mg $CaCO_3$/L

Table 3-3: Reference values and class limits for coastal waters Miljødirektoratet, 2020)

Parameter	Unit	Class I Background	Class II Good	Class III Moderate	Class IV Bad	Class V Very bad
Arsenic	µg/l	0 – 0.15	0.15 – 0.6	0.6 – 8.5	8.5 - 85	> 85
Lead	µg/l	0 - 0.02	0.02 - 1.3	1.3 - 14	14 - 57	> 57
Cadmium (see note 1)	µg/l	0 - 0.003	0.03 – 0.2	≤ 0.45(class1) 0.45 (class 2) 0.60 (class 3) 0.9 (class 4) 1.5 (class 5)	≤ 4.5(class1) 4.5 (class 2) 6.0 (class 3) 9.0 (class 4) 15 (class 5)	>15
Copper	µg/l	0 - 0.3	0.3 – 2.6		2.6 – 5.2	> 5.2
Chromium	µg/l	0 - 0.1	0.1 - 3.4	3.4 - 35.8	35.8 - 358	> 358
Mercury	µg/l	0 - 0.001	0.001 - 0.047	0.047 - 0.07	0.07 - 0.14	> 0.14
Nickel	µg/l	0 - 0.5	0.5 – 8.6	8.6 - 34	34 - 67	> 67
Zinc	µg/l	0 - 1.5	1.5 – 3.4	3.4 - 6	6 - 60	> 60

Note 1 - class 1: < 40 mg $CaCO_3$/L, class 2: 40 to < 50 mg $CaCO_3$/L, class 3: 50 to < 100 mg $CaCO_3$/L, class 4: 100 to < 200 mg $CaCO_3$/L and class 5: ≥ 200 mg $CaCO_3$/L

In most cases, the baseline class condition in surface watercourses in the Project catchment areas is currently either ‘very good’ or ‘good’. Under these conditions, the Vannforskriften defines that the water bodies must not deteriorate below a ‘good’ class. Therefore, the lower limit of the ‘good’ class has been used as the screening criteria. However, this approach should be confirmed in discussion with the regulatory authority as the Project progresses.

No country-specific guideline values were identified for suspended solids. Therefore, this study has adopted the European guidance for suspended solids in terms of guideline values for potential impacts on fish as set out in Table 3-4; European Inland Fisheries Advisory Commission (EIFAC), 1964.

Where the baseline water quality exceeds the relevant environmental quality standards, the onus is to demonstrate this through baseline monitoring. Baseline monitoring statistics can then be used to demonstrate a reasonable threshold value for the site-specific conditions.

Table 3-4: Correlation between concentration of suspended solids and effect on fish (EIFAC, 1964)

Suspended solids (mg/l)	Effect on fishing
< 25	No harmful effect
25 – 80	Good to medium fishing. Somewhat reduced yield
80 - 400	Significantly reduced fishing
>400	Very poor fishing, greatly reduced yield

3.6.2 Groundwater

The Norwegian Water Regulations (Vannforskriften) specifies criteria by which to classify groundwater as in 'good' or 'bad' chemical condition. The list of chemical parameters used to assess the chemical condition is shown in Table 3-5.

The threshold values define the boundary between 'good' and 'bad' chemical condition. The trigger action value is 75% of the threshold value. If this value is exceeded, then further investigation must be undertaken to assess whether the groundwater body is at risk of degradation.

Table 3-5: Threshold values for groundwater as defined by Miljødirektoratet (2016)

Parameter	Unit	Threshold value	Trigger action value
Nitrate	mg/L	50	37.5
Pesticides	µg/l	0.1	0.075
Total pesticides	µg/l	0.5	0.4
Chlorides	mg/l	200	150
Sulphate	mg/l	100	75
Arsenic	µg/l	10	7.5
Cadmium	µg/l	5	3.75
Lead	µg/l	10	7.5
Mercury	µg/l	0.5	0.4
Sum of Trichloroethene and Tetrachloroethene	µg/l	10	7.75

The water regulation requires two samples per year, collected for at least three years, to support the chemical classification of groundwater.

Groundwater is used for domestic water supply in the nearby villages of Gryta and Engjabøen. Therefore, EU Directive 2020/2184 drinking water guidelines have been used to provide an initial screening reference point for baseline groundwater quality data.

4 SITE CHARACTERISATION

4.1 Topography

The geomorphology of Engebø is typical of the Norwegian west coast with steep mountains and fjords, and exposed bedrock with limited vegetation cover. Engebø hill (Engjabødalen) hosts the deposit and runs parallel to the Førde Fjord, with an elevation ranging from sea level to approximately 335 m above sea level.

Away from areas of exposed bedrock, Engebø hill, where the open pit will be located, is sparsely vegetated with heather. The surrounding hillsides across the wider catchment area are generally vegetated with both natural and planted forest, although the steeper and higher elevations remain unvegetated. The process plant is located to the south - at the foot of Engebø Hill in a lower lying area of pasture, used mainly for grazing of sheep.

The WRD is located in a valley to the northeast and east of the Engebø hill which hosts a small, planted spruce forest, pasture and swamp land.

4.2 Climate

4.2.1 General

The climate at Engebø is typical for western coastal Norway and is characterised as temperate with long, warm days in summer and colder, darker, shorter days in winter. Snow is common in winter but due to the proximity to the sea and the relatively low altitude there is no permanent ground freezing or year-round snow accumulation. Annual precipitation exceeds 2,000 mm, ranging from around 100 mm/month precipitation in the summer increasing to around 400 mm/month in the winter. The Førde Fjord at Engebø is permanently ice-free.

4.2.2 Available Data

No local meteorological station has been installed at the Project site. However, there is an extensive network of active and historical meteorological stations across the country serviced by the Norwegian Centre for Climate Services[5] (NCCS).

Historical data does exist for a station within the Grytaelva catchment (the 'Gryta' station), located to the east of the Project, close to the Grytaelva river mouth where it discharges to the Førde Fjord (Figure 4-1). The Gryta station operated between 1968-1995, although this dataset only contains records for precipitation. Regional data from seven regional monitoring stations has been collated by SRK to support and augment this local record.

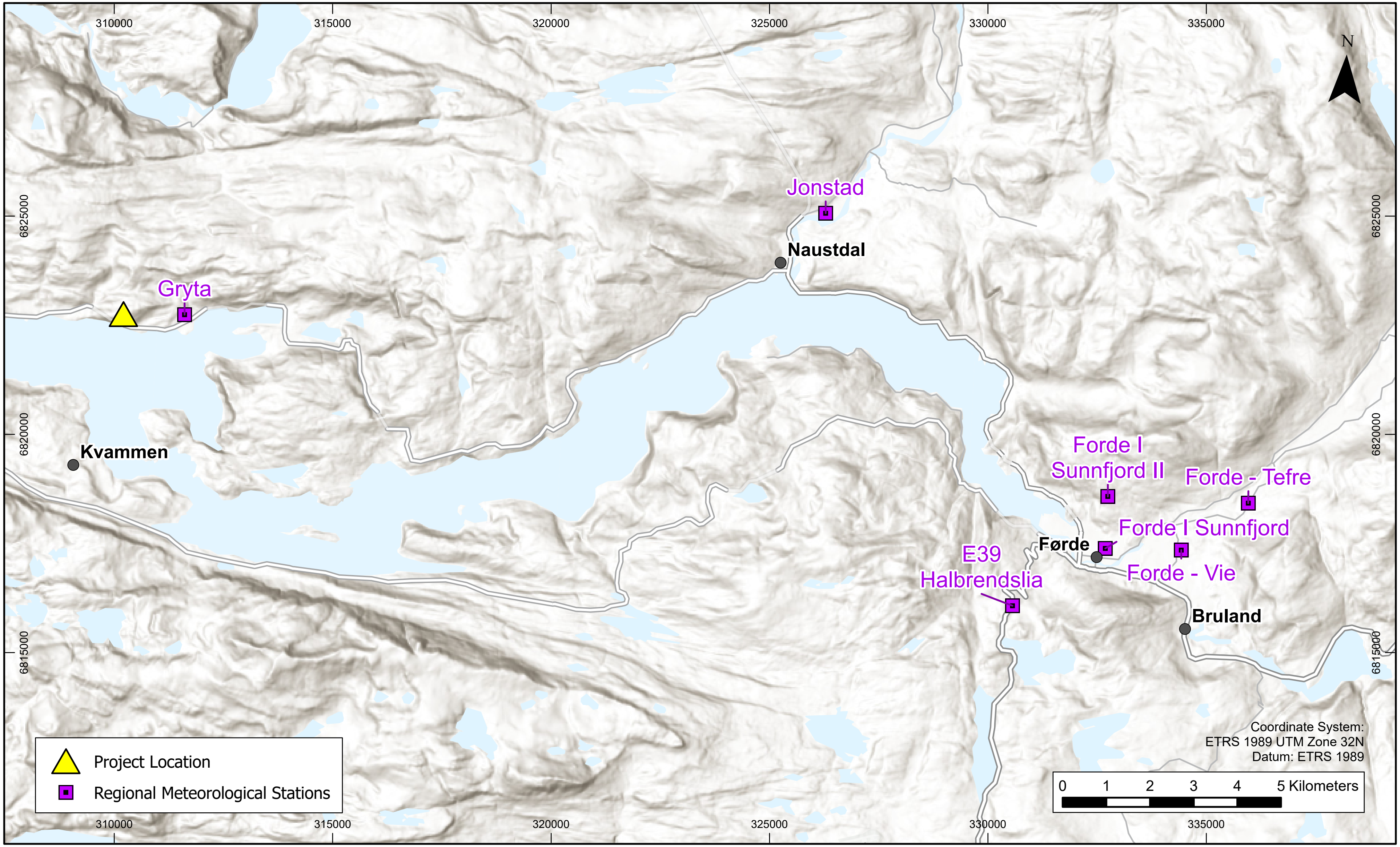
Stations used in this analysis are shown in Figure 4-1 and summarised in Table 4-1. A preliminary analysis of the regional stations was undertaken to identify periods of time with acceptable data. However, a full quality assurance check was not undertaken as NCCS data is quality controlled by the collaborative operators of the website, the Norwegian Meteorological Institute, the Norwegian Water Resources and Energy Directorate (NVE), NORCE and the Norwegian Mapping Centre,

[5] https://seklima.met.no/observations

In order to evaluate the spatial variability in precipitation across the study catchments, gridded precipitation data from the SeNorge2 website was included in the assessment (source: SeNorge - Se snøkart og klimakart for hele Norge). SeNorge2 provides high-resolution daily total precipitation, made by interpolating data from weather stations across the Norwegian mainland at a 1km resolution, to produce long-term precipitation datasets at either a regional or national level. The SeNorge2 data extends back to 1957 and is useful for simulating small-scale process in complex terrain (Lussana, C et. al, 2019).

Table 4-1: Summary of key information from regional meteorological stations used in the climate analysis

Station name	Lat (°)	Long (°)	Elevation (m)	Data period used	Parameters used
Førde I Sunnfjord II	61.46	5.84	41	01.07.1965 - 01.09.1985	Air Temp., Precipitation
Gryta	61.49	5.46	34	01.07.1968 - 31.12.1995	Precipitation
E39 Halbrendslia	61.44	5.82	237	06.07.2017 - now	Air Temp.
Førde I Sunnfjord	61.45	5.86	3	01.01.1919 - 01.06.1965	Air Temp., Precipitation
Førde - Vle	61.45	5.89	11	01.10.1985 - 01.10.1992	Air Temp., Precipitation
Førde - Tefre	61.46	5.92	64	01.12.1992 - 01.01.2018	Air Temp., Precipitation
Jonstad	61.52	5.73	7	07.08.1956 - 31.08.1958	Precipitation



SEPTEMBER 2024	32082	ENGEBØ WATER IMPACT ASSESSMENT	
srk consulting		Meteorological stations - Regional locations	Figure 4-1

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4.2.3 Precipitation

Data from the six regional stations summarised in Table 4-1 where precipitation is measured (i.e. excluding E39 Halbrendslia) was obtained which, combined, covers the period 1956 to 2019 (note: the period of record varies between stations). The regional stations used for the analysis were Gryta, Jonstad, Førde-Terfe, Førde-Vie, Førde I Sunnfjord, and Førde I Sunnfjord II, (refer to Figure 4-1). A summary of the precipitation data obtained is shown in Figure 4-2.

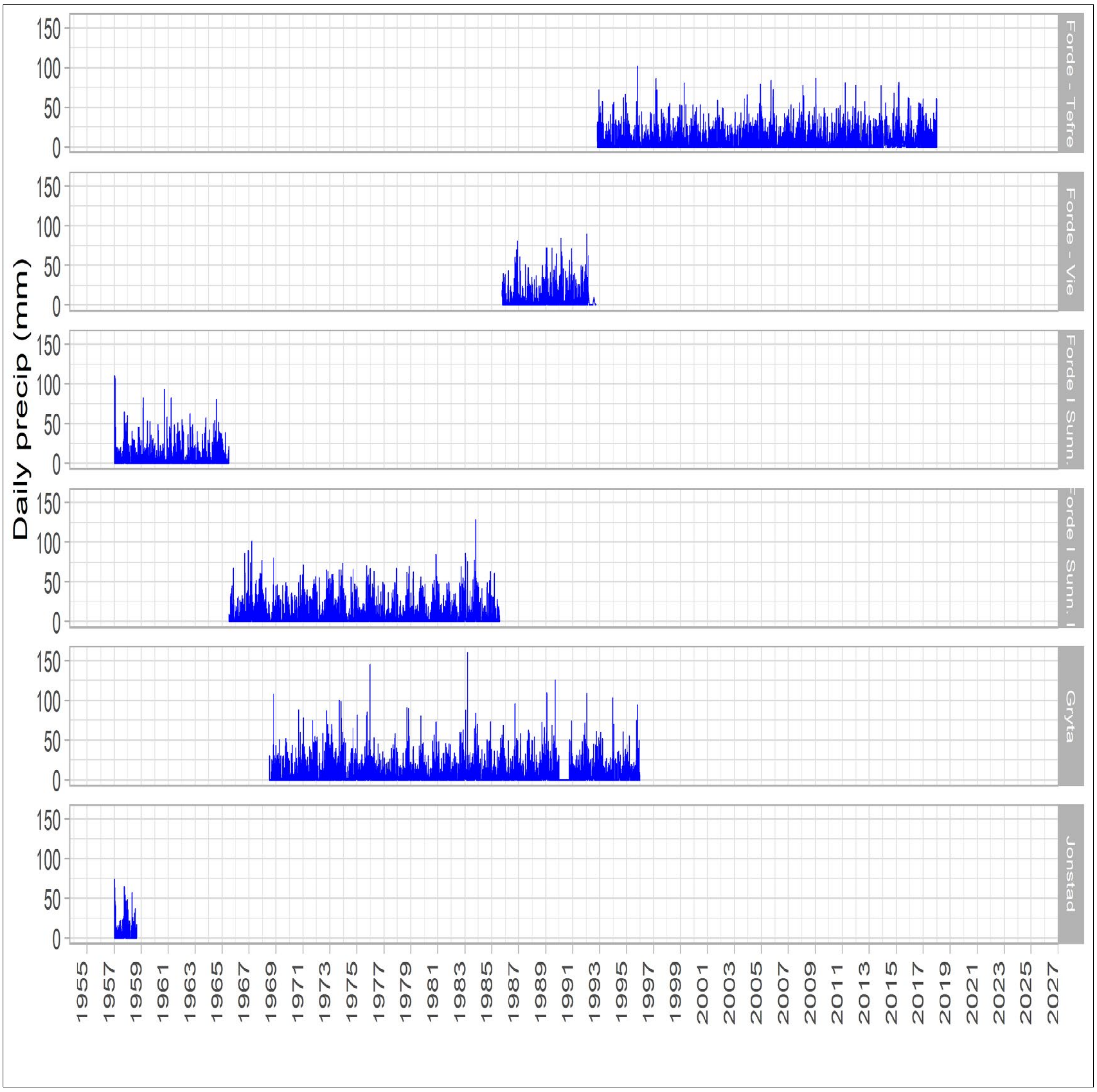


Figure 4-2: Daily precipitation data from the six regional stations recording this parameter

The Gryta station is considered as being the most representative of the Project site due to its proximity (<500 m) and comparable altitude (the station is located adjacent to the Project site, within the lower reaches of the Grytaelva catchment). Precipitation data has been recorded at the Gryta station from 1969 to 1996 (27 years). Long-term records are required to accurately represent the climate and hydrology of a site. For climatological studies, the World Meteorological Organization (WMO) recommends that ideally a minimum of 30 years of meteorological data (WMO, 2017). Whilst the Gryta records are just short of this recommended record length, they are not significantly so and are sufficient length for input to this study.

Average annual precipitation at Gryta is just over 2,400mm. Maximum precipitation occurs in the months of September to December and the driest period is between April through June with May being the driest month.

Monthly and average annual precipitation for the Gryta station is presented in Table 4-2 and graphically illustrated in Figure 4-3. Available data for regional stations Førde I Sunnfjord II and Førde – Tefre is also presented for comparison purposes, given that they are of sufficient record length and they are relatively close to the site. The data show a relatively small variation in monthly and annual precipitation between the three stations, with a mean annual precipitation ranging from 2,260 to 2,400 mm per year.

Table 4-2: Average monthly and annual precipitation in the region (mm)

ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Gryta	248	162	168	112	102	115	137	172	309	294	294	288	2,404
Forde I Sunn. II	223	134	185	104	85.5	107	124	145	287	297	298	293	2,282
Forde - Tefre	249	225	199	122	112	119	133	143	203	233	250	273	2,260

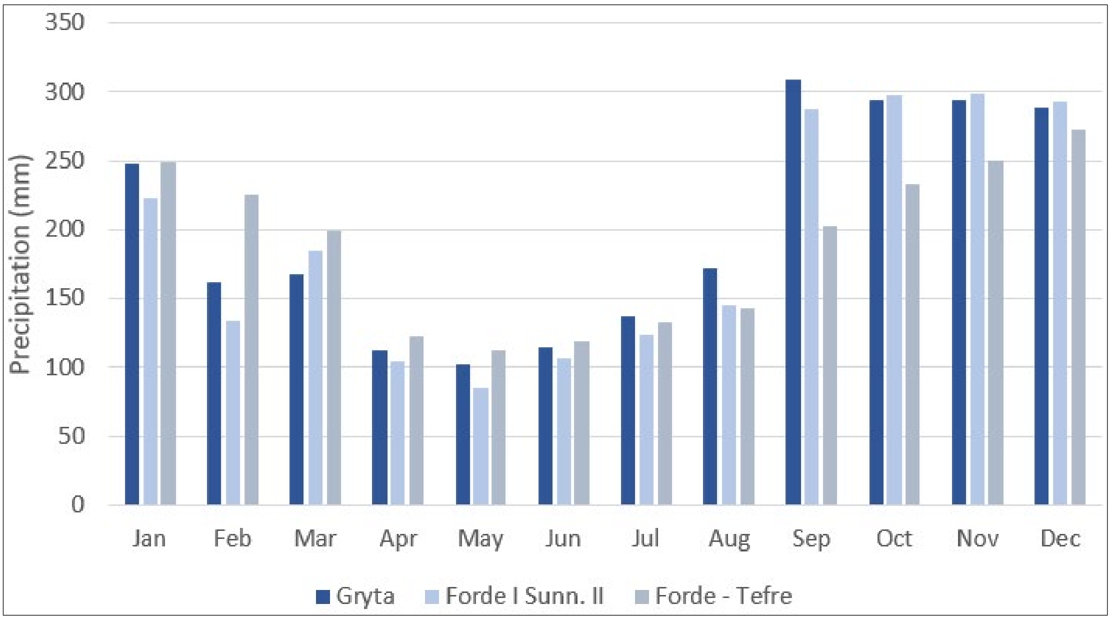


Figure 4-3: Monthly precipitation

4.2.4 Precipitation Corrected for Undercatch

Undercatch is the systemic error in measuring precipitation, particularly snow, due to wind blowing across a gauge's opening. Both gauged and gridded precipitation data are impacted by wind-induced undercatch in Norway (Lussana, C et. al, 2019), (Kochendorfer, J. et al, 2017), among other factors such as instrument error, post-processing and data quality assurance checks. In terms of gridded precipitation these errors are further exacerbated in mountainous areas of Norway above 2,000 masl where gauge networks are less dense than in lower lying areas, leading to further underestimation.

Precipitation from the Gryta station and SeNorge2 gridded precipitation were corrected for undercatch using the methodology described in Macdonald, J., et al., 2007. The catch efficiency (CE) is obtained from windspeed (WS) using the formula below and then applied to the daily precipitation values both datasets, according to the following equation. Wind speed information was obtained using gridded information from MERRA2[6].

$$CE = 1.010 * \exp\,(0.09 * ws)$$

Correction for undercatch can make a material change to precipitation values. After applying the undercatch correction to Gryta precipitation, an increase in annual precipitation from 2,404 mm to 3,180 mm is observed. Average monthly variation observed at Gryta precipitation, both before and after undercatch correction, is presented in Figure 4-4.

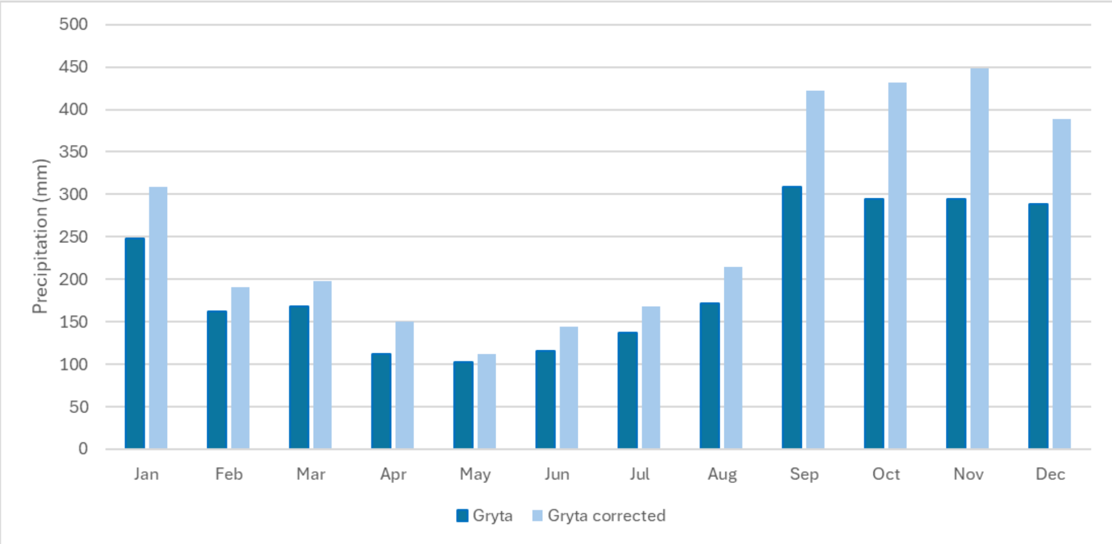


Figure 4-4: Average monthly variation of precipitation before and after undercatch correction

4.2.5 Temperature

Temperature data is available at five regional stations; E39 Halbrendslia, Førde-Tefre, Førde I Sunnfjord I, Førde I Sunnfjord II, and Førde-Vie. Figure 4-5 shows that temperature is typically stable over the years for which data is available and that there is no significant spatial variation in the Førde region.

[6] The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) is a NASA atmospheric reanalysis project that provides historical climate data from 1980 to the present. It assimilates a wide range of observational data to produce high-resolution, global climate datasets, which are used for climate research and weather forecasting. It is designed to provide a comprehensive and consistent record of the Earth's atmosphere, land surface, and ocean conditions from 1980 to the present, at a spatial resolution of approximately 0.5 degrees latitude by 0.625 degrees longitude across the globe.

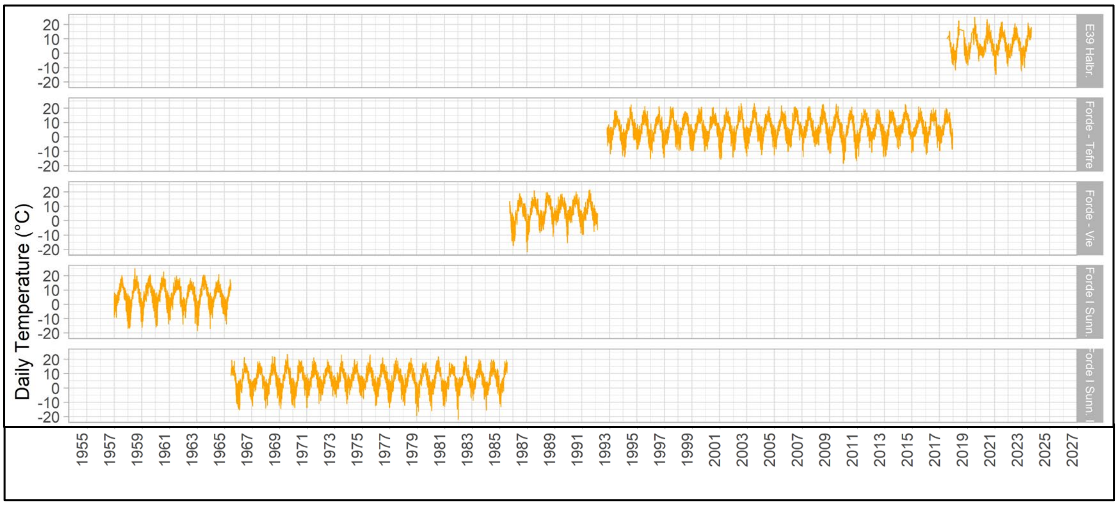


Figure 4-5: Observed daily temperature for the five regional stations recording this parameter

Temperature data from four of the five stations was evaluated further on the basis that they are all at a similar elevation to the Project site (data from E39 Halbrendslia was not included as it is located at as higher elevation). Figure 4-6 shows a box plot of the data, the plot indicating minimal spatial variation in temperature among these stations.

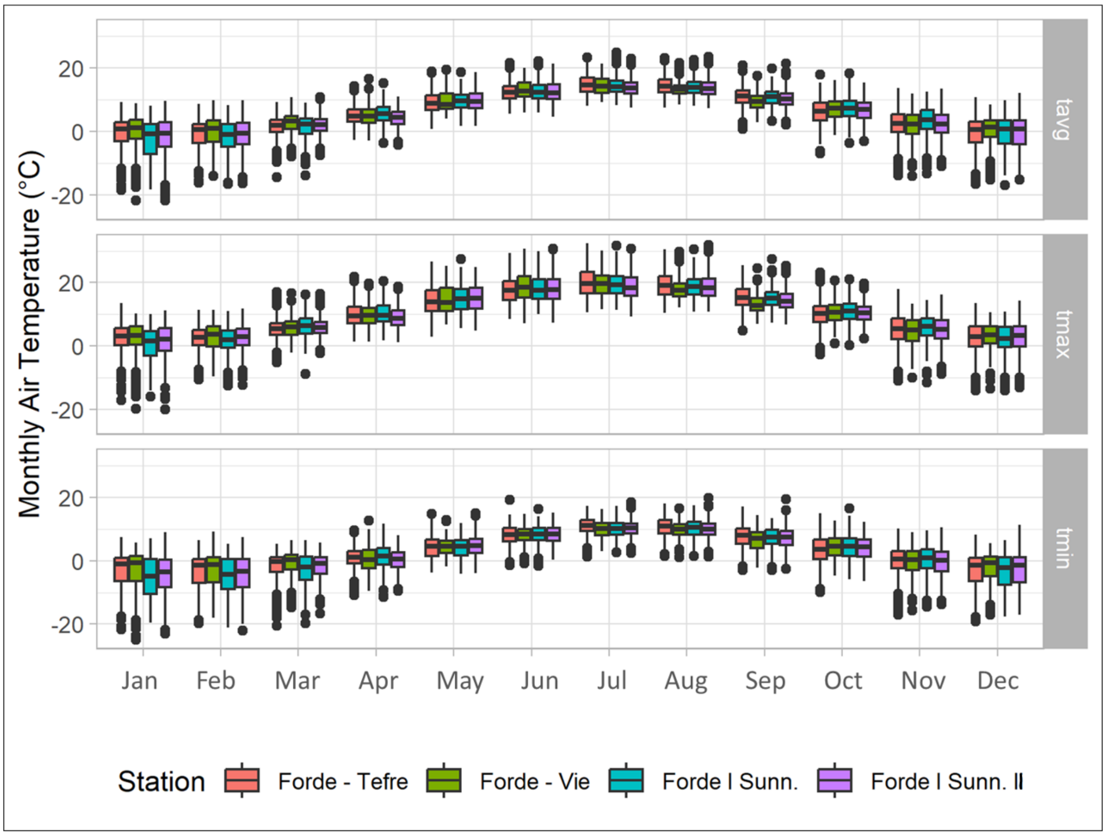


Figure 4-6: Box plot showing spatial variation in temperature across four regional stations

As there is no temperature data available for the Gryta station, data from the next nearest station at Førde I Sunnfjord II (approximately 30 km from site) has been adopted as a site representative.

Average monthly temperature at Førde I Sunnfjord II varies from -1.3 °C in January to 14.3 °C in July. Mean annual temperature is 6.3 °C. The monthly distribution of temperature is shown in Table 4-3 below.

Table 4-3: Average monthly temperature (°C) at Førde I Sunnfjord II (1965-1985)

ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Forde I Sunn. II	-1.3	-0.9	2.0	4.5	9.8	13.0	14.3	14.2	10.6	7.0	2.3	-0.2	6.3

4.2.6 Evaporation

Evaporation was estimated at Førde I Sunnfjord II based on the Hargreaves-Samani method. This method is based on an empirical relationship where reference evapotranspiration was regressed with solar radiation and air temperature data. Daily evaporation rate and monthly averages are presented in Table 4-4 and Figure 4-7. Annual average evapotranspiration is estimated as 594 mm.

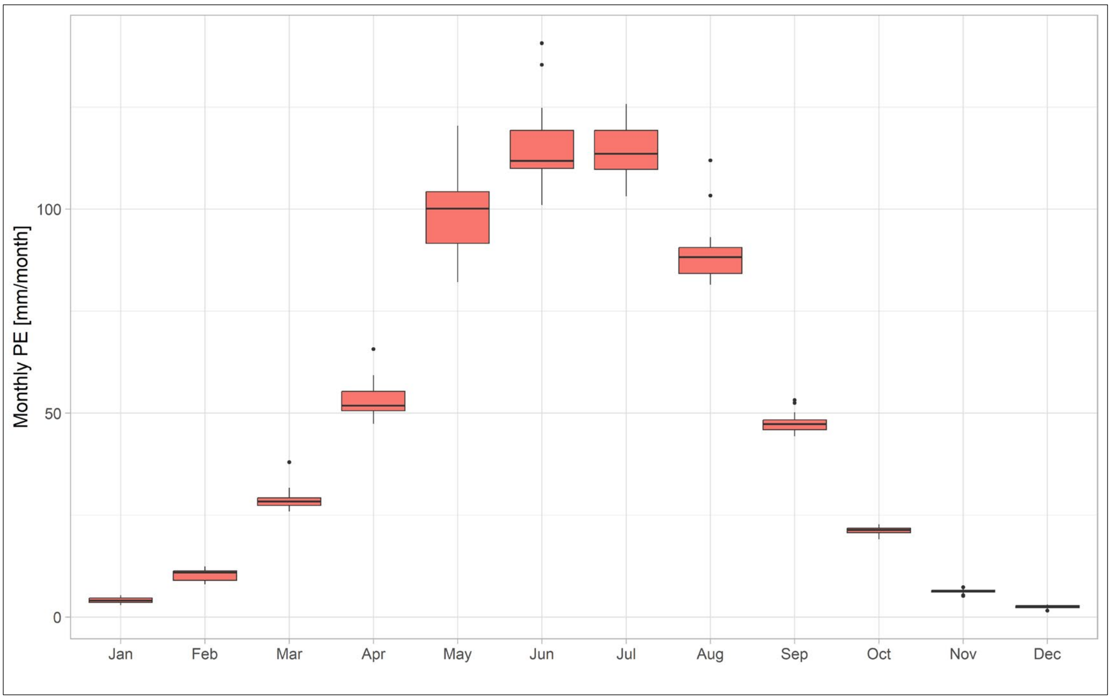


Figure 4-7: Monthly evaporation distribution at Førde I Sunnfjord II (1968 to 1985)

Table 4-4: Monthly average evaporation at Førde I Sunnfjord II (1965-1985)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
4.09	10.2	28.8	53.2	99.9	116	114	89.6	47.6	21.2	6.32	2.5	594

4.3 Climate Change

No site-specific climate change study has been undertaken for the Project site. However, a significant body of scientific research is available for Norway in general, including specific descriptions for the Vestland Region. The following is a general description of the predicted changes in climate that are relevant to this study, as outlined in the currently available public literature.

An increase in precipitation is predicted for all climate change scenarios by 2045 according to Klimaservicesenter (klimaservicesenter.no, 2021), which predicts precipitation in the Fjordane region in 2045 to increase on an all year basis by median 7% for RCP4.5[7] and 8% for RCP8.5. Increased precipitation is predicted during all seasons.

Temperature is also predicted to increase by around 2ºC on an annual basis, with slightly higher predicted temperature increase in winter and spring, which would likely result in higher snowmelt runoff.

The quantitative flow and water quality impact assessment is focussed on the summer low-flow period, as this is the period when impacts are considered most likely to have the potential to impact aquatic ecosystems (as discussed in Section 4.8). Given that precipitation is generally predicted to increase with climate change which would improve water availability, the preliminary WIA focuses on current conditions as the worst-case scenario.

An increase in precipitation, with more frequent and intense rain events, could increase catchment sediment loading from stormwater runoff. Potential impacts due to sediment loading are not included in this assessment. Sedimentation pond design is being undertaken by Asplan Viak (2023) and as such it is assumed that sedimentation pond outlet discharge will meet required sediment loading design criteria. SRK has not inputted into the sedimentation pond design criteria.

It is predicted that heatwaves and dry spells will become increasingly more frequent in Norway. Therefore, the impact analysis will specifically examine potential impacts under low flow conditions, especially summer low flow conditions.

4.4 Førde Fjord

The Førde Fjord is a 40 km marine fjord and is divided into three parts; the inner, central and the outer part. The section of the fjord that is located adjacent to the Project site is designated by the Miljødirektoratet as the outer section of Førde Fjord or ‘Førdefjorden-ytre’, water body ID 0281010202-C[8].

The inner and central part of the fjord is defined as a National Salmon fjord (NSF) by the Norwegian Parliament to protect the salmon stocks in Nausta. While the tailings disposal site lies outside the boundaries of the NSF, the salmon stock in Nausta and other nearby stocks migrate through the project area between spawning grounds in the rivers and feeding grounds in the sea.

The planned area for the sea tailings deposition (STD) is located in the outer part of the Førde Fjord. The outer part of the fjord slopes steeply down to more than 300 m depth, where the sea floor is dominated by fine marine sediments at the relatively flat bottom.

Water quality in the fjord is discussed further in Section 4.7.2.

[7] Most climate change projections are based on a range of greenhouse gas scenarios called Representative Concentration Pathways (RCPs) developed by the Intergovernmental Panel on Climate Change (IPCC). Each RCP provides a possible emissions trajectory over time (generally up to 2100) from RCP8.5 (higher unmitigated greenhouse gas emissions) to RCP2.6 (lower greenhouse gas emissions due to aggressive mitigation efforts).

[8] https://vann-nett.no/portal/#/waterbody/0281010202-C

4.5 Hydrology

4.5.1 General

The Project site is on the northern side of the Førde Fjord, located between the rivers Stølselva to the west and the Grytaelva to the east. A tributary of Grytaelva, the Engjabødalbekken, runs through the area planned for waste rock disposal in the Engjabødalen. The local drainage network and Grytaelva catchment area is shown in Figure 4-9.

The Grytaelva has been designated by the Miljødirektoratet as a river, waterbody ID 084-259-R[9]. The Stølselva is designated by the Miljødirektoratet as one of a collection of rivers located to the west of the project site labelled as 'Rivers Førdefjorden north', waterbody 084-260-R[10].

Local rivers show a rapid response to rainfall and snowmelt events, although the Gryta continues to flow all year round, likely contributed to from groundwater during low flow periods in summer and mid-winter, when sub-zero temperature and snowfall prevent surface runoff flows.

4.5.2 Stream Morphology

The Grytaelva is a small watercourse that flows into Førde Fjord on the east side of Engebøfjellet. The long-section profile of the Grytaelva changes from a relatively steep gradient in the upper reaches to a much lower gradient along the lower reaches. Riverbed materials are generally coarse-grained and rocky. In periods without precipitation, streamflow is low and much of the riverbed is exposed and above the waterline.

The lower reaches of the Grytaelva catchment are clearly affected by human activities such as farming, road construction, and other developments such as irrigation systems and offtakes for water supply.

Around 150 m upstream of the outlet into the Førde Fjord there is a waterfall with a total drop of around 6 m at the top of which a small (<1 m high) stone wall has been built. About 100 m upstream of this waterfall, there is another waterfall with a total drop of around 11 m. Previous studies (Asplan Viak' 2022; NINA, 2009) have suggested that these waterfalls represent a migration barrier for sea-migrating salmonids.

The Stølselva is a small watercourse that flows into Førde Fjord on the west side of Engebøfjellet. This river has similar morphological characteristics to the Grytaelva River.

4.5.3 Available Flow Data

Site specific streamflow monitoring has been undertaken by ERG, with support from SRK, at seven hydrological monitoring stations within the Grytaelva catchment (refer section 4.5.5 for details). Streamflow monitoring locations are located on the Grytaelva itself as well as on the Engjabødalbekken, a tributary of the Grytaelva and on the Stølselva.

[9] https://vann-nett.no/portal/#/waterbody/084-259-R
[10] https://vann-nett.no/portal/#/waterbody/084-260-R

No long-term flow record exists for either of these rivers. Therefore, regional data has been collated and analysed in this study to derive long term “donor” flow statistics and an analogue catchment for the purpose of calibrating modelling work.

4.5.4 Regional Flow Data

The Grytaelva lies within the Jolstra/Førde Fjorden river basin, located in the Sunnfjord area in the Vestland region of southwestern Norway. The Norwegian Water Resources and Energy Directorate (NVE) maintains the hydrological monitoring system in Norway, consisting of over 400 monitoring stations. Data is provided on river flows, snowfall, water level and many other parameters. Some stations are in active working order, while others are defunct and originate from as early as the 1900s.

There is no NVE hydrological station in place within the catchment of the Grytaelva or within immediate proximity of the watercourse. Instead, suitable donor catchments with established hydrological time series were used to generate an analogue for the Grytaelva catchment. The NVE hydrological database provides commercially available hydrological time series for each monitoring station. Donor catchment suitability was evaluated against criteria such as comparable catchment area, catchment characteristics and proximity to the site.

In order to assess the characteristics of the Grytaelva catchment, watershed analysis was conducted using 1 m LiDAR DTM data from the Norwegian Høgdedata web service[11]. The results indicate that the Grytaelva has a total catchment area of approximately 3.2 km^2. Topography slopes very steeply, from highs of approximately 550 m at the top of the catchment, to the Førde Fjord and sea level. Land cover within the catchment consists of bare mountain (exposed bedrock), forest, wetlands, bog and some agricultural pasture along the lowermost reaches.

Within the Jolstra river basin there are 12 fluvial hydrological monitoring stations, eight of which are now inactive. Of these, one station was active for less than a year and so has been excluded leaving four which have catchment areas considered comparable to the Grytaelva, i.e. less than 25 km^2, as summarised in Table 4-5.

[11] https://kartverket.no/api-og-data/terrengdata

Table 4-5: Jolstra river basin monitoring station details and catchment areas

Station number	Station name	Monitoring period	Catchment area (km^2)
084.CC2	Norddøla v/Holsen	2010-2013	14.71
084.E42C	Helgheim/Huus	2008-2012	7.97
084.E51A0	Sægrova	1995-2008	7.12
084.E5A0	Sygnesandselva	1997-2013	10.40

The Norddøla v/Holsen and Helgheim/Huus stations have been in operation for less than 5 years and so are not considered ideal catchment donors. The Sægrova and Sygnesandselva catchments are comparable in area to the Grytaelva catchment and have both operated for over 10 years, however both stations have been inactive for 15 and 10 years respectively. Additionally, both catchments have over 27% glacier land cover which does not represent an ideal analogue for the Grytaelva catchment, within which there are no glaciers. Glaciers will significantly impact the hydrological cycle, including increasing summer baseflows through snowmelt.

In order to find a more suitable donor catchment, the search was extended beyond the Jolstra river basin to a radius of 50 km^2 from the site. This search returned 19 fluvial monitoring stations of which nine were discounted as the catchment area was larger than 25 km^2. A further five were excluded as the recording period was less than 10 years. The remaining five potential catchment donors are shown in Table 4-6**.**

Table 4-6: Extended (50 km) radius monitoring station details and catchment areas

Station number	Station name	Monitoring period	Catchment area (km^2)
90.1.0	Førdeelv	2007-2023	2.99
86.12.0	Skjerdalselv	1982-2023	23.66
80.4.0	**Ullebøelv**	**1927-2023**	**8.31**
86.56.0	Breelva	2014-2023	8.25
86.7.0	Bortne	1970-1986	15.81

The Breelva monitoring station has only 9 years of data, but as this is close to the 10-year cut-off it has been included. The Bortne monitoring station stopped monitoring flows in 1986, however may still provide useful data. The majority of the remaining potential donor catchments are located further inland and at higher elevations than the Grytaelva catchment and contain glaciers.

A frequency exceedance analysis of the available time series for each of the potential donor catchments is displayed in Figure 4-8, which describes the proportion of time over the entire record during which flow is exceeded, scaled to the area of each catchment. Overall flows range from less than 0.1 L/s/km^2 to over 2,970 L/s/km^2. Flow duration curves for the Breelva and Skjerdalselv catchments are much larger due to glacial land cover; 17% at Skjerdalselv and 51.2% at Breelva, resulting in increased flows due to melt and snow build up.

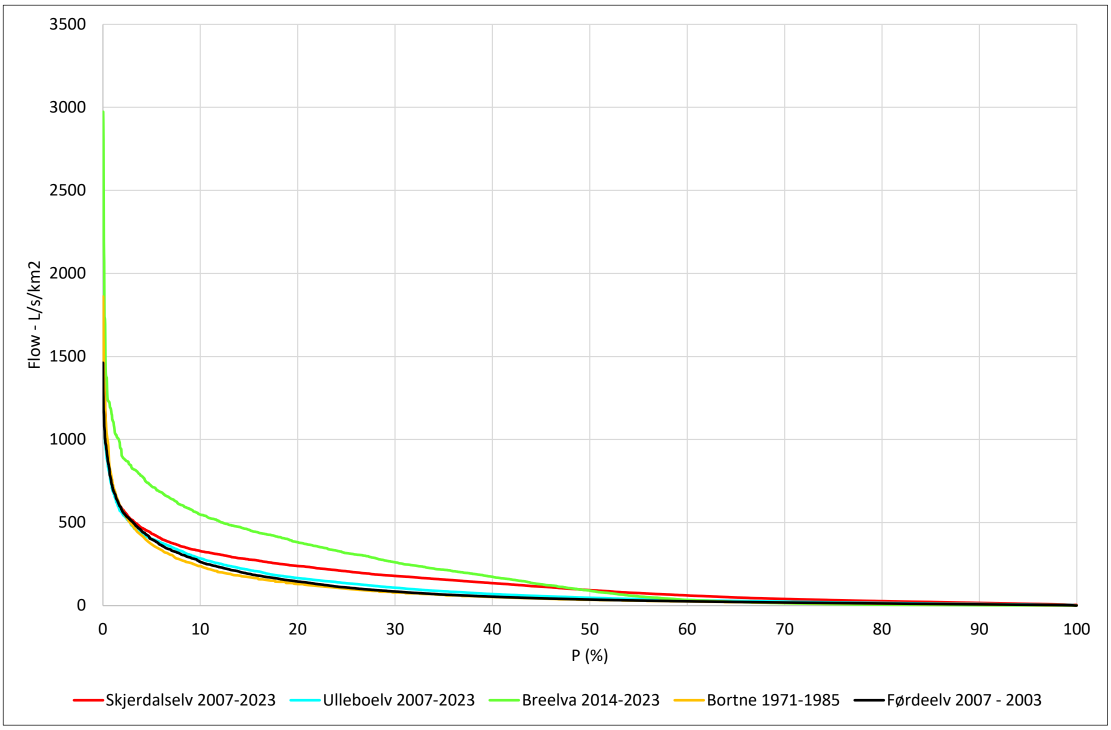


Figure 4-8: Flow duration curves for the short-listed regional flow monitoring stations analysed in this study

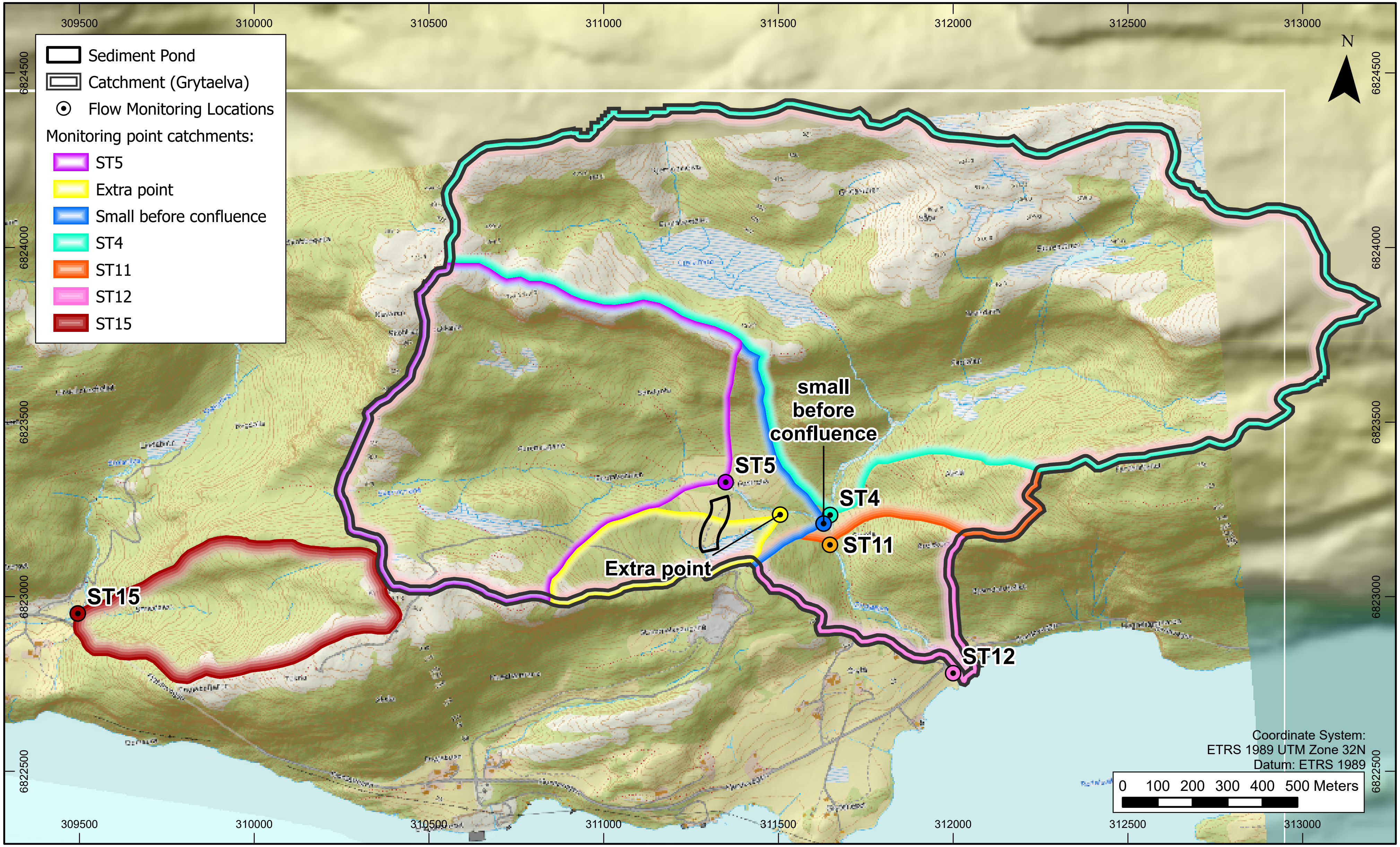
The most similar, directly comparable catchment found in the extended search area is the Førdeelv catchment, located approximately 45 km from the Grytaelva. This catchment is located in the Bremanger region on the island of Bremangerlandet. The Førdeelv catchment area is similar to the Grytaelva catchment at 2.99 km^2. The catchment elevation range is similar and Førdeelv catchment also drains directly to the coast. There is some variation in land cover between both catchments. There is a larger rural/residential component in the Førdeelv catchment than at Grytaelva. However, further examination of the rating curves and follow-up discussions with the NVE revealed the rating curve to be poor and therefore this was unsuitable for use as a donor.

The daily data for Ullebøelv was found to have a reliable rating curve and although larger than the Gryta, it is not significantly so and was therefore further assessed for use in model calibration. The Ullebøelv monitoring station has a long term record, is active at present and has been collecting data since 1927. The catchment has a topographical distribution from 886 masl to the monitoring station at 335 masl and comprises 79% bare mountain and 21% other land cover. Based on the assessment of the Grytaelva catchment and evaluation of donor catchment suitability, the Ullebøelv station was therefore selected as the preferred donor catchment.

4.5.5 Local Flow Monitoring

Locations of the site-specific flow gauging stations and associated catchment areas are shown in Figure 4-9 and summarised in Table 4-7. Flow measurement results are summarised in Figure 4-10. Photos and descriptions of each site installation are included in Appendix A.

These flow measurements were used to establish baseline streamflow conditions upstream, across and downstream of the proposed mine infrastructure. Project specific monitoring started in May 2023 and is ongoing.



SEPTEMBER 2024	32082	ENGEBØ WATER IMPACT ASSESSMENT	
srk consulting		Site flow measurement locations and catchment areas	Figure 4-9

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Table 4-7: Summary of surface water flow monitoring locations

Site ID	Location (UTM 36N)	River Name	Data available	Comments	Catchment area (km^2)
ST4	311648, 6823234	Grytaelva	25/05/2023-18/03/2024	On the Grytaelva, upstream of Engjabødalbekken confluence	2.85
ST5	311349, 6823328	Engjabødalbekken	25/05/2023-18/03/2024	Downstream of the proposed waste rock dump area	0.73
ST11	311658, 6823169	Grytaelva	25/05/2023-18/03/2024	On the Grytaelva, downstream of Engjabødalbekken confluence	2.96
ST12	312000, 6822781	Grytaelva	25/05/2023-18/03/2024	Close to Grytaelva mouth (outlet into Førde Fjord)	3.13
ST16	309495, 6822952	Stølselva	25/05/2023-18/03/2024		0.27
EP (“Extra point”)	311505, 6823235	Engjabødalbekken	25/05/2023	At the toe of proposed waste rock dump and the new inlet to the permanent sedimentation pond. Single flow gauging measurement, discontinued.	0.11
SBC (“Small before confluence”)	311621, 6823157	Engjabødalbekken	25/05/2023-05/10/2023	On the Engjabødalbekken, just upstream of the confluence with the Grytaelva.	0.96

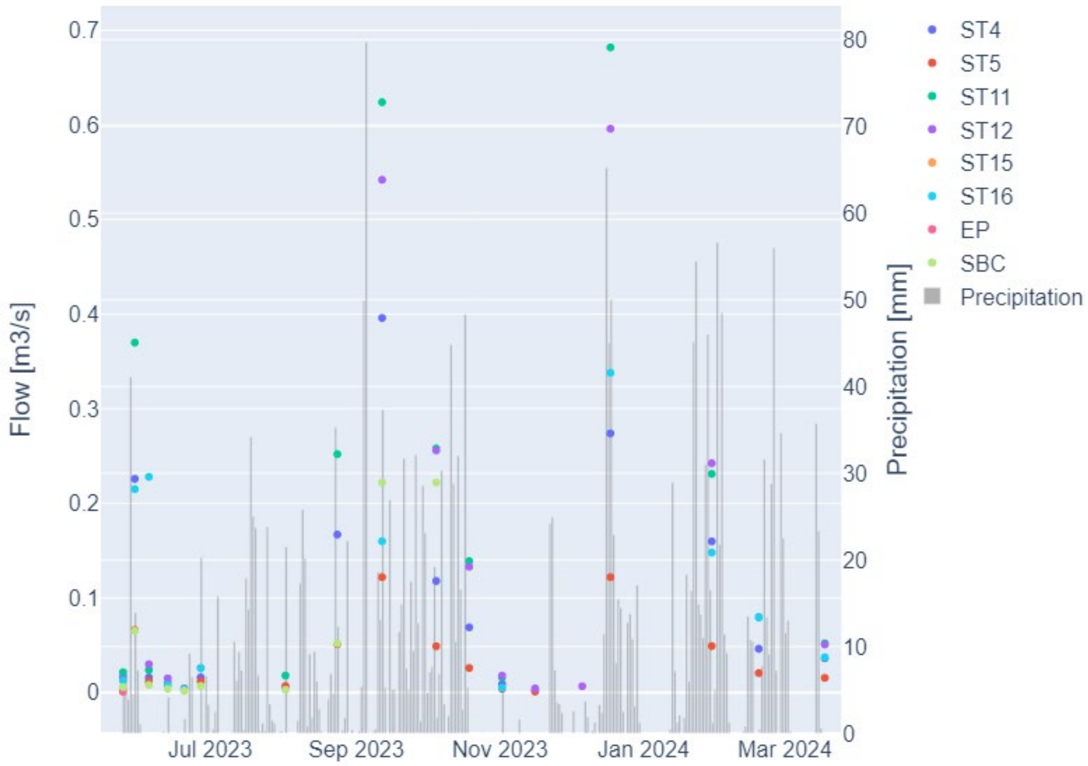


Figure 4-10: Time-series of spot flow measurements.

4.6 Hydrogeology

4.6.1 Geology

The Engebø deposit is hosted by medium to high grade metamorphic rocks including eclogites, gneisses and amphibolites. These are crystalline rocks with low primary porosity and permeability. Deformation events have led to the formation of several sets of structures that are of significance hydrogeologically as they contribute to secondary porosity and permeability.

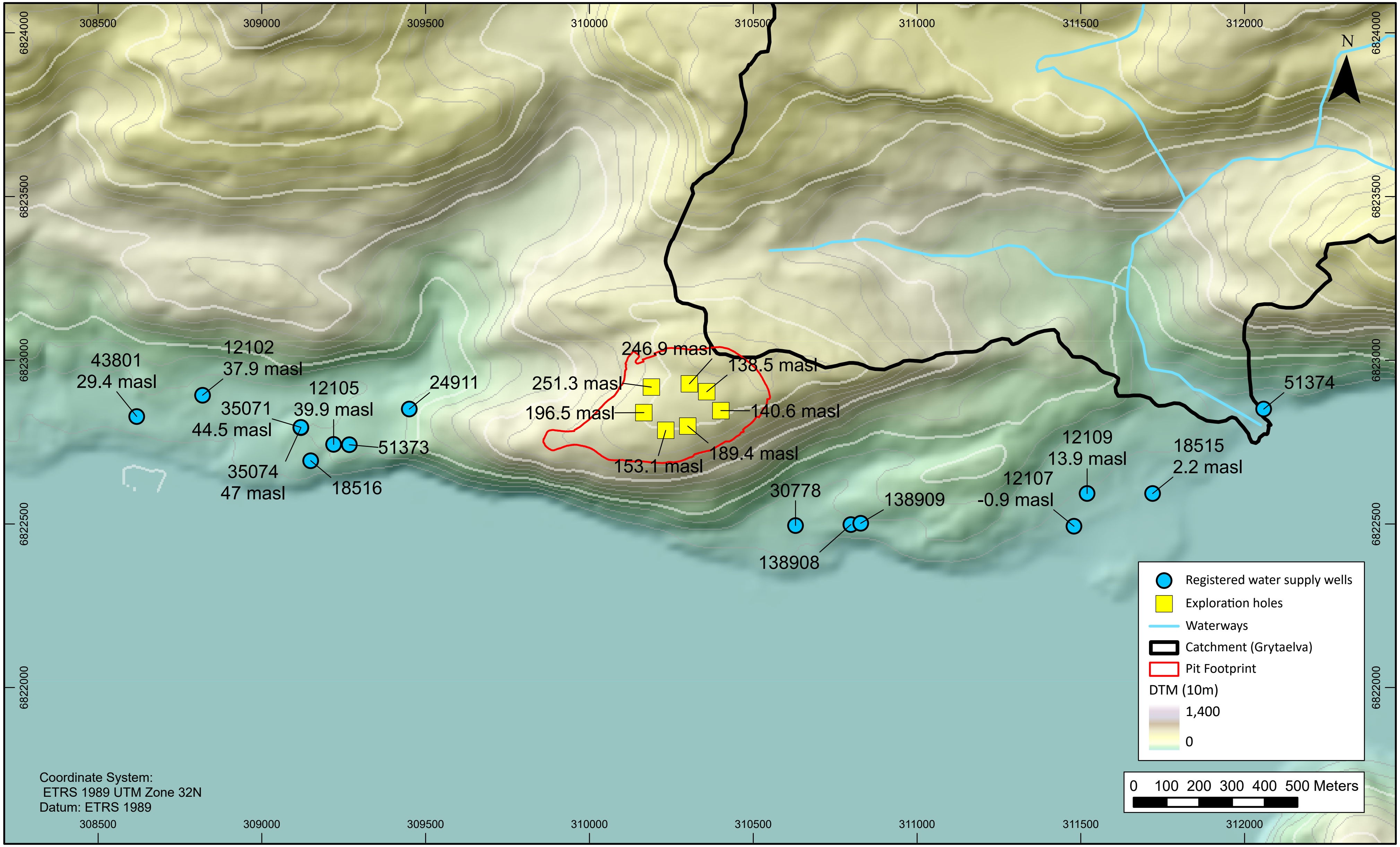
There is little or no overburden across most of the site area. Thin layers of soil and moraine (<0.5 m thick) can be found where topography is flat enough to allow this to accumulate.

4.6.2 Groundwater Levels

Static groundwater levels were measured during OTV/ATV logging in seven exploration boreholes across the central area of the deposit as part of a wider geophysical and spinner logging campaign undertaken by SRK in March 2018 (SRK, 2018). Additional groundwater level data are available from registered water supply wells in the Norwegian Environment Agency national database called “Vann-nett”[12]. All available groundwater levels are shown in Figure 4-11, although it should be noted that groundwater level measurements were not taken at the same time so may not be directly comparable.

Groundwater levels on the Engebø Hill around the area of the proposed open pit vary significantly (Figure 4-11) and do not conform to topography. This suggests a compartmentalised groundwater system with interconnectivity of fractures limited at a site-wide scale. Local groundwater flow in this environment will be controlled by the occurrence, transmissivity and degree of interconnectivity of fractures. Groundwater levels below the hilltops in the lower-lying areas of the catchment and close to the fjord appear to approximately follow topography being within a few metres of surface.

[12] https://vann-nett.no/



SEPTEMBER 2024	32082	ENGEBØ WATER IMPACT ASSESSMENT	
srk consulting		Groundwater monitoring locations and levels (masl)	Figure 4-11

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4.6.3 Hydrogeological Units and Hydraulic Properties

The key hydrogeological units present in the catchment area generally comprise peatland, glacial moraine and crystalline bedrock.

Figure 4-12 shows the distribution of glacial moraine and peat as mapped by the Geological Survey of Norway[13] (GSN). Crystalline bedrock underlies this superficial cover and is often exposed in areas where no cover is present which typically coincides with hilltops and steep hillsides. No direct measurements of hydraulic properties have been taken at the site.

Moraine material typically comprises a full range of grain size from clays to boulders. However, given the deposition of environment underlying the site, it is suggested that grain sizes are more likely to be at the higher end of this grain size range i.e. silt and larger. The deposition of moraine across the Project area is disjointed, with frequent bedrock exposures. The moraine at the Project site is rarely more than a few metres thick but has been reported to be thicker in some places, especially towards the fjord in the lower-lying areas of the catchment.

Small wetland areas occur within the Project area (Figure 4-12). Field measurements undertaken by Asplan Viak (2023) in the vicinity of the proposed WRD area, recorded peatland depths from 0.3 m to 1.2 m depth, with an average depth of 0.6 m. Peatland soils comprise a relatively high percentage (>30%) of partially decomposed organic matter which has developed under conditions of waterlogging. They typically exhibit a fibrous structure with a high porosity.

The superficial deposits can support localised perched groundwater systems. The hydraulic properties of the superficial deposits have not been characterised, but hydraulic conductivity of moraine is likely to be greater than 1E-6 m/s and higher than the peat where hydraulic conductivity of around 1E-8 m/s might be expected. Intergranular flow dominates groundwater flow in these deposits.

The fractured rock is likely to have relatively low permeability and storage, with groundwater flow almost exclusively controlled by geological structure.

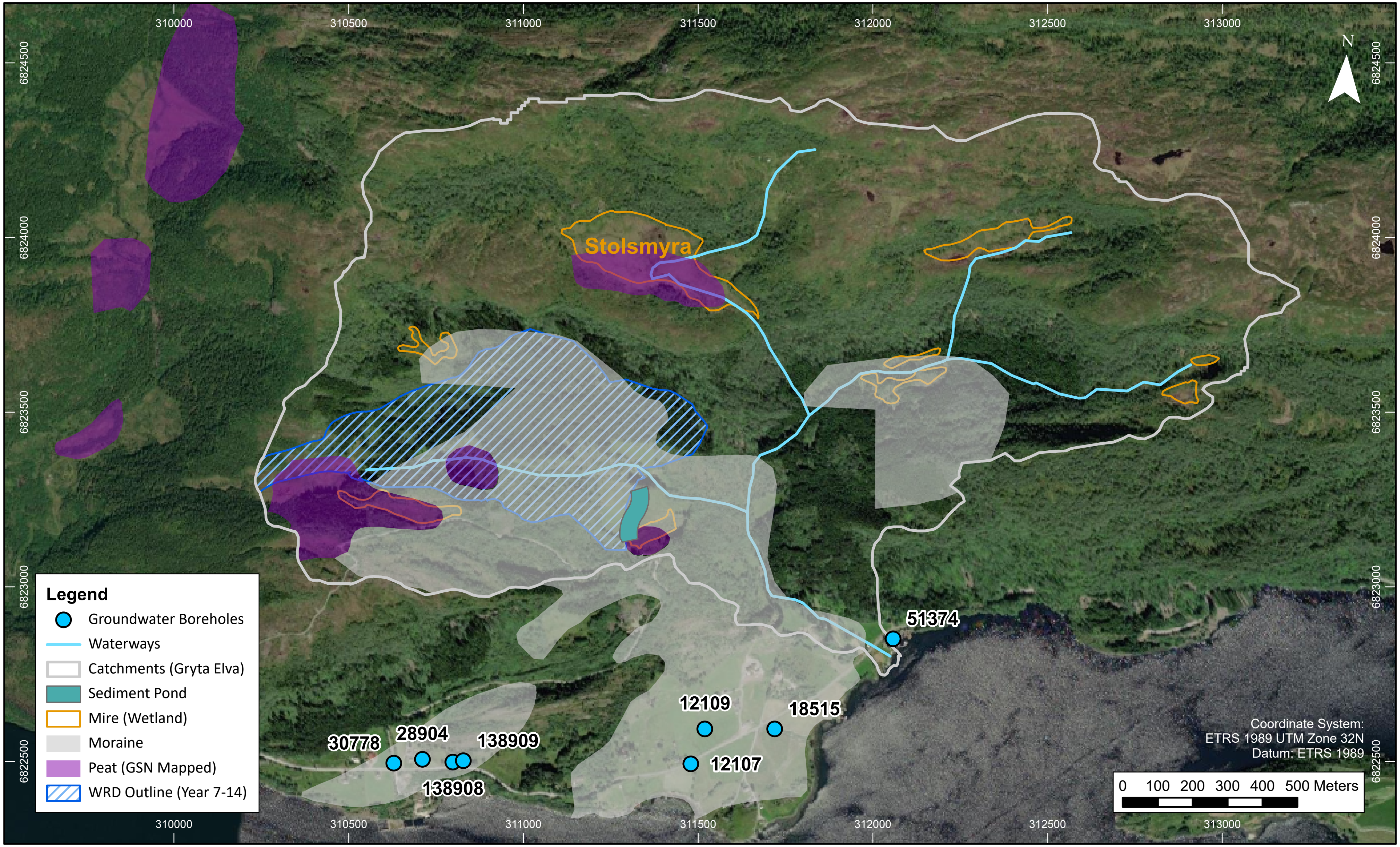
4.6.4 Recharge

Recharge to the superficial aquifers is likely either through direct precipitation recharge and recharge from streamflow in areas where the groundwater levels are below the river levels. It is therefore likely that flow in the Grytaelva is contributing to some extent to groundwater recharge in the thin moraine aquifer near the lower reaches of Grytaelva.

Recharge to the bedrock is through infiltration of precipitation, either directly into outcropping rock or via the superficial deposits. Recharge is likely to be spatially dependant, with greater recharge where fractures are present.

Most groundwater baseflow to the rivers is via the superficial moraine deposits.

[13] https://geo.ngu.no/kart/berggrunn_mobil/?lang=eng



SEPTEMBER 2024	32082	ENGEBØ WATER IMPACT ASSESSMENT	
srk consulting		Overburden geology and wetlands	Figure 4-12

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4.7 Water Quality

4.7.1 Streams and Rivers

Vann Nett chemical classification

The Vann Nett portal (https://vann-nett.no/portal/#/mainmap) outlines the current ecological and chemical state of water bodies in Norway that have been classified under the Vannforskriften. The current ecological condition of the Gryta is determined as 'Good', based on a 'Low' precision[14], and the current chemical state is classified as 'Undefined' with no information. The current ecological condition of Rivers Førdefjorden north, which includes the Stølselva, is determined as 'Bad', based on a 'Medium' precision[15] and the current chemical state is classified as 'Undefined' with no information.

The environmental goal for chemical state for the Gryta is 'Good' and this environmental target is expected to be reached in 2022-2027 with no risk identified to achieving this target. The environmental goal for chemical state for Rivers Førdefjorden north is 'Good' and this environmental target is expected to be reached in 2022-2027 with new measures stated as being necessary to achieve this.

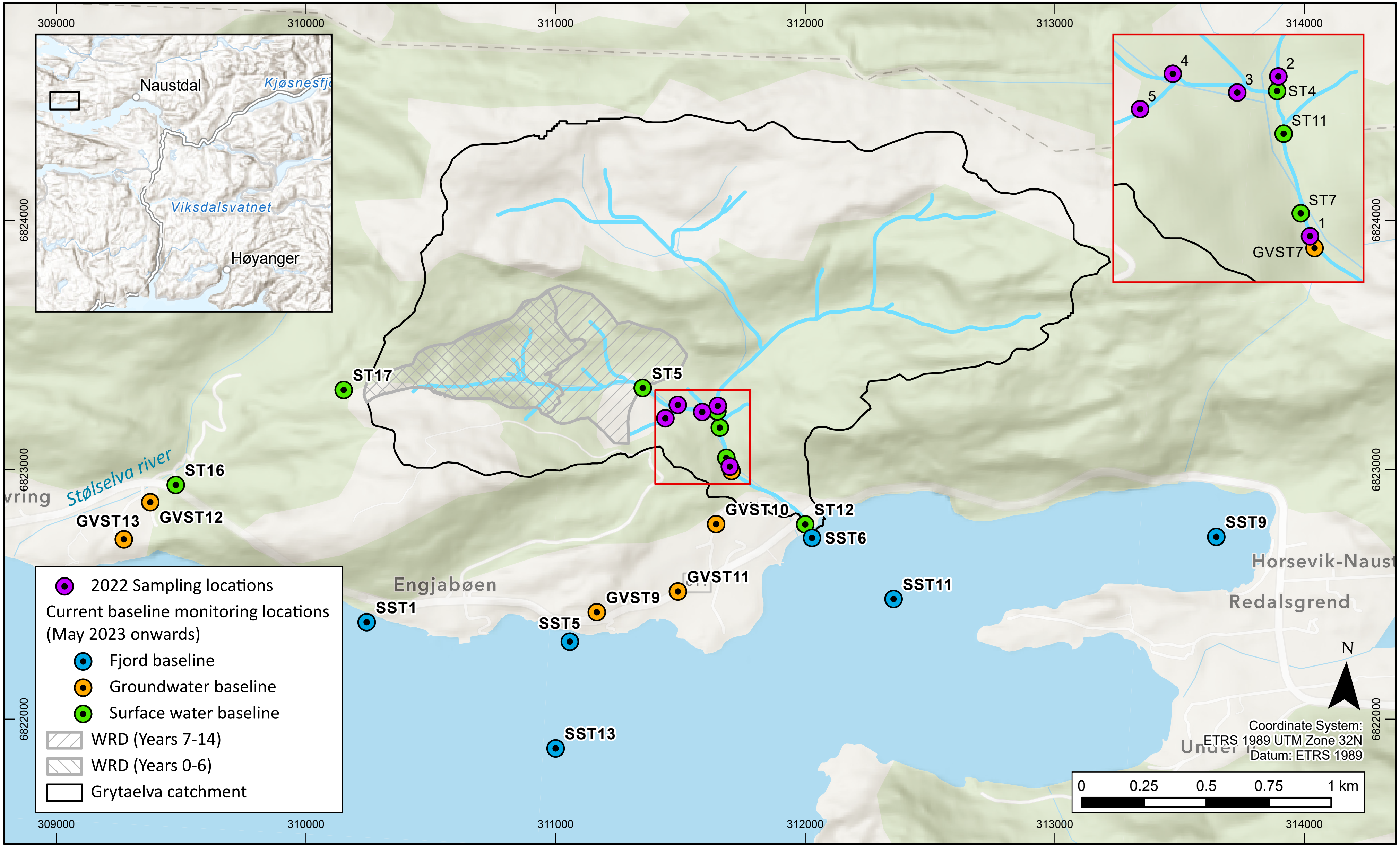
Baseline monitoring

As part of the WIA, ongoing water quality monitoring has been undertaken by ERG with monthly sampling from May 2023 conducted using a consistent monitoring network to determine baseline conditions. Data from a single sampling round in both 2008 and 2022 supplement the baseline monitoring dataset. The findings of the previous water quality sampling are summarised below:

Norwegian Institute for Nature Research (NINA), 2008: During this campaign, three samples were collected along the Grytaelva and two along the Engjabødalbekken, including one location on the lower Grytaelva that is noted as a source of drinking water. No coordinate data for the sampling locations and no water quality data was made available for this study. However, Asplan Viak (2022) report that, 'The samples showed a somewhat elevated content of nickel at the bottom of Grytaelva, as well as a somewhat elevated content of aluminium'. Based on the 2008 sampling campaign, an average pH value of 6.15 for the Grytaelva was reported.

Asplan Viak, October 2022: This sampling round was conducted during a period of high flow conditions where a total of five locations (P1 to P5) were sampled, two located along the Engjabødalbekken, one on the Grytaelva just upstream of the confluence with the Engjabødalbekken, one on the Grytaelva several hundred metres downstream of the confluence, and one on the outlet of a historical sedimentation pond. Exact coordinates of the sampling locations have not been provided. Water quality results from this sampling round have been incorporated into the baseline data and are described further below.

14 https://vann-nett.no/portal/#/waterbody/084-259-R
15 https://vann-nett.no/portal/#/waterbody/084-260-R



SEPTEMBER 2024	32082	ENGEBØ WATER IMPACT ASSESSMENT	
srk consulting		Baseline monitoring locations for water quality	Figure 4-13

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Ongoing baseline monitoring of surface water quality commenced in May 2023 by ERG, with technical support from SRK. ERG plan to continue baseline water quality sampling at the same sampling locations at monthly intervals on an ongoing basis.

Surface water quality grab samples are collected at various sampling points across the Project catchment areas including at flow monitoring locations on the Grytaelva upstream and downstream of the confluence with the Engjabødalbekken, as well as locations along the Engjabødalbekken including immediately downstream of the proposed final WRD footprint. Samples are also collected from the Stølselva, to the west of the Project area. The location of the sampling points is shown Figure 4-13.

Samples are submitted to ALS Laboratory Group Oslo, a NATA-accredited laboratory, for analysis of a comprehensive suite of parameters, including major ions, total and dissolved metal species and total nitrogen. Results are summarised in Table 4-8 as well as Figure 4-14 and Figure 4-15, below.

The October 2022 dataset has been combined with the baseline dataset from 2023 – 2024. The key observations are as follows:

- Stream water for the Grytaelva catchment is generally slightly acidic to neutral pH, ranging from pH 5.7 to pH 7.5. All pH values are classed as 'Background' or 'Good'. Stream location ST17 within the Stølselva catchment records lower pH values of 4.7 to 5.7, generally classed as 'Bad' with one measurement reaching 'Good' classification.
- EC values for both the Grytaelva and Stølselva catchment are very low, ranging from 0.3 to 16.5 mS/m, characteristic of the low dissolved mineral content.
- No exceedances of the Ministry of Climate and Environment (Klima- og miljødepartementet, 2007) freshwater guideline values for the prioritised trace metals; cadmium, lead, mercury, and nickel.
- Arsenic concentrations are recorded in exceedance of the Miljødirektoratet (2020) values classed as 'Moderate' in April 2024 at ST5 (1.54 ug/L), ST7 (0.79 ug/L), ST11 (0.66 ug/L), and ST12 (0.72 ug/L) (Figure 4-14 and Figure 4-15). It should be noted that a revised detection limit of 0.5 ug/L was applied from January to May 2024 which reflects the lower bound of the 'Moderate' classification and is therefore limiting in terms of classification beyond 'Good'.
- The source of elevated arsenic in the surface water is likely weathering and dissolution of minerals in the local geology, which was demonstrated in the elevated arsenic concentrations in the leach testing described in Section 6.2.1. The mobilisation of arsenic from dissolution of local geology appears to be more apparent during the spring snowmelt (Figure 4-15). However, this theory will need further investigation in future monitoring.
- Copper, chromium, and zinc concentrations are all classed as 'Moderate' to 'Good'[16]. There is an upward trend in concentrations of copper and zinc in 2024 at ST5 and ST17, however this is partly due to the increase in the detection limit used (Figure 4-14 and Figure 4-15).

[16] Copper, chromium and zinc do not have values for the range of classifications from 'Very Bad' to 'Background', refer to Table 3-2 for more information.

- The phosphorous concentrations are classed as ‘Background’ or ‘Good’ freshwater condition based on the Miljødirektoratet (2020) classification. It is noted that phosphorous is not included in the analysis from December 2023 onward.
- Very low concentrations of major ions are recorded. An increase in calcium, magnesium, sodium and potassium concentrations is noted in January to March 2024 followed by a decreasing trend to May 2024. This is interpreted to reflect the spring melt with elevated runoff mobilising sediment.
- Total nitrogen concentrations show a large range from 120 µg/L to 11,000 µg/L (i.e. 11 mg/L) in the Grytaelva catchment. The Engjabødalbekken (ST5) tends to have the highest nitrogen concentrations with values classed as ‘Very Bad’ and ‘Bad’ (Figure 4-14 and Figure 4-15). Total nitrogen concentrations for locations downstream of the Engjabødalbekken and Grytaelva confluence range up to 3,300 µg/L, these locations typically record values classed as ‘Moderate’, with the increase in February to March 2024 resulting in ‘Bad’ to ‘Very Bad’ concentrations. At ST4 (upstream of the confluence) total nitrogen concentrations tend to be lower, ranging from 130 µg/L to 300 µg/L and are classed as ‘Background’ or ‘Good’. This suggests that the spring melt is likely mobilising explosives residue in the Engjabødalbekken catchment.
- All water samples recorded low suspended solid concentrations of 7 mg/L or below, equivalent to the European Inland Fisheries Advisory Commission (EIFAC, 1964) designation of ‘no harmful effect on fish’ (<25 mg/L)

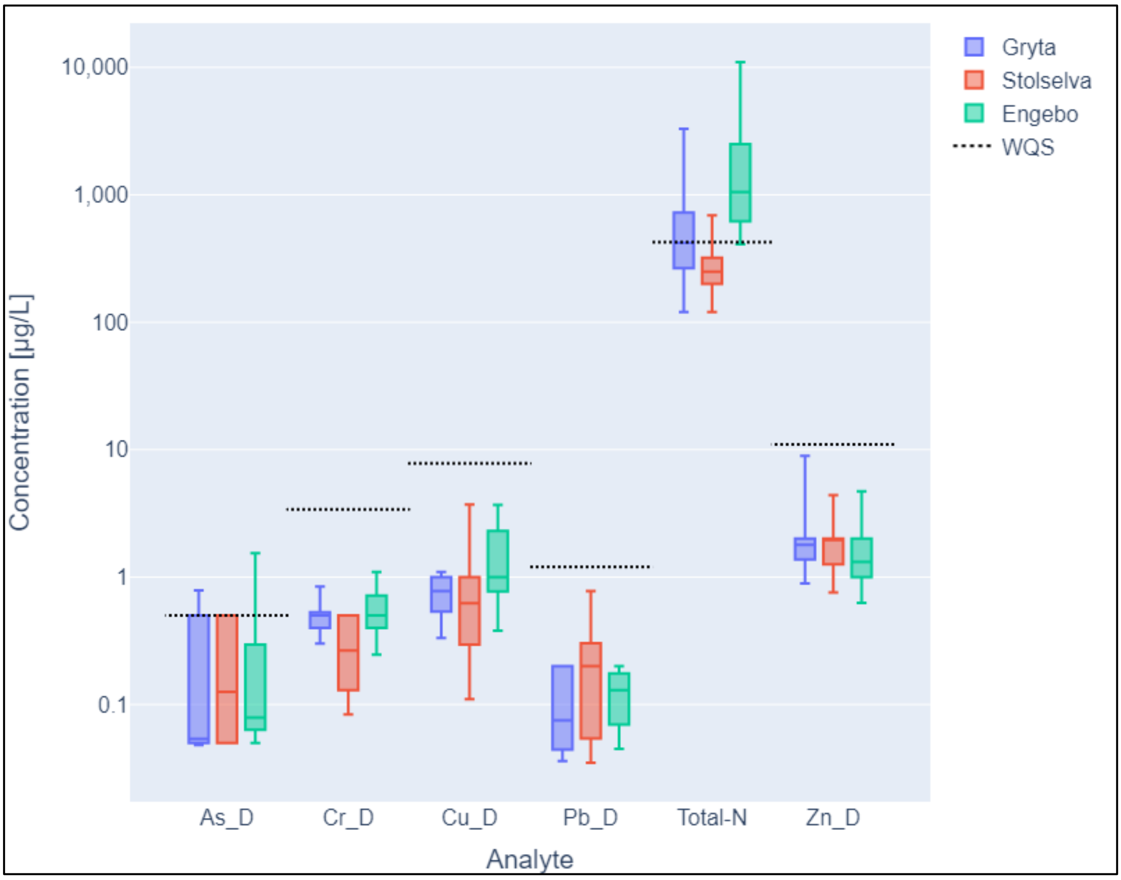


Figure 4-14: Box and whisker plot for surface water samples from various catchments versus water quality standards

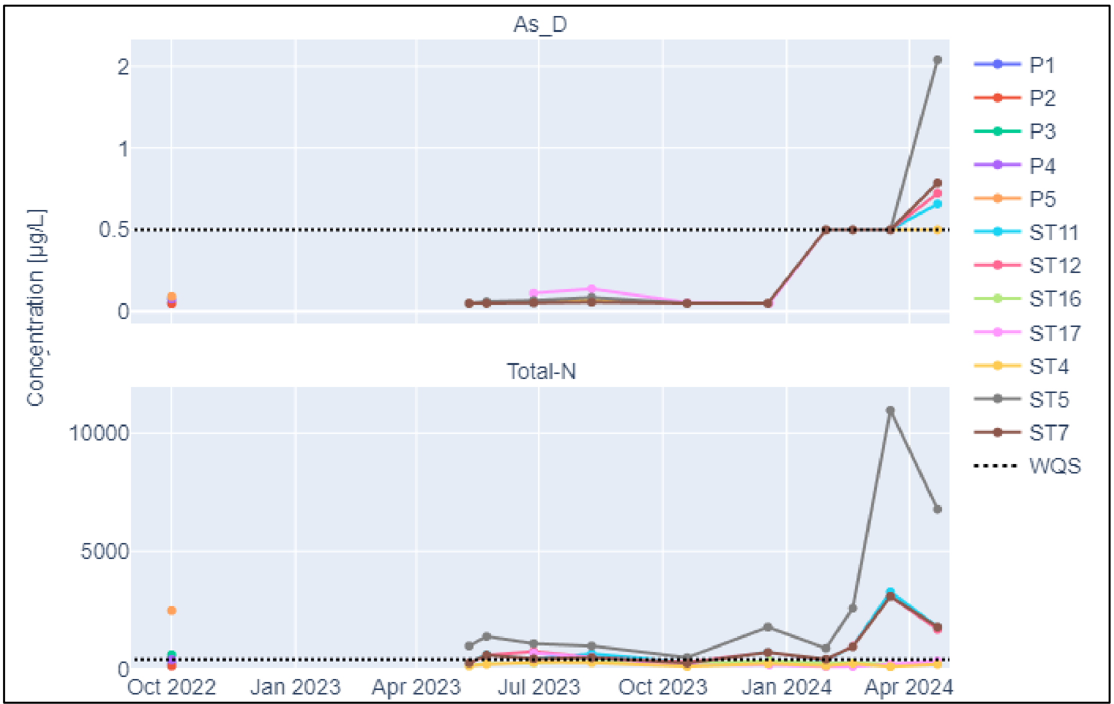


Figure 4-15: Time-series for surface water concentrations for dissolved arsenic (As_D) and total nitrogen (Total-N)

4.7.2 Fjord

The current ecological condition of the fjord at Førdefjorden-ytre is determined as 'Good', based on a 'Medium' precision of aspects such as benthic fauna, salinity, pH, nitrogen and phosphorous water concentrations and metals concentrations in the bottom sediments[17]. The current chemical state is classified as 'Good' based on a 'Medium' precision of lead in bottom sediments. Importantly, the current chemical classification does not appear to take into account recent water quality data, only bottom sediment concentrations.

The environmental goal for chemical state in Førdefjorden-ytre is 'Good' and this environmental target is expected to be reached in 2022-2027 but is at risk due to 'expected deterioration of environmental conditions due to increased impacts or increased effects of these'.

Fjord water quality sampling has been undertaken by ERG as part of baseline monitoring since May 2023, with samples collected in May 2023, June 2023 and October 2023. Water quality results for baseline fjord monitoring locations have been compared against relevant WQS in Table 3-3.

The baseline dataset from 2023 – 2024 has been used for analysis. The key observations are as follows:

- Water samples are generally neutral to slightly alkaline pH, ranging from pH 7.5 to pH 8.1.
- EC values range from 1,180 mS/m to 4,840 mS/m and reflects freshwater mixing with marine water.
- All samples meet the threshold for the Ministry of Climate and Environment (Klima- og miljødepartementet, 2007) coastal water guideline values for the prioritised trace metals cadmium, mercury, and nickel achieving 'Background' or 'Good' class. Cadmium, chromium, copper, mercury, and nickel concentrations for all water samples were classed as 'Background' or 'Good' class according to Miljødirektoratet (2020).
- Lead concentrations exceeded the coastal water guideline value of 1.3 µg/L in three samples; SST1 (2.74 µg/L), SST11 (2.75 µg/L) and SST13 (1.71 µg/L), leading to 'Moderate' class, with all other samples meeting the threshold for 'Good' class (Figure 4-16).
- Zinc concentrations range by over an order of magnitude from 2 to 35.2 µg/L and all locations record at least one sample with zinc concentration above 6 µg/L, classed as 'Bad' coastal water condition based on the Miljødirektoratet (2020) standards (Figure 4-16). The P90 zinc concentration from baseline monitoring in the fjord to date of 19.8 µg/L exceeds the WQS threshold for "good" class for coastal water of 3.4 µg/L, and is classed as 'Moderate'.
- Arsenic (dissolved) concentrations in the fjord water samples from the baseline period ranged from 0.5 to 2.7 µg/L (P90 of 1.6 µg/L) and were classed as 'Moderate' coastal water condition, with the threshold for 'good' coastal water set at 0.6 µg/L (Figure 4-16 and Figure 4-17).

[17] https://vann-nett.no/portal/#/waterbody/0281010202-C

- The source of elevated arsenic in the fjord water is likely weathering and dissolution of minerals in the local geology and it is expected that the fjord water is naturally elevated in arsenic as compared to the reference values in Miljødirektoratet (2020).
- With the exception of one water sample at SST1 in June 2023 (8.5 mg/L), all water samples recorded low suspended solids concentrations of <5 mg/L, equivalent to the EIFAC (1964) designation of 'no harmful effect on fish' (<25 mg/L).
- Total nitrogen concentrations are shown to increase significantly from February to April 2024 (Figure 4-17). This may be related to the increase in nitrogen concentrations observed in surface water at around the same time.
- The recent baseline monitoring suggests that the chemical status of the Førdefjorden is 'Moderate' class with respect to arsenic, zinc and lead dissolved water concentrations despite being classed as 'Good' on Vann Nett based on sediment metal concentrations.
- It is worth noting that the WFD makes provision for naturally elevated baseline concentrations of metals to be considered when assessing compliance of a water body to the relevant EQS as follows.

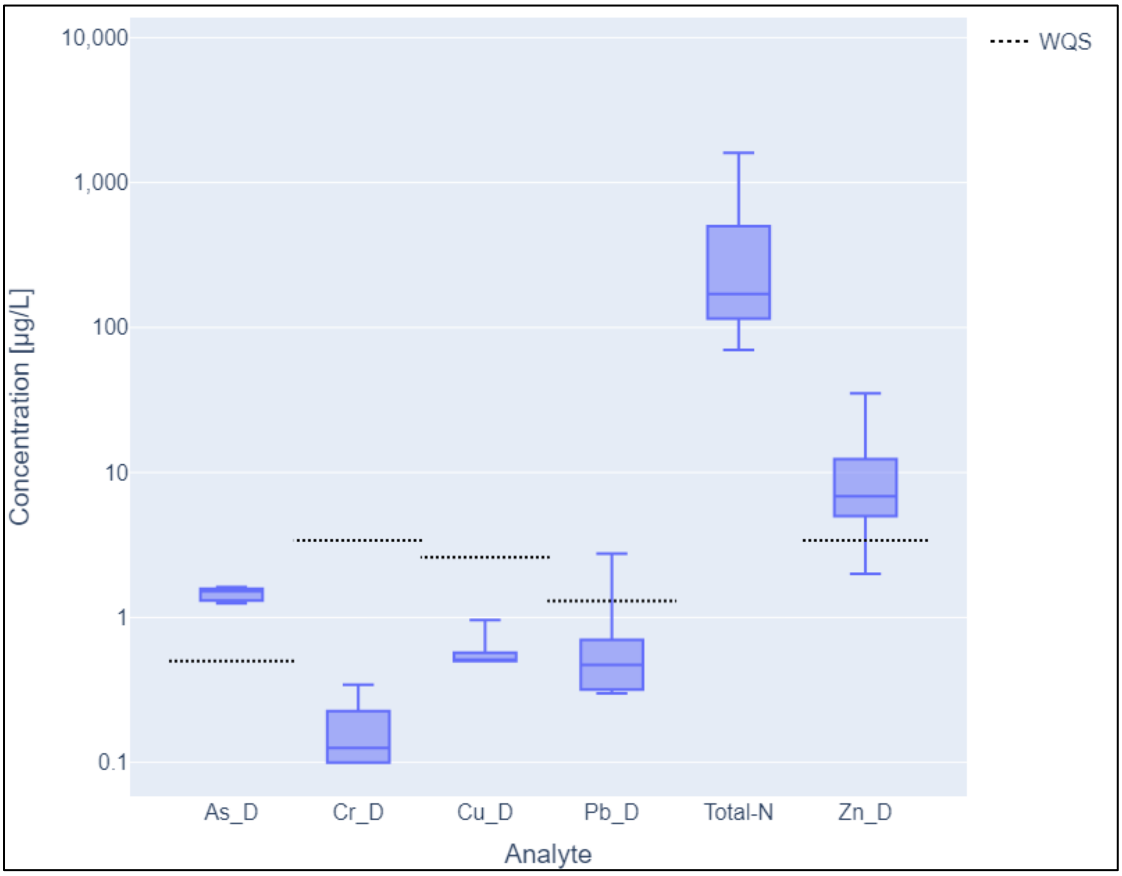


Figure 4-16: Box and whisker plot for fjord samples versus water quality limit for ‘Good’ class coastal waters

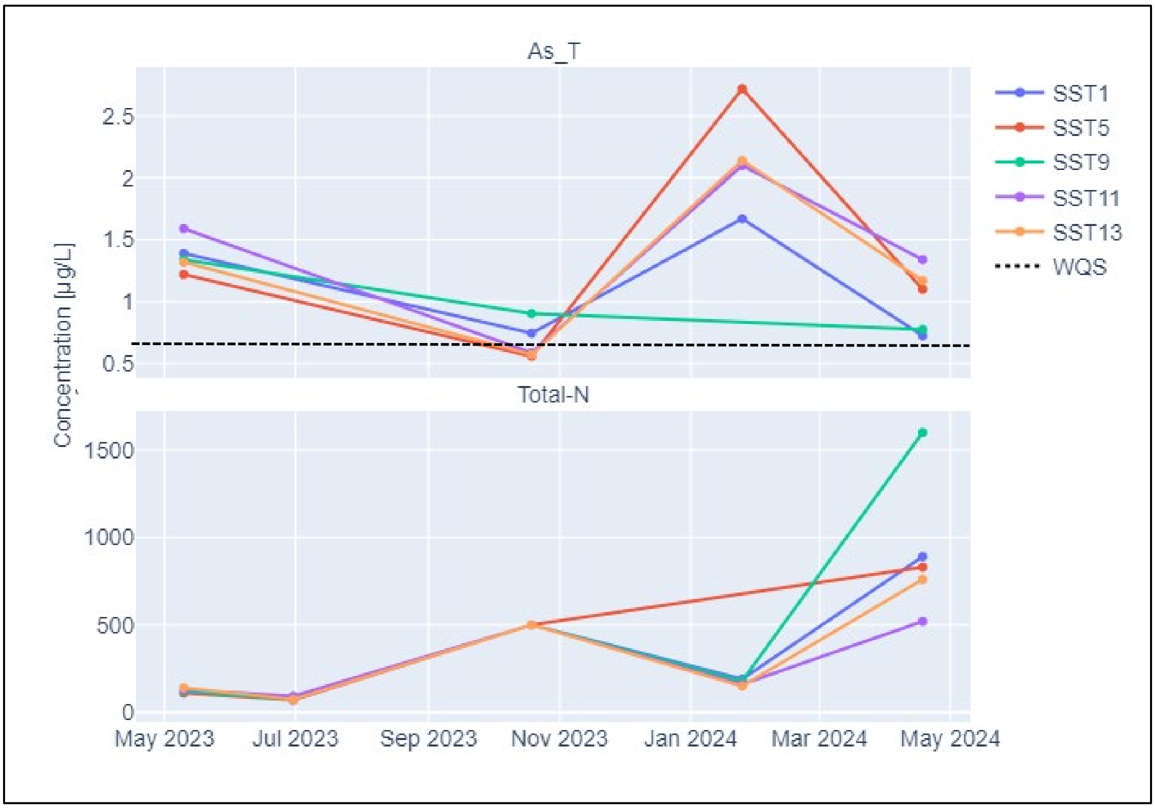


Figure 4-17: Time-series for fjord concentrations for total arsenic (As_T) and total nitrogen (Total-N). WQS is for ‘Good’ class coastal waters

Table 4-8: Summary of water quality data in the Engebo, Grytaelva and Stolselva catchments and the Forde Fjord

Parameter	Unit	Detection Limit	Klima- og miljødepartementet, 2007		Miljødirektoratet, 2020		Engebo				Gryta				Stolselva				Fjord			
			Maximum value for coastal water	Maximum value for freshwater	Upper bound for "Good" Class coastal water	Upper bound for "Good" Class freshwater	P10	P50	P90	Max	P10	P50	P90	Max	P10	P50	P90	Max	P10	P50	P90	Max
pH	-	0.1				6.7-6.2 (v.good) 6.2-5.6 (good)	5.72	6.70	7.06	7.20	5.90	6.55	6.90	7.50	4.80	5.85	6.55	7.20	7.59	7.95	8.10	8.10
Conductivity	mS/m	0.1					4.14	6.32	12.09	16.50	2.52	3.46	6.09	7.03	2.86	3.83	4.78	5.69	1216.00	2690.00	4495.00	4840.00
Suspended Solids	mg/L	5					5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	7.00	5.00	5.00	5.00	8.50
Dissolved Aluminium (Al)	µg/L	0.2					73.25	106.20	178.00	313.00	63.95	95.35	133.70	238.00	76.60	127.50	270.50	525.00	7.57	19.20	50.79	52.70
Dissolved Arsenic (As)	µg/L	0.05			0.6	0.5	0.05	0.08	0.50	1.54	0.05	0.06	0.50	0.79	0.05	0.13	0.50	0.50	1.27	1.52	1.60	1.62
Dissolved Barium (Ba)	µg/L	0.01					11.79	16.45	27.70	36.70	3.78	6.53	11.84	12.60	4.55	7.35	11.04	19.90	4.86	6.02	7.00	7.22
Dissolved Cadmium (Cd)	µg/L	0.002	0.45	0.45	0.2	0.08	0.00	0.01	0.05	0.05	0.00	0.01	0.05	0.05	0.00	0.02	0.05	0.05	0.05	0.05	0.06	0.09
Dissolved Cobolt (Co)	µg/L	0.005					0.24	0.38	0.56	0.59	0.08	0.15	0.25	0.32	0.05	0.09	0.21	0.26	0.05	0.05	0.05	0.06
Dissolved Chromium (Cr)	µg/L	0.01			3.4	3.4	0.28	0.50	0.75	1.10	0.34	0.50	0.70	0.85	0.12	0.27	0.50	0.50	0.10	0.13	0.29	0.34
Dissolved Copper (Cu)	µg/L	0.1			2.6	7.8	0.57	1.00	2.46	3.68	0.41	0.78	1.00	1.10	0.22	0.62	1.00	3.71	0.50	0.50	0.73	0.96
Dissolved Iron (Fe)	µg/L	0.4					62.78	81.25	200.50	277.00	39.44	59.80	136.20	156.00	30.86	99.10	292.40	482.00	4.00	6.11	24.02	26.50
Dissolved Mercury (Hg)	µg/L	0.002	-	0.07	0.047	0.047	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02	0.00	0.01	0.02	0.02	0.00	0.00	0.00	0.00
Dissolved Manganese (Mn)	µg/L	0.03					2.86	10.05	23.60	38.90	0.86	2.96	7.27	9.59	0.84	2.26	4.82	8.21	0.65	1.53	2.62	3.33
Dissolved Molybdenum (Mo)	µg/L	0.05					0.32	0.49	0.68	0.71	0.06	0.18	0.50	0.92	0.05	0.14	0.50	0.50	3.31	6.02	9.48	10.00
Dissolved Nickel (Ni)	µg/L	0.05	4	34	8.6	4	0.31	0.58	0.82	1.13	0.47	0.52	0.83	1.05	0.15	0.43	0.55	0.71	0.50	0.56	1.08	4.37
Dissolved Phosphorous (P)	µg/L	1				15	2.17	3.69	5.72	6.38	1.41	2.41	4.73	5.98	1.74	3.15	7.66	7.98	40.00	40.00	40.00	40.00
Dissolved Lead (Pb)	µg/L	0.01	1.2	14	1.3	1.2	0.05	0.13	0.20	0.20	0.04	0.08	0.20	0.20	0.04	0.20	0.41	0.78	0.30	0.47	1.55	2.75
Dissolved Silicon (Si)	µg/L	30					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dissolved Strontium (Sr)	µg/L	2					17.75	23.35	59.85	66.90	7.06	12.05	38.12	45.10	3.79	15.20	34.21	86.50	2369.00	4270.00	6890.00	7270.00
Dissolved Vanadium (V)	µg/L	0.005					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dissolved Zinc (Zn)	µg/L	0.2			3.4	11	0.89	1.62	4.14	4.72	1.11	1.90	2.45	8.94	1.14	2.00	2.09	4.39	3.08	6.85	19.84	35.20
Total nitrogen (Tot-N)	µg/L	20				250 (v. good) 425 (good) 675 (moderate) >1250 (v.bad)	524.00	1100.00	5960.00	11000.00	166.00	435.00	1790.00	3300.00	158.00	250.00	408.00	690.00	74.00	170.00	809.00	1600.00
Nitrate-N (NO3-N)	µg/L	6					657.40	1330.00	6290.00	8250.00	69.50	259.00	1450.00	2060.00	17.00	69.50	175.50	258.00	30.00	150.00	150.00	150.00
Nitrate As NO3	µg/L	27					2975.00	5095.00	27050.00	36500.00	309.00	1195.00	6340.00	9130.00	78.10	306.50	907.20	1140.00	10.00	100.00	660.00	660.00
Nitrite-N (NO2-N)	µg/L	4					657.40	1330.00	6290.00	8250.00	69.50	259.00	1450.00	2060.00	17.00	69.50	175.50	258.00	30.00	150.00	150.00	150.00
Nitrite As NO2	µg/L	13					4.60	13.00	182.80	194.00	5.00	13.00	40.50	48.00	3.00	13.00	13.00	13.00	1.00	1.00	32.80	32.80
Nitrate and Nitrite-N	µg/L	6					671.90	1179.00	6141.00	8310.00	70.70	273.00	1410.00	2080.00	6.00	69.50	202.70	258.00	2.00	5.00	150.00	150.00
Total Organic Carbon (TOC)	µg/L	100					2750.00	3750.00	6550.00	9700.00	2490.00	3200.00	5280.00	9600.00	2600.00	5450.00	11100.00	23000.00	1030.00	1350.00	2070.00	3600.00

4.7.3 Groundwater

There are no classified groundwater bodies in the Project area. Based on available water quality data outlined in Section 4.7.3, groundwater in the catchment would fall under the “Good” classification as described in Section 3.6.2, although insufficient data is currently available to classify the groundwater quality appropriately.

Groundwater quality sampling has been undertaken by ERG as part of baseline monitoring since May 2023, with three sampling dates (June 2023, January 2024 and April 2024).

Water quality results for baseline groundwater monitoring locations have been compared against relevant WQS’s in Table 4-9, below.

Table 4-9: Groundwater monitoring results compared against Norweigen Water Quality Standards

Parameter	Unit	Detection Limit	Miljødirektoratet (2016)		Groundwater		
			Threshold	Trigger	P10	P50	Max
pH	-	0.1			6.18	7.30	8.00
Conductivity	mS/m	0.1			5.67	15.30	47.00
Suspended Solids	mg/L	5			5000.00	5000.00	5000.00
Dissolved Aluminium (Al)	µg/L	0.2	200	150	2.00	7.30	95.20
Dissolved Arsenic (As)	µg/L	0.05			0.06	0.50	6.88
Dissolved Barium (Ba)	µg/L	0.01			12.28	34.60	91.40
Dissolved Cadmium (Cd)	µg/L	0.002	5.000	3.750	0.003	0.050	0.050
Dissolved Cobolt (Co)	µg/L	0.005			0.02	0.06	3.11
Dissolved Chromium (Cr)	µg/L	0.01			0.05	0.50	0.81
Dissolved Copper (Cu)	µg/L	0.1			3.04	13.80	132.00
Dissolved Iron (Fe)	µg/L	0.4	200	150	2.15	4.00	502.00
Dissolved Mercury (Hg)	µg/L	0.002	0.500	0.400	0.002	0.020	0.020
Dissolved Manganese (M	µg/L	0.03	50	37.5	0.20	0.95	182.00
Dissolved Molybdenum (N	µg/L	0.05			0.50	0.74	5.63
Dissolved Nickel (Ni)	µg/L	0.05	20	15	0.39	0.65	4.42
Dissolved Phosphorous (	µg/L	1			1.00	1.63	8.84
Dissolved Lead (Pb)	µg/L	0.01	10.000	7.500	0.20	0.42	2.87
Dissolved Silicon (Si)	µg/L	30			0.00	0.00	0.00
Dissolved Strontium (Sr)	µg/L	2			60.05	113.70	1100.00
Dissolved Vanadium (V)	µg/L	0.005			0.00	0.00	0.00
Dissolved Zinc (Zn)	µg/L	0.2			7.48	18.30	132.00
Total nitrogen (Tot-N)	µg/L	20			71.60	260.00	1200.00
Nitrate-N (NO3-N)	µg/L	6			30.00	200.00	830.00
Nitrate As NO3	µg/L	27	50000.000	37500.000	106.00	880.00	4100.00
Nitrite-N (NO2-N)	µg/L	4			30.00	200.00	830.00
Nitrite As NO2	µg/L	13	500	375	1.00	7.85	13.00
Nitrate and Nitrite-N	µg/L	6			20.80	200.00	920.00
Total Organic Carbon (TO	µg/L	100			256.00	1600.00	5800.00

The baseline dataset from 2023 – 2024 has been reviewed, the key observations are as follows:

- Sodium concentrations are low (4 – 19 mg/L) indicating no ingress of saline fjord water into the groundwater system at the sampled locations.
- Concentrations typically fall below the EU drinking water guideline values and the Norwegian Water Regulation (Vannforskriften) trigger values set at 75% of the threshold value (Miljødirektoratet, 2016). The only exceptions are manganese, iron and sulphate as follows (also refer to Figure 4-18):
- Manganese concentrations from GVST13 in June 2023 (182 µg/L) and January 2024 (153 µg/L) in exceedance of the default trigger action value of 37.5 µg/L.
- Iron concentrations in GVST13 in January 2024 (502 µg/L) in exceedance of the default trigger action value of 150 µg/L; and
- Sulphate concentrations in GVST12 in January 2024 (79 mg/L) which exceeds the trigger value but is below threshold value of 100 mg/L.

The exceedances in manganese are likely derived from weathering of local host rocks and are not considered anthropogenic. Elevated iron and sulphate concentrations are likely associated with the presence of peatland in the catchment.

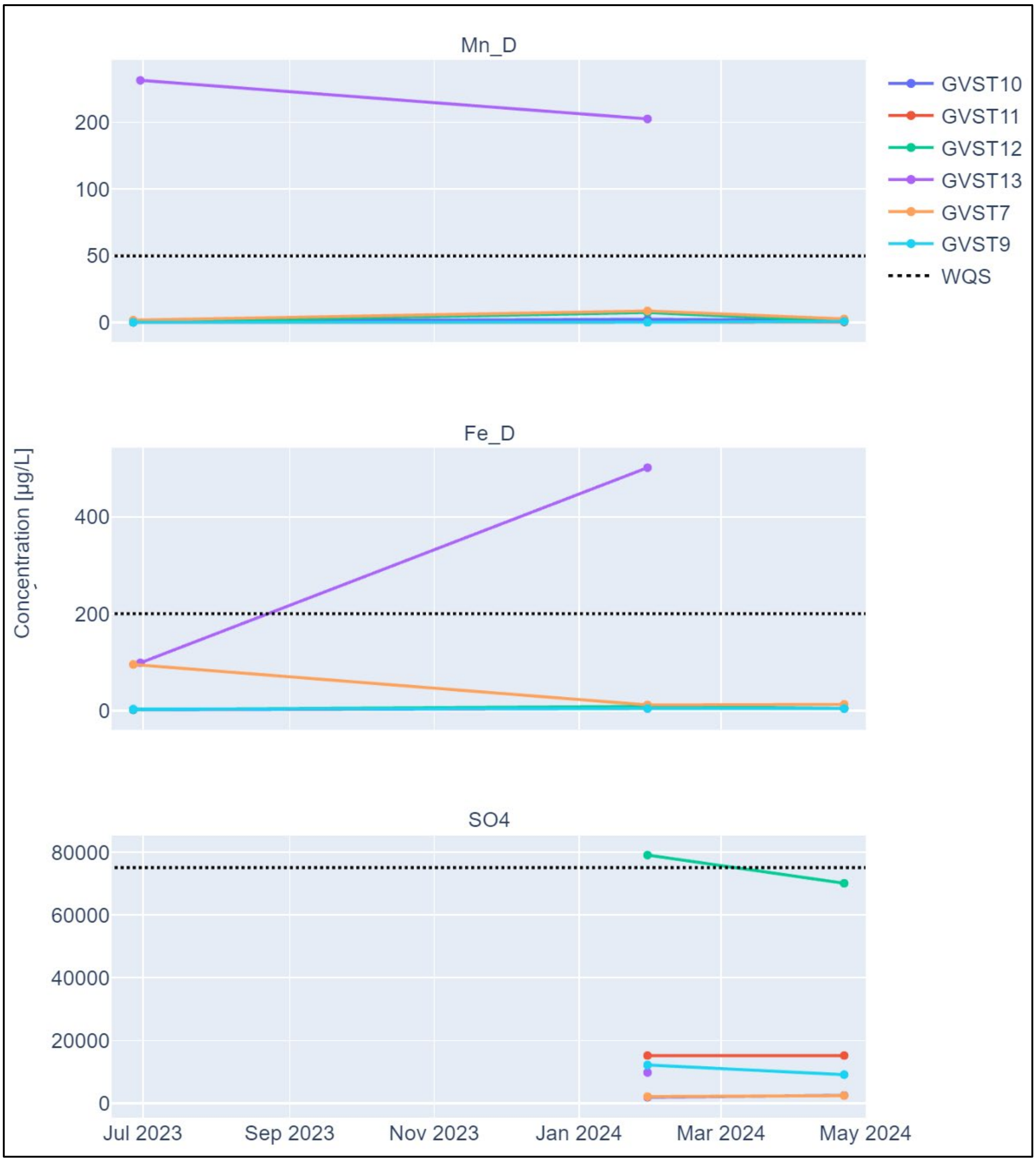


Figure 4-18: Groundwater quality time-series for Manganese, Iron and Sulphate

4.8 Water Dependent Ecosystems

Both the Grytaelva and Stølselva host populations of trout and eel. Previous investigations in the Grytaelva indicate that the river has a population of sea otters, as well as being an important breeding area for eels belonging to the Førde Fjord. These studies considered the Grytaelva to have medium value for riverine fish communities.

There is no known recreational fishing in the Grytaelva or Stølselva.

There are a number of wetland areas located across the Grytaelva catchment, including some within the Engjabødalbekken catchment, that will be affected directly by the mine footprint, as well as other wetland located in the upper catchment of the Grytaelva which are unlikely to be impacted by the mine development. A map of known wetland areas within the Grytaelva catchment as well as areas of peatland as mapped by GSN (see also Section 4.6.3) in relation to the proposed Project layout is shown in Figure 4-12.

4.9 Other Water Users

No known direct abstraction of surface water has been mapped or recorded across the Project area.

The Geological Survey of Norway (NGU) is responsible for maintaining the National Groundwater Database[18] (GRANADA) which provides information on groundwater wells in Norway. There are four groundwater wells registered in the village of Gryta, four in Engjabøen and a further eight in Indre Vevring located west of the Project. Well details are summarised in Table 4-10. Well locations and groundwater levels (where available) are shown on Figure 4-11.

Two wells are used for farming, one for domestic energy supply, and five have a specified use for domestic water supply. In the absence of evidence to the contrary, and adopting a precautionary approach, it is assumed that all other wells are used for domestic water supply and must therefore comply with drinking water quality standards.

It is noted that eleven of the sixteen wells have a shallow inclination (< 35°). This suggests that the wells are targeting the shallow aquifers i.e. groundwater contained in the superficial deposits, rather than the deeper bedrock. This is consistent with a low permeability bedrock with limited potential to transmit groundwater overlain by superficial deposits with higher permeability.

SRK understands that water users in the Gryta community have expressed concern that several properties take water from a well that has its inflow from the Grytaelva and that diversion of the Engjabødalbekken Creek may cause the well to run dry during dry periods. SRK also understands that local residents have reported barely enough drinking water during the summers of 2020 and 2021. The well is an old concrete well dug/built into the Grytaelva, and is not registered in any system. It is likely that this well is recharged to some extent from the Grytaelva (see Section 4.6.4).

[18]The National Groundwater Database (GRANADA) is owned and operated by the Geological Survey of Norway (NGU). Granada (ngu.no).

Table 4-10: Community groundwater wells (GRANADA, 2023)

Borehole ID	X	Y	Village	Borehole			Depth to bedrock	Depth to water[1]	Drilling date	Use	Industry	Comment
				Depth	Dip	Azi						
				m	°	°	m	m				
12107	311479	6822493	Gryta	45	5	330	1	15	09/03/1978	Water supply	Unknown	Slightly hard water
12109	311519	6822593	Gryta	56	20	-	-	9	-	Water supply	Unknown	
18515	311719	6822593	Gryta	67	90	n/a	-	8	01/01/1975	Water supply	Farming	Clean, good water, never hard, never dry
51374	312058	6822851	Gryta	60	35	315	2	-	03/12/2007	Water supply	Domestic	
28904	3107101	6822506	Engjabøen	133	90	n/a	1.5	38	06/05/1998	Water supply	Other	
30778	310629	6822495	Engjabøen	57	30	20	4	-	15/05/2001	Water supply	Domestic	
138908	310798	6822498	Engjabøen	150	35	0	1	-	13/12/2022	Water supply	Other	
138909	310828	6822502	Engjabøen	150	35	0	1	-	14/12/2022	Water supply	Other	
35074	309119	6822794	Indre Vevring	99	90	n/a	-	2.5	21/01/2005	Water supply	Domestic	
12102	308819	6822893	Indre Vevring	40	90	n/a	-	6	27/03/1979	Water supply	Unknown	Hard water
35071	309119	6822795	Indre Vevring	156	15	270	3	5	19/01/2005	Energy	Domestic	
24911	309450	6822851	Indre Vevring	120	20	60	1	-	14/05/2003	Water supply	Farming	
51373	309267	6822742	Indre Vevring	96	25	315	-	-	30/11/2007	Water supply	Domestic	
12105	309219	6822743	Indre Vevring	69	12	360	-	13	16/03/1979	Water supply	Unknown	
43801	308618	6822828	Indre Vevring	54	20	90	0.5	3	12/07/2006	Water supply	Domestic	
18516	309149	6822693	Indre Vevring	69	90	n/a	1	-	01/01/1985	Water supply	Domestic	Clean, good water, a little hard

4.10 Summary of Key Catchment Water Risks

Based on SRK's assessment of the key catchment characteristics outlined above, the key water risks for the catchments with potential to be impacted by the Project are:

Water quality. Surrounding watercourses are generally of good water quality with aquatic ecosystems that are likely sensitive to changes in water quality and to impacts from discharge of poorer quality water.

Water availability during low flow periods. This is relevant both in terms of drinking water where streamflow recharges local drinking water wells but also in terms of minimum stream flows to ensure no ecological impacts to stream ecology e.g. eels and fish in the lower sections of the surrounding creeks when surface water flows from surrounding streams are low.

This study focuses particularly on these potential water risks although all potential water risks to the surrounding catchments are considered.

5 POTENTIAL IMPACTS SCOPING ASSESSMENT

5.1 Introduction

This section of the WIA seeks to identify and describe:

- Sources i.e. aspects of the proposed Project that have the potential to represent sources of impact to surrounding water features;
- Pathways i.e. routes by which potential impacts from identified sources could migrate; and
- Receptors i.e. water dependent ecosystems and/or other water users which could be negatively affected by the above.

A water impact can only occur if, at any given point in time, a source is linked to a receptor via a pathway. The previous sections have been used to develop a conceptual source-pathway-receptor model for the Project.

An initial scoping assessment of the potential to significantly impact baseline conditions within the study area was undertaken considering the sources, pathways and receptors identified.

5.2 Sources

SRK has identified the following potential sources of water impacts which require further consideration:

- Open pit development and associated drawdown of groundwater levels;
- Blasting of rock within the open pit with nitrogen-containing explosives (nitrate and ammonia) - residues from which could be dissolved in pit water subsequently captured by pit dewatering systems and discharged to the sedimentation pond;
- Metal leaching from exposure of open pit wall rocks;
- Waste rock dump metal leaching and generation of suspended solids;
- Run-off from haul roads and other site areas containing elevated suspended solids;

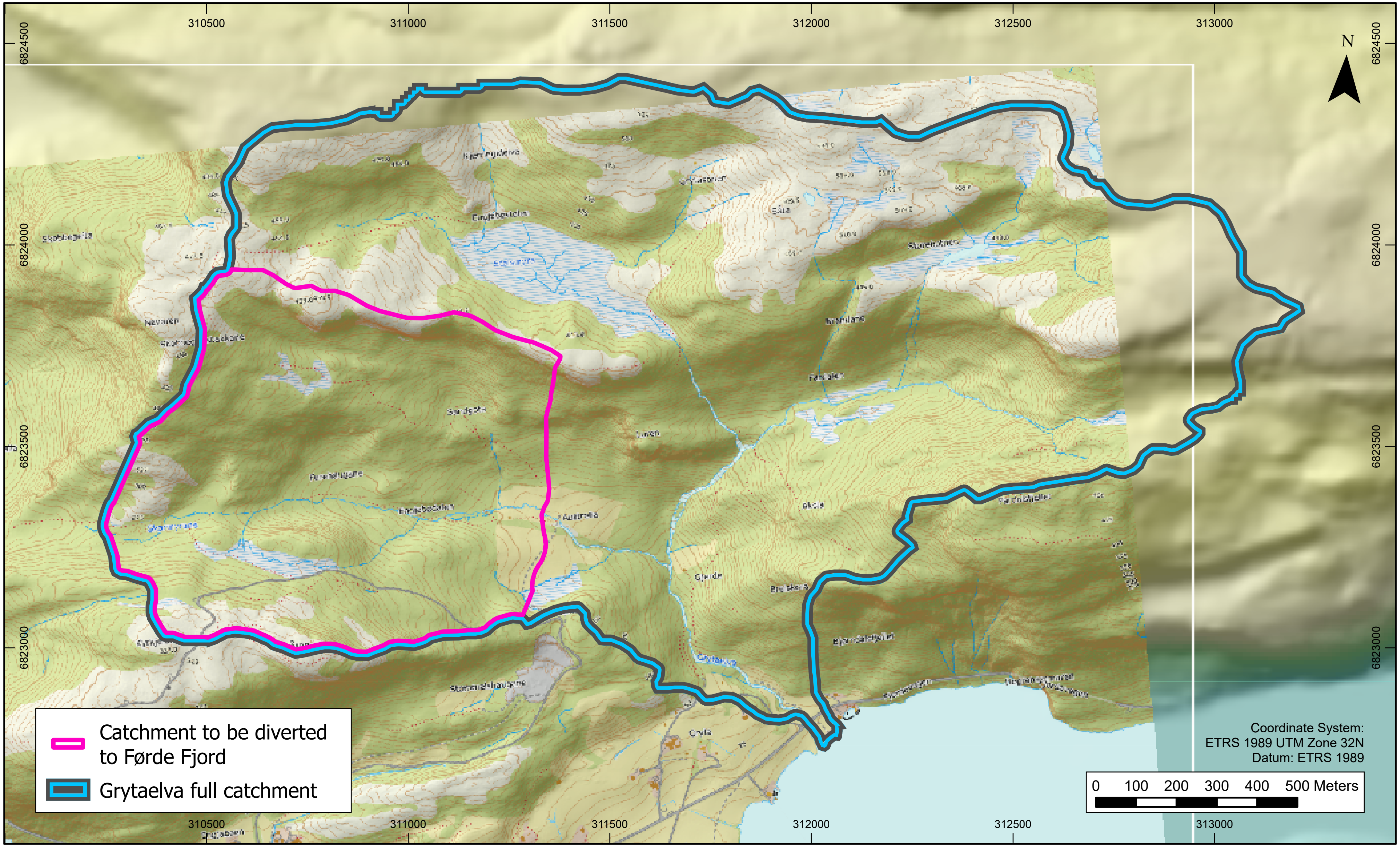
- Accidental spills and leakages from plant site and vehicles; and
- Diversion of mine site run-off (contact water) to the sedimentation pond and rerouting to the Førde Fjord.

5.3 Pathways

5.3.1 Surface Water Runoff

Surface water runoff is expected to be the most significant potential pathway for contamination to migrate from the above potential sources. All runoff from the open pit, the majority of the haul road, the lay down area, and the WRD will report to the sedimentation pond, as shown in Figure 5-1. The sedimentation pond water will be discharged directly to the Førde Fjord. Therefore, further analysis of the potential sedimentation pond water chemistry is required in order to assess the potential for water impacts to the fjord.

The diversion of runoff from the mine site footprint to the Førde Fjord (via discharge from the sedimentation pond) is also a pathway for flow impacts due to reduction in runoff to the Grytaelva compared to baseline conditions.



SEPTEMBER 2024	32082	ENGEBØ WATER IMPACT ASSESSMENT	
srk consulting		Portion of the Grytaelva catchment diverted to the Førde Fjord	Figure 5-1

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5.3.2 Groundwater Flow

The WRD will be constructed on compacted moraine to limit seepage. Residual seepage from the base of the WRD that enters the underlying glacial till will be collected by toe drains and directed to the sedimentation pond. The sedimentation pond will be blasted into bedrock with any underlying fractures or geological structures grouted. Therefore, seepage from the pond to the groundwater system should be negligible.

The bedrock is a low permeability, compartmentalised system where fracture flow dominates the groundwater regime. Groundwater levels suggest the interconnectivity of fractures is limited at a site-wide scale and that connection with a wider aquifer is limited. Furthermore, given the very steep topography, any contaminant migration from surface sources into groundwater is likely to pass through the superficials and re-emerge into surface water rather than migrating through the bedrock aquifer. Therefore, it is considered that the bedrock aquifer is unlikely to present a viable pathway for contaminants to migrate from the open pit or WRD areas.

The pit and tunnel will be excavated in low permeability bedrock and groundwater drawdown is expected to be restricted and localised. Therefore, drawdown impact from pit dewatering is expected to be negligible. Groundwater drawdown impacts are made more unlikely due to the nature of the deposit on a hill elevated well above any groundwater receptors located near the fjord.

Although deep groundwater flow does not present a significant risk for contaminant migration, groundwater flow may also occur through superficial deposits, including moraine and peatlands. These superficial deposits provide a potential pathway between mine infrastructure and the local surface water network.

5.4 Receptors

Water dependent ecosystems and other water users are described in Sections 4.8 and 4.9.

Based on this assessment, the key water-related receptors that could be potentially impacted by the project are as follows:

Grytaelva: This stream contains important populations of eel which require a certain minimum water level during summer and which are sensitive to changes in water quality. Any material reduction in summer baseflow due to diversion of the Engebø catchment above the sedimentation pond could therefore impact these water dependent ecosystems. Furthermore, any water quality impacts could affect stream aquatic life, including the aforementioned eel populations.

Shallow groundwater around the lower reaches of the Grytaelva. Groundwater in the glacial moraine around the lower reaches of the Grytaelva is likely recharged to some extent from the creek itself. A material reduction in flow in the Grytaelva could lead to a reduction in available groundwater resources immediately adjacent to the lower reaches of the Grytaelva. This could affect existing drinking water wells in this area, specifically well 51374, as described in Section 4.9.

Førde Fjord: The fjord is a significant ecological receptor of aquatic life which is potentially sensitive to input water quality. All mine site run-off will be discharged to the fjord, following settlement of fines in the sedimentation pond. Therefore, the fjord represents a key receptor that requires assessment as part of this WIA.

5.5 Assessment of Potential Changes to Surface Water Flow

A summary of source-pathway-receptor linkages with the potential to impact on surface water flow conditions is outlined in Table 5-1. The scoping of surface water flow risks suggested that some further quantitative flow impact assessment was required, which is described in Section 7.1.

Table 5-1: Scoping of potential impacts to surface water flow conditions and proposed approach to assessment

Aspect	Potential impact	Potential for Effect on Key Hydrological Parameter				Summary of proposed approach
		Flow pathways	Average flows	Low flows	Flood flows	
Dewatering of open pit.	Potential for groundwater drawdown around the pit and decrease in baseflows to springs at the foot of the Engebø hill deposit and local small surface water courses.		√	√		Low permeability bedrock deposit. Groundwater drawdown expected to be restricted and localised. **Risk considered negligible**. Quantitative analysis not considered required at this stage.
Diversions of the project catchment to the sedimentation pond and the Fjord, resulting in a reduction in flows in the Grytaelva.	Runoff from disturbed areas of the mine site (WRD, haul roads, laydown/service & equipment parking areas) and some natural ground catchment areas that cannot be practically diverted will be directed to the sedimentation pond, decreasing flows to the Grytaelva during critical flow periods. This has the potential to impact aquatic life in the Grytaelva.	√	√	√		**Further evaluation required**. Quantitative flow impact assessment in Section 7.1. The summer low-flow period required particular attention as this is the period when flow impacts are considered most likely to have the potential to impact eel populations, considered the most sensitive aquatic ecosystem in the Grytaelva.
Failure of water sedimentation pond.	Potential for increased flows and release of uncontrolled water quality to the Grytaelva				√	Assessment of failure of pond is **not part of this assessment**. Sedimentation pond design is being undertaken by Asplan Viak, the lead site surface water infrastructure design engineers.

5.6 Assessment of Potential Changes to Surface Water Quality

A summary of source-pathway-receptor linkages with the potential to impact on surface water quality is outlined in Table 5-2. The scoping of surface water quality risks suggested that some further quantitative quality impact assessment was required, which is described in Section 7.2.

Table 5-2: Scoping of potential impacts to surface water quality

Aspect	Potential impact	Summary of proposed approach
Runoff and/or seepage from site reporting to the sedimentation pond and discharged to the Førde Fjord.	Potential for generation of poor-quality water due to water-rock interactions in the WRD, nitrogen loading from blasting residues, or sediment in runoff from disturbed areas. This poor-quality water could be mobilised in either runoff and/or seepage to shallow groundwater, both of which would report to the sedimentation pond. Water from the sedimentation pond will be discharged to the fjord, with potential impacts on fjord water quality.	**Further evaluation required**. Quantitative analysis of the likely sedimentation pond chemistry is evaluated in Section 7.2 and compared to relevant fjord water quality criteria.
Seepage of poor-quality runoff in the sedimentation pond to underlying groundwater	Impact on groundwater quality in the shallow moraine under and downstream of the sedimentation pond. Potential for seepage to the Grytaelva via baseflow.	Sedimentation pond blasted into bedrock and grouted so **risk to underlying groundwater considered negligible**.
Uncontrolled release of sedimentation pond water to Grytaelva catchment during a flood event.	Release of uncontrolled water quality into the Grytaelva.	The overspill is designed to direct up to a 1 in 200 year event. If this was exceeded, the sedimentation pond would overtop via the emergency spillway discharging to the same channel running along the access road to the fjord and would not overspill into the Gryta.
Tailings co-disposal to the fjord	Potential for change in water quality in fjord due to undersea tailings disposal.	Assessment of tailings co-disposal is not a part of this assessment.

5.7 Assessment of Changes to Groundwater

A *qualitative* assessment of potential changes to groundwater, provided in Table 5-3, concludes that no *quantitative* analysis is required for potential groundwater impacts which are considered negligible. Therefore, no further groundwater-specific quantitative analysis of potential water impacts has been undertaken.

Table 5-3: Scoping of potential impacts to groundwater

Aspect	Potential impact	Potential for effect on key hydrological parameter		Summary of proposed approach
		Groundwater level/ availability	Groundwater quality	
Pit dewatering	Potential for groundwater drawdown around the pit and tunnel to affect springs, well abstractions and baseflow to rivers.	√		Pit and tunnel excavated in low permeability bedrock deposit. Groundwater drawdown expected to be restricted and localised. Therefore, potential for negative impact on springs or well abstractions considered to be **negligible**. Rivers show a rapid response to rainfall and snowmelt events, although some river baseflow during low flow periods will likely be contributed to from groundwater. Most groundwater enters the rivers via the superficial moraine deposits. These deposits are recharged by direct precipitation and flow from the peatlands and wetlands higher in the catchments. It is considered unlikely that localised drawdown in the bedrock surrounding the open pit or tunnel will cause significant drawdown in the superficial deposits. Therefore, the impact of pit dewatering on baseflow to rivers will be **negligible**. Since the potential impacts are considered negligible **no further analysis has been undertaken**.
Reduction in groundwater baseflow to the Grytaelva due to mine infrastructure, especially the WRD and sedimentation pond.	Reduction in baseflow to the Grytaelva due to: interception of shallow groundwater flow in the Engebø valley by the sedimentation pond; and reduction in shallow aquifer recharge due to covering of moraine and peatland areas with the WRD.	√		The WRD will cover 16% (0.16km^2) of the total peatland area in the Grytaelva catchment. It will also cover 15% (0.25km^2) of the glacial moraine. The WRD will be constructed on compacted moraine to limit seepage into the underlying superficial deposits (to minimise the risk of groundwater contamination) and therefore the WRD will reduce recharge to underlying deposits. However, WRD seepage will be collected in the sedimentation pond meaning that the water is retained within the Grytaelva catchment. The impact of reduction in shallow aquifer recharge and interception of groundwater baseflow to the Grytaelva is considered **negligible**. As the potential impacts are considered negligible **no further groundwater impact analysis has been undertaken**. However, the potential impact of the WRD on flows in the Grytaelva, including during low-flow periods where baseflow contribution could be material, is assessed quantitively in Section 7.2.

Aspect	Potential impact	Potential for effect on key hydrological parameter		Summary of proposed approach
		Groundwater level/ availability	Groundwater quality	
Reduction in flow in the Grytaelva leading to reduced groundwater availability.	Reduction in flow in the Grytaelva leading to a reduction in groundwater recharge and availability in water wells associated with the groundwater near the lower reaches of the Grytaelva.	√		The potential impact of the Project on flows in the Grytaelva, including during low-flow periods, is assessed quantitively in Section 7. Qualitative assessment of potential impacts on groundwater availability will be made once an assessment of flow impacts has been undertaken.
Seepage from WRD and other mine infrastructure (intermediate sump, settlement pond) to groundwater.	Potential changes in water quality of the groundwater in the moraine, with the potential for migration to areas of groundwater currently used for water supply.		√	The bedrock aquifer poses **negligible** risk due to the low conductivity and limited interconnectivity of the faults (SRK, 2018). There is no shallow aquifer pathway from the WRD or sedimentation pond to groundwater abstraction wells in the villages of Engjabøen or Indre Vevring and therefore the risk to groundwater quality is **negligible**. The only potential risk is contamination of the shallow aquifer along the Grytaelva which extends beneath the WRD and sedimentation pond. The WRD will be constructed on compacted moraine to limit seepage and any residual seepage will be collected via underdrainage and directed to the sedimentation pond. The sedimentation pond will be excavated into bedrock and any fissures grouted to render the pond base impermeable to all effect and minimise seepage to any underlying groundwater. Therefore, the potential for changes in the quality of the groundwater is considered **low** to **negligible**. Since the potential impacts are considered low to negligible **no further analysis has been undertaken**.

6 QUANTITATIVE IMPACT ANALYSIS METHODOLOGY

6.1 Overview

This section describes the methodology for quantifying potential impacts of the Project development on the Grytaelva catchment. An initial scoping assessment outlined in Section 5 identified the following key impacts that require quantitative assessment:

- Reduced surface runoff to the Grytaelva due to changes to the natural drainage patterns as a result of the mine footprint i.e. catchment diverted and runoff captured by the sedimentation pond. With runoff from disturbed areas directed to the sedimentation pond there will be decreased flows to the Grytaelva during critical flow periods. This has the potential to impact aquatic life in the Grytaelva.
- Potential for generation of poor-quality water from site reporting to the sedimentation pond and discharged to the Førde Fjord, with potential impacts on fjord water quality.

This quantitative assessment was undertaken using the following general modelling approach:

- Geochemical source term characterisation and modelling to define the source term for WRD seepage and runoff, as well as nitrogen release from blasting in the open-pit, used in subsequent water quality assessment.
- Development of a water and load balance in the dynamic simulation software GoldSim to simulate movement and storage of water across the Project footprint, as well as mass movement (flux) of potential contaminants within these flows, the latter through a simple mixing approach. The water balance component of the model simulates the climate of the region through use of stochastic precipitation based on historical precipitation observed at the nearby Gryta meteorological station. A rainfall-runoff and snowmelt model calibrated to donor catchment data and available site spot flow data is applied in GoldSim, to investigate the impact of mine infrastructure on the surface water runoff to the local river system. The load balance calculations use the GoldSim ContaminantTransport Module (GCTM) to perform chemical mass calculations and predict sedimentation pond water quality during the operational period.
- Geochemical mixing models are then used to predict the equilibrated state of predicted water quality in the sedimentation pond, taking into account geochemical processes such as equilibration (precipitation and dissolution) of mineral phases as well as some sorption processes.

6.2 Geochemical Source-term Characterization

6.2.1 Leaching from Waste Rock

Introduction

Interaction of exposed waste rock materials with rainfall and other contact waters may release solutes that will influence the runoff contact water chemistry. Release of those contact waters with elevated solute concentrations into the environment has the potential to impact on local water quality.

Numerical assessments have been undertaken to evaluate the potential contact water quality for the WRD and to identify where interactions with mine materials may lead to potential risks of deterioration in the sedimentation pond quality, which in turn will be diverted to the Førde Fjord.

The prediction of water quality at mine sites is challenging due to the complex interaction of multiple variable processes giving rise to inherent uncertainties in the predictions. The quantities of mine waste and contact rocks are large, the facilities cover large areas and the scale of materials (from fine grained clays to large boulders) and seasonal changes in rainfall all combine to result in large scale heterogeneity.

Waste Rock Characterization

ERG has prepared a Waste Management Plan for the Engebø Project which presents the waste types to be generated by the mine together with an initial characterisation of these materials. Waste rock test work undertaken includes acid base accounting (ABA), multi-element analysis as well as static and kinetic leach testing. The assessment indicates that the waste is classified as non-hazardous with leaching characteristics as for inert material.

Samples selected for kinetic leach testing (humidity cell test (HCT)) included one leuco-eclogite and one amphibolite sample. These samples were selected and sampled by the Client as representative of the waste rock materials generated by the mine.

ABA tests indicated a low acid potential (AP) due to the low sulphide content. The neutralization potential (NP) is relatively high due to the presence of various carbonates in the rock. This causes the neutralization potential ratio (NPR) to be higher than the established thresholds for materials classified as non- acid generating (NPR > 3). This holds for both the rock types tested.

Static leaching tests (percolation) was undertaken on the two samples according to the Swedish Institute for Standards SIS-CEN/TS 14405 technical specification[19] over a period of 30 days at various liquid/solid (L/S) ratios. The solutes are assayed, and results can be compared to European Standard EN 12457-3:2002[20]. Results from the two samples show metal content in the solute typically 10 to 50 times below the inert thresholds.

Solute release from the Engebø waste rock will occur as water interacts with the waste rock and percolates through the waste rock mass. Kinetic leach testing using HCTs was undertaken according to EN 12457-3 to assess solute release rates from the waste rock materials. The methodology and results of the waste rock kinetic test work are presented in SRK (2023).

The HCTs were run for a period of 20 weeks and the leachate collected each week was analysed for a range of parameters including pH, EC, major ions and trace solutes. Based on the HCT results, both rock types indicate limited solute release rates. The HCT testing therefore supports the results from the ABA and percolation tests in demonstrating there is no evidence for potential long-term release of potentially polluting elements, or generation of acidic drainage.

[19] SIS-CEN/TS 14405:2004. Characterization of waste - Leaching behaviour tests - Up-flow percolation test (under specified conditions)
[20] BS EN 12457. Characterisation of waste. Leaching. Compliance test for leaching of granular waste materials and sludges

The geochemical characterisation programme indicates that the majority of the waste is non-potentially acid generating (PAG) and so issues of acid-release or high metal or sulfate concentrations are not anticipated. Segregation of waste rock is not anticipated to be required.

Scaling

Numerical calculations have been conducted using an up-scaling modelling approach that aims to extrapolate from the laboratory HCT measurements of solute leaching to facility-scale behaviour – this is termed ‘scaling’. Assumptions are required in order to scale (i.e. extrapolate) the numerical predictions of water quality from laboratory scale data (on the available samples) to the large, field-scale facilities that will be present and generating contact waters.

The numerical calculations to estimate potential contact water quality are therefore an approximation to provide an indication of potential water quality from the different facilities. These calculations aim to be conservative to be protective of the receiving environment in order to identify potential risks and inform on potential mitigation options that may be required.

The scaling process applies several factors to estimate solute release rates from the laboratory data as follows:

- **Geochemical weathering behaviour and solute release rates** of the rock materials based on the HCT data, as described in the previous section. Solute species that were not detected in the leachates in any of the weekly samples include bromide, beryllium, bismuth, boron, cadmium, mercury, phosphorus, tin, and zinc. As these species were not detected during the HCT tests they are unlikely to be released at significant concentrations in the contact waters. Furthermore, scaled calculations of these species when they have not been detected would lead to considerable over-estimation of their potential concentrations in the mine waters. Therefore, these solutes have not been included in the water quality predictions. For those species where there were results below the analytical detection limits, but one or more results reported a positive measurement, the scaling calculations have applied a concentration of half the detection limit when calculating the arithmetic mean of the leachate. Predicted results have been reported for these species, but where elevated concentrations have been identified, the number of results below the relevant detection limit was considered when assessing the risk of high concentrations in the contact waters and receiving waters.
- **Temperature** influences reaction rates, as lower temperatures under field conditions relative to lab conditions will reduce the solute release rates. Temperature influences the rate of weathering process, with weathering typically occurring more slowly at low temperatures and faster at higher temperatures. For the purpose of this assessment, an estimate of the temperature scaling factor has been derived using the Arrhenius equation to relate the difference in temperature between the laboratory and field conditions. Using this approach, and assuming that the HCTs were run at an average temperature of 20 °C and a typical mean field temperature within the waste rock mass is 10 °C, this provides a scaling factor of 0.3.

- **Particle size distribution** of the rock material will influence the exposed reactive surface area of the materials, as the waste rock will be coarser than the HCTs (which are conducted on sub-6 mm material). MEND Report 1.20.1 (MEND, 2009) indicates that the proportion of fines can typically vary between 5 and 40% of the rock mass, although for some hard rock settings this can be as low as 3% (of fines less than 2mm), and higher proportions may be encountered in weaker rocks or those that weather rapidly, such as shales. Kempton (2012) discusses scaling factors and the particle size distributions of waste rock, indicating that between 8 and 40% of the waste rock occurs as sub-6 mm material depending on the site, geology, blasting methods etc. Overall, for the scaling factors in the numerical modelling a value of 20% has been applied as the proportion of fine materials equivalent to the solute release rates for the HCTs (sub 6 mm material). This value has been chosen as a reasonable estimate of the potential quantity of fine-grained materials, but the actual value could be lower due to the hard rock nature of the mined material.
- **Oxygen;** for WRDs where sulfide oxidation will give rise to release of acidity and solutes, oxygen can be an important factor. As the Engebø waste rock is expected to contain low quantities of sulfide, the presence of oxygen is not considered limiting and a factor of 1 is applied.
- **Rainfall and hydrology** that will dictate the water flow and the degree of contact/flushing of the weathering products form zones within the waste rock, with some zones being regularly flushed by water and some zones being effectively isolated form mobile water. This aspect was applied in the GoldSim model, based on the hydrological modelling of the mine site water balance.

Geochemical modelling

The scaling calculations are based on solute release rates and mass balance calculations. However, these do not take account of solubility controls and interactions with atmospheric gases (such as de-gassing of carbon dioxide or interaction of solute species with oxygen). The mass balance compositions could therefore be over-saturated with respect to some mineral phases and may not be reflective of likely water compositions in contact with the atmosphere.

To address this, solution compositions derived from the mass balance calculations in GoldSim were entered into the PHREEQC geochemical modelling software. The PHREEQC models applied a modified version of the Minteq.v4 thermodynamic database supplied with the v3.4.0-12927 version of PHREEQC (Parkhurst and Appelo, 1999 and 2013). The Minteq database was selected for this study because it includes a comprehensive range of elements and solid phases for consideration in ARDML water quality predictions as well as key sorption reactions for iron oxyhydroxides.

The PHREEQC model applies the specification of gas phases (oxygen and carbon dioxide) and a number of equilibrium phases that are allowed to precipitate if they become oversaturated. The suite of minerals chosen is based on the geology and mineralization at Engebø, and an understanding of the types of parameters commonly observed in mining-impacted leachates.

The models assume that trace solute species may be removed from solution via sorption onto freshly generated mineral precipitates such as iron oxides, with arsenic being particularly susceptible to sorption to iron oxyhydroxide phases. Ferrihydrite ($5Fe_2O_3 \cdot 9H_2O$) represents the primary sorption surface. The mass of ferrihydrite used in the models is assumed to be identical to the mass of the precipitated ferrihydrite in the model reaction step and is controlled by the chemistry of the solution. As with mineral phase precipitation, the mass of trace elements removed through adsorption is assumed to be permanently removed from the system following incorporation and co-precipitation with the ferrihydrite phase.

6.2.2 Nitrogen Release from Explosives

The quantity of nitrogen compounds that could enter open pit sump water and/or be leached from the WRD has been estimated based on explosives usage, assumed missed or un-detonated rounds, and/or, leached nitrogen, together with estimated seepage flow rates. The potential release of nitrogen compounds into the environment is summarised as follows:

- Blasting will be required for competent rock materials.
- Blast holes will be drilled and then charged with emulsion explosives. There is a risk of spillage and losses from the blast hole during this process.
- During wet periods a proportion of the explosives may be leached into the sump water. This will be limited by the use of emulsion explosives and can be further limited by minimising the time between charging and detonation.
- The detonation will fragment the rock. However, a small proportion of the explosives may not fully detonate and will be retained on the mineral surface. During the period that the ore and/or waste rock remains within the pit, the nitrogen residues may be leached away by rainwater and pumped from the pit sump to the sedimentation pond.
- Waste rock hauled to the WRD may include residual levels of explosives, which may be leached from the WRD by water infiltrating through the waste rock.

The potential concentrations of nitrogen compounds have been calculated as follows:

- The powder factor (PF) is the quantity of explosives to be used for a given rock type. ERG specified a PF of 0.28 kg/t for ore and 0.26 kg/t for waste rock.
- The proportion of N compounds (as N) in emulsion is 0.24, assuming the emulsion comprises 80% ammonium nitrate by weight (VTT, 2015).
- The proportion of N compounds lost by spillage, leaching or remaining un-detonated is assumed to be 5% - based on case studies in VTT (2015) for open pit operations. Underground operations tend to have higher N losses. The 5% example was for an operation using ANFO (ammonium nitrate fuel oil) not an emulsion. Losses using emulsion may be lower due to emulsion's water-resistant properties.

In combination with the annual tonnage of competent waste rock and the factors above, the mass of residual N was estimated. The following assumptions have been adopted to estimate the leaching of residual N for the WRD:

- It has been assumed that due to the leachable nature of the nitrogen compounds (post-blasting) and the wet climate, that 50% of the residual nitrogen is leached before the waste rock is hauled to the WRD; thus only 50% of the residual nitrogen reports to the WRD.

- Once within the WRD it is assumed that only 20% of the waste rock will be routinely flushed by water, as per the scaling factors applied for the AMD calculations (based on preferential pathways through the coarse, competent rock materials). This factor could potentially be lower as the competent materials will be coarser grained than most of the waste rock.
- It is assumed that 70% of the N residue occurs as nitrate and 30% as ammonium. This is based on the case studies in VTT (2015) and provides a worst-case condition for ammonium concentrations.

6.3 GoldSim Model

6.3.1 Overview

A catchment-wide water balance and solute mass balance model has been developed in the GoldSim software platform to predict surface water flows and water quality for the sedimentation pond and receiving environment during the operational period of the Project.

The existing GoldSim water balance (SRK, 2022) has been updated and coupled with a non-reactive solute mass balance (mixing) model using the GoldSim Contaminant Transport Module (GCTM). Source terms described in Section 6.2 are combined with flow rates from the water balance to predict contaminant concentrations. An overview of the GoldSim modelling is provided in the following sections.

6.3.2 Water Balance Set-up

This study represents an update of the previous site-wide water balance GoldSim model (SRK, 2022). Flow components of the water balance set-up are described in detail in SRK, 2024a. Updates to the existing GoldSim water balance for the purposes of this study include:

- Reduction of the model timestep from monthly to daily to give improved resolution and better confidence in the predictions.
- Implementation of stochastic rainfall using the WGEN[21] model within GoldSim which generates stochastic daily precipitation based on monthly statistics from the local Gryta meteorological station historic precipitation timeseries.
- Incorporation of updated hydrology inputs; daily runoff, snowpack accumulation and snowmelt are combined into a single lumped parameter model integrated within GoldSim using the CemaNeige[22] model for snowpack and snowmelt, and the GR4J[23] rainfall-runoff model. The rainfall-runoff model replaces the simple runoff coefficient approach previously used for the catchment.
- Validation of runoff to baseline spot flow monitoring which commenced in May 2023 on a monthly basis.

[21] Stochastic weather generator: originally developed in the 1980s at the US Department of Agriculture Agricultural Research Service (Richardson and Wright, 1984)
[22] Snow accumulation and ablation model
[23] Rural Engineering Model with 4 parameters daily (Perrin et al, 2003)

- Upgrade to the WRD model. Runoff from the WRD is estimated based on the SCS Curve Number (CN) Method[24]. A delay element is used to estimate the amount of time it takes for surface infiltration to percolate through the WRD and report as toe seepage.
- The water balance is determined probabilistically (Monte Carlo) to accommodate the potential uncertainty and variability in model input parameters related to surface water.
- The natural catchment with runoff reporting to the sedimentation pond has been subject to minor revisions as defined by Asplan Viak, 2023.
- The latest sedimentation pond water storage facility design has been incorporated, as defined in Asplan Viak, 2023. The sedimentation pond design allows for approximately 18,600 m³ of total storage volume. However, the top 9,300 m³ is a dynamic storage volume used to contain storm events and to provide flow to the gravity fed outlet pipe. Furthermore, the bottom 25% of the pond i.e. 4,650 m³, has been set aside to allow accumulation of sediment which will be cleaned out periodically. Therefore, on a conservative basis, the GoldSim model has assumed that only the portion of the sedimentation pond between the 25% and 50% stage level i.e. 4,650 m³ will be available at all times for mixing. Furthermore, only this portion of the pond is deemed available for decanting to the Grytaelva for flow compensation purposes. An output of predicted sedimentation pond volumes under flow compensation conditions is considered in the results to ensure that sufficient water is available from the sedimentation pond to undertake flow compensation throughout the period as required.

6.3.3 WGEN Stochastic Precipitation

The Gryta precipitation timeseries (adjusted for undercatch; refer to Section 4.2.4) was used to develop monthly statistics for use in the WGEN weather generator (Richardson and Wright, 1984) which in turn was used to generate stochastic precipitation daily sequences in GoldSim. WGEN is a stochastic weather generation method which produces a synthetic precipitation data set for the required duration, the output being a statistical fit to the analogue record. The generated stochastic precipitation record over the project lifetime (to 2040) for the 100 realisations used in the Engebo model are presented in Figure 6-1, showing the mean, 10th percentile (“10%”) and 90th percentile (“90%”).

The stochastic precipitation generation module allows day to day precipitation patterns to vary, while maintaining consistent seasonal patterns. Occasionally, this module will generate daily precipitation totals that are much higher than observed due to the incorporation of statistical data which allows for potential extreme events not recorded in the period of historical data.

[24] The CN Method was originally developed by the SCS for conditions prevailing in the United States i.e. empirical analysis of runoff from small catchments monitored by the USDS. The National Resources Conservation Service (NCRS), formerly referred to as SCS, CN method is described in detail in NEH-4 (SCS 1985).

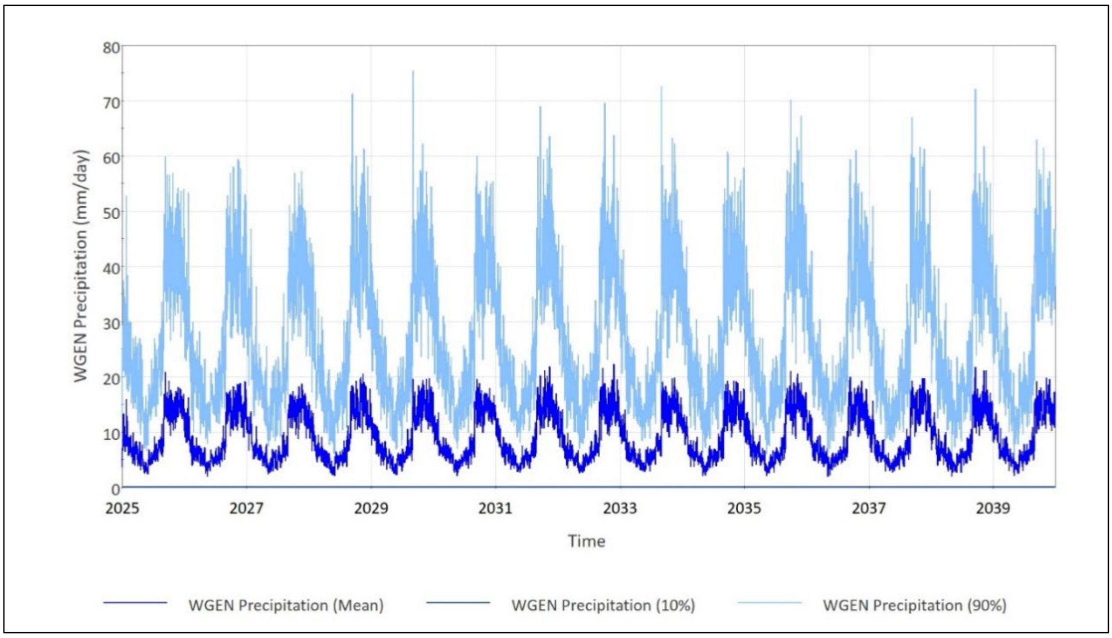


Figure 6-1: Stochastic precipitation

6.3.4 Snowmelt and Runoff Estimation

Snowpack accumulation, snowmelt and runoff are obtained using the CemaNeige model for snowpack and snowmelt, and the GR4J (Génie Rural à 4 paramètres Journalier) Runoff model to simulate discharge at the catchment scale. Both models are implemented in GoldSim and described in detail in SRK, 2024a.

The CemaNeige model is a snow accumulation and snowmelt model which uses only temperature and precipitation as inputs and two parameters to determine snowmelt; a melt factor based on temperature and a second parameter to model the temperature inertia in the snowpack. The CemaNeige model accumulates solid precipitation which is released in the form of melt calculated using the degree-day method (X mm of melt per degree above freezing per day), adjusted by a snowpack temperature inertia term. Rainfall and snow melt is passed to the GR4J rainfall-runoff model.

The GR4J model uses 4 parameters to model interception and evaporation, runoff from a "production store", routing and attenuation through a "routing store" (Perrin, C., et al., 2003). This model was selected to represent site conditions based on the model input requirements and the model's ability to generate specific components of storage and runoff.

This daily precipitation-runoff model requires daily potential evaporation and precipitation to provide a runoff output. The transformation of inputs to runoff as an output is based on calibration of four parameters (X1, X2, X3 and X4).

6.3.5 Flow Calibration and Validation

A snowpack and runoff (hydrological) model was setup within the GoldSim water balance and used to assess potential impact of mine infrastructure on surface water runoff to the Engjabødalbekken and Grytaelva, and consequently potential impact on downstream flow.

No continuous flow monitoring data is available for the catchment of the Gryta or within the immediate proximity of the watercourse. Suitable donor catchments with established hydrological time series were used to generate an analogue for the Gryta catchment, as described in Section 4.5.4. The daily data for Ullebøelv was found to have a reliable rating curve and was therefore selected as the donor for use in model calibration. The CemaNeige and GR4J model precipitation-runoff described in the previous section was therefore calibrated and validated using the local runoff records from Ullebøelv catchment for 2008 to 2017. Precipitation and temperature at this location were obtained from NVE data and precipitation was corrected for undercatch. This resulted in a calibration NSE[25] of 0.56 for daily timestep.

The model was then validated using flow records from 2018 to 2021, which produced satisfactory daily runoff results for the Ullebøelv. The six model parameters used to simulate catchment runoff and streamflow for the Ullebøelv were then implemented in GoldSim for the Project catchments and validated against spot flow measurements at ST11. This validation is qualitative only as it is not possible to directly compare the flow time series produced by GR4J with spot measurements. Results indicate that the model flows from GR4J exhibits a similar pattern and magnitude to the spot measurements.

6.3.6 Solute Load Balance Model

Prediction of selected water quality parameter concentrations was undertaken using a conservative mass balance approach using the GoldSim GCTM.

In the software, volumetric loadings are mixed from each of the potential contaminant sources in relative proportions with non-contact water (in the sedimentation pond and Grytaelva). This approach is conservative in that it is non-reactive such that solutes are not reduced by any other mechanism other than dilution. It does not consider geochemical processes such as mineral saturation, pH equilibrium, atmospheric gas equilibrium or attenuation through adsorption. However, for this reason the chemistry outputs from GoldSim were then equilibrated using PHREEQC as a final step to account for mineral saturation, pH equilibrium, and atmospheric gas equilibrium.

An overview of the GoldSim balance model setup is presented in Figure 6-2. The load calculations utilise the source terms presented in Section 5.2 together with the flow estimates derived as part of the flow components of the water balance described in 6.3.2.

Sedimentation pond water quality was modelled through consideration of:

- Loadings from contact runoff water impacted by the WRD;
- Loadings from pit dewatering (nitrogen species only); and
- Loadings from runoff of natural ground.

[25] NSE stands for Nash-Sutcliffe Efficiency, which is a statistical metric used to assess the predictive accuracy of hydrological models. It is commonly used during model calibration and validation to compare the observed data with the model-simulated data.

A conservative approach is adopted and maximum baseline water quality concentrations for the Engjabødalbekken (ST5) measured to date are applied[26].

A total of 42 water quality parameters (i.e. potential contaminants) were modelled, including EC, major ions and metals, shown in Table 6-1.

Total suspended solids (TSS) is excluded from SRK's qualitative analysis. TSS does not act conservatively due to sedimentation processes and therefore cannot be accurately represented through mass balance approach. However, this study assumes that the design criteria for the sedimentation pond will be met in terms of sediment removal and that these design criteria reflect the water quality requirements in the receiving environment.

pH does not act conservatively but has been estimated through the equilibrium geochemical modelling of the GoldSim output chemistry using PHRREQC geochemical modelling software as a final step.

Further details of the surface water quality assessment modelling are described in Section 6.5.

Table 6-1: List of water quality parameters in the Load Balance

Species ID	Name	Species ID	Name	Species ID	Name
Alkalinity	Alkalinity	As	Arsenic	P	Phosphorus
EC	Conductivity	Ba	Barium	Se	Selenium
Br	Bromide	Be	Beryllium	Si	Silicon
Cl	Chloride	Bi	Bismuth	Ag	Silver
F	Fluoride	B	Boron	Sr	Strontium
NO3	Nitrate	Cd	Cadmium	S	Sulfur
NO2	Nitrite	Cr	Chromium	Tl	Thallium
Total-N	Total Nitrogen (as N)	Co	Cobalt	Sn	Tin
SO4	Sulfate	Cu	Copper	Ti	Titanium
Ca	calcium	Fe	Iron	U	Uranium
Na	sodium	Pb	Lead	V	Vanadium
Mg	magnesium	Li	Lithium	Zn	Zinc
K	potassium	Mn	Manganese	Hg	Mercury
Al	Aluminium	Mo	Molybdenum	Zn	Zinc
Sb	Antimony	Ni	Nickel	Hg	Mercury

[26] with the exception of Total Nitrogen (as N) concentrations for March 2024 and dissolved arsenic concentration for April 2024 at ST5, as these concentrations were not
considered representative of ongoing baseline conditions (see Section 4.7.1).

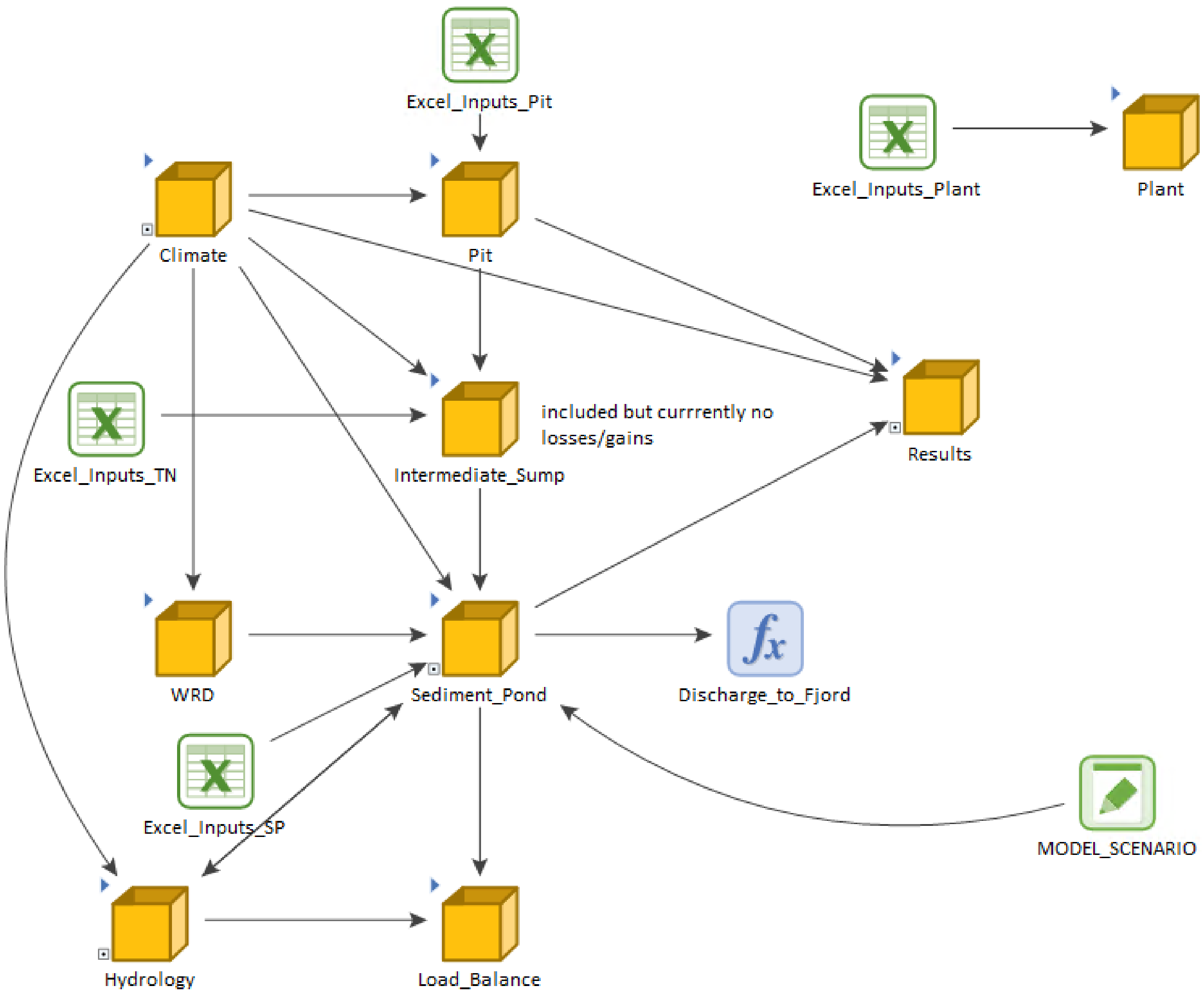


Figure 6-2: Setup of the Engebo WIA GoldSim model

6.4 Approach to Surface Water Flow Impact Assessment

The water balance predicts daily flows within the Grytaelva catchment at key monitoring points for baseline and operational scenarios. Baseline flow estimates at each monitoring point are calculated using the product of daily runoff totals (mm) generated by the snowpack and runoff model (Section 6.3.2) and delineated catchment areas (Table 4-7). For the purpose of the impact assessment, it is assumed that lost runoff volumes (due to diverting a portion of the mine site catchment to the sedimentation pond) is proportional to the lost catchment area.

Impacts on the Grytaelva are assessed by comparing the baseline (pre-scheme, no mining present) scenario and operational (with scheme, future conditions with the full mine Project description in place) scenario. The operational phase is divided into two phases based on two main phases of WRD development, as described in Section 2.3:

- Phase 1: up to year 6 of mine development.
- Phase 2: from years 7 to 14 of mine development.

Changes in flow are reported in terms of percentile flows and % changes from baseline with the scheme in place for:

- Annual and summer only low-flow conditions, Q95 i.e. flows expected to exceed this value 95% of the time;
- Annual median flows, Q50; and
- Annual high flows, Q10 i.e. flows expected to exceed this value only 10% of the time.

Potential flow impacts are assessed at the following monitoring locations:

- ST4, on the Grytaelva, upstream of the Engjabødalbekken confluence (control point);
- ST11, immediately downstream of the confluence with the Engjabødalbekken; and
- ST12, on the Grytaelva, a short distance upstream of the river mouth.

6.5 Approach to Surface Water Quality Assessment

SRK ran the water balance and solute load balance GoldSim model for two scenarios:

1. No mine in place.
2. The current proposed mine development split into Phases 1 and 2, as outlined in Section 2.3. This scenario sees the WRD footprint growing over the life of the mine. All contact water from the site reports to the sedimentation pond which decants to the fjord. No discharge from the site to the Grytaelva is allowed.

For each scenario, the GoldSim model was run on a daily time-step, using a Monte Carlo probabilistic simulation with 100 realisations, to capture the sensitivity of various water balance fluxes to the stochastically-generated rainfall and evaporation sequences. The results for each scenario are presented for the median, 10th percentile (P10) and 90th percentile (P90) monthly values based on 100 simulated sequences, unless stated otherwise.

The maximum P90 result across the full model timeseries in GoldSim was then inputted into PHREEQC where key geochemical processes (dissolution/precipitation and sorption) in the pond water and river water were modelled using the same methodology as outlined in Section 6.2.1.

Both the GoldSim maximum P90 chemistry (representing mixing processes only) and the PHREEQC equilibrated chemistry (representing other geochemical processes such as equilibration with mineral phases and sorption) are presented in the final results.

The potential water quality impacts to the Førde Fjord were assessed by directly comparing the modelled sedimentation pond water chemistry against water quality screening criteria for coastal waters, as described in Section 3.6.

6.6 Summary of Key Assumptions and Limitations

Some of the key assumptions and limitations of each aspect of the modelling approach taken to quantify potential flow and water quality impacts are summarised below.

- Scaling factors are a large source of uncertainty in the geochemical modelling of source term concentrations. Although SRK has followed industry standard practice in definition of scaling factors, based on publicly available literature, the site-specific conditions are likely to be extremely variable and difficult to predict. Moreover, the predicted source term concentrations are highly sensitive to the scaling factors applied. SRK has taken a precautionary approach in applying scaling factors which produce results on the higher end of the range of concentrations that might be expected. However, ongoing monitoring of WRD seepage during operations will be critical to allow some degree of calibration of the current predictions of source term chemistry, including the scaling factors applied (see monitoring recommendations in Section 8).
- The average results from HCT testing across the duration of the tests have been used as the basis for prediction of source term chemistry, rather than using the water chemistry derived towards the end of the tests. This approach assumes that there will be little depletion of the source term i.e. it does not account for the fact that contaminant release will likely tail off over time. This precautionary approach has been applied given the fact that new material will be added to the dump on a relatively regular basis. However, as with the scaling factors, this is an area of uncertainty in the source term chemistry prediction and will require further calibration once an initial actual WRD seepage chemistry can be measured (see monitoring recommendations in Section 8).
- The geochemical models are limited to inorganic reactions and do not take into account the complexities associated with biologically-mediated reactions. They are limited to mass balance and thermodynamic equilibrium reactions and reaction rates are based on the solute release data and the calculations do not include specific reaction kinetics and rates. The models do not consider the effects associated with the formation and precipitation of mineral species other than those specified. Due to kinetic constraints, a portion of the potentially oversaturated mineral phases may not actually precipitate (e.g. silicate minerals). A select suite of minerals is therefore specified that are allowed to precipitate, based on relevance for the environment in question, site-specific knowledge, experience in evaluating kinetic constraints and relevance of key phases for given styles of mineralisation (Eary, 1999).

- Nitrogen release calculations assume that all N reporting to the WRD is leached in the same year that the waste rock is placed and assumes no lag in the migration of seepage to the base of the WRD.
- The water and load balance, by necessity, include the simplification of a number of complex natural phenomena, including but not limited to climate, runoff, snow melt, snowpack formation, infiltration and seepage attenuation. The model uses physical models that are only representative of the processes, calibrated to available baseline data where possible, but many of these processes do not exist in the current undeveloped conditions and future behaviours cannot be predicted with precision. For climatic inputs, the model addresses uncertainty through inclusion of stochastic inputs for precipitation and multiple realisations using the Monte-Carlo approach.
- Due to the lack of robust flow and meteorological data at the project site, the snowmelt and runoff model was calibrated using data from a donor catchment. This donor catchment was selected for its similar characteristics to the project catchment, although differences in hydrological response are possible. Additionally, meteorological data from various sources, considered representative, were utilized and corrected, particularly for precipitation, to enhance the calibration process. These assumptions may lead to calibration results that require adjustment or improvement once site-specific data become available, ensuring reliable results based on actual conditions. Despite these limitations, for this analysis and given that the model is designed for a relative impact evaluation - i.e. comparing conditions with and without the mine (rather than for designing or sizing infrastructure such sedimentation ponds and other surface water systems) - the model is considered sufficiently representative. Therefore, the focus is on accurately determining the differences between current and proposed conditions, rather than on providing absolute flow values.
- The GoldSim model assumes a conservative mass balance approach (i.e. mixing only) to predict water chemistry in the sedimentation pond and in the Grytaelva. No other geochemical reactions or any other processes that could provide attenuation of contaminants are considered in the GoldSim modelling. For this reason, the maximum P90 result across the full model timeseries in GoldSim was then inputted into PHREEQC where key geochemical processes (dissolution/precipitation of key mineral phases and sorption) in the pond water and river water were modelled.
- Site-specific flow monitoring for the Grytaelva catchment is limited to monthly spot flow measurements since May 2023, with no continuous flow monitoring and no ratings curve developed for the monitoring site, which is insufficient data to calibrate a reliable hydrological model. This study therefore uses a “donor catchment” approach to the calibrating the SWWB which is then used to model runoff from the Project catchment. However, the calibration of the runoff model in GoldSim will not be able to be validated until long-term continuous flow data is available from the Grytaelva catchment itself. Therefore, this study should be re-evaluated after continuous flow monitoring data has been acquired over a period of a full hydrological year at consistent locations where rating curves have also been developed (see Section 8).

7 QUANTITATIVE IMPACT ANALYSIS RESULTS

7.1 Assessment of Potential Flow Impacts in the Grytaelva

This section evaluates the potential impacts of the Project on downstream flow at locations on the Grytaelva (as described in Section 6.4).

The water balance predicts daily baseline and operational stream flows for the 15-year simulation period of the mine at each of the flow monitoring locations within the Grytaelva catchment. Simulated average monthly flows for baseline and operational scenarios (Phase 1 and Phase 2 respectively) are presented in Appendix B. Figure 7-1 and Figure 7-2 present an example of simulated daily flows (at ST11, located on the Grytaelva just downstream of the Engjabødalbekken confluence) for baseline and operational conditions, respectively.

Flow duration curves (FDCs), developed using the simulated daily flows for Phase 1 and Phase 2 for 100 Monte Carlo realisations are presented in Appendix C. Flow duration curves for these scenarios have also been generated for summer (June, July and August) low flows only (Appendix C). The summer low-flow period is given particular consideration as this is the period when flow impacts are considered most likely to have the potential to impact eel populations. Figure 7-3 presents an example FDC summer low flow plot at ST11.

Modelled flows for various return periods for the baseline scenario are summarised in Table 7-1. Modelled flows for various return periods for operational conditions for Phases 1 and 2 (see Section 2.3) of WRD development are presented in Table 7-2 and Table 7-3, respectively.

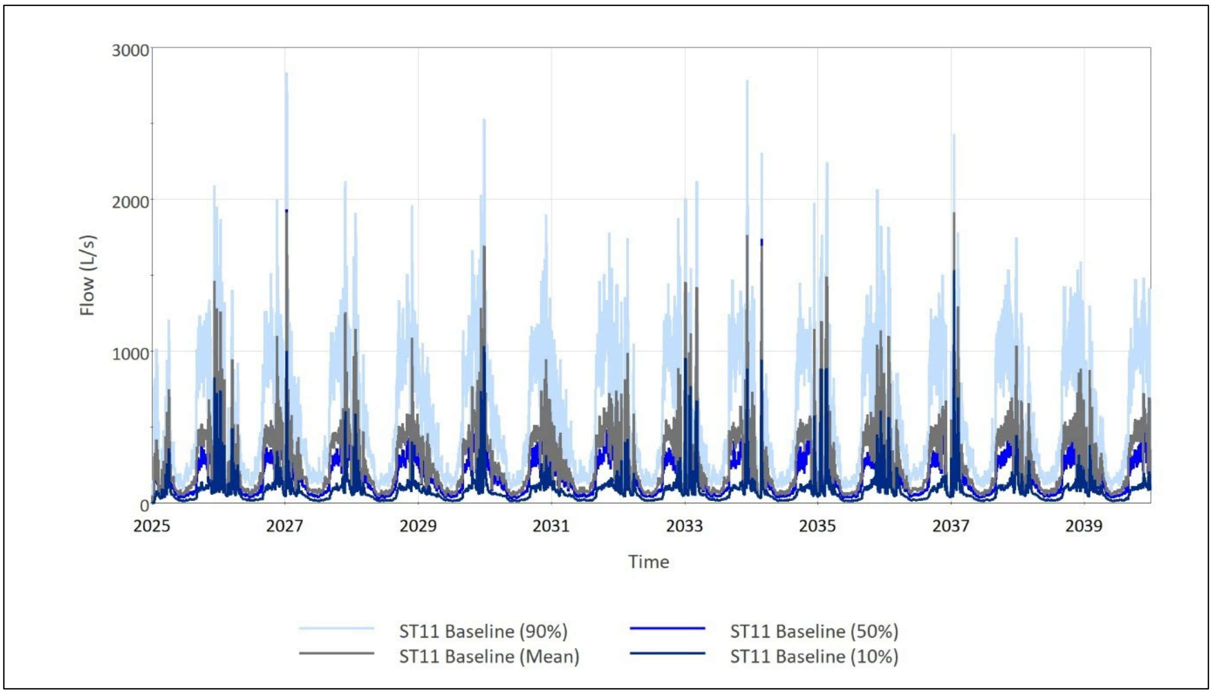


Figure 7-1: Simulated daily flow timeseries at ST11 for Phase 1 (baseline) scenario

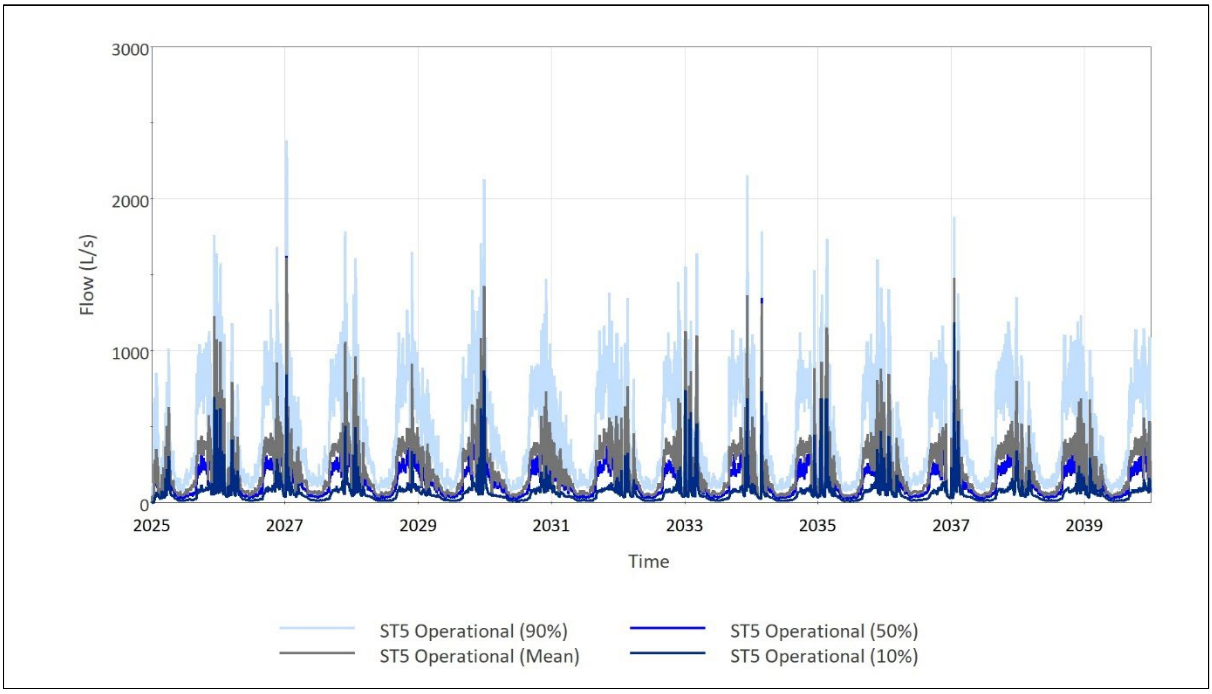


Figure 7-2: Simulated daily flow timeseries at ST11 for Phase 2 (operational) scenario

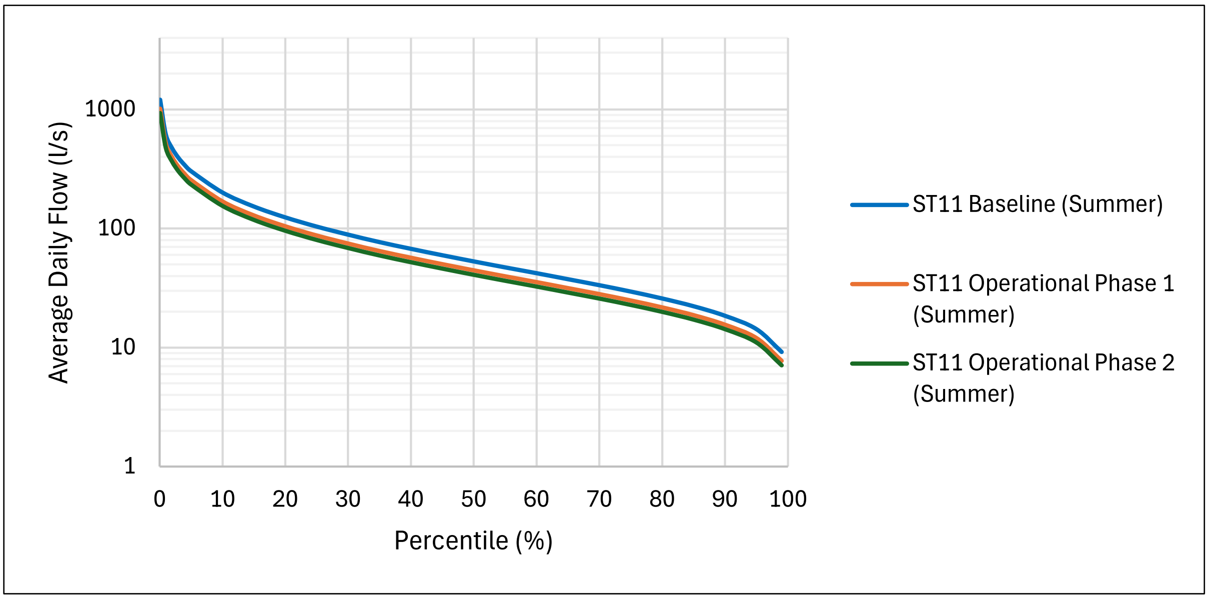


Figure 7-3: Summer flow duration curve for baseline and operational scenarios at ST11

Table 7-1: Modelled flows for various percentiles for baseline scenario (no mine in place)

Station ID	Q95	Q50	Q10	Q95 summer
ST4	22.2	124.4	631.4	13.8
ST5	5.6	31.9	161.8	3.5
ST11	22.8	129.2	656.5	14.3
ST12	24.1	136.5	694.4	15.1

Table 7-2: Modelled flows for various percentiles for Operational Phase 1 scenario (with the Phase 1 WRD in place)

Station ID	Q95	Q50	Q10	Q95 summer	% change from baseline
ST4	22.2	124.4	631.4	13.8	0%
ST5	2.0	11.4	57.6	1.3	64%
ST11	19.2	108.6	552.2	12.0	16%
ST12	20.5	115.9	589.7	12.8	15%

Table 7-3: Modelled flows for various percentiles for Operational Phase 2 scenario (with the final WRD in place)

Station ID	Q95	Q50	Q10	Q95 summer	% change from baseline
ST4	22.2	124.4	631.4	13.8	0%
ST5	0.5	2.6	13.3	0.3	92%
ST11	17.6	99.9	507.9	11.0	23%
ST12	18.9	107.3	545.4	11.9	21%

No change is predicted at ST4 which is located upstream of the confluence with the Engjabødalbekken and therefore is not impacted by the Project.

ST5 is located on the Engjabødalbekken near the base of the proposed WRD and therefore the majority of flow at this location (92%) will eventually be diverted to the sedimentation pond.

ST11, located on the Grytaelva just downstream of the Engjabødalbekken confluence, is expected to see a reduction in average daily flows of around 23%. Simulated baseline summer Q95 at ST11 is 14.3 L/s which is expected to reduce to 11 L/s with the full mine development in place.

ST12, on the Grytaelva just upstream from the river mouth where it discharges to the fjord, is predicted to experience a reduction in daily flows by around 21%. The simulated baseline summer Q95 for ST12 is 15.1 L/s, which is expected to reduce to 11.9 L/s with the full mine development in place.

The potential implications in terms of aquatic life ecosystems in the Grytaelva (the main identified receptor) of a 21 to 23% reduction in flow are not currently well understood. ERG is planning works to install continuous monitoring and to better refine the rating curve for the lower Gryta where the eel habitats are believed to be located. A reliable rating curve would allow the modelled reduction in flow to be equated to a water level change in the river.

The lower sections of the Grytaelva, where eel populations have been identified, has been significantly modified by human development with road crossings and channel straightening. In the Biodiversity Action Plan for the Project, restoration of pools is suggested in order to create areas of standing water that remain throughout the summer low flow period and which better support eel populations during the active portion of their lifecycle (eels generally hibernate in the riverbed and banks during the winter low flow period). ERG have committed to implementing this after startup and within the first 3 years of operation. This work would also help to buffer potential water level changes from flow reduction.

7.2 Assessment of Potential Quality Impacts to the Fjord

Predicted water quality results for the sedimentation pond are shown against relevant screening criteria (as outlined in Section 3.6.1) in Table 7-4, for three key points within the mine development; after the end of year 3, at the end of Phase 1 (year 6) and at the end of Phase 2 (year 14).

The results are presented for the maximum P90 result across the full model timeseries in GoldSim equilibrated in PHREEQC, which represents key geochemical processes (dissolution/precipitation of key mineral phases and sorption) in the pond. The results from the sedimentation pond chemistry are compared directly to the water quality standards for coastal water as it is assumed that sedimentation pond water will be discharged directly to the Førde Fjord.

Timeseries results for predicted concentrations of selected contaminants of concern in the sedimentation pond are shown in Figure 7-4 to Figure 7-5.

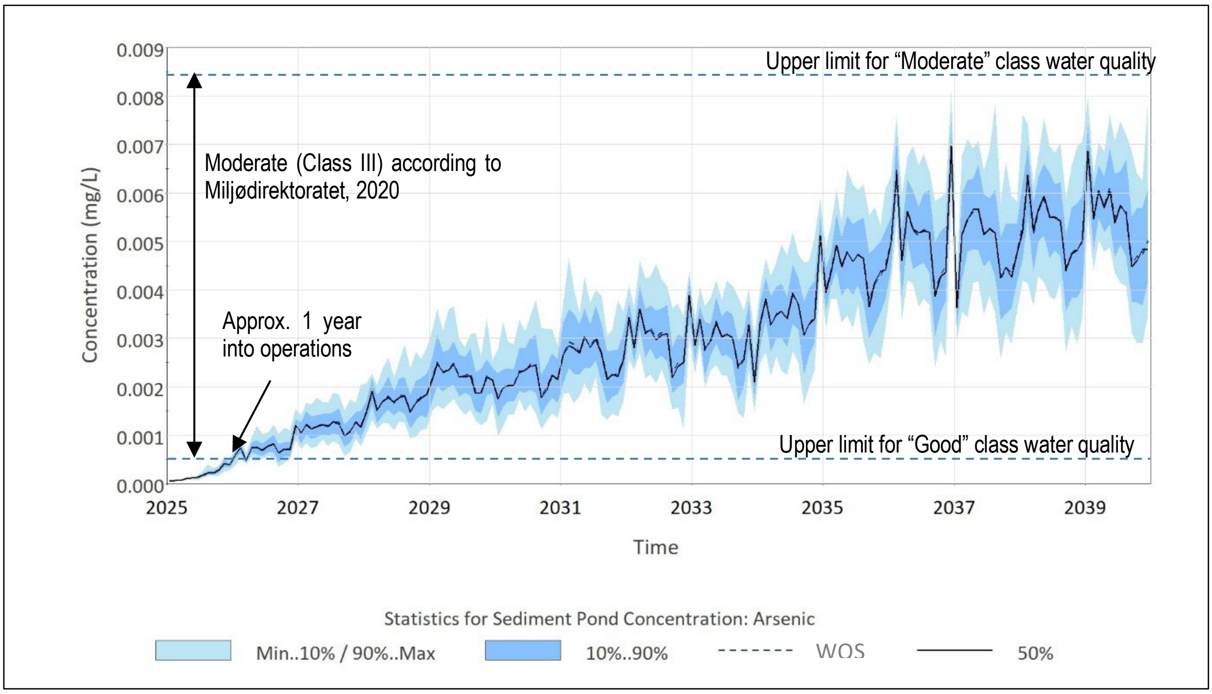


Figure 7-4: Predicted arsenic concentrations (mg/L) in the sedimentation pond

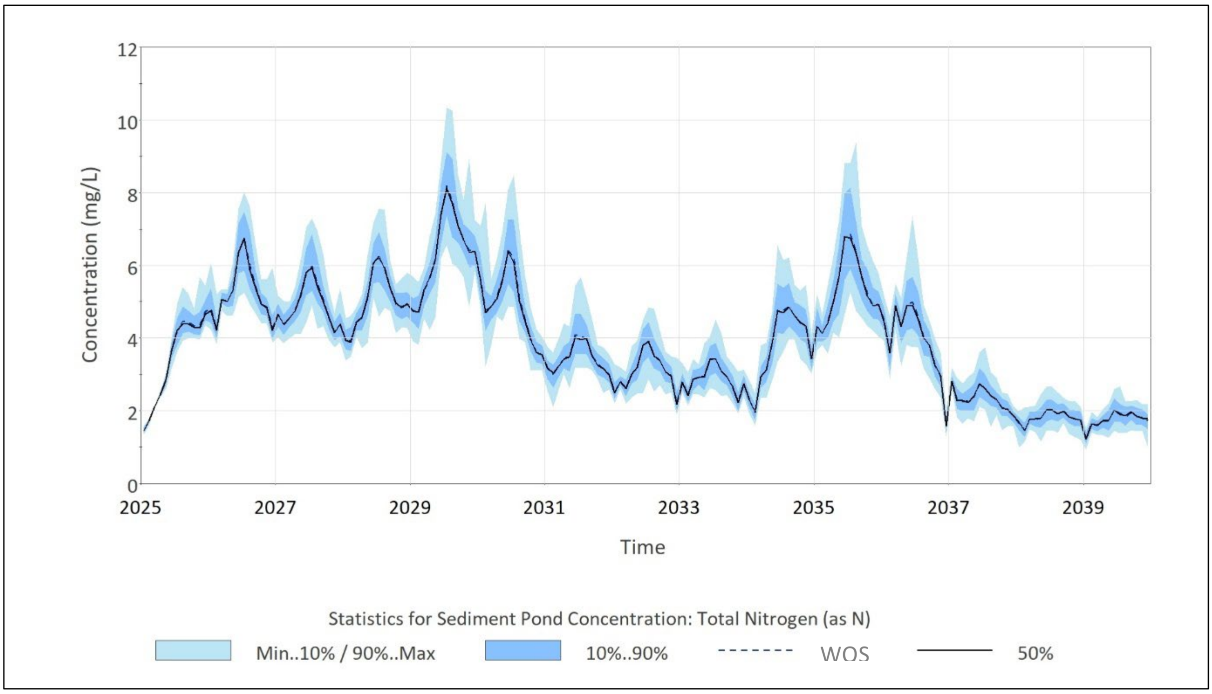


Figure 7-5: Predicted total nitrogen (as N) concentrations (mg/L) in the sedimentation pond [note: no WQS for N for coastal water]

Table 7-4: Summary of surface water quality predictions and relevant screening criteria (all values in ug/L)

Parameter	Unit	Detection limit[2]	Klima- og Miljødepartementet, 2007: Maximum value for		Miljødirektoratet, 2020: Upper bound for		Baseline monitoring			P90 Phase 2 Sedimentation Pond[1]	P90 Phase 1 Sedimentation Pond[1]	P90 Year 3 Sedimentation Pond[1]	P90 ST11[1]
			Coastal water	Freshwater	"Good" Class coastal water	"Good" Class freshwater	Min	Mean	Max				
Aluminium (Al)	µg/L	0.2					72.8	129.6	313.0	0.3	0.2	0.1	0.1
Arsenic (As)	µg/L	0.05 (0.5)			0.6	0.5	<0.05	0.26	1.54	5.3	0.8	0.7	0.7
Barium (Ba)	µg/L	0.01					11.7	18.4	36.7	53.2	33.0	15.5	15.5
Cadmium (Cd)	µg/L	0.002 (0.05)	0.45	0.45	0.2	0.08	<0.05	0.005	0.006	0.0	0.0	0.0	0.0
Cobalt (Co)	µg/L	0.005					0.22	0.38	0.59	0.5	0.4	0.2	0.2
Chromium (Cr)	µg/L	0.01			3.4	3.4	<0.5	0.37	0.67	0.6	0.0	0.3	0.3
Copper (Cu)	µg/L	0.1			2.6	7.8	0.38	1.03	3.68	0.8	0.3	0.1	0.1
Iron (Fe)	µg/L	0.4					62.6	114.2	277.0	0.1	0.2	0.2	0.2
Mercury (Hg)	µg/L	0.002 (0.02)	-	0.07	0.047	0.047	<0.002	<0.002	0.003	0.0	0.0	0.0	0.0
Manganese (Mn)	µg/L	0.03					2.76	12.7	38.9	33.9	27.5	8.8	8.8
Molybdenum (Mo)	µg/L	0.05 (0.5)					<0.5	0.45	0.71	5.0	1.3	0.8	0.8
Nickel (Ni)	µg/L	0.05	4	34	8.6	4	0.38	0.65	1.13	1.6	0.8	1.0	1.0
Phosphorous (P)	µg/L	1				15	2.0	3.9	6.4	nd[5]	nd[5]	nd[5]	nd[5]
Lead (Pb)	µg/L	0.01	1.2	14	1.3	1.2	0.04	0.08	0.15	0.1	0.0	0.0	0.0
Strontium (Sr)	µg/L	2					16.8	33.7	66.9	928.1	213.4	154.3	154.3
Vanadium (V)	µg/L	0.005					0.13	0.20	0.36	12.4	2.6	2.1	2.1
Zinc (Zn)	µg/L	0.2 (2)			3.4	11	<2	1.9	4.7	nd[5]	nd[5]	nd[5]	nd[5]
Total Nitrogen (Tot-N)	µg/L	20				425	120	500	11,000	9124	9124	7477	1663

Notes:

[1] Values in red cells are flagged as WQS and baseline exceedances and values in orange cells are flagged for discussion
[2] Peak Total Nitrogen concentrations recorded for February, March and April 2024 sampling rounds not included
[3] Higher detection limits (bracketed) for dissolved metals applied for the 2024 monitoring rounds
[4] Statistics calculated using half the non-detect concentrations
[5] nd: Parameter not detected in geochemical test work above detection limit so excluded from predictions as not expected to increase current baseline which is above detection limit in many cases

The results for the sedimentation pond show elevated concentrations of aluminium and iron in the mixing only simulation (GoldSim) but a reduction in concentrations once these parameters have been equilibrated in PHREEQC. This represents the precipitation of aluminium and iron mineral phases in the sedimentation pond when exposed to oxidising conditions.

P90 arsenic concentrations are predicted to be elevated above the WQS (Miljødirektoratet, 2020) for "Good" class coastal water of 0.6 µg/L but to stay within the baseline monitoring concentrations until at least the end of Phase 1 (Table 7-4 and Figure 7-4). During Phase 2, arsenic concentrations are predicted to exceed the baseline range as well as the WQS values for "Good" water. As discussed in Section 4.7.2, arsenic concentrations in the fjord from the baseline sampling showed a P90 of 1.6 µg/L, with almost all of the samples classed as 'Moderate' coastal water condition. The source of elevated arsenic in the fjord water is likely to be weathering and dissolution of minerals derived from the local rock strata and it is expected that the fjord water is naturally elevated in arsenic.

The model predicts that precipitation of iron oxyhydroxides in the sedimentation pond allows a portion of arsenic to be removed by sorption which also marginally reduces the dissolved arsenic concentration in the sedimentation pond itself. These iron-arsenic complexes could then potentially be removed during regular removal of sediment accumulation in the base of the pond (desilting) and placed on the WRD, if carefully managed.

Arsenic is predicted to reach a concentration of around 5.3 µg/L by the end of Phase 2, which is higher than the maximum baseline monitoring concentration of 1.54 µg/L but within the current classification category of "Moderate". This concentration is a direct result of the detection of arsenic in the waste rock characterisation testing.

Total nitrogen is predicted to be elevated in the sedimentation pond at concentrations of up to 9 mg/L. However, no limit values are defined for coastal waters in either sets of guideline values used in this study (Klima- og miljødepartementet, 2007; Miljødirektoratet, 2020).

Nitrogen values are often elevated associated with mining projects due to the use of explosives for blasting, and the predicted value is well within the range of total nitrogen concentrations that SRK has typically seen on other mining projects across Scandinavia. The predicted nitrogen concentrations released from mining areas used in the modelling are based on literature values and typical of active operations in other areas of Scandinavia (see Section 6.2).

Other parameters which are predicted to be elevated in the sedimentation pond compared to baseline monitoring are strontium and vanadium, which were both detected in waste rock characterisation testing. Strontium is not typically associated with toxicity effects and SRK is not aware of any water quality standards for strontium. Vanadium has been associated with toxicology effects in freshwater algae and limit values of up to 3 µg/L have been proposed to the EU for freshwater ecosystems (Smit, 2012). However, these limit values have not been adopted into Norwegian legislation and SRK is not aware of any coastal water limit values.

7.3 Mitigation Controls

Good blasting practices and careful management of explosives could help to reduce the nitrogen concentrations reporting to the sedimentation pond. The release of nitrogen has been estimated based on assumed missed or un-detonated rounds, and where these can be minimised or eliminated, the release of nitrogen can be greatly reduced.

Monitoring of site water quality in itself provides an additional control against potential water impacts. For example, monitoring of nitrogen concentrations in the in-pit and ex-pit sumps could identify potential deviations from the assumptions of nitrogen release used in this impact assessment, whereby any such deviations might be addressed by modifying blasting and/or explosives handling procedures.

Also, ongoing regular monitoring of the sedimentation pond will provide an additional control against potential discharge of poor water quality either to the fjord or, in the case of base flow compensation, the Grytaelva.

Finally, monitoring of groundwater levels in wells that could be affected e.g. by reduced flow in the Grytaelva will allow any changes from the baseline to be detected early, and compensated for, if required.

Recommendations for ongoing monitoring are outlined in Section 8, below.

8 MONITORING AND CONTINGENCY ACTIONS

The objectives of the water monitoring program are to:

- Obtain adequate data to develop an understanding of baseline surface water and groundwater conditions, including spatial and temporal changes in flow and water quality.
- Provide an early warning of potential deviations from baseline conditions in surface water groundwater water bodies that could potentially be impacted by the Project.
- Ensure that Project discharges are compliant with the Discharge Permit, the Norwegian Discharge Standards and EU Water Framework Directive.
- Assess the effectiveness of management strategies to minimise potential impacts to surface water receptors.

A summary of proposed monitoring is provided in Table 8-1, below and described in detail together with key monitoring parameters and actions to be completed in the case of deviation from expected results in the Water Management Plan (SRK, 2024b). The WMP also includes proposed trigger and compliance values against which monitoring results can be compared against.

Table 8-1: Summary of proposed monitoring

Parameter	Current	Planned
Climate parameters	None.	Automated Weather Station planned at site of previous Gryta NORCE station.
Stream flow	Spot flows at ST4, ST5, ST11, and ST12. Monthly.	Spot flows at ST4, ST5, ST11, and ST12. Monthly. Continuous logger monitoring of water level (stage) at ST5 and ST11.
Groundwater level	Well IDs 51374, 18515, 12109, and 12107. Quarterly.	Well IDs 51374, 18515, 12109, and 12107. Quarterly.
Stream water Quality	All ST locations. Monthly.	All ST locations. Monthly.

Parameter	Current	Planned
Fjord water Quality	All SST locations. Monthly.	All SST locations. Monthly
Pond water quality	None.	In-pit sump, ex-pit sump, sedimentation pond. Monthly.
Groundwater quality	Well IDs 51374, 18515, 12109, and 12107. Quarterly.	Well IDs 51374, 18515, 12109, and 12107. Quarterly.

9 WATER RISK ASSESSMENT

The results of this WIA are summarised into a water risk assessment in Table 9-1.

Table 9-1: Summary of water impacts and proposed additional controls

Aspect	Risk	Potential impact	Assessment approach	Impact (with no additional controls in place)[27]	Proposed additional controls	Residual impact (with controls in place)[11]
Water quality impacts	Water quality impacts from site runoff to the Grytaelva	Poor quality runoff (including Total Suspended Solids) reaching the Grytaelva and changing baseline water quality, leading to an impact on aquatic ecosystems.	Sedimentation pond and outlet will prevent runoff from site from entering the Grytaelva. No further assessment required.	**Negligible change.** No change in water quality is expected downstream of the sedimentation pond.		**Negligible change.** No change in water quality is expected downstream of the sedimentation pond.
Water quality impacts	Water quality impacts from site runoff to the Førde Fjord.	Potential for generation of poor-quality water due to water-rock interactions in the WRD, which could be mobilised in either runoff and/or seepage to shallow groundwater, both of which would report to the sedimentation pond.	Quantitative prediction of the likely sedimentation pond chemistry was produced in GoldSim and compared to relevant fjord water quality criteria. No attenuation of water quality is expected between the sedimentation pond and where this water will be discharged to the Førde Fjord.	**Somewhat degraded.** Most parameters in the sedimentation pond are predicted to stay below the relevant water quality standards (where applicable) for coastal WQS values from Miljødirektoratet, 2020 based on class limit values for "good" class. Total nitrogen, strontium and vanadium are predicted to reach relatively elevated concentrations, but no limit values are defined for coastal water for these parameters and they are not considered contaminants of concern. As discussed in Section 4.7.2, arsenic concentrations in the fjord from the baseline sampling showed a P90 of 1.6 µg/L, with almost all of the samples classed as 'Moderate' coastal water condition. The source of elevated arsenic in the fjord water is likely weathering and dissolution of minerals in the local geology and it is expected that the fjord water is therefore elevated in arsenic under natural conditions. P90 (low-flow) arsenic concentrations in the sedimentation pond are predicted to be "Moderate" class (aligned with the current water quality classification of the fjord) and to stay within the range of concentrations recorded during baseline monitoring of the fjord until at least the end of Phase 1. Therefore, no measurable water quality impacts are predicted above the current baseline conditions in the fjord during Phase 1. During Phase 2, arsenic concentrations at the outlet of the sedimentation pond are predicted to exceed the baseline range observed within the fjord assuming no dilution, albeit concentrations are predicted to remain within a "Moderate" class. This allows time during the Phase 1 of the operation to refine the current predictions with additional monitoring and to develop suitable mitigation controls, if required, noting that the WFD allows for natural background concentrations for metals and their compounds.	Develop a Water Management Plan, including monitoring and planned responses to deviation from expected concentrations of key contaminants of concern. Regular sampling from the in-pit and ex-pit sumps plus the sedimentation pond from project inception. This will allow comparison of actual versus modelled chemistry. Sedimentation pond chemistry is predicted to deteriorate over time during Phase 1 and therefore potential for poor quality sedimentation pond water could be identified and managed/mitigated though additional controls, such as a change in waste rock management or further evaluation of dilution and mixing opportunities in the fjord itself, e.g. co-disposal or an amended fjord decant. Sampling should be connected to a monitoring action response plan (TARP) which allows for agreed actions (such as further investigation) based on trigger levels defined through modelling and prediction of water quality.	**Negligible change.** With these additional controls in place, it is considered unlikely that the fjord would be impacted by poor quality water runoff from the site outside allowable limits within Phase 1 of the operation and that these risks could be manage through either refined assessment or additional mitigation controls in time for Phase 2.
Water quality impacts	Seepage of poor quality runoff in the sedimentation pond to underlying groundwater	Impact on groundwater quality in the shallow moraine under and downstream of the sedimentation pond. Potential for seepage to the Grytaelva via baseflow.	Qualitative assessment only.	**Negligible change.** Sedimentation pond excavated into bedrock and grouted (where required) so risk to underlying groundwater considered negligible.	n/a	**Negligible change.**
Water quality impacts	Release of sedimentation pond water to Grytaelva catchment during flood event.	Release of uncontrolled water quality into the Grytaelva.	Qualitative assessment only.	**Negligible change.** The overspill is designed to direct up to a 1 in 200 year event. If this was exceeded, the sedimentation pond would overtop via the emergency spillway discharging to the same channel running along the access road to the fjord and would not overspill into the Gryta. The risk to water quality during very high flow periods is considered negligible.	n/a	**Negligible change.**

[27] On a scale from "negligible change", "somewhat degraded", "degraded", to "severely degraded" (M-1941, Miljødirektoratet, 2023).

Aspect	Risk	Potential impact	Assessment approach	Impact (with no additional controls in place)[27]	Proposed additional controls	Residual impact (with controls in place)[11]
Water quality impacts	Seepage of poor quality water from the WRD and other mine infrastructure (intermediate sump, sedimentation pond) to groundwater.	Potential changes in water quality of the groundwater in the moraine, with the potential for migration to areas of groundwater currently used for water supply.	Qualitative groundwater assessment only.	**Negligible change.** The bedrock aquifer likely poses negligible risk as a groundwater pathway for contaminant migration from the open pit or WRD areas. Site investigations (SRK, 2008) suggest that the bedrock is low permeability and groundwater levels in the vicinity of the planned open pit vary significantly, indicating a compartmentalised system with limited interconnectivity of the faults at a site-wide scale. There is no shallow aquifer pathway from the WRD or sedimentation pond to groundwater abstraction wells in the villages of Engjabøen or Indre Vevring. The WRD will be constructed on compacted moraine to limit seepage and any residual seepage will be collected via underdrainage and directed to the sedimentation pond. The sedimentation pond will be blasted from bedrock and grouted, where required, to minimise seepage to any underlying groundwater. Therefore, the potential for contaminant migration through the shallow moraine is also considered negligible.	n/a	**Negligible change.**
Water quality impacts	Tailings co-disposal to the fjord	Potential for change in water quality in fjord due to undersea tailings disposal.	Assessment of tailings co-disposal is not of this assessment.	n/a	n/a	n/a
Water availability impacts	Reduction in flows in the Grytaelva.	Runoff from disturbed areas of the mine site (WRD, haul roads, laydown/service & equipment parking areas) and some natural ground catchment areas (that cannot be practically diverted) will be directed to the sedimentation pond, decreasing flows to the Grytaelva. This has the potential to impact aquatic life in the Grytaelva during critical flow periods.	Quantitative flow impact assessment using the GR4J Runoff and CemaNeige Snow model, calibrated to donor catchment hydrological timeseries and compared to site data. The summer low-flow period required particular attention as this is the period when flow impacts are considered most likely to have the potential to impact eel populations which are considered the most sensitive aquatic ecosystem in the Grytaelva.	**Somewhat degraded.** No change in flow is predicted upstream of the confluence with the Engjabødalbekken. The modelled summer Q95 for ST11 (located on the Grytaeleva just downstream of the Engjabødalbekken confluence) is 14.3 L/s pre-scheme[28], reducing to 11 L/s post scheme[29], a difference of 3.2 L/s (23% reduction in flow). The modelled summer Q95 for ST12 (located just upstream where the Grytaelva discharges to the fjord) is 15.1 L/s pre-scheme reducing to 11.9 L/s post scheme, a difference of 3.2 L/s (21% reduction in flow). The potential implications in terms of aquatic life ecosystems in the Grytaelva (the main identified receptor) of a 21 to 23% reduction in flow are not currently well understood. Insufficient flow monitoring has been undertaken to date (automatic continuous stage monitoring required) to be able to develop a reliable rating curve that could equate a reduction in flow to a water level change in the river.	Develop a Water Management Plan, including monitoring and planned responses to deviation from expected flows. Continue spot flow monitoring at ST4, ST5, ST11 and ST11, and install continuous flow monitoring at ST5 and ST11. Develop a rating curve for flow monitoring sites such that water level changes can be predicted at key locations and the potential impact on aquatic ecosystems can be accurately assessed. Assess the implications of the sensitivity to water level changes at key locations where sensitive aquatic life has been identified. Explore options for buffering any potential water level changes and improving the eel and trout habitat in general.	**Negligible change.**
Water availability impacts	Reduction in groundwater contribution to baseflows in the Grytaelva.	Interception of shallow groundwater flow in the Engebø valley by the sedimentation pond and reduction in shallow aquifer recharge due to covering of moraine with the WRD.	Qualitative assessment only	**Negligible change.** The WRD will cover around 16% of the total peatland area in the Grytaelva catchment and around 15% of the glacial moraine. The glacial moraine is relatively thin and does not represent a materially significant aquifer in the Engebødalen. Therefore, no material changes in groundwater flow to the Grytaelva are expected.	n/a	**Negligible change.**

[28] Pre-scheme (baseline condition with no mining present)
[29] Post-scheme (future conditions with full mine development in place)

Aspect	Risk	Potential impact	Assessment approach	Impact (with no additional controls in place)[27]	Proposed additional controls	Residual impact (with controls in place)[11]
Water availability impacts	Open pit dewatering leading to water availability impacts and/or reduction in groundwater baseflow to the Grytaelva.	Potential for groundwater drawdown around the pit and tunnel to affect springs, well abstractions and baseflow to rivers. Potential for groundwater drawdown around the pit and decrease in baseflows to springs at the foot of the Engebø hill deposit and local small surface watercourses.	Qualitative assessment only.	**Negligible change.** Pit and tunnel excavated in low permeability bedrock deposit. During initial stages of pit development, surficial moraines/ peat deposits will be excavated. Groundwater drawdown expected to be restricted and localised. Rivers show a rapid response to rainfall and snowmelt events, although some river baseflow during low flow periods will likely be contributed to from groundwater. It is expected that most groundwater enters the rivers via the superficial moraine deposits (Section 4.6.4). These deposits are recharged by direct precipitation and flow from peatlands and wetlands higher in the catchments. Therefore, the impact of pit dewatering on baseflow to rivers is expected to be negligible.	n/a	**Negligible change.**
Water availability impacts	Reduced groundwater availability	Reduced groundwater availability in water wells associated with groundwater near the lower reaches of the Grytaelva.	Qualitative groundwater assessment only. The Grytaelva is likely to be a key source of recharge to some wells. Potential impact of the Project on flows in the Grytaelva, including during low-flow periods, was assessed quantitively.	**Somewhat degraded.** The impact of reduction in baseflow to the Grytaelva is unlikely to be more than the predicted P90 reduction in summer low flow in Grytaelva, which is 23%.	Monitoring in water wells. ERG to provide an alternative supply in the case that any material impacts are detected.	**Negligible change.** Any potential impact will be monitored and ERG will provide alternative supply for an wells where a measurement reduction in water availability is observed,
Flooding	Failure of water sedimentation pond causing downstream flooding.	Potential for increased flows and release of uncontrolled water quality to the Grytaelva	Assessment of failure of pond is **not part of this assessment**. Sedimentation pond design is being undertaken by Asplan Viak and is currently ongoing.	n/a	n/a	n/a

10 CONCLUSIONS

This study demonstrates that, with additional controls, risks to water receptors in the catchments surrounding the Engebø Project can be managed. Three key water risks were identified in the water risk assessment that require additional consideration and management. These are as follows:

Arsenic concentrations in discharge from the sedimentation pond to the fjord

P90 (low-flow) arsenic concentrations discharging from the sedimentation pond are predicted to be remain within the “Moderate” classification for coastal waters and within the baseline monitoring range, until at least the end of Phase 1. However, during Phase 2, arsenic concentrations in the sedimentation pond discharge are predicted to exceed the baseline range (albeit staying within the “Moderate” water quality class), assuming no dilution in the fjord.

This allows time during the Phase 1 of the operation to refine the current predictions with additional monitoring and to develop suitable mitigation controls, if required. ERG have developed a Water Management Plan (SRK, 2024b), including monitoring and planned responses to deviation from expected concentrations.

During Phase 1, appropriate site-specific water quality limits (SSWQLs) for the fjord adjacent to the project site should be developed in collaboration with the regulator, Miljødirektoratet.

The WFD may provide allowance for the following aspects which should be considered in deriving SSWQLs:

- Natural background concentrations, for example where naturally occurring concentrations prevent compliance with the relevant EQS; and
- Mixing zones adjacent to points of discharge, for example an allowance for exceedances of the relevant EQS where those concentrations do not affect the compliance of the rest of the water body.

Regular sampling from the in-pit and ex-pit sumps plus the sedimentation pond will allow comparison of actual versus modelled chemistry and validation of the model predictions. Poor quality sedimentation pond water could be identified and managed/mitigated though additional controls, such as a change in waste rock management or further evaluation of dilution and mixing opportunities in the fjord itself, e.g. co-disposal or an amended fjord decant.

With these additional controls in place, and with a monitor and mitigate type approach as the project develops through Phase 1 of operations, it is considered unlikely that the fjord would be impacted by poor quality water runoff from the site.

Reduction in flows in the Grytaelva

The summer Q95 flow is predicted to reduce by up to 23% for ST11 (located on the Grytaeleva just downstream of the Engjabødalbekken confluence) and 21% for ST12 (located just upstream where the Grytaelva discharges to the fjord). The potential implications in terms of aquatic life ecosystems in the Grytaelva (the main identified receptor) of a 21 to 23% reduction in flow are not currently well understood. The Water Management Plan (SRK, 2024b) includes monitoring and planned responses to deviation from expected flows. Installation of continuous flow monitoring instrumentation at ST5 and ST11 will allow the development of a rating curve for flow monitoring sites such that water level changes can be predicted and the potential impact on aquatic ecosystems can be accurately assessed.

ERG also plan to assess the implications of the sensitivity to water level changes at key locations where sensitive aquatic life has been identified and explore options for buffering any potential water level changes and improving the eel and trout habitat in general.

With these additional controls in place, the risk of an impact to aquatic life from a reduction in flows in the Grytaelva due to the Project is assessed as low.

Reduced groundwater availability

Specifically, a risk of reduced groundwater availability in water wells associated with groundwater near the lower reaches of the Grytaelva due to a reduction in flow. The impact of reduction in baseflow to the Grytaelva is unlikely to be more than 23% i.e. the P90 predicted reduction in summer low flow in Grytaelva.

Any potential impact will be monitored and ERG will provide alternative supply for an wells where a measurement reduction in water availability is observed.

11 RECOMMENDATIONS

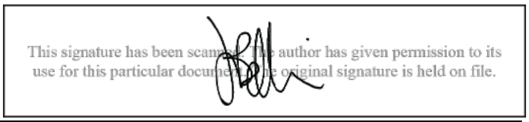
Based on the outcomes of this WIA in terms of the key potential water impacts and identified potential management controls (Section 9 Water Risk Assessment), SRK recommendations for further work to be considered by ERG as the Project progresses include:

- Produce a Water Management Plan which outlines a framework for managing water during construction and operations of the Project in order to minimise impacts to surrounding water receptors. It should build on, and be informed by, this document.
- Continuation and improvement of baseline surface water and groundwater monitoring outlined in the WMP as follows:
    - Set-up of a local meteorological station at the site of the previous Gryta NORCE station;
    - Continued monthly spot flow measurements at the existing flow monitoring locations within the Grytaelva catchment.
    - Installation of automatic continuous stage monitoring devices at ST4, ST11 and ST12.
    - Define the rating curve at these monitoring sites which would allow any reduction in flow predicted in this WIA to be equated to a water level change in the river, thereby improving the definition of the potential impact to aquatic habitats.

  - Continued monthly baseline surface water quality monitoring at the existing river monitoring locations and in the Fjord near the outlet of the Grytaelva.
  - Continued 3-monthly baseline groundwater monitoring (levels and quality) at selected registered water wells near the mouth of the Grytaelva (subject to access).

- Initiation of regular (monthly) surface water sampling from the in-pit and ex-pit sumps, and the sedimentation pond from Project inception. This will allow comparison of actual versus modelled chemistry. Sedimentation pond chemistry is predicted to deteriorate over time and therefore potential for poor quality sedimentation pond water could be identified and managed/mitigated though additional controls, such as a change in waste rock management or a water treatment system.
- Produce regular (6-monthly) monitoring reviews where results from baseline monitoring are compared against relevant trigger values and WQS but also where the existing site understanding can be revisited and updated as required. Review trigger values as required.
- Focus from monitoring reviews should be on the sedimentation pond input and output chemistry and particular the accuracy of modelling predictions to date.
- Improved quantitative assessment of water quality impacts in the Førde Fjord, including evaluation of dilution and mixing processes, once input chemistry has been further refined.
- Initiate dialogue with Miljødirektoratet regarding SSWQL's for arsenic (and other parameters where appropriate) based on the results from the above further studies, specifically taking into account the naturally occurring baseline concentrations in the fjord, as well as a consideration of mixing zones, if appropriate.
- Implement a habitat improvement program on the lower Grytaelva in order to improve eel habitat from its current state as well as to buffer any potential water level changes.

For and on behalf of SRK Consulting (UK) Limited



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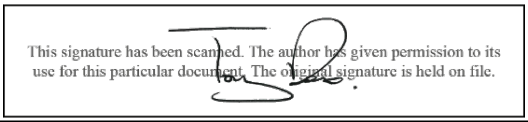

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Date Issued: 23rd October 2024

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ABBREVIATIONS AND UNITS

Abbreviations

ABA Acid Base Accounting
AP Acid Potential
EC Electrical Conductivity
EEA European Economic Area
EIFAC European Inland Fisheries Advisory Commission
EQSs Environmental Quality Standards
EU European Union
GSN Geological Survey of Norway
HCT Humidity Cell Test
IPCC Intergovernmental Panel on Climate Change
NP Neutralization Potential
NPR Neutralization Potential Ratio
NSF National Salmon Fjord
NVE Norwegian Water Resources and Energy Directorate
PAG Potentially Acid Generating
PF Powder Factor
pH Potential Hydrogen
RBDs River Basin Districts
RCPs Representative Concentration Pathways
REACH Regulation Evaluation Authorization and Restriction of Chemicals
STD Sea Tailings Deposition
SWE Snow Water Equivalent
TARP Trigger Action Response Plan
WIA Water Impact Assessment
WFD Water Framework Directive
WRD Waste Rock Dump
WTP Water Treatment Plant
LoM Life of Mine
RoM Run of Mine

Units

kg/t	kilograms per tonne
Km	Kilometre
Km^2	Kilometre squared
L/s	Litres per second
$L/s/km^2$	Litres per second per kilometre squared
m	metre
m^3	metres cubed
m^3/s	cubic metre per second
mg	milligram
mg/L	milligrams per litre
mm	millimetre
m/s	metres per second
mS/m	millisiemens per metre
Mtpa	million tonnes per annum
uS/cm	millisiemens per centimetre
µg/l	micrograms per litre
%	percentage
ºC	degrees celsius

APPENDIX

A SURFACE WATER FLOW GAUGING LOCATIONS IMAGES AND NOTES

Location ID	Notes
ST 4 	Wooden survey pegs added to indicate the flow measurement survey extents
ST5 	Wooden survey pegs added to indicate the flow measurement survey extents

Location ID	Notes
ST11 	Wooden survey pegs added to indicate the flow measurement survey extents Potential location for automatic continuous stage monitoring device
ST12 	Wooden survey pegs added to indicate the flow measurement survey extents

Location ID	Notes
ST15 	Wooden survey pegs added to indicate the flow measurement survey extents
Extra point 	Wooden survey pegs added to indicate the flow measurement survey extents

<table>
<tr><th>Location ID</th><th>Notes</th></tr>
<tr><td>Small before confluence
</td><td>Wooden survey pegs added to indicate the flow measurement survey extents</td></tr>
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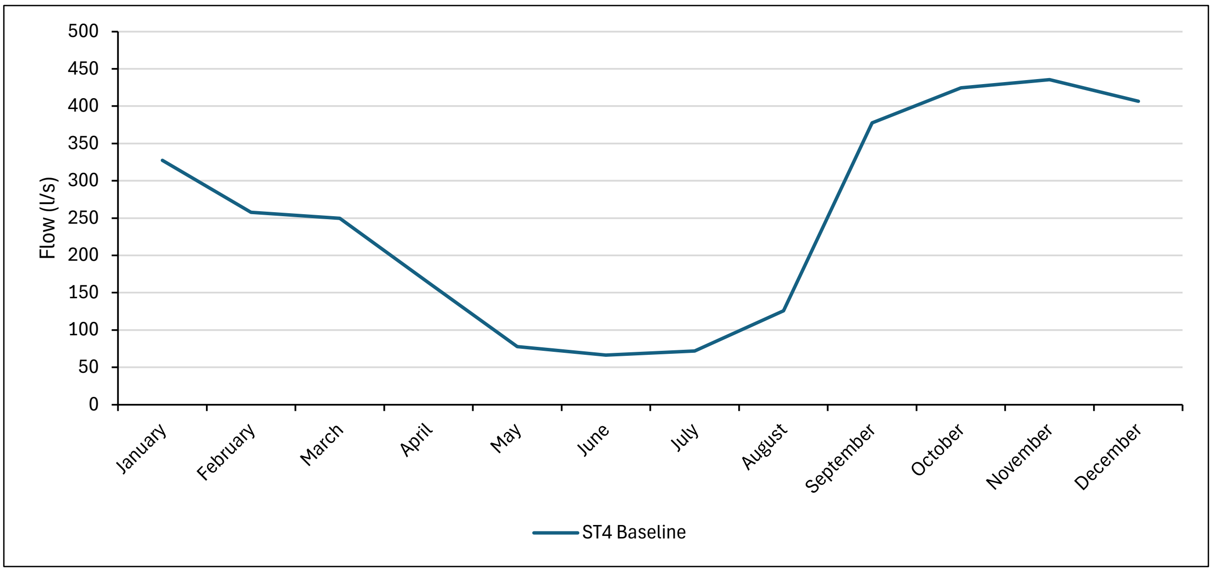
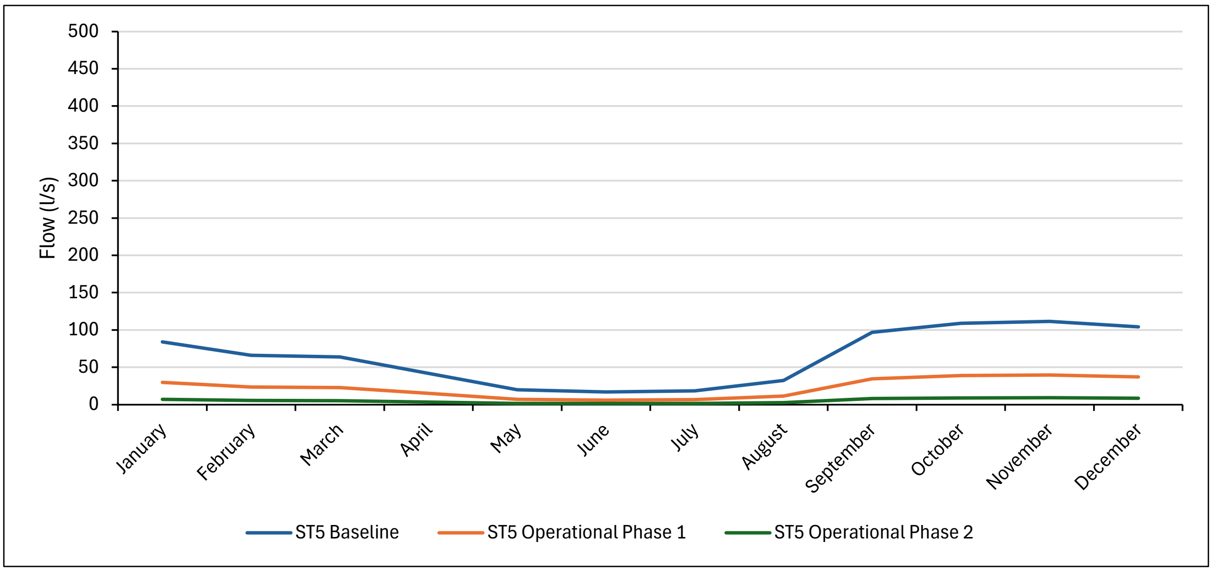
APPENDIX

B SIMULATED MONTHLY STREAMFLOW

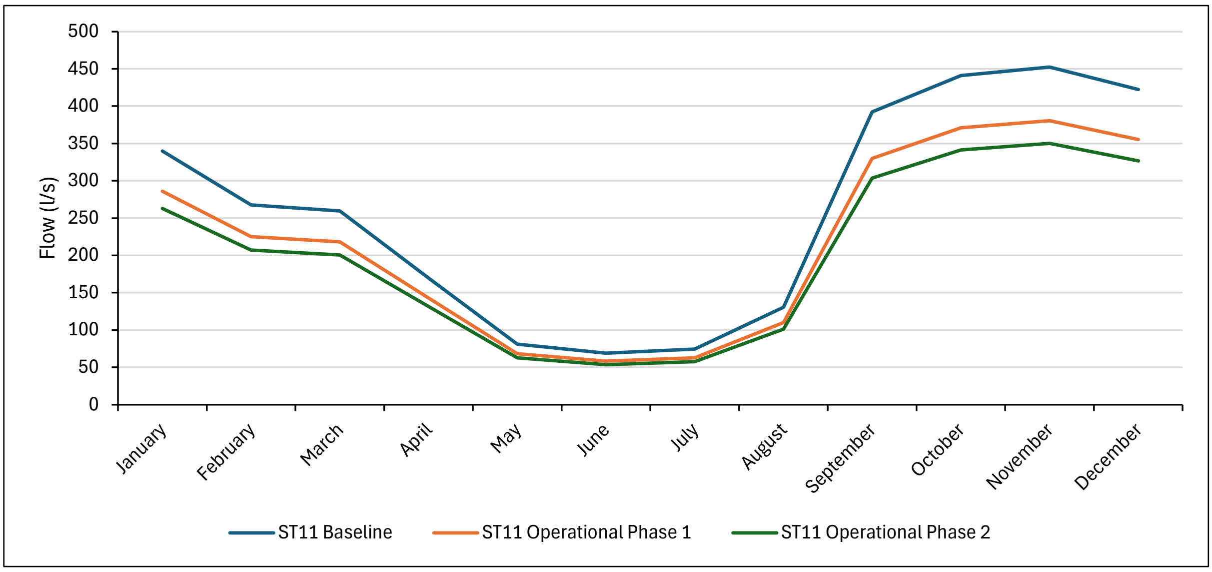
B1: Simulated monthly stream flow at ST4



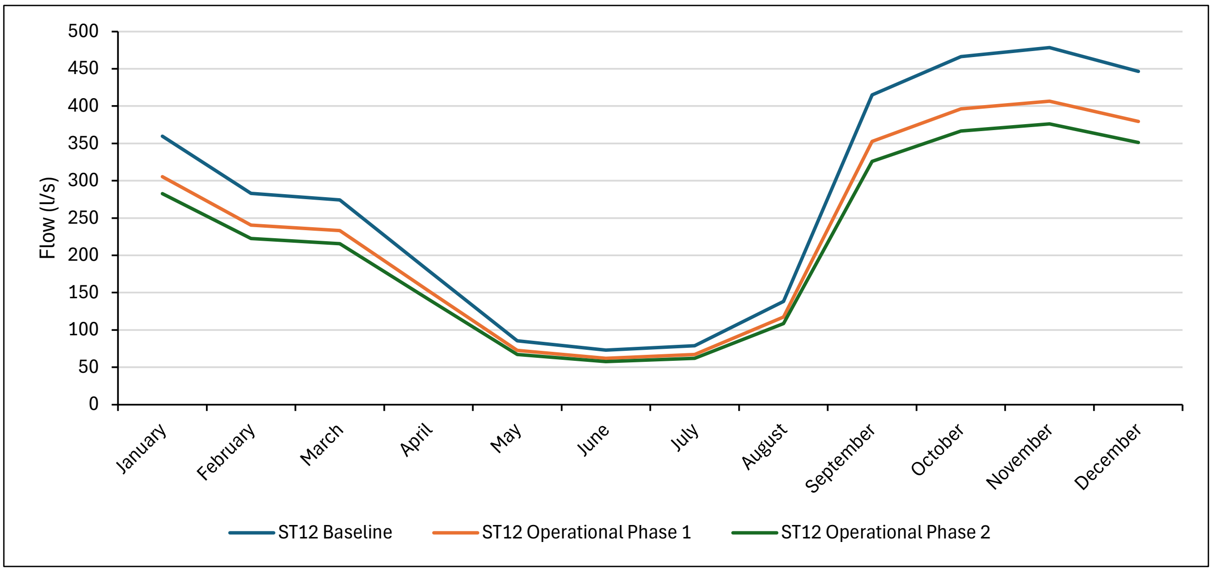
B2: Simulated monthly stream flow at ST5



B3: Simulated monthly stream flow at ST11



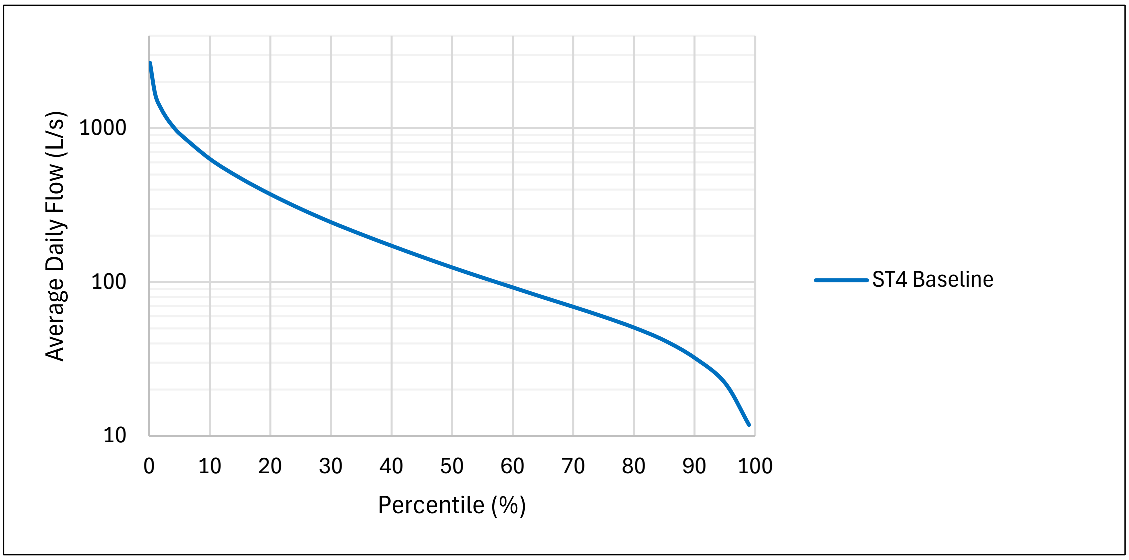
B3: Simulated monthly stream flow at ST12



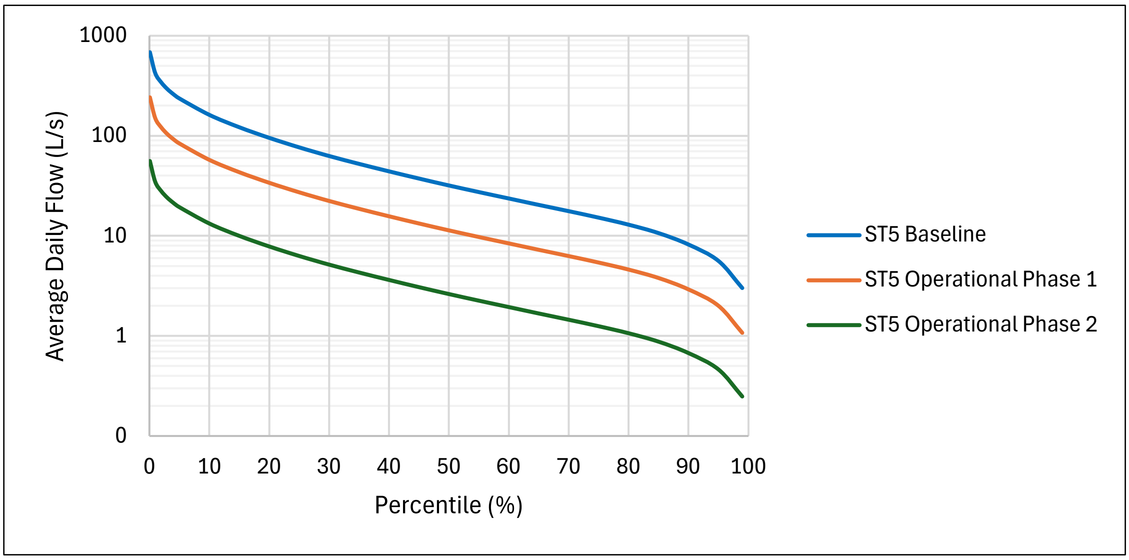
APPENDIX

C SIMULATED FLOW DURATION CURVES

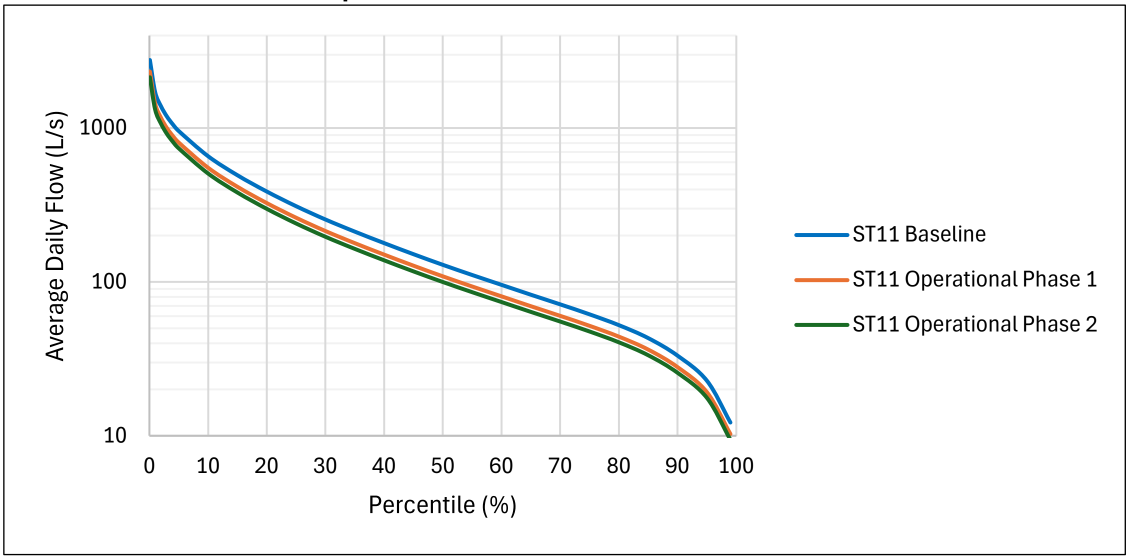
C1: FDC for baseline flow scenario at ST4



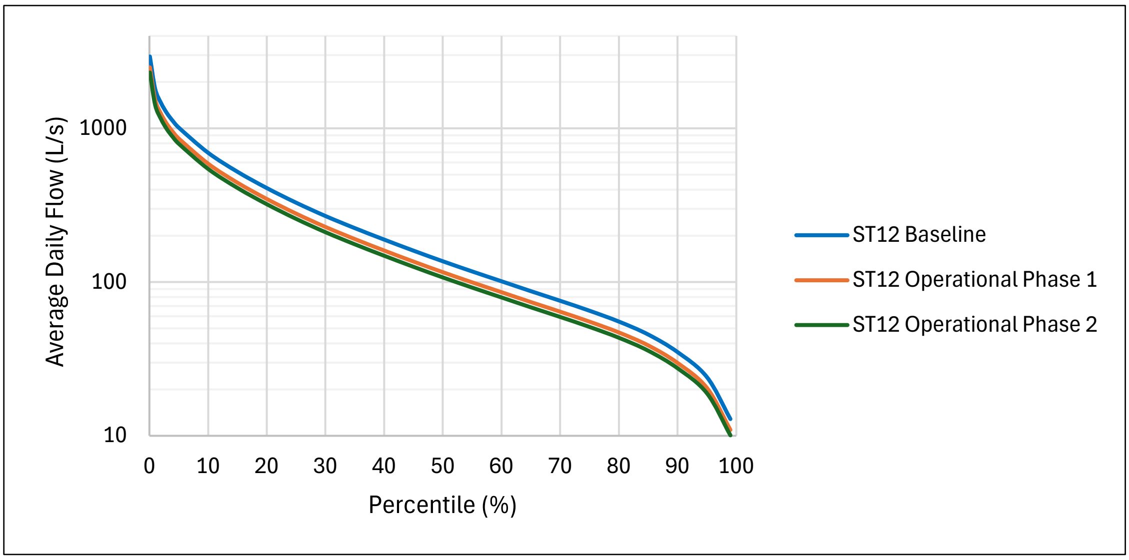
C2: FDC for baseline and operational flow scenarios at ST5



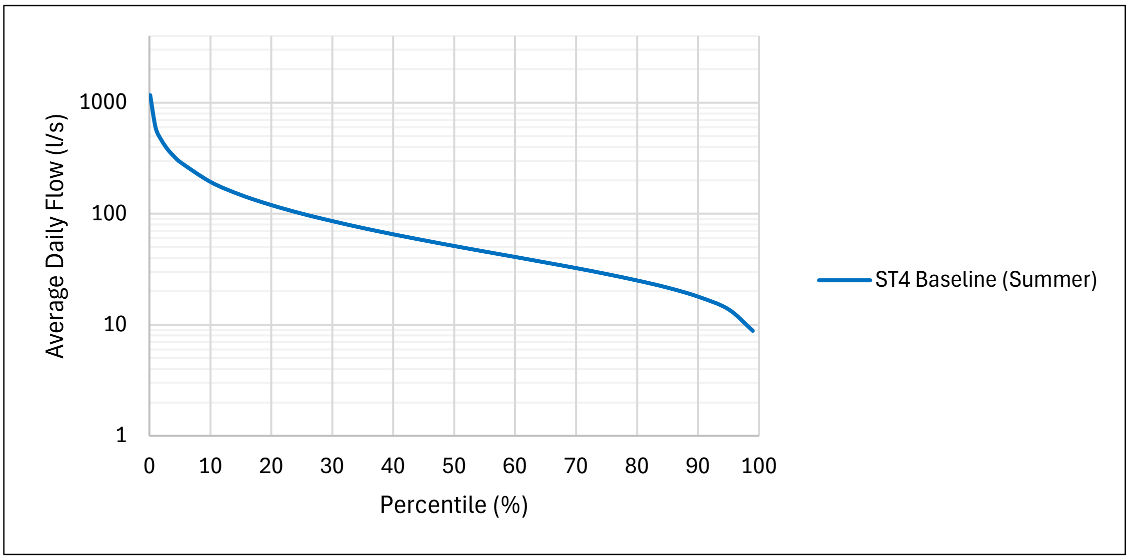
C3: FDC for baseline and operational flow scenarios at ST11



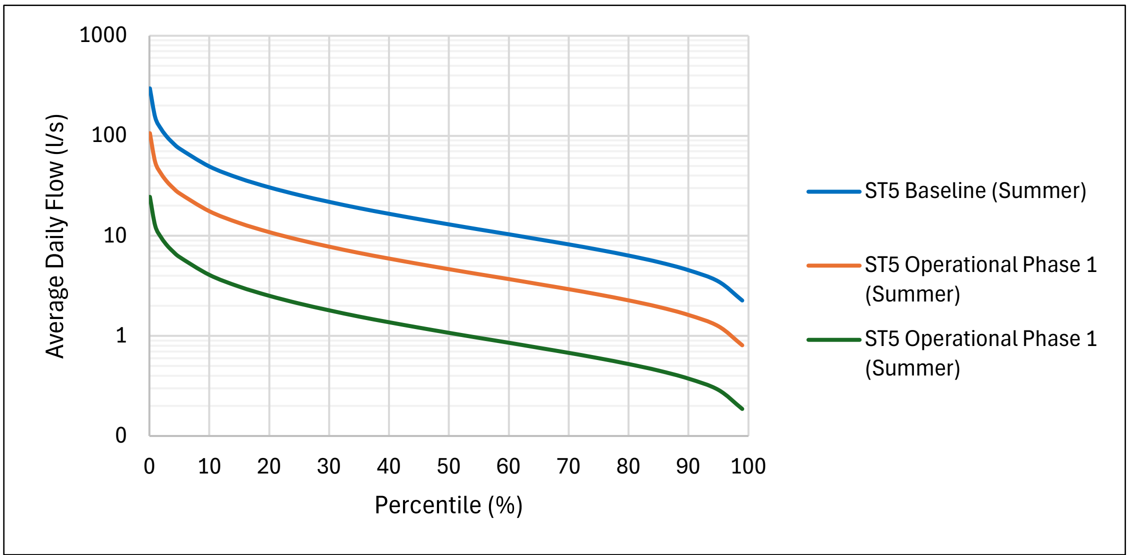
C4: FDC for baseline and operational flow scenarios at ST12



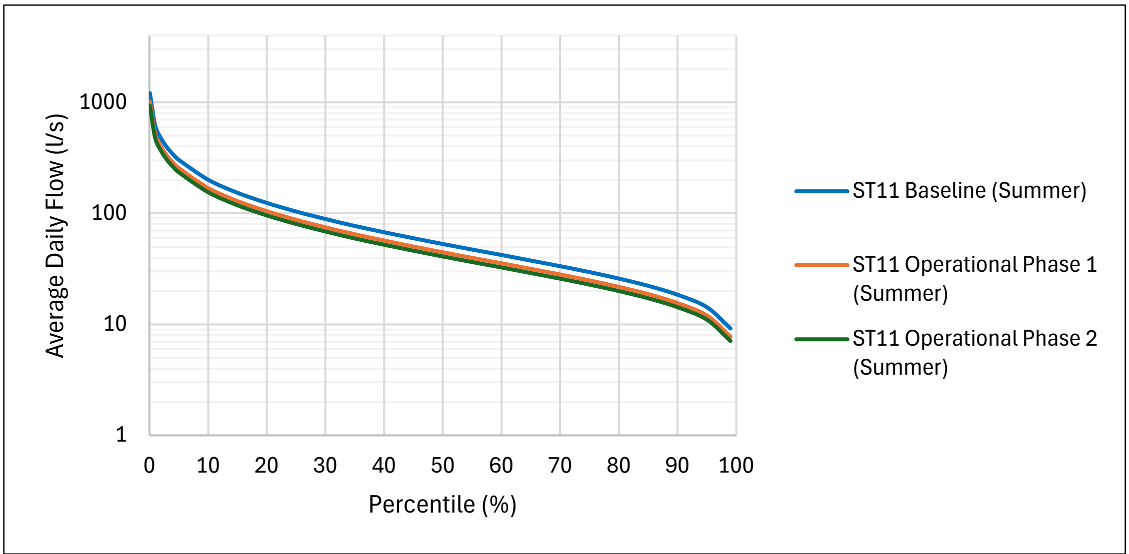
C5: Summer FDC for baseline and operational flow scenarios at ST4



C6: Summer FDC for baseline and operational flow scenarios at ST5



C7: Summer FDC for baseline and operational flow scenarios at ST11



C8: Summer FDC for baseline and operational flow scenarios at ST12