

Engelbø Water Management

Demonstrating Compliance with Standards, Leading Practice and Managing Water Impacts

James Bellin, Teams

Introduction

Scope as defined by Orion

- Demonstrate compliance with the Discharge Permit, Norwegian Discharge Standards, and EU Water Framework Directive.
- Provide assurances that contact water will not be discharged into Gryta Creek.
- Identify events and circumstances affecting the site-wide water balance and mitigation options.
- Scope is addressed in two key documents:
 - Water Impact Assessment (WIA)
 - Water Management Plan (WMP) for the Engebø Project

WIA versus WMP

WIA:

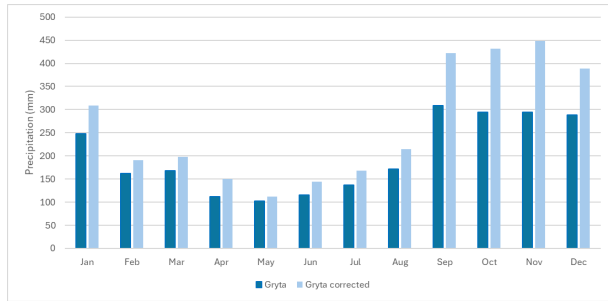
- Outlines legislative and regulatory context.
- Assesses risks to water quality and quantity.
- Prediction of potential impacts on local water resources and ecosystems and evaluation of mitigation measures using a GoldSim model of the catchment.
- Incorporates updated baseline monitoring and stakeholder consultation.
- Assesses effects on ecosystems and local communities.

WMP:

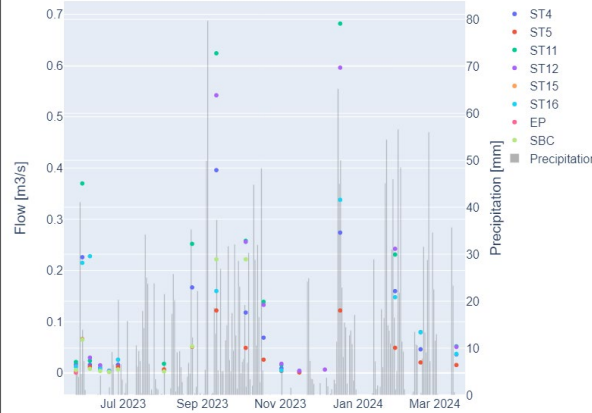
- Provides a framework for managing water resources during the operational phase of a project.
- Outlines operational strategies and controls to ensure sustainable use and compliance with regulations.
- Contingency plans.
- Includes a comprehensive monitoring program.

Baseline monitoring update, May 2023 to present

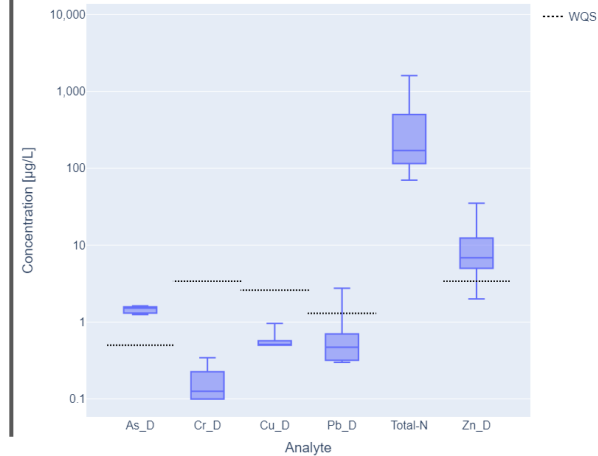
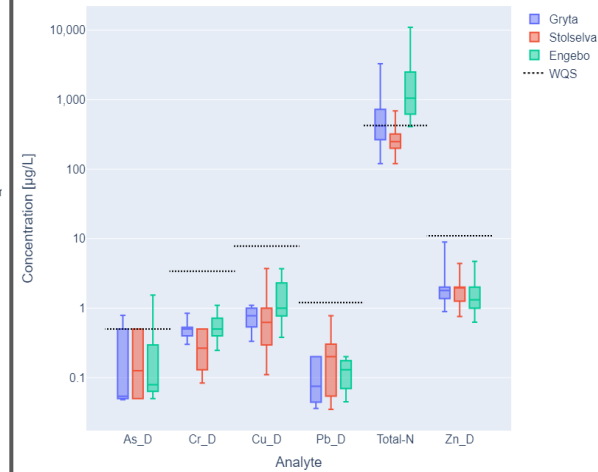
Updated climate data corrected for undercatch



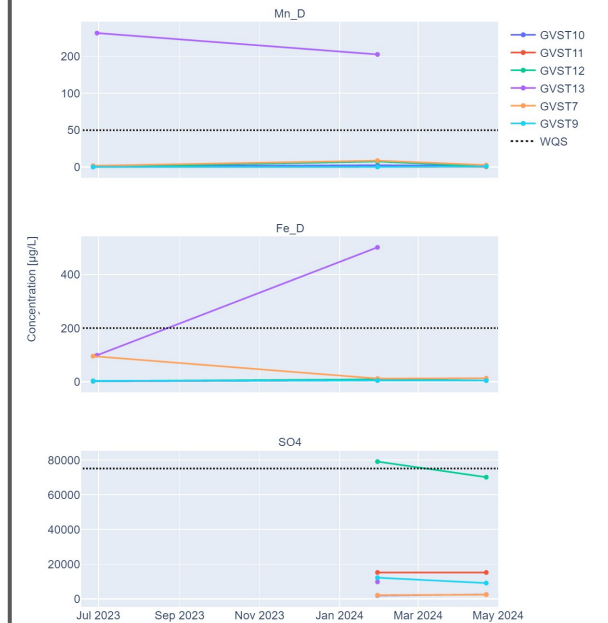
Local flow monitoring (7 locations)



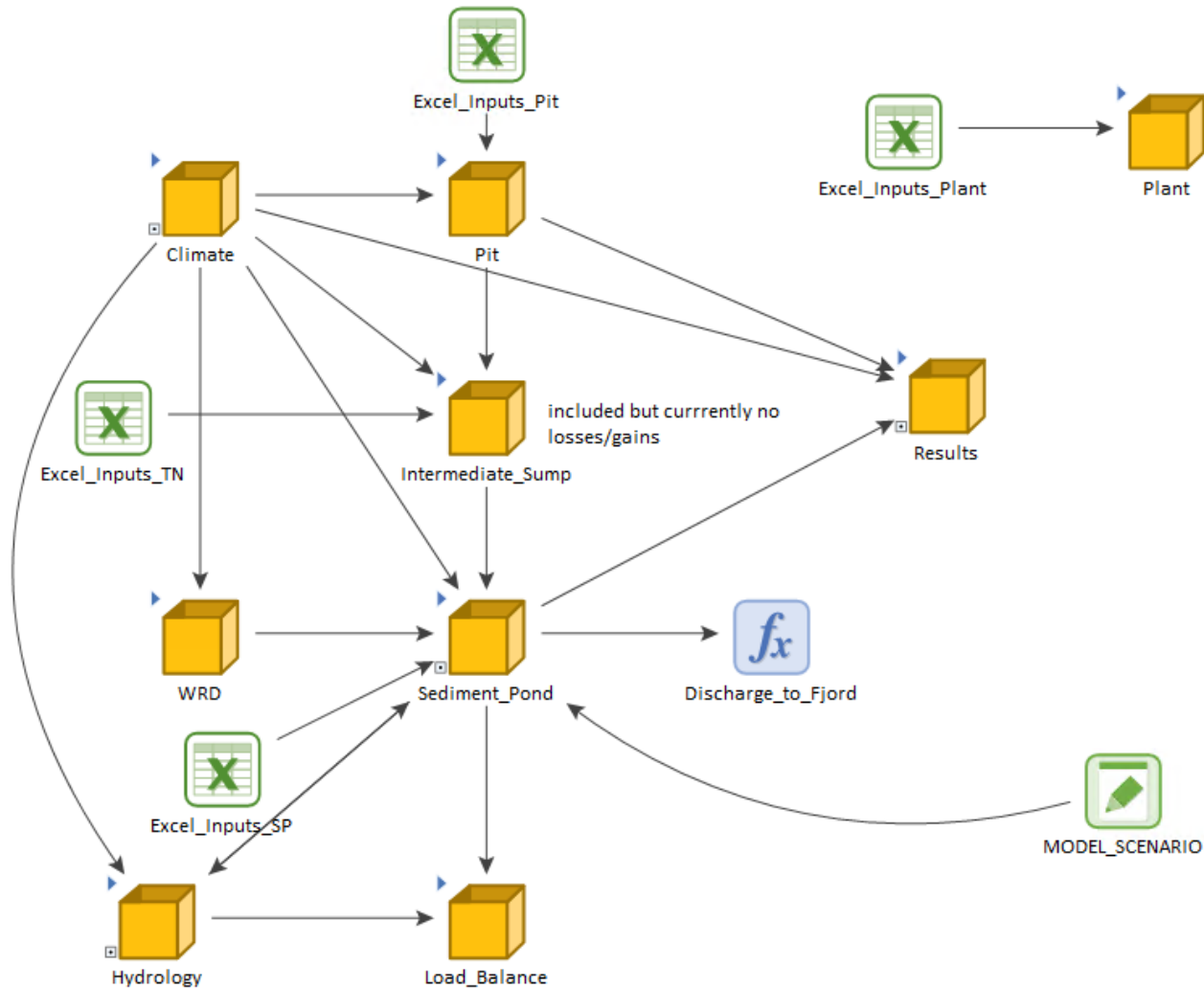
Surface water (7 locations) and fjord water quality (6 locations)



Groundwater quality (6 locations)



GoldSim Model Updated



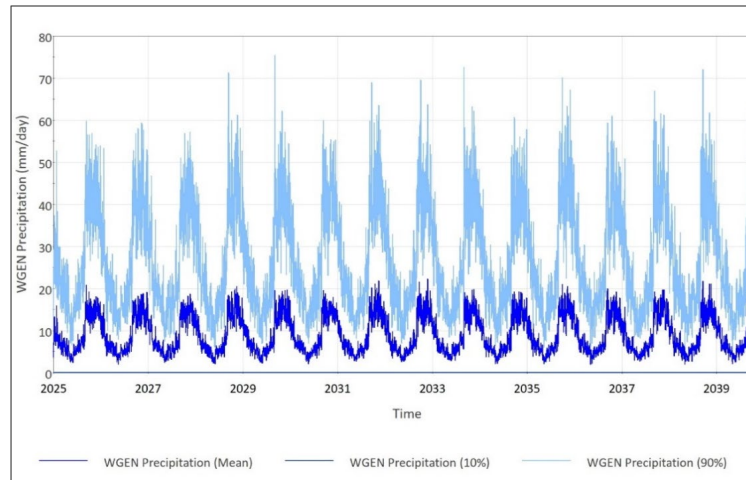
- Catchment-wide water balance (not just site).
- Flow and load.
- Equilibration of predicted water chemistries in PHREEQC.

Key updates:

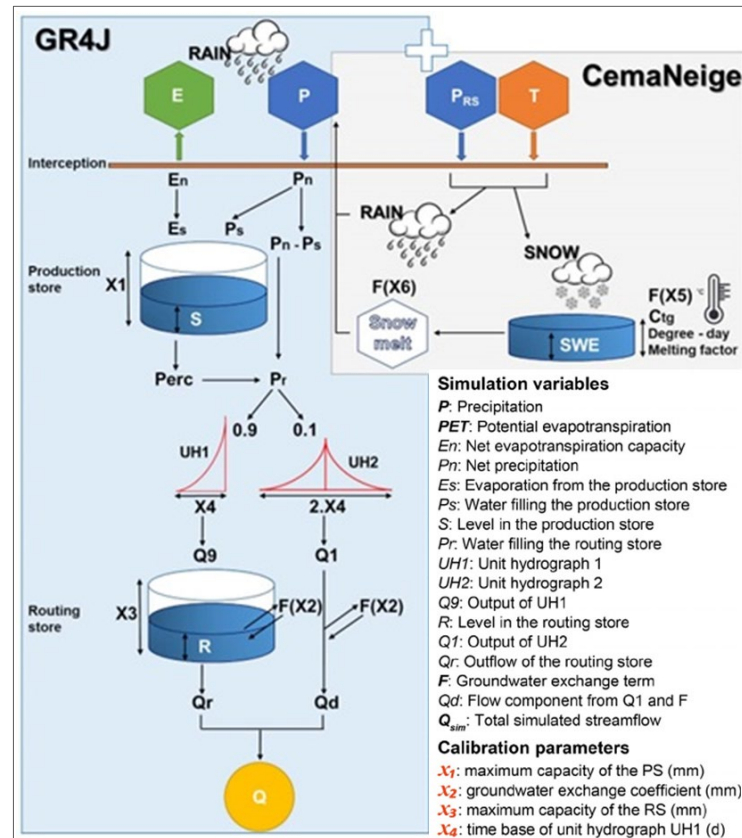
- Reduction in timestep from monthly to daily.
- Validation of runoff to baseline spot flow monitoring.
- Probabilistic (Monte Carlo) simulation.
- Updated WRD model using SCS CN.
- Updated sediment pond design.
- Updated simulation of rainfall, snowmelt and runoff.

Updated Simulation of Rainfall, SnowMelt and Runoff

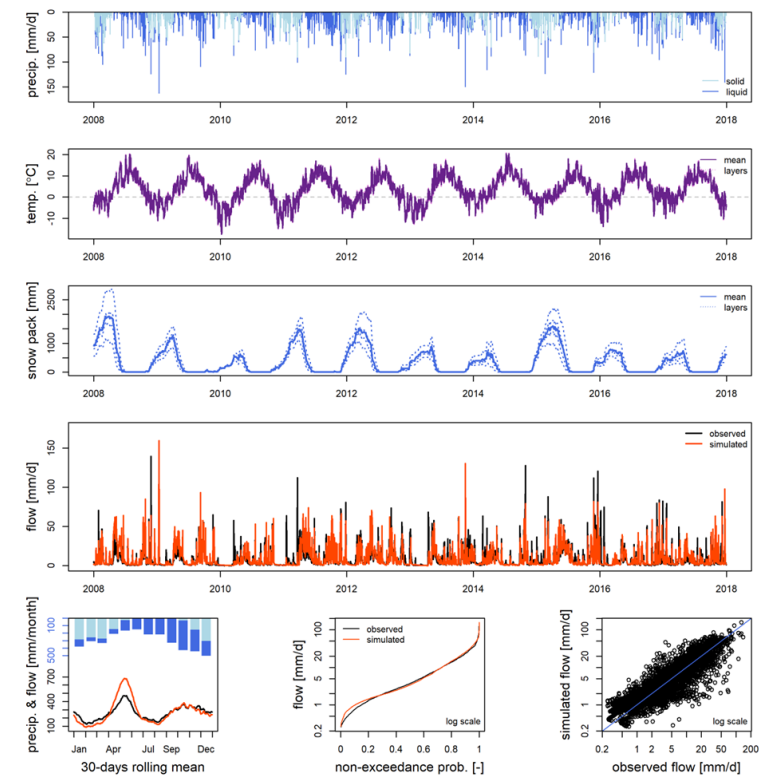
Stochastic Precipitation using WGEN climate generator



CemaNeige SnowMelt Model



GR4J Rainfall Runoff Model



Assurances for Grytaelva

- All contact water captured by the sedimentation pond which will prevent runoff from site from entering the Grytaelva.
- Discharge connected to an open drainage outlet to the fjord.

WMP defines:

- Site water management concepts to ensure water cannot be discharged to Gryta Creek.
- Monitoring of Gryta Creek and surrounding receiving environment.
- Regular monitoring and maintenance of the sedimentation pond.



Sediment pond

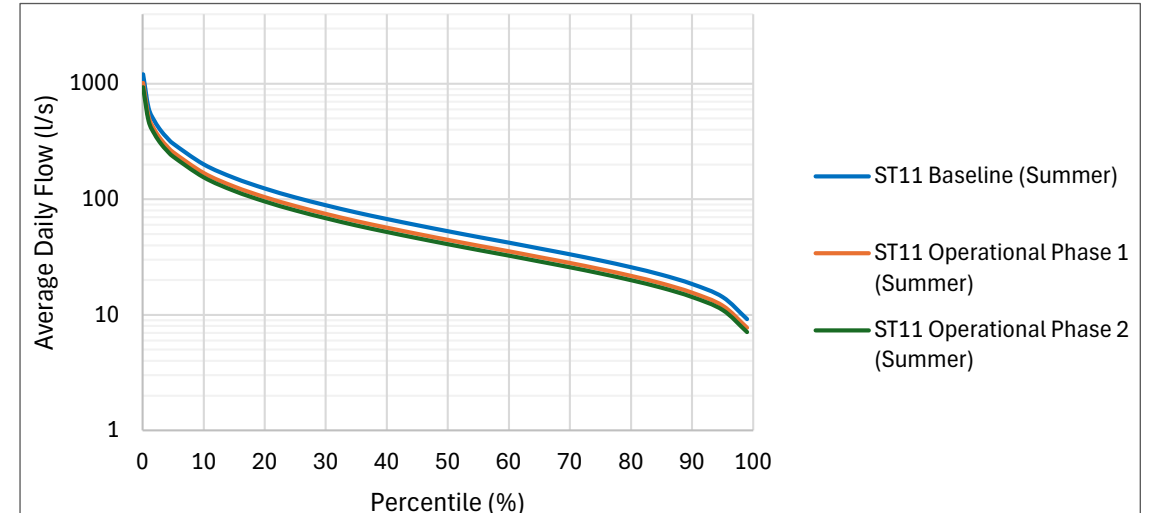


Key engineering controls:

- Sedimentation pond excavated into bedrock and cemented to minimize seepage and risk to underlying groundwater.
- Overspill is designed to direct up to a 1 in 200 year event. If 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 overflow into the Gryta.**

Proactive mitigation of potential flow impacts to the Grytaelva

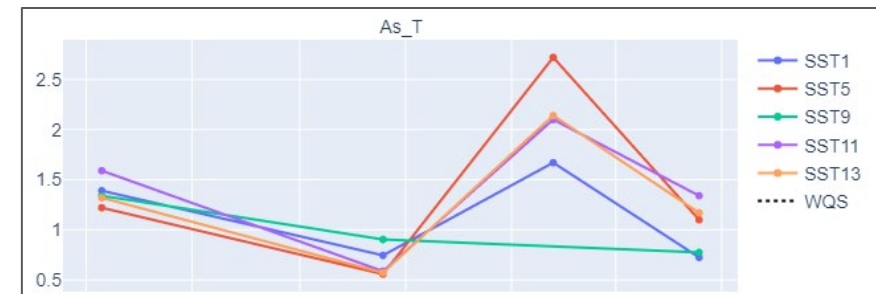
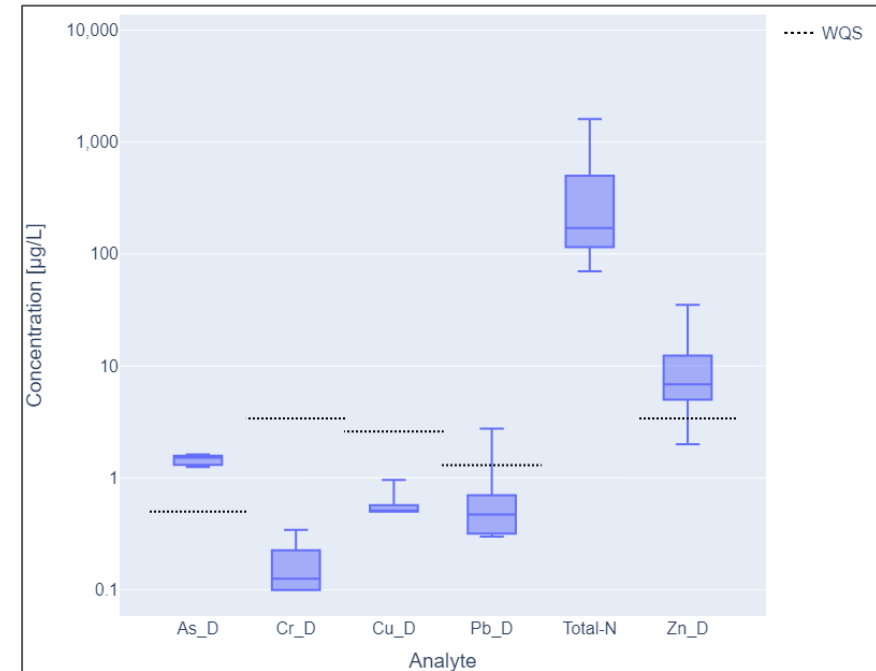
- Summer Q95 flow predicted to reduce by up to 23% for ST11 and 21% for ST12 (on the Grytaelva downstream of the site) by the end of the mine life.
- **Risk of an impact to aquatic life from a reduction in flows in the Grytaelva is assessed as low. However...**
- WMP includes monitoring and planned responses to deviation from expected flows (discussed later).
- ERG exploring options for buffering any potential water level changes and improving the eel and trout habitat in general, according to the Biodiversity Action Plan.



Water quality objectives for the Førdefjorden

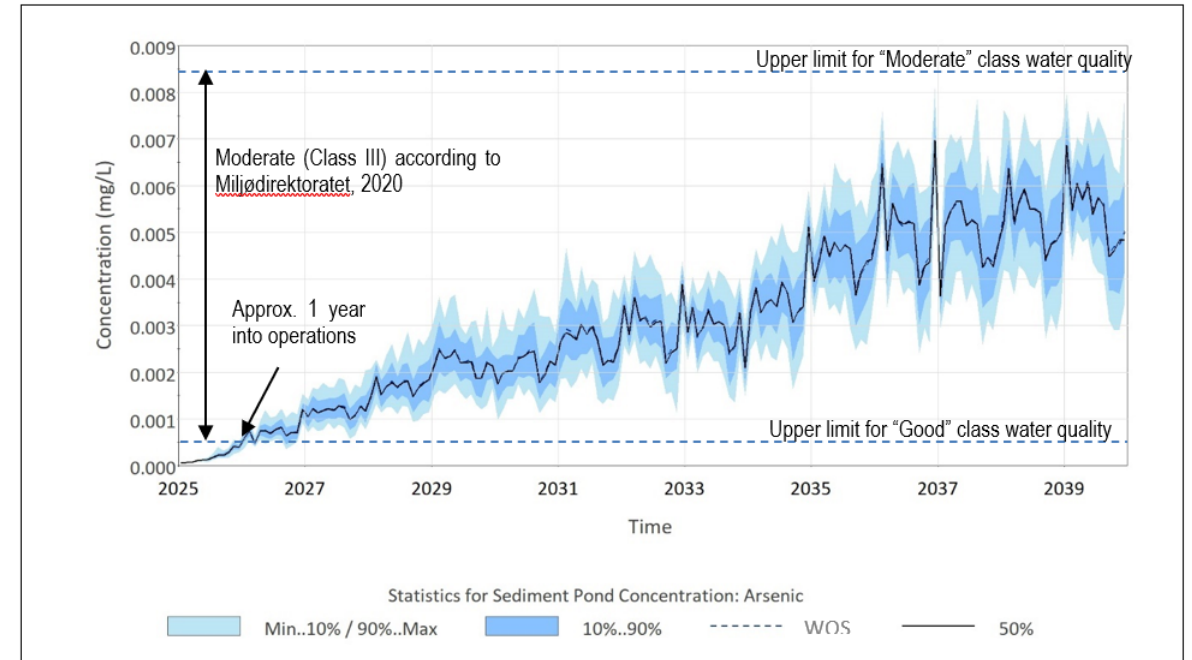
- The current chemical state of Førdefjorden-ytre is “**Bad**” including “**Bad**” for Lead, Arsenic and Copper.
- Baseline monitoring in the Førdefjorden around the project site shows “**Moderate**” water quality with respect to Arsenic, Zinc and occasionally Lead.
- Naturally elevated arsenic is interspersed to be derived from the surrounding geology and naturally occurring.
- The chemical environmental target for Førdefjorden-ytre is “**Good**”.
- However, this is not an appropriate target for arsenic given natural baseline conditions. The WFD states that:

“The Appropriate Agency may, when assessing the monitoring results against the relevant EQS, take into account— (i) natural background concentrations for metals and their compounds where such concentrations prevent compliance with the relevant EQS;”



Arsenic predicted to exceed baseline range but not class

- **Risk:** modelled arsenic concentrations in discharge from the sedimentation pond to the fjord :
 - During **Phase 1 (0-6 years)**, modelled P90 (low-flow) arsenic concentrations discharging from the sedimentation pond are within the “Moderate” class (current) and within the previous baseline monitoring range for the fjord i.e. no discernible impact.
 - During **Phase 2 (years 7-14)**, modelled P90 arsenic concentrations predicted to stay within “Moderate” class but exceed baseline range, assuming no dilution in the fjord.



SSWQLs for the fjord will be required

- **Action:** during Phase 1, develop SSWQLs for the fjord adjacent to the project site in accordance with the Water Framework Directive and in collaboration with the regulator. Work with the regulator to ensure that these are reflective of the appropriate RBMPs.
- **Action:** during Phase 1, refine predictions and develop suitable contingency mitigation controls, *if required*, such as:
 - Change in waste rock management
 - Co-disposal of discharge with tailings
 - Amended fjord decant, further into the fjord
 - Allowance for a “mixing zone” with application of site-specific water quality limits (SSWQLs) over simple Guideline Values applied at end of pipe. From the WFD:

“(1) The Appropriate Agency may designate mixing zones adjacent to points of discharge in surface water bodies. (2) In mixing zones designated under sub-paragraph (1), concentrations of one or more substances listed in Table 1 may exceed the relevant EQS if those concentrations do not affect the compliance of the rest of the water body with those standards.”

Management of abnormal events

- WMP outlines management strategies to minimise potential impacts due to project development, specifically:
 - Management actions
 - Performance indicators, reporting/evidence
 - Timing
 - Responsible parties
- Comprehensive monitoring program with trigger levels to:
 - Develop an understanding of baseline conditions
 - Provide early warning of potential deviations from baseline conditions
 - Assess the effectiveness of management strategies to minimise potential impacts

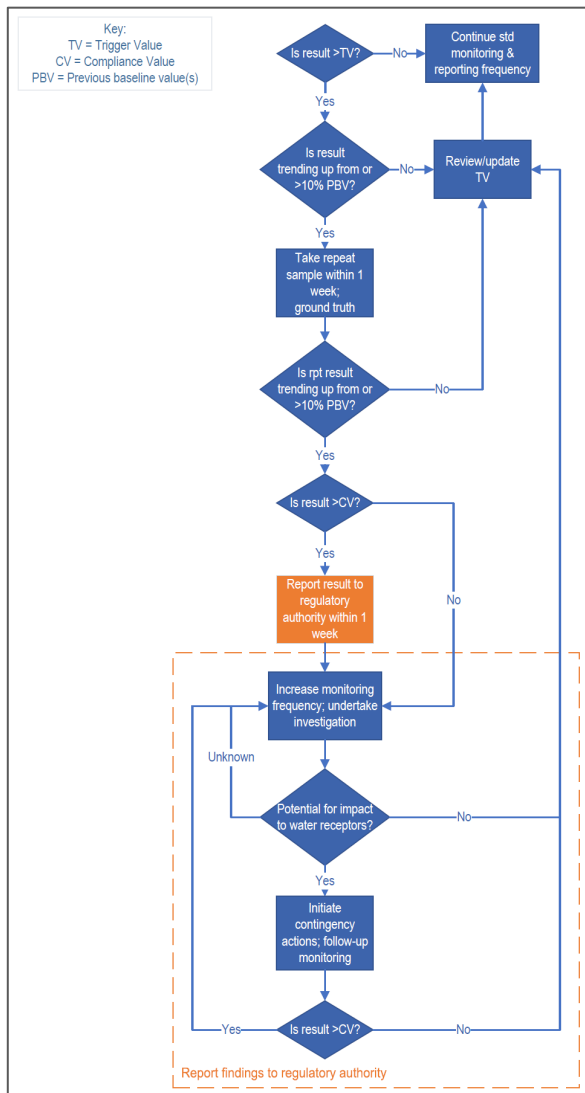


Water Quality Objectives

Surface Water		Groundwater	
Compliance Values	Trigger Values	Compliance Values	Trigger Values
<p>Klima- og miljødepartementet (2007) for prioritised substances (some hydrocarbons plus cadmium, lead, mercury and nickel).</p> <p>Miljødirektoratet (2020) for metals, pH, total phosphorus, and total nitrogen.</p> <p>Applicable for freshwater and coastal waters.</p>	<ul style="list-style-type: none"> • Default set at the P90 baseline. • Compared to ensure it is protective of the WQS. • Some P90 baseline values exceed WQS, these are flagged for further discussion with the regulator. • N P90 exceeds WQS but 75% of WQS maintained as no natural sources identified. 	<p>Norwegian Water Regulations (Vannforskriften) (Miljødirektoratet, 2016)</p>	<p>Vannforskriften states that the default trigger action value should be 75% of the threshold value.</p> <p>If this value is exceeded, then further investigation should be undertaken.</p>

Trigger values (TVs) are specific thresholds set to initiate a management response or further investigation when exceeded and should be protective of the Compliance Values as well as being protective of specific environmental values, such as aquatic ecosystems, human health, or agricultural uses. They are used as early warning indicators to prompt further investigation or management actions.

Contingency actions in case of a TV exceedance



Measure / Target	Contingency Actions
Exceedance of Trigger Values	<ul style="list-style-type: none"> Compare to previous monitoring data across all sites. If the results are within +/-10% bounds of previous dataset and no measurable trend is observable, continue monitoring at the usual frequency. Report Trigger Values exceedances in the annual report Report any exceedances of the Compliance Value to the regulatory authority within 1 week².
Exceedance of Trigger Values AND Outside of +/-10% of previous dataset and with measurable trend	<ul style="list-style-type: none"> Undertake further monitoring within 1 week including duplicate sampling. Ground truth the results of the disturbance to validate findings of the assessment and/or determine/identify what may be causing the exceedances. Where exceedance was not caused by project activities and/or the next round of monitoring results return to Trigger Values or within +/-10% of previous baseline dataset, continue monitoring at the usual frequency. Report Trigger Value exceedances in the annual report. Report any exceedances of the Compliance Value to the regulatory authority within 1 week².
Second consecutive exceedance of Trigger Values AND Outside of +/-10% of previous dataset and with measurable trend	<ul style="list-style-type: none"> Where cause identified during ground truthing and can be rectified, undertake action immediately. For actions which require alternate resources, schedule works to be undertaken as soon as possible. Verify water management infrastructure is operating as per design. Where physical blockages or structural integrity issues are identified seek immediate rectification to ensure management response can be met. For actions which require alternate resources, schedule works to be undertaken as soon as possible. Undertake investigations to determine if exceedances have the potential to cause environmental harm to the receiving environment. Where the water quality exceedance does not have the potential for environmental harm (i.e. to vegetation, fauna or fauna habitat), resume standard monitoring frequency. Report Trigger Value exceedances in the annual report Report any exceedances of the Compliance Value to the regulatory authority within 1 week².
Second consecutive exceedance of Guideline Values AND Outside of +/-10% of previous dataset and with measurable trend AND Ground truthing determine exceedances to be attributable to project activities	<ul style="list-style-type: none"> Increase monitoring in catchments where water quality has been compromised. Where the exceedance is in an area where excess water is being discharged, cease discharge until the source of the exceedance is identified, if safe to do so. Where it is unsafe to cease discharge (e.g. risk of catastrophic pond failure due to exceedance of design freeboard) it may be necessary to continue discharge for a limited period. Where the change causes a reduction in community water supply, engage with stakeholders to identify alternative options. In some cases, this may involve providing direct support for the construction of local wells and/or water treatment facilities. Review management measures with an adaptive management response. Once management actions have been completed, undertake a subsequent monitoring event to verify surface water flow is within acceptable limits. Report Trigger Value exceedances in the annual report.

Conclusions

Summary:

- The WIA and WMP together provide a framework for ensuring compliance, managing contact water, and mitigating potential impacts, meeting the requirements outlined in the Orion scope.
- Water management actions include some habitat improvement on the lower Grytaelva, following the Biodiversity Action Plan.
- Ongoing studies will be required to validate predicted arsenic concentrations in the fjord and to ensure effective controls are developed in Phase 1 of operations (to year 6 of operations), if applicable.

Next Steps:

- Implement the outlined strategies and continue monitoring to validate current model predictions, ensure ongoing compliance and develop effective water management procedures and controls.
- Further investigation into exploring options for buffering any potential water level changes and *improving* eel and trout habitats on the lower Grytaelva.



SRK Office Locations



We are an independent, international consultancy providing focused advice and solutions to clients, mainly in the earth and water resource industries.

For mining projects, we offer services from exploration to mine closure. Our specialists are leaders in fields such as due diligence, technical studies, mine waste and water management, permitting, and mine rehabilitation.

Applying their extensive knowledge and experience, our consultants develop innovative approaches and practical techniques that meet clients' unique needs and financial objectives. Among our clients are many of the world's major, medium-sized, and junior metal and industrial mining houses, exploration companies, financial institutions, EPCM firms, and government departments.



1,600+
People Worldwide



45+
Years in Business



40+
Offices Worldwide



30,000+
Projects

Copyright and Disclaimer

Copyright and Disclaimer

Copyright (and any other applicable intellectual property rights) in this document and any accompanying data or models which are created by SRK Consulting (UK) Limited ("SRK") is reserved by SRK and is protected by international copyright and other laws. Copyright in any component parts of this document such as images is owned and reserved by the copyright owner so noted within this document.

The use of this document is strictly subject to terms licensed by SRK to the named recipient or recipients of this document or persons to whom SRK has agreed that it may be transferred to (the "Recipients"). Unless otherwise agreed by SRK, this does not grant rights to any third party. This document shall only be distributed to any third party in full as provided by SRK and may not be reproduced or circulated in the public domain (in whole or in part) or in any edited, abridged or otherwise amended form unless expressly agreed by SRK. Any other copyright owner's work may not be separated from this document, used or reproduced for any other purpose other than with this document in full as licensed by SRK. In the event that this document is disclosed or distributed to any third party, no such third party shall be entitled to place reliance upon any information, warranties or representations which may be contained within this document and the Recipients of this document shall indemnify SRK against all and any claims, losses and costs which may be incurred by SRK relating to such third parties.

SRK respects the general confidentiality of its potential clients' confidential information whether formally agreed with them or not and SRK therefore expects the contents of this document to be treated as confidential by the Recipients. The Recipients may not release the technical and pricing information contained in this document or any other documents submitted by SRK to the Recipients, or otherwise make it or them available to any third party without the express written consent of SRK.

© SRK Consulting (UK) Limited 2024