REPORT NO. 212022/2

MYRA FALLS MINE

2021 RECLAMATION REPORT FOR MINES ACT PERMIT M-26

Submitted to:

Myra Falls Mine
A Trafigura Group Company

Myra Falls Mine

Prepared by:

Robertson GeoConsultants Inc.
Consulting Engineers and Scientists for the Mining Industry
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March 2022

Executive Summary

General

This is the 2021 Reclamation Report for the Myra Falls Mine (MFM). This report was prepared by Robertson GeoConsultants Inc. (RGC) and MFM's Environment Department as part of annual reporting for *Mines Act* Permit M-26. Key aspects of this report are summarized below.

Overview – Construction, Mining Operations, and Surface Activities

A total of 741,320 tonnes were mined in 2021. Monthly ore production rates increased in late 2021, when the average monthly production rate increased to 53,600 tonnes per month from September to December. Approximately 85% of the ore produced in 2021 was produced from the HW Zone, which includes the Marshall, Ridge, and Battle Gap ore bodies. The remaining ore was produced from the Price Zone, which was actively mined throughout 2021. No active mining took place in the Lynx or Myra zones underground in 2021.

Approximately 232,700 tonnes of waste rock were produced in 2021, more than 90% of which was produced from the HW Zone. Approximately 17,600 tonnes of waste were mined in Price Zone and subsequently utilized to backfill mined out stopes. Approximately 501,200 tonnes were milled in 2021. The monthly milling rate ranged from 16,665 tonnes in February 2021 to 55,540 tonnes in July 2021, with an average monthly milling rate of approximately 41,800 tonnes per month.

Mine Waste Characterization Results

Approximately 888,000 t (or approximately 444,000 m^3) of existing waste rock from the historic WRDs was re-located to the Lynx TDF berm in 2021. Approximately 85% of the waste rock re-located was re-located from WRD2, with far lesser amounts re-located from WRD1, WRD3, and WRD6. Approximately 56% of the waste rock samples collected from WRD2 and WRD3 in 2021 are classified as Non-Potentially Acid Generating (PAG) material. Waste rock samples collected from WRD3 and WRD6 during re-location are classified as PAG material. 2021 mine waste characterization results therefore suggest a mixture of PAG and Non-PAG materials were used to construct the Lynx TDF berm.

No direct samples of fresh, Run-of-Mine (ROM) waste rock were collected in 2021 and waste rock in the construction stockpiles was mixed with existing waste rock from surface. Each of the monthly tailings samples for which there are data and a sample of raw (beached) tailings collected from the Lynx TDF in 2021 are classified as PAG material.

Authorized Effluent Discharges and Effluent Monitoring

In total, 13,361,800 m^3 of treated effluent was discharged to Myra Creek in 2021. The average daily discharge rate in 2021 was 36,800 m^3/day, or 11,200 m^3/day lower than the 48,000 m^3/day that is authorized by Effluent Permit PE-6858. Hence the daily average discharge rates in 2021 were compliant with Permit PE-6858. Further details are provided in the 2021 Annual Monitoring Report for Effluent Permit PE-6858.

Eight grab samples of treated effluent (at 11A-Runoff) exceeded Metal and Diamond Mine Effluent Regulations (MDMER) limits in 2021. Six of the exceedances were related to elevated TSS values in January 2021 and there were two exceedances recorded for Zn-t. Routine toxicity testing results for 2021 were compliant with MDMER requirements.

Unauthorized Discharge Events

There were two unauthorized discharge events in 2021. One occurred on September 17th, when turbid runoff from the public road reported to Myra Creek during a high intensity rainfall event. In total, an estimated 54,000 L of runoff reported to Myra Creek during the event. Total Suspended Solids (TSS) and some metal concentrations in the flows to the creek exceeded MDMER limits and the samples showed no acute toxicity. The other unauthorized discharge event occurred on October 25th when the 25-Sump overtopped during a high rainfall event. Unauthorized discharge ceased when a back-up pump was started. TSS and some metal concentrations in the flows to the creek on October 25th exceeded MDMER limits. A grab sample showed acute toxicity for trout but samples collected downstream showed 100% survival. Concentrations of Cu and Zn in Myra Creek on September 17th and October 25th exceeded BC Water Quality Guidelines (WQGs). These exceedances cannot, however, be attributed to the spill event, as both of these metals typically exceed BC WQGs in Myra Creek.

Routine Water Quality Monitoring Results – Permit M-26

A sample from the Car Bridge Seep was collected in 2021. No samples of the Pipe Bridge Seep, Warehouse Seep, Lower Pumphouse No. 4 Seep (or “PH4 Seep B), or Upper Pumphouse No. 4 Seep were collected in 2021, as no flows were observed at these seep locations by site staff. Flows from the Main Spring (now collected by the DDSD) were sampled on several occasions in 2021. Most of the samples collected in 2021 were characterized by metal concentrations lower than discharge criteria from Effluent Permit PE-6858. However, Zn-d and Zn-t concentrations in samples collected when flows in the DDSD are first observed by site staff were higher than discharge limits from Effluent Permit PE-6858 due to the “first flush” of oxidation products from local waste rock and fill. All flows from the DDSD are currently routed to the water treatment system and not to Myra Creek, as the decant structure required to convey these flows to Myra Creek has not been constructed.

In recent years (starting in 2018), Zn concentrations in groundwater captured by the Old TDF under-drains have decreased due to the operation of the Phase I Lynx SIS upgradient in the Lynx Reach. This trend did not continue in 2021, as Zn concentrations in groundwater captured by the Old Outer Drain and each segment of the New Outer Drain (NOD) were higher in 2021 than in recent years. These increases are attributed to a change in how the Old TDF under-drain system was operated for most of 2021, as a sump setting was changed in February 2021. Groundwater quality immediately downgradient of the Old TDF under-drains also deteriorated in 2021 due to increased groundwater bypass since early 2021 when the change to the operation of the Old TDF under-drains were made.

SIS Performance

Previous hydraulic testing of the NOD (RGC, 2016a) during a variety of flow conditions showed that hydraulic gradients are usually directed towards the drains, meaning that creek water is discharging towards the drains rather than groundwater discharging to Myra Creek (see RGC, 2020, for further details). In early 2021, the Old TDF under-drains (particularly the NOD segments) continued to be effective in preventing ARD/ML-impacted groundwater in the Lower Old TDF Reach from discharging to Myra Creek. However, in February 2021, the operation of the under-drain system was changed, following the commissioning of a new sump level transmitter at Pumphouse No. 4. The water level in the sump increased above the drain inlets as a result, which prevented the drains from draining freely into the sump. This resulted in reduced hydraulic gradients and hence reduced flow rates within the individual drain segments. Hence the under-drain system did not perform as effectively in 2021 as it has in recent years, implying greater bypass of ARD/ML-impacted groundwater to the creek.

The Phase I Lynx SIS was operated at reduced capacity in 2021, as pumping well PW14-01 was not operating at all in 2021. Moreover, pumping rates for pumping well PW14-04 were estimated to be around 35% less than in 2020 due to an increased set level. Note that data loggers were not recording in 2021 and captured groundwater volumes and loads are approximate estimates only based on performance in previous years. The combined Zn load captured by the Phase I Lynx SIS in 2021 is estimated to be approximately 16 t, which represents about 58% of the total Zn load captured by the Old TDF under-drains and delivered to the Superpond via Pumphouse No.4. The Phase I Lynx SIS therefore captured substantial contaminant loads from groundwater in the Lynx Reach in 2021, albeit lower loads than in 2018, 2019, and 2020. In recent years, the system appears to have reduced contaminant loads in groundwater to the Old TDF under-drains. This could not be confirmed for 2021, due to the change in operation of the Old TDF under-drains, which has affected groundwater quality near the under-drains and water quality in Myra Creek.

In early 2021, the Interim Phase II Lynx SIS operated intermittently and pumping ceased some time in August when water levels decreased below the well screens and the system was subsequently disconnected. Also, it appears that pumping wells PW18-01 and PW18-02 did not operate in 2021. An estimated 77,000 m^3/month of impacted groundwater and 138 kg/month Zn were captured by the Interim Phase II Lynx SIS in 2021. This Zn load is less than 1% of the Zn load recovered by the Phase I Lynx SIS over the same period. The load captured by the Interim Phase II Lynx SIS is therefore much smaller than the load captured by the Phase I Lynx SIS, although the system has proven to be effective in capturing moderately impacted groundwater, particularly during the winter months.

Data loggers at the Phase I Lynx SIS pumping wells were restarted in March 2022 and recording of flow and level data resumed. A contractor is further scheduled to provide comprehensive maintenance and repairs for the PW14 pumps to ensure operation at full design capacity. This includes repairs at PW14-01 which is currently not operating and an inspection of the well screen at PW14-04 which operates at reduced capacity. MFM is in the process of recommissioning the Phase II Lynx SIS including repairs to the PW18 pumps that may have been damaged by freezing.

RGC recommended MFM to decrease the sump level at Pumphouse No. 4 and operate the system at previously established settings that maximize capture of ARD/ML-impacted groundwater. MFM is in the process of changing the operation of the under-drains and RGC will be on site in April 2022 to monitor the hydraulic response.

Water Quality Impacts to Myra Creek

Water quality in Myra Creek deteriorated in 2021 due to the changes in operation of the system of Old TDF under-drains (as of February 2021), which allowed greater bypass of ARD/ML-impacted groundwater to the creek. The highest metal concentrations in Myra Creek (up to 350 µg/L Zn-t) were observed in late August 2021 when streamflows were lowest and subsequently decreased during the wetter months of late 2021. Metal concentrations in late 2021 remained higher than observed in early 2021 before the change in the operation of the Old TDF under-drain system. Further monitoring is needed to confirm whether water quality will improve once the under-drain system is operated at the recommended settings and if any improvement will be realized once the Phase I Lynx SIS is operated continuously and at full capacity.

2021 Reclamation Activities Completed

Waste rock from WRD2 in the Upper Lynx Open Pit was removed in 2021 as part of open pit reclamation. The highwall of the pit was machine-scaled as it was exposed and stability was assessed by an engineer from Onsite Engineering as waste rock was removed. The relocation of waste rock from WRD3 (in the Upper Lynx Open Pit) will continue in 2022. Planning for the reclamation of the Upper Lynx Open Pit continued in 2021, as MFM works towards returning the area to an exposed pitwall above the Lynx TDF.

An Elk Collaring program and a cover trial for the Lynx TDF closure cover commenced in 2021 as part of reclamation research. Also, the 5-Year Mine and Reclamation Plan was submitted in January 2021 and is under review by the EMLI now. Public engagement on the plan is ongoing by MFM. Further details on these reclamation activities are provided in Section 6.

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List of Acronyms and Abbreviations

ABA	Acid Base Accounting
AP	Acid Generating Potential
ARD	Acid Rock Drainage
CRAB	Core Rack Area Borrow
MDMER	Metal and Diamond Mine Effluent Regulations
EMLI	Ministry of Energy, Mines and Low Carbon Innovation
EMS	Environmental Management System
FLNRO	Forests, Lands, Natural Resource Operations
IEG	Integral Ecology Group
MAC	Mining Association of Canada
ML	Metal Leaching
MECC	Ministry of Environment and Climate Change Strategy
MERS	Mine Effluent Reporting System
MFM	Myra Falls Mine
ML	Metal Leaching
MVA	Myra Valley Aquifer
NOD	New Outer Drain
NP	Neutralization Potential
NPR	Neutralization Potential Ratio
OMS	Operation, Maintenance, and Surveillance
PAG	Potentially Acid Generating
QA/QC	Quality Assurance/Quality Control
RGC	Robertson GeoConsultants Inc.
SIS	Seepage Interception System
TDF	Tailings Disposal Facility
TDG	Transportation of Dangerous Goods

TSM	Towards Sustainable Mining
WHMIS	Workplace Hazardous Materials Information System
WLBM	Water and Load Balance Model
WQG	Water Quality Guideline
WRD	Waste Rock Dump

MYRA FALLS MINE

2021 RECLAMATION REPORT FOR MINES ACT PERMIT M-26

1 INTRODUCTION

1.1 GENERAL

This is the 2021 Reclamation Report for the Myra Falls Mine (MFM). This report was prepared by Robertson GeoConsultants Inc. (RGC) and MFM's Environment Department as part of annual reporting for *Mines Act* Permit M-26.

1.2 TERMS OF REFERENCE

MFM is a base metal mine located at the south end of Buttle Lake on Vancouver Island approximately 90 km southwest of the city of Campbell River. The mining and milling operations primarily produce zinc, copper, and lead concentrates that are trucked to a port terminal in Campbell River for shipment abroad. The mine has been operated since 1966 by various operators and is located within the Strathcona-Westmin Provincial Park (**Figure 1-1**). The park was partitioned from the Strathcona 'Class A' Provincial Park in 1965 and designated as a 'Class B' provincial park due to industrial activity. Strathcona-Westmin 'Class B' Provincial Park covers the area permitted for the mine to carry out its mining operations. Myra Falls also operates under Park Use Permits issued by B.C. Parks. These permits authorize the use of 'Class B' parklands for mining, power generation, power transmission, and roads. The current land use in Myra Valley is for mining and mining-related purposes.

The 3,328-hectare (ha) area of Strathcona-Westmin 'Class B' Provincial Park is held as crown grants and mining leases, issued under the *Mines Act* by the Ministry of Energy, Mines, and Low Carbon Innovation (EMLI). The mine property is comprised of six Crown-granted mining leases all wholly owned by Myra Falls Mine Ltd. (see **Figure 1-1** for mining leases). Site offices are located within L1344 Being Bear Paw Mineral Claim, Clayoquot District. Physiographically, the mine site is located in the lower reaches of the Myra Creek valley. Myra Creek flows eastward through the site before discharging into Buttle Lake about 1.5 km downstream of the original (or "Old") Tailings Dam Facility (TDF). Thelwood Valley is south of Myra Valley and is largely unaffected by mining activities. There is a hydroelectric dam (Jim Mitchell Dam) and related access roads in Thelwood Valley and the Price 4-level, Price 5-level, and Price 13-level portals are located in Thelwood valley. The mine site is located at an elevation of 300 to 350 m above mean sea level (m asl). Elevations on site are also adjusted to maintain positive elevations for the underground workings[1]. Mean annual precipitation (MAP) is 2,549 mm, about 80% of which occurs from October through March.

Figure 1-2 shows the key features of the mine site, including the Waste Rock Dumps (WRDs), the original (or "Old") TDF, the Lynx TDF, and the mill and other mine-related infrastructure, including the Superpond and the Myra Ponds that comprise the site's water treatment system. WRD1 is the largest of the historic WRDs and is partially buried by tailings in the Old TDF. Some of the waste rock in the other historic WRDs, e.g., WRD2, WRD3, is being re-located as part of raising the Lynx TDF berm. The current General Site Plan, as of December 31st, 2021, is provided in **Figure 1-3** (as required). The Surge Pond[2] in the former Reclaim Sand Area (RSA) and various portals to the Lynx and Myra underground workings are shown. Underground mine workings (not shown) are extensive within Myra Valley and extend to Thelwood Valley. Further descriptions of site components are provided as necessary throughout this report and in MFM's Operations, Maintenance, and Surveillance (OMS) manual (MFM, 2022).

Groundwater quality in the Myra Valley Aquifer (MVA) and Myra Creek is impacted by Acid Rock Drainage/Metal Leaching (ARD/ML). The historic WRDs, e.g. WRD1, and Lynx berm, which is constructed primarily using sulfide-rich waste rock, are the largest sources of ARD/ML to groundwater in the MVA and, in turn, to Myra Creek. Tailings are a minor source of contaminants related to ARD/ML. Flows of underground mine water only affect groundwater quality locally in some areas of the site. Further details on contaminant sources and groundwater and surface water quality impacts are provided in RGC (2020). RGC (2020) documents the latest conceptual hydrogeological model and numerical groundwater model for the site, and the Site-Wide Water and Load Balance Model (WLBM), which simulates contaminant concentrations in Myra Creek from 2012 to 2019.

MFM operates a Site-Wide Seepage Interception System (SIS) to capture ARD-impacted groundwater from the MVA downgradient of the major contaminant sources on site. The SIS consists of the Old TDF under-drain system, the Phase I Lynx SIS, and the Interim Phase II Lynx SIS. The Old TDF under-drain system

[1] 3,048 m (or 10,000 feet) is added to all elevations on site or in any mine plans or drawings. MFM also maintains a local grid coordinate system that is translated and rotated relative to UTM Zone 10. The origin of the mine coordinate system is UTM 10 5494371.316N 308000.103E and the coordinate grid is rotated 50.12° relative to the UTM grid (or 48° relative to true north).

[2] The Reclaim Sand Area was converted to a Surge Pond in 2016. The Surge Pond receives precipitation runoff (contact water) from the Old TDF. The pond is lined and was installed in tailings.

is comprised of the Tailings Inner Drain, the original (or "Old") Outer Drains, and the New Outer Drain (NOD). The NOD was constructed in 2008 to augment the performance of the Old Outer Drains and ensure there was an operable under-drain system in case the original drains were damaged during construction of the Seismic Upgrade Berm for the Old TDF. The Phase I Lynx SIS consists of a fence of pumping wells (PW14-01, PW14-03, and PW14-04) screened in permeable sediments of the MVA in the Mill area and near the Lynx TDF. These pumping wells were installed in 2014 and have been operating (near continuously) since September 30th, 2017. The Interim Phase II Lynx SIS consists of a fence of shallow pumping wells (PW18 series) downstream of the Car Bridge. The Interim Phase II Lynx SIS has operated intermittently since March 2019. The Interim Phase II Lynx SIS is intended to capture shallow acidic seepage that was observed to express along the creek bank immediately downgradient of the Car Bridge following high rainfall periods (RGC, 2018). This system was installed following consultation with the MECC when the seepage was discovered.

ARD/ML-impacted groundwater, mine water, and precipitation runoff are directed to the water treatment system for treatment. The system is a Low-Density Sludge (LDS) system that consists of two lime silos, two sets of mixing/reactor tanks, a primary settling pond called the Superpond, and a series of six Polishing Ponds on the south side of Myra Creek. Treated effluent is discharged to Myra Creek from the right hand (south) creek bank, as per Effluent Permit PE-6858. Water quality in Myra Creek is impacted, to some degree, by the discharge of treated effluent, which accounts for approximately 20% of the Zn load in Myra Creek downstream of the site. Contaminant loads from ARD/ML-impacted groundwater to the creek account for most of the remaining Zn load in Myra Creek (see RGC, 2020). Reducing contaminant loads in Myra Creek during mining operations is a key objective of the Site-Wide SIS, hence details on MFM's efforts in this regard are provided in this report. Cd, Cu, and Zn are the key parameters of concern in Myra Creek, as concentrations of each consistently exceed acute (and chronic) provincial Water Quality Guidelines (WQGs). Concentrations of each of these metals can also exceed WQGs for Buttle Lake. Further details are provided in Section 4 of this report and in the 2021 Monitoring Report for Effluent Permit PE-6858.

Reclamation activities and aspects of the mining operation and construction activities that are relevant to environmental conditions at surface are detailed in this report. Most of the surface construction activities in 2021 (and recent years) have focused on constructing the Lynx TDF embankment berm. The berm is being constructed from existing waste rock that is sourced primarily from WRD2 and WRD3 and Run-of-Mine (ROM) waste rock that is generated by mining activities. Further details on dam construction are provided in Wood (2022) and references therein. Waste rock volumes and the geochemical characteristics of re-located waste rock and other materials are provided in Section 2 of this report.

1.3 REPORT OBJECTIVES

The objectives of this report are to:

- Summarize construction and mining activities in 2021, as required for Permit M-26.

- Summarize the recent performance of the Site-Wide SIS and water quality in Myra Creek.
- Review required water monitoring results for Permit M-26.
- Summarize reclamation activities completed in 2021.

1.4 Scope of Work

MFM's Environment Department requested that RGC organize the preparation of the 2021 Reclamation Report and prepare sections that pertain to waste rock geochemistry, recent SIS performance, and environmental impacts due to ARD. RGC compiled and interpreted the geochemical data gathered by MFM in 2021, as per the ARD/ML Management Plan. Nicole Pesonen (MFM's Manager of Environment and Community Engagement) prepared the tables that are required by the EMLI for the Annual Reclamation Report and related text, and Section 5, which describes reclamation activities completed in 2021. Seepage sampling and groundwater quality monitoring of selected wells is required by *Mines Act* Permit M-26. The water quality results that are required are intended to provide some indication of the performance of the Old TDF under-drains and groundwater bypass to the MVA downgradient of the under-drains and Myra Creek. This is needed to provide the EMLI with some indication of current water quality impacts due to mine waste disposal at surface and the effectiveness of the SIS that is operating. An overview of the performance of the Site-Wide SIS, with an emphasis on groundwater flows and contaminant loads captured to support the discussion of recent water quality trends for groundwater and Myra Creek, is therefore provided in this report. A comprehensive assessment of SIS performance that includes an evaluation of the hydraulic performance of the system is beyond the scope of this report.

1.5 Report Organization

This report consists of the following sections:

- *Section 1. Introduction.* This section provides background information and outlines the objectives and scope of this report.
- *Section 2. Construction and Mining Operations.* This section summarizes construction and mining operations in 2021 and provides the key tables that are required by the EMLI in a reclamation report. The geochemical characteristics of mine waste materials produced and/or re-located in 2021 are also discussed.
- *Section 3. Effluent Monitoring Results.* This section summarizes effluent water quality in 2021 with respect to MDMER limits and summarizes key events and incidents in 2021.
- *Section 3. Water Quality Monitoring Results and SIS Performance.* This section provides seepage and groundwater quality monitoring results that are required for Mines Act Permit M-26. A discussion of SIS performance, with an emphasis on flows and loads captured, is provided to support the discussion of recent water quality trends for groundwater and Myra Creek.

- *Section 5. Reclamation Activities.* This section details reclamation activities completed in 2021, including vegetation monitoring, erosion and sediment control activities, and ongoing reclamation research.
- *Section 6. Summary.* This section summarizes key monitoring results and reclamation activities completed in 2021.

1.6 Company Info and Key Contacts

The operating company is registered as ***822638-5, Myra Falls Mine Ltd.*** The company contacts for the location are:

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Environment & Community Engagement Manager

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Other key contact information for Myra Falls Mine is as follows:

Trafigura Branch Office:

Trafigura PTE Ltd.

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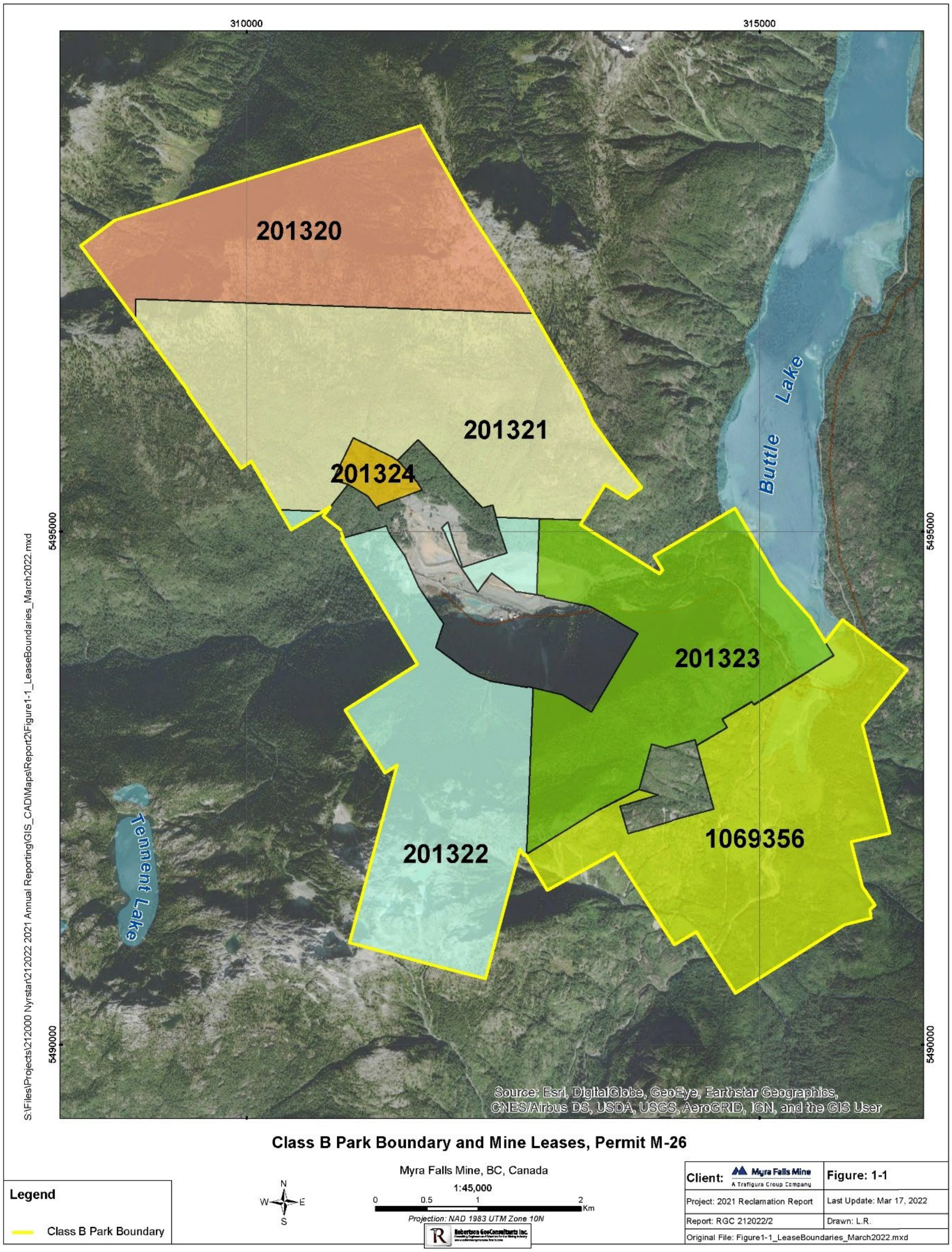
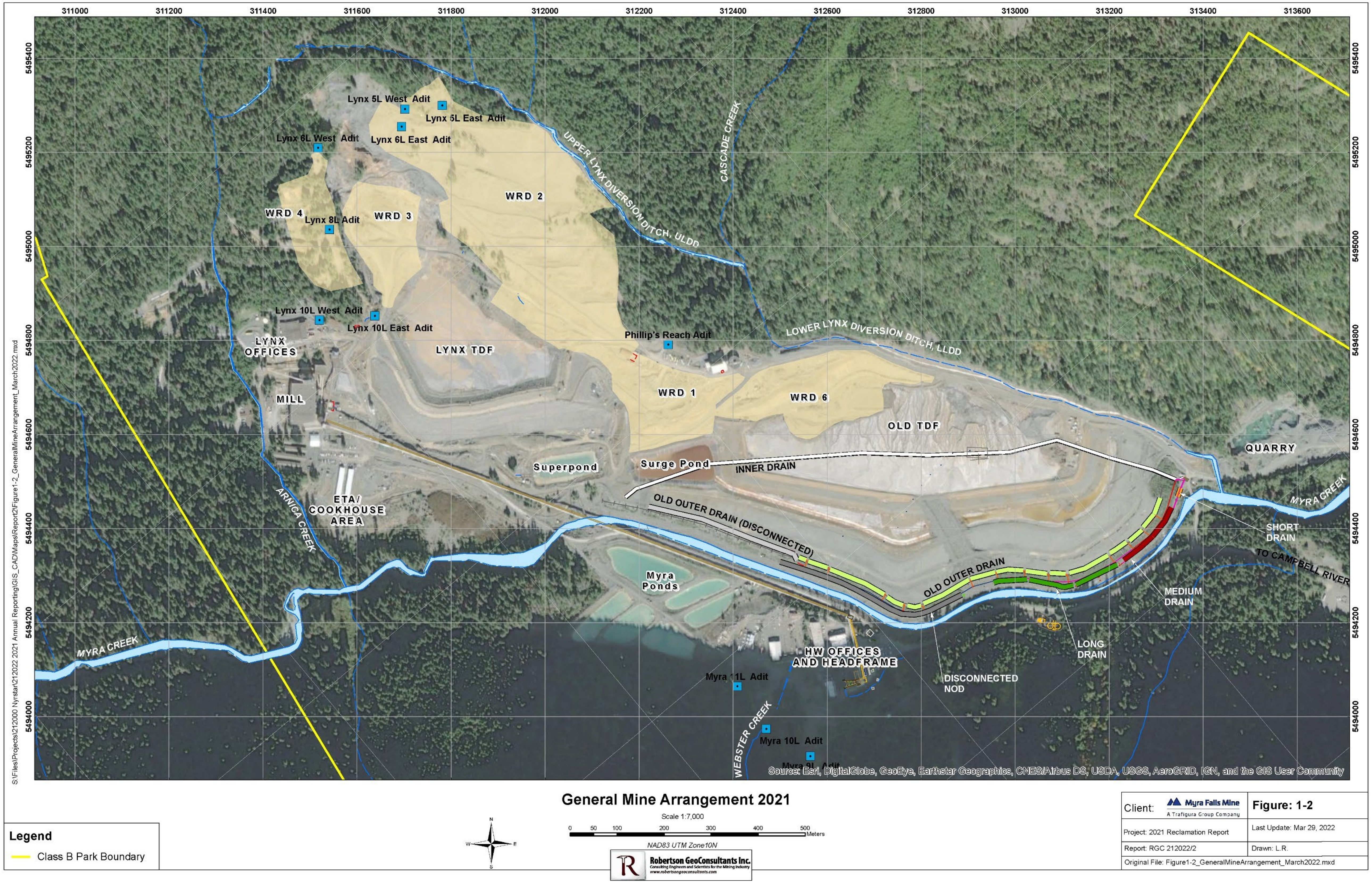
1207 Geneva

Switzerland



Class B Park Boundary and Mine Leases, Permit M-26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Lynx 5L East Adit
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Lynx 6L East Adit
WRD 2
WRD 4
Lynx 8L Adit
WRD 3
UPPER LYNX DIVERSION DITCH, ULDD
CASCADE CREEK
Lynx 10L West Adit
Lynx 10L East Adit
LYNX OFFICES
LYNX TDF
Phillip's Reach Adit
LOWER LYNX DIVERSION DITCH, LLDD
MILL
WRD 1
WRD 6
OLD TDF
QUARRY
Superpond
Surge Pond
INNER DRAIN
ETA/ COOKHOUSE AREA
ARNICA CREEK
OLD OUTER DRAIN (DISCONNECTED)
OLD OUTER DRAIN
MYRA CREEK
SHORT DRAIN
TO CAMPBELL RIVER
MEDIUM DRAIN
Myra Ponds
LONG DRAIN
HW OFFICES AND HEADFRAME
DISCONNECTED NOD
Myra 11L Adit
WEBSTER CREEK
Myra 10L Adit
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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General Mine Arrangement 2021
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NAD83 UTM Zone10N
Robertson GeoConsultants Inc.
Legend
Class B Park Boundary
Client: Myra Falls Mine A Trafigura Group Company
Figure: 1-2
Project: 2021 Reclamation Report
Last Update: Mar 29, 2022
Report: RGC 212022/2
Drawn: L.R.
Original File: Figure1-2_GeneralMineArrangement_March2022.mxd

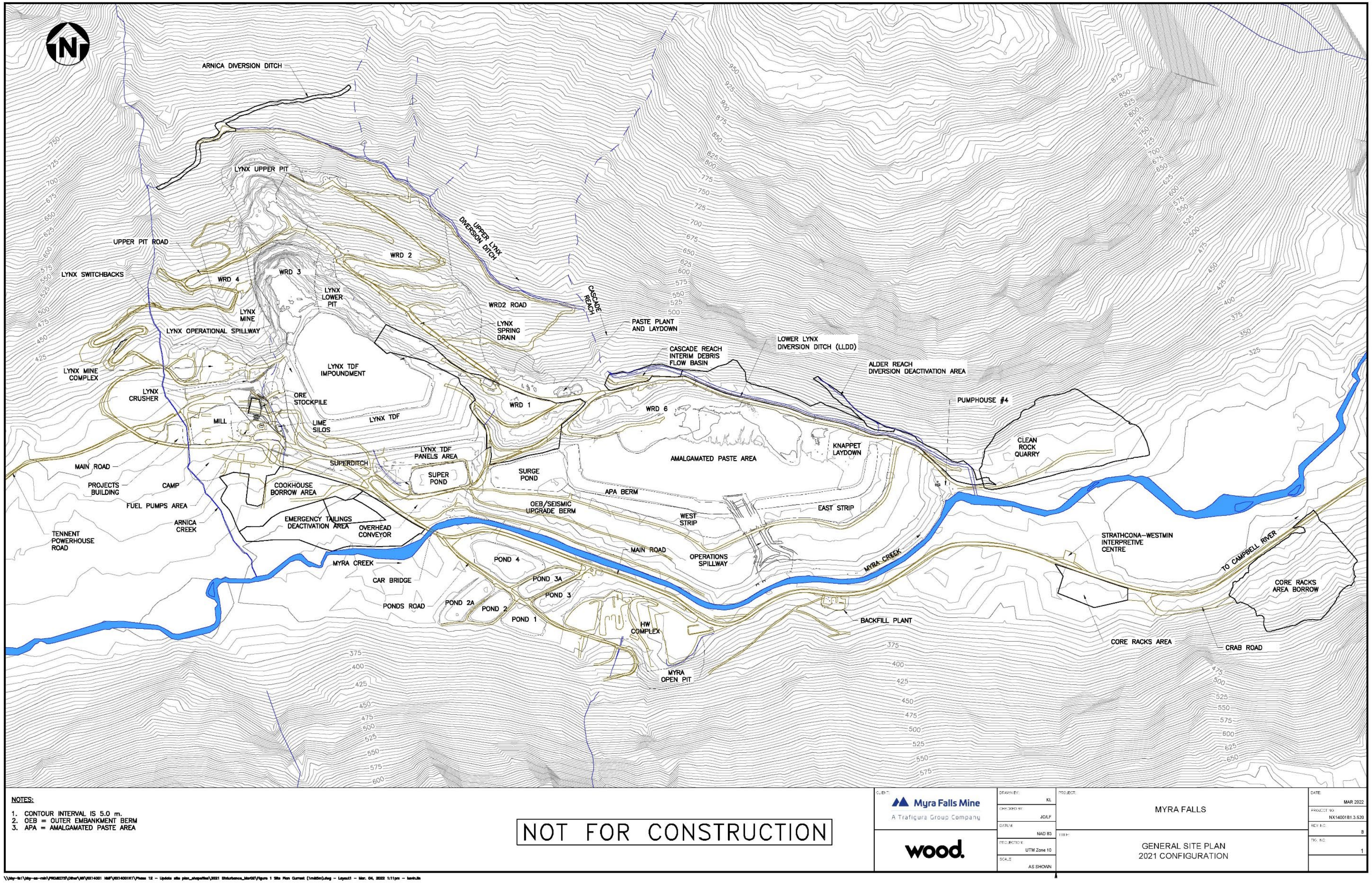


Figure 1-3. General Site Plan, as of December 31st, 2021

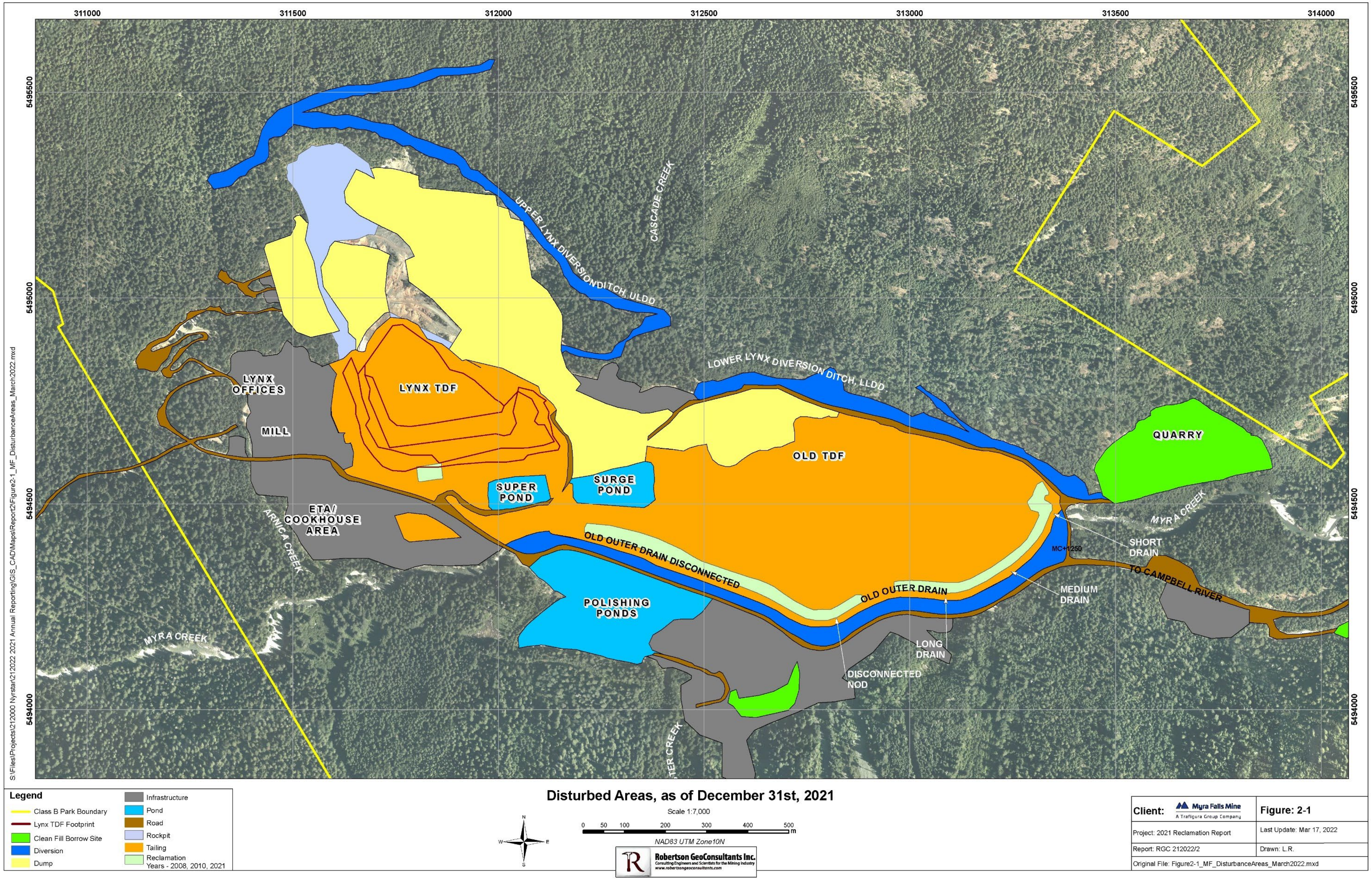
2 CONSTRUCTION AND MINING OPERATIONS

2.1 MINING AND MILLING PRODUCTION – 2021

MFM restarted operations in 2018 and has continued to ramp up toward full production through 2021. Myra Falls targeted an increased monthly production to 55,000 tonnes of ore per month in 2021, with further ramp-up to full production. MFM achieved an average of 42,400 tonnes per month overall in 2021, with a marked improvement toward the latter part of the year where the average increased to 53,600 tonnes per month. A total of 741,320 tonnes were mined in 2021, as depicted in **Table 2-1** (EMLI Table 3).

The Price Zone was actively mined throughout 2021, with a total of 95,732 tonnes mined. 78,110 tonnes of ore were transported by cart through the Price 13 Portal and hauled to the mill stockpile via surface haul truck; 17,622 tonnes of waste were mined in Price and utilized to backfill mined out stopes. The HW Zone includes the Marshall, Ridge and Battle Gap ore bodies. A total of 557,630 tonnes were mined from the HW Zone in 2021. 430,521 tonnes of ore and 215,067 tonnes of waste were mined in the HW area. Effectively, all of the waste mined in the HW zones was trucked to surface. No active mining took place in the Lynx or Myra zones underground in 2021.

A total of 501,232 tonnes were milled in 2021, as depicted in **Table 2-1** (EMLI Table 3). The EMLI Table 4 has not been included, as no specialized milling was completed in 2021. Samples were taken from the milled materials for Acid Base Accounting (ABA) but results have not yet been reported by the laboratory. At currently anticipated mining and depletion rates, a mine life of at least six years is expected. This estimate would be entirely dependent on forecasted and prevailing metal prices, currency exchange rates, as well as fluctuating costs of mining and processing.



Disturbed Areas, as of December 31st, 2021

Table 2-1 (EMLI Table 3)

Monthly Mining and Milling Production, as of December 31st, 2021

COMPANY: MYRA FALLS MINE LTD. PERMIT NO.: M-26

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mining Production (tonnes)													
Price Ore	5,190	5,124	9,807	3,667	5,627	2,037	7,411	4,298	9,783	9,695	6,834	8,637	**78,110**
Pr. Waste	2,436	2,355	6,734	3,717	1,830	550	0	0	0	0	0	0	**17,622**
HW Ore	27,773	19,643	30,825	36,288	37,807	21,532	39,781	37,406	47,448	33,047	57,012	41,960	**430,521**
HW Waste	22,654	21,598	25,741	25,910	21,278	6,478	18,250	15,256	17,477	13,106	12,977	14,342	**215,067**
Totals	**58,053**	**48,720**	**73,107**	**69,582**	**66,542**	**30,597**	**65,442**	**56,960**	**74,708**	**55,848**	**76,823**	**64,939**	**741,320**
Milling Production (tonnes)													
MFM Mill	34,324	16,665	38,925	45,567	48,454	22,151	55,540	52,006	50,077	44,964	45,142	47,417	**501,232**
Milling Total	**34,324**	**16,665**	**38,925**	**45,567**	**48,454**	**22,151**	**55,540**	**52,006**	**50,077**	**44,964**	**45,142**	**47,417**	**501,232**
Paste Tailings (tonnes)													
Lynx TDF	25,237	3,738	20,849	30,245	21,654	17,866	40,268	31,557	34,591	29,047	25,296	34,749	**315,097**
Paste Underground	6,386	11,660	12,222	9,157	20,499	2,366	9,455	15,039	10,990	10,990	15,108	7,684	**131,556**
Tailings Total	**31,623**	**15,398**	**33,071**	**39,402**	**42,153**	**20,232**	**49,723**	**46,596**	**45,581**	**40,037**	**40,404**	**42,433**	**446,653**

Milling Capacity	2,040	tonnes per day

Include:

- All mining locations (both underground and surface, including borrow areas)
- All milling locations (both on-site and off-site)

2.2 Surface Development and Disturbed Areas

2.2.1 *Existing Surface Development – Status 2021*

Surface development to date is shown in **Figure 2-1**. In 2021, the direct disturbance footprint totals 184.9 ha, excluding hydro dam infrastructure, which is outside the Mine's Act permit boundary permitted through BC Parks under Park Use Permit 102663). The majority of the disturbance footprint is within Myra Valley with some additional mining infrastructure in the adjacent Thelwood Valley. The previous estimate of the direct disturbance footprint (198.7 ha) was re-assessed as part of the Habitat Loss Mitigation Plan submitted in 2019 (see Wood, 2019).

Approximately one-third (31.6%) of the direct disturbance footprint is related to the TDFs. The original, or "Old" TDF is near the eastern boundary of the site, operated from 1984 to 2011 and is inactive. The Lynx TDF has operated since 2008 and is the only active surface tailings on site. Tailings have been deposited in one of the two TDFs since 1984, when tailings deposition to the south end of Buttle Lake ceased. WRDs represent about the second largest (15.6%) component of the direct disturbance footprint. Other components of the direct disturbance footprint, including roads and mine-related infrastructure are provided in **Table 2-2 (EMLI Table 1)**.

WRD1 is the largest of the WRDs and is partially buried beneath tailings in the Old TDF. WRD2 is located along the hillslope to the north of the Superpond and Lynx TDF and WRD3 is located near the back of the Lynx pit. Most of the waste rock from WRD3 has been removed, however, as it is being used to construct the Lynx TDF embankment berm. WRD7 was mined out for construction materials in 2019. WRD6 is located above the road to the Paste Plant on top of the exposed portion of WRD1.

The Clean Quarry expansion was approved in 2020. This resulted in a small increase in the overall footprint of the site, with logging of approximately 2.2 ha in January 2021. Construction efforts focused on areas within the existing mine footprint, in particular the Lynx TDF dam raise. The raise was completed using some waste rock from underground, waste rock stored in construction stockpiles located on the Old TDF, WRD1 and WRD6, and re-purposed waste rock from Waste Rock Dumps 2 and 3. Boulders from the WRDs were crushed as required for use as fine materials as needed for bedding material and to blend with waste rock when it did not meet the material specifications for fine content.

2.2.2 *Projected Surface Development (Next Five Years)*

Mining at Myra Falls is confined to underground operations. Future surface development is limited to surface waste facilities, infrastructure upgrades, and the development of clean fill borrow sites. Semi-annual berm raises of the Lynx TDF are planned to continue over the life of the facility (estimated five years). Over the next five years, it is anticipated that the Lynx Berm will continue in incremental lifts to its ultimate permitted elevation and footprint utilizing both waste rock directly from underground and excavated from the WRDs 2, 3 and 6 under the stabilization plan for closure of those facilities (Amec Foster Wheeler, 2017). Lifts will be constructed to the final outer shell including the closure cover as depicted in the Lynx Berm Face Cover Design (Wood, 2020).

It is anticipated that over the next four years the dam construction schedule will utilize the majority of waste rock brought to surface. The Lynx Berm will continue to act as the active waste rock dump during the majority of the year. Wood has provided specifications on material placement outside of the normal construction window that will allow MFM to maximize the productivity of these efforts in off-season conditions. It is expected that WRD3 will be mined to completion in 2022, with WRD2 used as the primary construction material in 2023 and 2024, when the available excess waste is expected to be largely exhausted from this source.

The Clean Quarry expansion will continue with topsoil salvage in 2022/2023, and rock quarry activities as needed based on construction activities each year following. This expansion will facilitate the clean-fill and drainage rock components of the Old TDF Closure Cover as well as the Lynx TDF Closure Spillway, Lynx Spring Drain, and Lynx Closure Cover. MFM will reclaim these areas to the maximum extent possible annually, as described in the Environmental Protection Program section.

Table 2-2 (EMLI Table 1)

Summary of Areas Disturbed and Reclaimed, as of December 31st, 2021

DISTURBANCE	MINING		RECLAMATION								LAND USE OBJECTIVES**
	AREA DISTURBED (ha)		AREA RECONTOURED (ha)		AREA SEEDED/PLANTED (ha)		AREA FERTILIZED (ha)		AREA REVEGETATED* (ha)		
	2021	TOTAL***	2021	TOTAL***	2021	TOTAL***	2021	TOTAL***	2021	TOTAL***	
Waste Dumps	-1.1	28.8	3.4	9.0	0	0	0	0	0	0	
Tailings Facilities	-2.2	58.4	0	1.2	0.4	4.2	0.4	3.4	0.4	1.4	
All Infrastructure Features	-0.3	30.8	0	0	0	0	0	0	0	0	
Roads	0	22.2	0	17.3	0	21.3	0	21.3	0	14.3	
Rock Pits	0.1	6.6	0	0	0	0	0	0	0	0	
Stockpiles	0	n/a	0	0	0	0	0	0	0	0	
Clean Fill Borrow Sites	3.5	13.4	0	1.4	0	1.4	0	0	0	0	
Stream Diversions	0	14.4	0	1.6	0	0	0	0	0	0	
Water Holding and Treatment Ponds	0	10.2	0	11.7	0	7.5	0	7	0	7	
Total	**0.1**	**184.9**	**3.4**	**42.2**	**0.4**	**34.4**	**0.4**	**31.7**	**0.4**	**22.7**	

EXEMPT e.g., pit high walls	6.6	ha

Please specify what the exempt areas are (with maps) in the body of the annual reclamation report including rationale as to why they are considered exempt. This number should already be included in the total disturbed ha.

* In order for an area to be recorded as "revegetated", it must have supported vegetation that will lead to the designated land use objective for at least one year. Please provide monitoring data in the Annual Reclamation Report to support the areas reported here.

** Specify land use. Options include: forestry, grazing, wildlife habitat, recreation, agricultural, industrial, residential, and other. Indicate all options that apply.

*** Total up to December 31st, 2021.

2.3 MINE WASTE CHARACTERIZATION RESULTS

A total of forty-four (44) samples were collected and submitted for Acid Base Accounting (ABA) and near-total metal concentrations (by Aqua Regia digestion) in 2021. ABA results for waste rock samples and samples of sludge from the Superpond and Price Pond collected in 2021 are provided in **Table 2-3**. ABA results for tailings are provided in **Table 2-4**. Near-total metal concentrations for samples collected in 2021 are provided in **Table 2-5**. Neutralization Potential (NP), Acid Generating Potential (AP), S_{total}, and Neutralization Potential Ratio (NPR) values for waste rock and tailings samples are plotted in **Figure 2-2** and **Figure 2-3**. Values for samples collected in 2020 are plotted with the values for 2021 for comparison. Previous data and information on the terms above are provided in the ARD/ML Management Plan. Further details on the mine waste characterization results for 2021 are provided in the sub-sections below.

2.3.1 *Run-of-Mine Waste Rock and Development Rock*

The six samples of waste rock from the APA stockpile collected in 2021 represent ROM waste rock or waste rock from WRD2 or WRD3 that was too wet to be used for construction. These materials cannot be differentiated however and no fresh samples of ROM waste rock from Phillips Reach or development rock were collected in 2021. Most of the approximately 215,000 tonnes of waste rock used to construct the Lynx TDF berm in 2021 (see **Table 2-6**) is ROM waste rock from Phillips Reach. The lack of sampling of this material is inconsistent with the ARD/ML Management Plan, which recommends one sample per 10,000 m3 of waste rock brought to surface from the underground.

2.3.2 *Existing (Re-Located) Waste Rock*

Approximately 888,000 t (or approximately 444,000 m^3) of existing waste rock from the historic WRDs was re-located to the Lynx TDF berm in 2021 (see Section 2.4). Approximately 85% of the waste rock re-located was re-located from WRD2, with far lesser amounts re-located from WRD1, WRD3, and WRD6. Twenty-five samples were collected from WRD2 and WRD3 during the re-location of waste rock from these dumps to the Lynx TDF berm. This represents approximately one sample per 15,500 m^3 of waste rock re-located, so fewer than recommended in the ARD/ML Management Plan, i.e., one sample per 10,000 m^3. Also, most of the samples were collected during sampling campaigns on June 11th and October 7th, so there is some bias towards the waste rock re-located on these days.

Approximately 56% of the waste rock samples collected from WRD2 and WRD3 in 2021 are classified as Non-PAG material (NPR > 2). This is a higher percentage of Non-PAG material than re-located in 2020, when almost all the waste rock re-located was higher sulphide PAG material **(Figure 2-2).** The sample collected from WRD3 in 2021 and each of the samples from WRD6 are classified as PAG material. Each of these samples is characterized by no appreciable NP and a very low (<0.005) NPR value. The waste rock re-located from WRD3 and WRD6 in 2021 is characterized by substantial S_{SO4}, which indicates there is substantial existing acidity in these partially-oxidized materials. This is consistent with the strong acid generating characteristics of these materials, particularly the waste rock from WRD6.

2.3.3 *Water Treatment Sludge and Sludge from Price Pond*

A sample of water treatment sludge from the Superpond was collected in January 2021 and a sample of sludge from the bottom of the Price Pond was collected in April 2021. Both samples are classified as Non-PAG material and are characterized by elevated near-total metal concentrations (see Table 2-5).

Table 2-3

ABA Results for Waste Rock and Water Treatment Sludge Samples, 2021

Sample ID	Sampling Date	Paste pH	S_{total} wt%	S_{SO4} wt%	$S_{sulphide}$ wt%	AP kg $CaCO_3$ eq./t	NP kg $CaCO_3$ eq./t	NNP kg $CaCO_3$ eq./t	NPR	Class
Waste rock (APA stockpile)										
23034	11-Jun-2021	8.0	4.1	0.1	4.0	124	40	-85	0.3	PAG
23035	11-Jun-2021	8.8	0.2	0.03	0.2	6.3	74	68	12	Non-PAG
23036	11-Jun-2021	8.1	3.9	0.1	3.8	118	41	-77	0.3	PAG
23037	11-Jun-2021	8.1	3.0	0.1	2.9	89	47	-42	0.5	PAG
23038	11-Jun-2021	8.2	2.8	0.1	2.7	85	34	-51	0.4	PAG
23039	11-Jun-2021	8.2	3.1	0.1	3.0	94	35	-59	0.4	PAG
	Minimum	*8.0*	*0.2*	*0.03*	*0.2*	*6.3*	*34*	*-85*	*0.3*	-
	Maximum	*8.8*	*4.1*	*0.1*	*4.0*	*124*	*74*	*67.7*	*12*	-
	Average	*8.2*	*2.8*	*0.1*	*2.8*	*86*	*45*	*-41*	*2.3*	-
Waste rock re-located from WRD2										
21261	29-Apr-2021	8.3	0.04	0.03	0.02	0.6	22	22	37	Non-PAG
23027	11-Jun-2021	9.2	3.0	0.01	3.0	95	9.0	-86	0.1	PAG
23028	11-Jun-2021	9.2	3.1	0.01	3.1	97	9.7	-87	0.1	PAG
23029	11-Jun-2021	7.3	3.7	0.6	3.2	99	24	-76	0.2	PAG
23030	11-Jun-2021	7.9	0.2	0.2	0.02	0.6	44	44	73	Non-PAG
23031	11-Jun-2021	8.5	0.7	0.04	0.7	21	28	7.2	1.3	PAG
23032	11-Jun-2021	8.5	0.2	0.03	0.2	5.9	28	22	4.7	Non-PAG
23033	11-Jun-2021	8.1	0.2	0.1	0.2	5.0	39	34	7.8	Non-PAG
30277	19-Jun-2021	8.6	0.3	0.3	0.02	0.5	59	58	112	Non-PAG
30278	23-Jun-2021	8.0	0.8	0.4	0.4	14	62	48	4.5	Non-PAG
4393	30-Jun-2021	7.6	0.4	0.2	0.2	5.3	21	16	3.9	Non-PAG
4397	5-Jul-2021	8.1	1.4	0.5	0.8	26	43	17	1.7	PAG
30281	9-Jul-2021	8.4	0.6	0.4	0.2	7.0	50	43	7.2	Non-PAG
30282	10-Jul-2021	8.5	0.8	0.4	0.4	12	49	37	4.1	Non-PAG
4394	21-Jul-2021	7.8	0.4	0.2	0.1	3.4	20	17	5.9	Non-PAG
30283	21-Jul-2021	7.8	1.8	0.8	1.0	32	38	5.3	1.2	PAG
30288	7-Oct-2021	8.2	1.6	0.5	1.1	35	42	7.1	1.2	PAG
30289	7-Oct-2021	8.2	0.5	0.3	0.1	4.6	41	37	9.1	Non-PAG
30290	7-Oct-2021	8.0	0.8	0.4	0.4	13	48	35	3.7	Non-PAG
30291	7-Oct-2021	6.0	6.1	1.9	4.1	129	4.1	-125	0.03	PAG
30292	7-Oct-2021	7.7	1.0	0.5	0.6	18	31	12	1.7	PAG
30293	7-Oct-2021	7.9	0.4	0.3	0.1	4.0	47	43	12	Non-PAG
30294	7-Oct-2021	7.6	1.2	0.7	0.5	15	27	12	1.8	PAG
30295	7-Oct-2021	7.9	0.4	0.3	0.04	1.1	26	25	22	Non-PAG
	Minimum	*6.0*	*0.04*	*0.01*	*0.02*	*0.5*	*4.1*	*-125*	*0.03*	-
	Maximum	*9.2*	*6.1*	*1.9*	*4.1*	*129*	*62*	*58*	*112*	-
	Average	*8.0*	*1.2*	*0.4*	*0.9*	*27*	*34*	*7.0*	*13*	-
Waste rock re-located from WRD3										
30287	7-Oct-2021	4.0	8.8	2.1	6.7	209	0	-209	<0.005	PAG
	Minimum	-	-	-	-	-	-	-	-	-
	Maximum	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Waste rock re-located from WRD6										
30284	7-Oct-2021	3.5	4.1	2.0	2.1	65	0	-65	<0.005	-
30285	7-Oct-2021	4.0	2.9	1.5	1.4	43	0	-43	<0.005	-
30286	7-Oct-2021	5.1	11	2	8.9	278	0	-278	<0.005	-
	Minimum	*3.5*	*2.9*	*1.5*	*1.4*	*43*	*0*	*-278*	-	-
	Maximum	*5.1*	*11*	*2*	*8.9*	*278*	*0*	*-43*	-	-
	Average	*4.2*	*5.9*	*1.8*	*4.1*	*129*	*0*	*-129*	-	-
Water treatment sludge										
21252*	29-Jan-2021	8.4	2.3	0.6	1.7	54	286	232	5.3	Non-PAG
21259**	8-Apr-2021	8.8	0.1	0.1	0.1	*2.5*	60	57	24	Non-PAG

Note: Red values represent detection limits indicating that the measured parameter is below detection limit.
* Superpond sludge re-located to Myra 1 Pond
** Sludge sample from the Price Pond

2.3.4 *Tailings*

Twelve monthly samples of tailings were collected from the spigot point on the west or south embankment of the Lynx TDF in 2021 (see **Appendix A**)[3]. A sample of beached (raw) tailings was also collected in June 2021. ABA and metal results for this sample and nine monthly samples collected from January to September were available for this report. S_{total} values for samples range from 4.5 to 6.7 wt.% and the samples are characterized by up to 1.3 wt. % S_{SO4}. Hence the majority of S_{total} is unoxidized sulphide ($S_{sulphide}$). Each of the tailings samples is classified as PAG material, with NP values between 18 to 68 kg $CaCO_3$ eq./t with an average of 34 kg $CaCO_3$ eq./t. ABA results for 2021 are consistent with results for 2020.

Table 2-4

ABA Results for Tailings Samples, 2021

Sample ID	Sampling Date	Paste pH	S_{total} wt%	S_{SO4} wt%	$S_{sulphide}$ wt%	AP kg $CaCO_3$ eq./t	NP kg $CaCO_3$ eq./t	NNP kg $CaCO_3$ eq./t	NPR	Class
Beached raw (desiccated) tailings sample from the back of dam										
21268	14-Jun-2021	7.7	6.7	1.1	5.7	177	31	-146	0.2	PAG
Monthly tailings samples										
21251	21-Jan-2021	7.1	5.6	0.1	5.5	173	18	-155	0.1	PAG
21253	19-Feb-2021	8.1	4.6	0.1	4.5	140	68	-72	0.5	PAG
21257	18-Mar-2021	6.7	5.9	0.2	5.7	179	31	-148	0.2	PAG
21260	29-Apr-2021	7.8	6.7	0.1	6.7	208	27	-181	0.1	PAG
21266	20-May-2021	7.6	5.2	0.1	5.0	158	37	-120	0.2	PAG
21267	14-Jun-2021	7.8	5.9	1.3	4.6	143	42	-100	0.3	PAG
21269	17-Jul-2021	7.5	4.5	1.3	3.3	102	28	-73	0.3	PAG
21270	28-Aug-2021	7.2	4.6	0.9	3.7	116	18	-98	0.2	PAG
21271	25-Sep-2021	7.9	4.8	0.7	4.2	130	34	-96	0.3	PAG
21272	29-Oct-2021									
21273	17-Nov-2021									
21274	21-Dec-2021									
	Minimum	*6.7*	*4.5*	*0.1*	*3.3*	*101.9*	*17.8*	*-181.0*	*0.1*	-
	Maximum	*8.1*	*6.7*	*1.3*	*6.7*	*208.1*	*68.3*	*-71.7*	*0.5*	-
	Average	*7.5*	*5.3*	*0.5*	*4.8*	*149.8*	*33.8*	*-116.0*	*0.2*	-

[3] Results for samples collected in for October, November, and December not yet available.

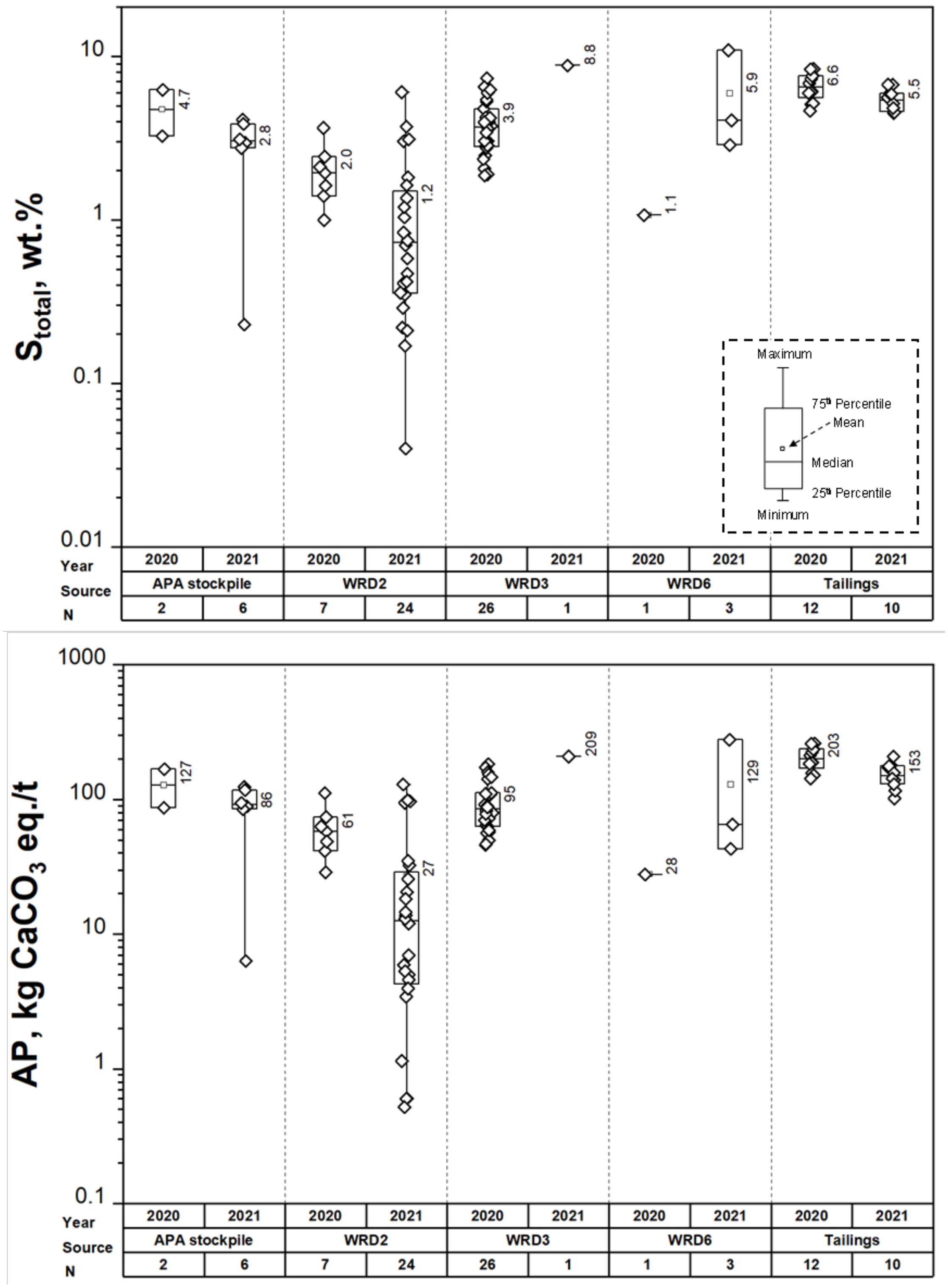


Figure 2-2. S_{total} and AP Values for Mine Waste Materials, 2020 and 2021

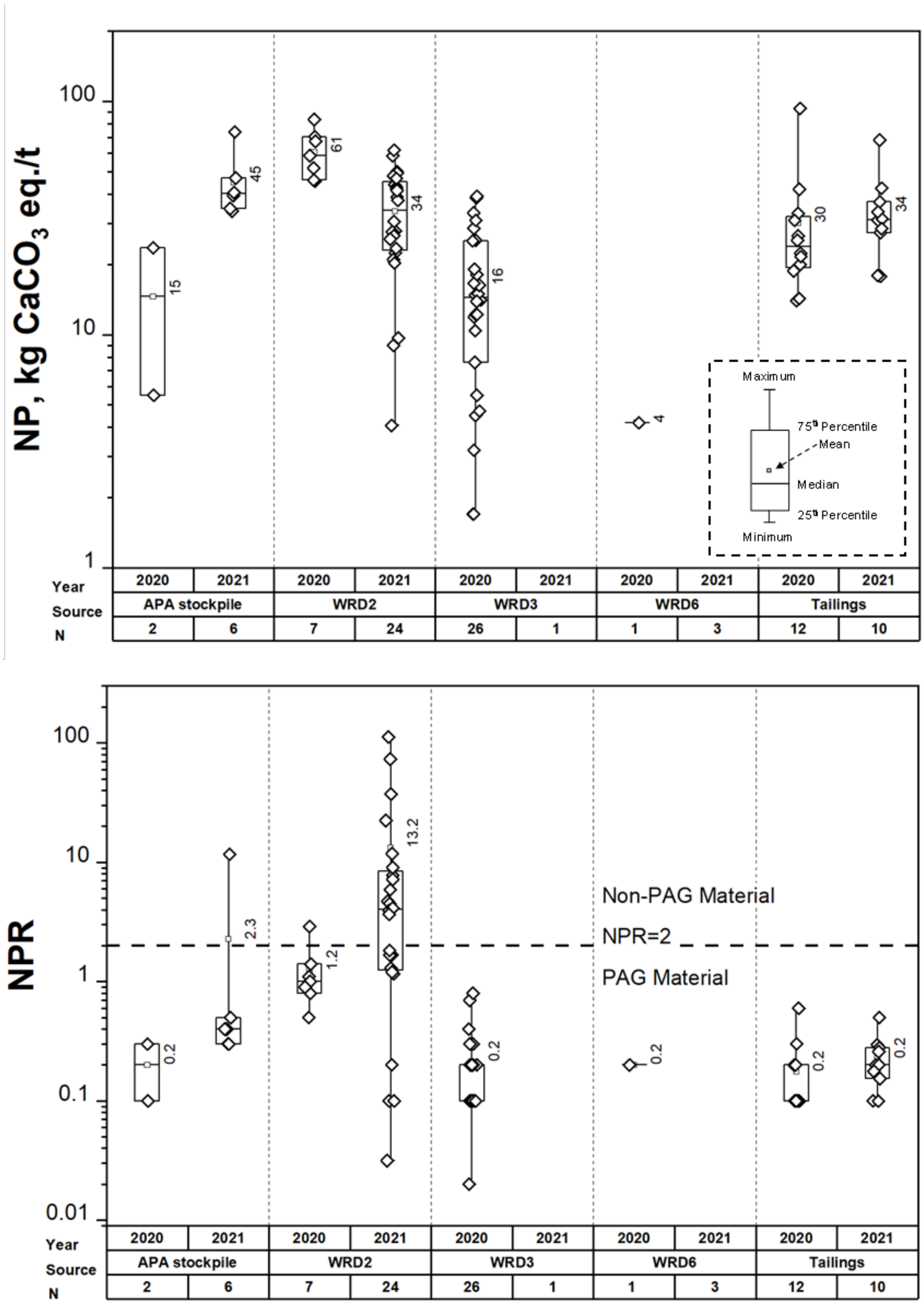


Figure 2-3. NP and NPR Values for Mine Waste Materials, 2020 and 2021. The 2021 NPR values for samples from WRD3 and WRD6 are close to zero, so they are not plotted in boxes.

Table 2-5

Selected Near-Total Metal Concentrations in Waste Rock, Tailings, and Sludge Samples, 2021

Sample ID	Sampling Date	Total S TC000 % 0.02	As AQ200 PPM 0.5	Au AQ200 PPB 0.5	Cd AQ200 PPM 0.1	Co AQ200 PPM 0.1	Cu AQ200 PPM 0.1	Fe AQ200 % 0.01	Mn AQ200 PPM 1	Mo AQ200 PPM 0.1	Ni AQ200 PPM 0.1	Pb AQ200 PPM 0.1	U AQ200 PPM 0.1	Zn AQ200 PPM 1
Waste rock (APA stockpile)														
23034	11-Jun-2021	4.1	106	128	40	13	952	4.6	705	7.9	25	570	0.5	7,817
23035	11-Jun-2021	0.2	8.8	11	1.5	17	86	4.0	945	1.1	19	52	0.2	380
23036	11-Jun-2021	3.9	111	147	73	13	1,422	4.1	670	11	31	1,573	0.7	>10000
23037	11-Jun-2021	3.0	145	60	32	14	859	3.7	691	8.3	41	700	0.8	5,764
23038	11-Jun-2021	2.8	38	66	19	15	705	3.9	857	6.4	33	374	0.6	3,684
23039	11-Jun-2021	3.1	135	90	43	13	1,097	3.7	835	7.6	19	661	0.6	8,174
Waste rock re-located from WRD2														
21261	29-Apr-2021	0.04	3.5	4.8	0.5	21	58	5.1	1,080	0.6	14	17	0.2	197
23027	11-Jun-2021	3.0	44	99	11	16	487	5.5	836	7.6	22	358	0.2	2,134
23028	11-Jun-2021	3.1	41	88	19	19	1,052	5.0	1,048	5.9	24	521	0.2	4,268
23029	11-Jun-2021	3.7	30	99	22	18	676	5.0	1,038	6.0	20	627	0.2	5,264
23030	11-Jun-2021	0.2	8.1	20	1.4	20	107	4.5	979	0.8	19	86	0.1	387
23031	11-Jun-2021	0.7	12	40	10	21	264	4.7	981	1.3	23	315	0.2	2,563
23032	11-Jun-2021	0.2	8.4	11	1.9	17	90	4.0	908	0.7	16	56	0.1	436
23033	11-Jun-2021	0.2	9.4	16	2.4	18	115	4.3	906	1.3	17	84	0.3	553
4394	21-Jul-2021	0.4	7.7	30	3.5	25	182	5.8	1,133	1.0	20	173	0.2	919
30293	7-Oct-2021	0.4	13	25	3.9	21	199	4.9	1,123	1.5	21	167	0.3	846
Waste rock re-located from WRD3														
30287	7-Oct-2021	8.8	139	586	15	10	1,136	9.8	402	26	27	513	0.5	2,772
Waste rock re-located from WRD6														
30286	7-Oct-2021	11	169	698	12	10	946	11	387	28	29	456	0.6	2,303
Beached raw tailings (desiccated) at the back of Lynx TDF														
21268	14-Jun-2021	6.7	168	194	31	11	754	5.6	732	20	39	1,126	1.6	6,525
Monthly tailings samples (Lynx TDF) from spigot														
21251	21-Jan-2021	5.6	175	260	15	6.8	778	4.5	246	16	27	1,098	1.0	4,264
21523	19-Feb-2021	4.6	70	227	13	14	609	4.8	764	13	69	737	1.0	3,282
21257	18-Mar-2021	5.9	155	328	56	9.4	1,170	4.7	747	24	43	3,518	1.6	>10000
21260	29-Apr-2021	6.7	158	437	30	9.4	899	5.2	712	22	38	1,300	2.4	6,582
21266	20-May-2021	5.2	220	165	41	8.7	892	4.5	668	19	33	1,456	2.1	8,079
21267	14-Jun-2021	5.9	163	358	60	9.3	1,254	4.8	782	26	36	2,282	1.6	>10000
21269	17-Jul-2021	4.5	107	280	28	9.1	530	3.8	556	26	49	1,700	2.4	5,997
21270	28-Aug-2021	4.6	94	217	18	7.7	459	4.0	629	15	23	964	1.2	4,181
21271	25-Sep-2021	4.8	94	355	17	10	547	4.6	1,018	26	33	1,003	2.3	4,166
21272	29-Oct-2021													
21273	17-Nov-2021													
21274	21-Dec-2021													
Water treatment sludge														
21252*	29-Jan-2021	2.3	92	234	82	37	2,638	4.1	4,469	11	55	1,035	1.8	>10000
21259**	8-Apr-2021	0.1	5.5	2.0	1.1	13	68	4.2	707	1.4	7.6	70	0.2	305

Notes:

* Superpond sludge re-located to Myra 1 Pond

** Sludge sample from the Price Pond

2.4 EXISTING QUANTITIES OF MINE WASTE MATERIALS AT SURFACE

Table 2-6 (EMLI Table 2) summarizes the quantities of existing waste rock, tailings, low-grade ore, coarse reject, and other mine waste materials, as of December 31st, 2021. Paste tailings were deposited in the Lynx TDF in 2021.

Table 2-6 (EMLI Table 2)

Quantities of Waste Rock, Tailings, Low Grade Ore, Coarse Reject and Other Mine Waste as of December 31st, 2021**.** Note: All quantities are in tonnes.

Name of Waste Pile or Pond	Acid Generating Waste		Potentially Acid Generating Waste		Non-Acid Generating Waste	
Waste Dumps	**2021**	**Total**	**2021**	**Total**	**2021**	**Total**
1	0	0	-39,748	5,848,627	0	0
2	0	0	-757,302	794,203	0	0
3	0	0	-16,910	83,028	0	0
4	0	0	0	163,085	0	0
6	0	0	-74,176	367,331	0	0
Lynx TDF Berm	0	0	1,107,282	4,203,177	342	15,532
Construction Stockpiles	0	0	-4,079	96,913	-342	24,233
Total	**0**	**0**	**215,067**	**11,556,364**	**0**	**39,765**
Tailings Ponds	**2021**	**Total**	**2021**	**Total**	**2021**	**Total**
Old (Myra TDF)	0	0	0	11,592,647	0	0
Lynx TDF	0	0	315,097	2,753,475	0	0
Total	**0**	**0**	**315,097**	**14,346,122**	**0**	**0**

2.5 GROWTH MEDIUM SAMPLING RESULTS

There is one stockpile of growth medium onsite at Myra Falls. This material was stripped from the CRAB (Core Rack Area Borrow) area during the development of the clean fill borrow source. No movement of material to or from this stockpile occurred in 2021 as depicted in **Table 2-7**. No samples were collected from the existing stockpile in 2021.

Table 2-7 (EMLI Table 5)

Quantities of Soil & Overburden Salvaged & Stockpiled for Reclamation Use, as of December 31st, 2021

Area Salvaged (Location and Area in ha)	Salvage Volumes to Stockpile Locations (m^3)		
	Stockpile 1 (Quarry)	Total Salvage Volumes (m^3)	# of Samples for Suitability
CRAB 4.7 ha	5239 m^3	5239 m^3	0
Totals	5239 m^3	5239 m^3	0

3 EFFLUENT MONITORING RESULTS

3.1 EFFLUENT MONITORING REQUIREMENTS (MDMER)

3.1.1 *Physical and Chemical Parameter Monitoring*

Surface water quality monitoring for Environment Canada's Metal and Diamond Mine Effluent Regulations (MDMER) consists of two major components: Effluent Monitoring and Environmental Effects Monitoring (EEM), each of which involves multiple monitoring programs. Effluent is monitored weekly for pH, flow, and total concentrations of arsenic, copper, cyanide[4], lead, nickel, zinc, total suspended solids and radium-226[5]. Quarterly grab samples are analyzed for hardness, alkalinity, and total concentrations of aluminum, cadmium, iron, mercury, molybdenum, ammonia, nitrate, selenium, temperature, total and dissolved organic carbon, phosphorus, chloride, fluoride, sulphate, dissolved oxygen, and EC. Myra Creek upstream and downstream of the effluent discharge point is monitored for the same list of deleterious substances as the effluent on a quarterly basis. Streamflows in Myra Creek are monitored continuously at station MYR-BDG-US (near the Car Bridge) and MYR-BDG (across from the former backfill plant).

3.1.2 *Biological Monitoring Studies*

The acute toxicity of effluent is tested quarterly using juvenile rainbow trout and *Daphnia magna* LC50 tests. Sub-lethal (chronic) toxicity effects of effluent on a fish, invertebrate, aquatic plant and algal species are tested semi-annually with one test typically in May and another in November.

3.1.3 *Reporting*

Water quality and toxicity results from MDMER monitoring are reported online using Environment Canada's Mine Effluent Reporting System (MERS) within the Environment Canada Single Window Information Manager (SWIM) data platform (https://ec.ss.ec.gc.ca/en/cs). Biological monitoring studies are submitted as full reports to the MDMER Program Scientists via the Environmental Effect Monitoring Electronic Reporting System (EEMERS) also within the SWIM.

Monitoring of the ecosystem health is completed in a three-year cycle. MFM completed Year 3 of Cycle 6 in 2020 which completed the analysis reporting on Cycle 6 of the Environmental Effects Monitoring (EEM). In 2021, a study design report will be developed for Cycle 7 of the EEM. No measurable differences in the

[4] Cyanide is not used at MFM and is therefore not required to be monitored.
[5] Monitoring results for Radium 226 below method detection limit, frequency reduced to quarterly.

EEM that could be attributed to the quality of the treated effluent from MFM were found in the Cycle 6 program (see Nautilus Environmental, 2020).

3.2 2021 Effluent Water Quality and Toxicity Testing Results

3.2.1 *Effluent Water Quality*

Table 3-1 summarizes MDMER limit value exceedances for 2021. Further details and time trends for treated effluent are provided in the 2021 Monitoring Report for Effluent Permit PE-6858. Eight grab samples of treated effluent (at 11A-Runoff) exceeded MDMER limits in 2021. Six of the exceedances were related to elevated TSS values in January 2021 and there were two exceedances recorded for Zn-t.

Table 3-1

MDMER Limit Value Exceedances for Treated Effluent, 2021

Station ID*	Date	Time	Parameter	MDMER Effluent Limit	Results	RDL	Unit	MDMER Sample Type
11A-Runoff	1-Jan-2021	18:00	Zn-t	1.00	1.29	0.004	mg/L	Grab
11A-Runoff	1-Jan-2021	18:00	TSS	30	35.0	1	mg/L	Grab
11A-Runoff	2-Jan-2021	8:30	TSS	30	42.0	1	mg/L	Grab
11A-Runoff	2-Jan-2021	12:30	TSS	30	45.7	1	mg/L	Grab
11A-Runoff	2-Jan-2021	17:00	TSS	30	45.4	1	mg/L	Grab
11A-Runoff	5-Jan-2021	16:45	TSS	30	45.5	1	mg/L	Grab
11A-Runoff	10-Jan-2021	-	TSS	30	30.7	1	mg/L	Grab

Note:
RDL= Reported Detection Limit
*11A-Runoff is referred to as station MP-EFF in Effluent Permit PE-6858

3.2.2 *Toxicity Testing Results*

Appendix B provides toxicity testing results for 2021. All quarterly samples for 96-hour LC50 test results were >100% vol./vol. survival rate for rainbow trout.

3.3 Events Outside of Normal Operational Parameters

Table 3-2 summarizes events outside of normal operational parameters with respect to MDMER. Each event was communicated to regulatory authorities and follow-up reports detailing the cause and mitigation efforts were submitted to MECCS and Environment Canada as appropriate (see **Appendix C**). Other agencies, such as the Vancouver Island Health Authority and BC Parks, were also notified of these events.

The most notable of the events were unauthorized discharge events on September 17th and October 25th. These events are summarized as follows:

- **Unauthorized discharge to Myra Creek on September 17th.** A non-compliance event occurred on September 17th (see DGIR Report 212283). Turbid runoff from the public road to Myra Creek was observed during a high intensity rainfall event, when 34.4 mm of rainfall occurred from 1:00 – 5:00pm. Turbid water entered Myra Creek between the Car Bridge and 25-Sump at an estimated rate of 5 L/s. During the event, water quality samples and a sample for acute toxicity testing were collected by MFM staff from the flows to Myra Creek and Myra Creek itself approximately 10 m downstream of the inflow point to the creek. During the event. MFM surface crew create water bars and cross trenches from the road surface to the existing storm ditch network to direct the turbid water into the water treatment system. The operator also removed any sills left by the grader, which were preventing water from flowing into the ditch upslope of the discharge. In total, 54,000 L of runoff reported to Myra Creek during the event. TSS and some metal concentrations in the flows to the creek exceeded MDMER limits and the samples showed no acute toxicity. Concentrations of Cu and Zn in Myra Creek exceeded BC WQGs. These exceedances cannot, however, be attributed to the spill event, as both of these metals typically exceed BC WQGs in Myra Creek.
- **25-sump overtopping on October 25th.** This event was related to the overtopping of the "25-Sump" to Myra Creek during a high rainfall event (see DGIR Report 212856 for details). MFM experienced a significant rain event (>20 mm/24 hours) that started on the evening of October 24th and continue through midday on October 27th. An estimated 185.5 mm of rainfall occurred during the event, with a maximum 24-hour intensity of 95 mm/24 hours between 4:00pm and 5:00pm on October 25th. Turbid water was observed to be entering the overflow channel for the 25-Sump at 4:20pm on October 25th, with a small turbidity cloud having formed in Myra Creek at the confluence of the creek and the overflow ditch soon after the water was first observed. MFM Environment Department staff measured flows over the weir in the sump and collected samples of sump discharge and samples from the mixing zone in Myra Creek. A back-up pump was started by the Tailings Operator during sampling. Discharge from the sump ceased within a few minutes of the pump being operated and additional samples from the sump box were collected. The sump was estimated to have overtopped for 15 minutes, during which an estimated 3000-3500 L was released to Myra Creek. TSS and some metal concentrations in the flows to the creek exceeded MDMER limits (see **Appendix J**). A grab sample of the turbid water that overtopped showed acute toxicity for trout, but samples from downstream showed 100% survival (see **Appendix C**). Concentrations of Cu and Zn in Myra Creek exceeded BC WQGs. These exceedances cannot, however, be attributed to the spill event, as both of these metals typically exceed BC WQGs in Myra Creek. The overtopping event appears to have been caused, in part, by debris that obstructed the float switch that turns the back-up pumps on, and additional flows to the 25-Sump from the project office area

during this high rainfall event. Pumps have since been serviced and additional back-up pumps have been ordered (see DGIR report in **Appendix J**).

Table 3-2

Summary of Events Outside Normal Operating Procedures, 2021

Incident Date	Incident Type	Monitoring Station	Incident Description	Cause of Incident
January 1st	MDMER limit exceedance	11A-Runoff	MDMER limits for Zn-t and TSS exceeded in grab sample	Large flows during storm event
January 2nd	MDMER limit exceedance	11A-Runoff	MDMER limit for TSS exceeded in three grab samples	Large flows during storm event
January 5th	MDMER limit exceedance	11A-Runoff	MDMER limit for TSS exceeded in grab sample	Large flows during storm event
January 10th	MDMER limit exceedance	11A-Runoff	MDMER limit for TSS exceeded in grab sample	Large flows during storm event
February 11th	Spill	n/a	Paste tailings bypass to ground near Paste Plant	Paste pipe split at elbow
April 20th	Spill	n/a	Spill from punctured tote at the mill	Penetration of 1000L tennafroth tote with forklift
July 28th	Spill	n/a	2-25L of diesel released from water truck	Rock punctured the tank
September 17th	Unauthorized discharge	n/a	Road runoff to Myra Creek	Drainage ditch overflowed
September 21st	MDMER limit exceedance	11A-Runoff	MDMER limit for ZN-t exceeded in grab sample	Large flows during storm event
October 25th	Spill	n/a	25-Sump overtopped	Large flows during storm event

4 WATER QUALITY MONITORING RESULTS AND SIS PERFORMANCE

4.1 MONITORING NETWORKS

4.1.1 *Groundwater Monitoring Network*

Groundwater monitoring wells and pumping wells at MFM are shown in **Figure 4-1.** A close-up view of the Lynx Reach (see below) is provided in **Figure 4-2** for reference. Construction details for all the groundwater monitoring wells and pumping wells on site are summarized in **Table 4-1** and **Table 4-2**. Forty-one of these wells, i.e. the 'MW13' and 'TD13' well series, were installed in 2013 as part of RGC's initial hydrogeological field investigation. Other monitoring wells were installed during previous site investigations in 2011 or earlier (see RGC, 2014, for additional details) or as part of recent hydrogeological and geotechnical investigations. No new monitoring wells were installed in 2021.

4.1.2 *Surface Water Monitoring Stations*

Surface water monitoring stations are shown in **Figure 4-3**. Station MC-M1 (for Myra Creek) is upstream of the mine site and station MC-M2 is downstream of the mine site near Buttle Lake. Stations MC-S11 (near the Car Bridge) and MC-TP4 (downstream of the Old TDF) are within the mine site. Daily composite samples are collected from Myra Creek with an auto-sampler at station MC-TP4. Grab samples are collected at other stations (see RGC, 2020, for further details). Myra Creek has been divided into three reaches based on water quality observations: the Lynx Reach, Upper Old TDF Reach, and the Lower Old TDF Reach. The Lynx Reach extends from Arnica Creek (near the mill) to chainage marker MC+50 m, which is about 100 m downstream of the Car Bridge, The Lynx Reach therefore includes the Mill area, the ETA/Cookhouse Area, and the Lynx TDF. The Upper Old TDF Reach extends from station MC+100 m to the rock outcrop on the north bank of Myra Creek near chainage marker MC+850 m and includes WRD1 and WRD6. The Lower Old TDF Reach extends from chainage marker MC+850 to MC+1350 m, where the connected portion of the NOD is located.

MFM staff typically conduct monthly water quality surveys along Myra Creek adjacent to the Old TDF on a voluntary basis when the creek can be safely accessed. The monthly surveys involve collecting samples from thirty (30) stations from station MC-S11 to MC-TP4, i.e. from chainage markers MC+100 m to MC+1350 m. Station MC-S11 is approximately 100 m upstream of the Car Bridge and station MC-TP4 is at chainage marker MC+1350 m. Routine monthly creek surveys also involve collecting samples of seepage that expresses near Myra Creek, including the Car Bridge Seep and the Pipe Bridge Seep and a seep near chainage marker MC+800. Metal concentrations in daily samples of treated effluent collected with an auto-sampler at station 'Runoff 11A' (near the Parshall flume) are determined. Other surface water monitoring stations are '3-Runoff' at a small seep in the Lynx switchback area and at the mouth of Arnica Creek at '7-Arnica'.

Table 4-1

Groundwater Monitoring Wells and Pumping Wells Installed in 2011, 2013 and 2014

Well ID	Installation Date	UTM Location NAD 1983 UTM Zone 10N Easting	Northing	Depth Drilled m bgs	Stickup m	TOC Elevation m MD	Screening Interval m bgs top	bottom	Screened Material	Hydrostratigraphic Unit
BK01-13S	-	311897	5494454	13.4	-	3372	10.1	13.1	-	-
BK01-13D	-	311897	5494454	22.3	-	3372	18.6	21.6	-	-
MW04-01	-	-	-	-	-	-	-	-	-	-
MW-A	-	313168	5494310	15.8	-	3361.9	11.6	13.1	Gravel and Sand	-
MW-B	-	313171	5494304	14.8	-	3358.4	11.6	13.1	Gravel and Sand	-
MW-C	-	313173	5494297	14.8	-	3354.8	11.6	13.1	Gravel and Sand	-
MW-D	-	313166	5494309	7.6	-	3361.9	6.1	7.6	Coarse Sand	-
MW-E	-	313169	5494302	5.8	-	3358.2	4.3	5.8	Coarse Sand	-
MW-F	-	313173	5494296	5.8	-	3354.8	4.3	5.8	Coarse Sand	-
MW-G	-	312101	5494437	-	-	3362.7	-	-	-	-
MW11-01	22-Jun-11	311700	5494580	30.5	-	3387.8	28.4	29.9	Gravel with 0.1 Sand, minor fine	-
MW11-02	21-Jun-11	311652	5494377	9.1	-	3371.7	5.5	8.5	Sand and Gravel	-
MW11-04	21-Jun-11	312048	5494452	6.4	-	3364.5	4.9	6.4	Silt with Rock	-
MW11-05S	24-Jun-11	313071	5494570	10.1	-	3391.4	5.4	10.1	Tailings	-
MW11-05D	23-Jun-11	313071	5494570	42.1	-	3391.6	40.2	42.1	Tailings	-
MW13-01	14-Aug-13	310789	5494305	11	0.97	3390.7	8.2	11.2	Bedrock (Dacite) Bedrock	Bedrock
MW13-02S	30-Jul-13	311492	5494515	44.8	1.02	3385.1	20.4	23.5	Well-graded gravel, with sand	Colluvial/Landslide
MW13-02D	30-Jul-13	311492	5494515	29.4	1.02	3385.1	29.2	35.4	Well-graded sand, with gravel	Glaciofluvial
MW13-03	26-Jul-13	311637	5495005	38.8	1	3444.4	35.7	28.7	Well-graded gravel, with sand	Waste Rock
MW13-04	27-Jul-13	311943	5494999	17	1.12	3490	7.7	10.7	Well-graded gravel, with sand	Colluvial
MW13-05S	29-Jul-13	311952	5494522	57	0.83	3376.5	10.7	13.7	Well-graded gravel Colluvial	Colluvial
MW13-05D	29-Jul-13	311952	5494522	20.1	0.79	3376.5	20.2	26.2	Well-graded sand, with gravel	Glaciofluvial
MW13-06S	13-Aug-13	312053	5494573	68.9	0.99	3376.9	12.8	15.9	Well-graded gravel, with sand	-
MW13-06D	13-Aug-13	312053	5494573	35.4	0.97	3376.8	35.4	41.5	Well-graded sand, with gravel	Glaciofluvial
MW13-07S	13-Aug-13	312246	5494683	59.7	1.04	3419	26.5	32.6	Well-graded gravel, with sand	Waste Rock and Colluvial
MW13-07D	13-Aug-13	312246	5494683	53.6	1.04	3419	53.6	59.7	Well-graded gravel, with sand	Dense Colluvial/Till
MW13-08S	12-Aug-13	312401	5494721	34.1	0.99	3419.6	17.1	20.1	Well-graded gravel, with sand	Waste Rock
MW13-08D	12-Aug-13	312401	5494721	31.1	0.99	3419.6	31.4	34.1	Bedrock (Dacite)	Bedrock
MW13-09S	8-Aug-13	312461	5494702	59.7	0.97	3423.1	29.3	35.4	Well-graded gravel, with sand	Waste Rock
MW13-09D	8-Aug-13	312461	5494702	50.3	0.94	3423.1	50.3	54.9	Bedrock (Dacite)	Bedrock
MW13-10S	7-Aug-13	312563	5494731	59.7	0.99	3431.6	35.4	41.4	Well-graded gravel, with sand	Waste Rock
MW13-10D	7-Aug-13	312563	5494731	55.5	1	3431.6	55.5	58.5	Bedrock (Dacite)	Bedrock
MW13-11S	27-Jul-13	312350	5494307	17	1.02	3363.8	4.3	7.3	Well-graded gravel and sand	-
MW13-11D	27-Jul-13	312350	5494307	11.5	1.03	3363.8	12.2	15.2	Well-graded gravel, with sand	Glaciofluvial
MW13-12	31-Jul-13	312463	5494012	20.1	0.85	3415.5	11	15.5	Well-graded gravel, with sand	Colluvial
MW13-13	27-Jul-13	312674	5494194	14.2	0.95	3362.5	9.2	12.2	Well-graded gravel, with sand	Glaciofluvial
MW13-14S	28-Jul-13	313298	5494393	17.7	0.92	3356.6	8	11	Well-graded gravel, with sand	Glaciofluvial
MW13-14D	28-Jul-13	313298	5494393	14.7	0.9	3356.6	14.7	17.7	Well-graded gravel, with sand	Glaciofluvial
MW13-15S	29-Jul-13	313333	5494446	19.2	-0.05	3355.8	9.5	12.5	Well-graded gravel and sand	-
MW13-15D	29-Jul-13	313333	5494446	16.2	-0.05	3355.8	16.2	19.2	Well-graded gravel, with sand	Glaciofluvial
MW13-16S	28-Jul-13	313359	5494348	20	0.99	3361.2	11	14	Well-graded gravel, with sand	Colluvial/Glaciofluvial
MW13-16D	28-Jul-13	313359	5494348	17	1.02	3361.2	17.1	20.1	Well-graded gravel, with sand	Glaciofluvial
MW13-17	28-Jul-13	313395	5494503	8.6	0.97	3355	5.5	8.5	Well-graded gravel and sand	-
MW13-18S	31-Jul-13	313436	5494438	23.1	1.07	3353.2	9.1	13.7	Well-graded gravel, with sand	-
MW13-18D	31-Jul-13	313436	5494438	20.1	1.07	3353.2	20.1	23.2	Well-graded gravel, with sand	Glaciofluvial
MW13-19	14-Aug-13	312046	5494420	20.1	1	3364.3	17.1	20.1	Well-graded sand, with gravel	Glaciofluvial
TD13-01S	11-Aug-13	312645	5494522	47.6	0.96	3390.4	20.1	26.2	Tailings (with coarse seam)	Tailings
TD13-01D	11-Aug-13	312645	5494522	36.6	0.98	3390.5	36.6	44.2	Well-graded gravel with sand	Glaciofluvial
TD13-02S	9-Aug-13	312664	5494418	41.4	0.92	3383.5	19.6	25.6	Tailings (with coarse seam)	Tailings
TD13-02D	9-Aug-13	312664	5494418	35.1	0.91	3383.5	35.1	38.1	Well-graded sand; with gravel	Glaciofluvial
TD13-03S	10-Aug-13	312970	5494536	47.6	1.14	3390.9	20.4	26.4	Tailings (with coarse seam)	Tailings
TD13-03D	10-Aug-13	312970	5494536	44.5	1.07	3390.8	44.5	47.6	Well-graded gravel with sand	Glaciofluvial
TD13-04S	11-Aug-13	312756	5494656	49.7	0.8	3396.1	26.2	29.2	Well-graded gravel with sand	Waste Rock
TD13-04D	11-Aug-13	312756	5494656	41.4	0.84	3396.2	41.4	44.5	Well-graded gravel with sand	Glaciofluvial
TD13-05S	9-Aug-13	313085	5494445	41.4	1.06	3383	20.1	23.2	Tailings Tailings	Tailings
TD13-05D	9-Aug-13	313085	5494445	35.1	1.04	3383	35.1	38.1	Well-graded gravel with	Glaciofluvial
MW14-01S	3-Sep-14	311590	5494594	32.3	0.8	3391	23.9	26.9	Sand and Gravel	-
MW14-01D	3-Sep-14	311590	5494594	32.3	0.8	3391	29.4	32.4	Bedrock	-
MW14-02S	4-Sep-14	311645	5494692	22.9	0.7	3398.8	6.1	9.1	Gravel	-
MW14-02D	4-Sep-14	311645	5494692	22.9	0.7	3398.8	18.3	22.9	Gravel and Bedrock	-
MW14-03S	9-Jul-14	311828	5494528	22	0.9	3379.6	18.6	21.6	Sand and Gravel	-
MW14-03D	8-Jul-14	311831	5494526	37.5	0.8	3379.4	32.3	35.4	Gravel	-
MW14-04S	28-Aug-14	312127	5494544	7.9	0.8	3373.3	3.1	6.1	Gravel	-
MW14-04D	28-Aug-14	312130	5494543	41.1	0.8	3373.6	18.7	21.7	Sandy Gravel	-
MW14-05S	13-Sep-14	311738	5494475	26.5	0.7	3374.2	7.3	8.8	Gravel	-
MW14-05M	13-Sep-14	311738	5494475	26.5	0.7	3374.2	11	14	Gravel	-
MW14-05D	13-Sep-14	311738	5494475	26.5	0.7	3374.2	23.2	26.2	Gravel	-
PW14-01	23-Aug-14	311947	5494555	31.6	0.9	3377.5	26.4	29.5	Gravel	-
PW14-03	6-Sep-14	311702	5494553	41.5	0.9	3386.1	29	32	Gravel	-
PW14-04	9-Sep-14	312133	5494539	23.8	0.9	3373.8	19.5	21.9	Coarse Gravel	-

Notes:
m bgs = m below ground surface

Table 4-2

Groundwater Monitoring Wells Installed in 2015, 2016, 2017, 2018 and 2019

Well ID	Installation Date	UTM Location NAD 1983 UTM Zone 10N		Depth Drilled,	Stickup,	TOC Elevation,	Screening Interval, m bgs		Screened Material	Hydrostratigraphic Unit
		Easting	Northing	m bgs	m	m MD	top	bottom		
MW15-01S	5-Mar-15	313317	5494563	15.8	3368.4	0.8	4.3	7.3	Gravel with Silt and Sand (Medium Dense)	Fill
MW15-01D	5-Mar-15	313317	5494563	15.8	3368.4	0.8	10.7	12.8	Silty Gravel with Sand (Dense)	Lateral Till
MW15-02S	4-Mar-15	313258	5494598	16.5	3380.4	0.8	4.3	7.3	Gravel with Silt and Sand (Medium Dense)	Fill
MW15-02D	4-Mar-15	313258	5494598	16.5	3380.4	0.8	11.0	12.5	Gravel with Silt and Sand (Very Dense)	Lateral Till
MW15-03S	2-Mar-15	313172	5494613	4.3	3384.4	0.6	2.4	4.0	Gravel with Clay and Sand over Wood Debris (Medium Dense)	Fill
MW15-03M	2-Mar-15	313171	5494613	25.6	3384.7	0.8	11.0	14.0	Gravel with Clay and Sand (Medium Dense)	Fill
MW15-03D	2-Mar-15	313171	5494613	25.6	3384.6	0.8	18.9	21.9	Gravel with Sand and Silt (Very Dense)	Basal Till
MW15-04S	1-Mar-15	313148	5494638	18.0	3392.6	0.9	3.7	6.1	Silty Clayey Gravel (Medium Dense)	Fill
MW15-04D	1-Mar-15	313148	5494638	18.0	3392.6	0.9	8.2	10.7	Wood debris (2m) over Gravel with Sand (Medium Dense)	Colluvium
MW15-05S	25-Apr-15	313078	5494664	21.0	3395.6	0.9	8.8	11.9	Gravel (Medium Dense)	Colluvium
MW15-05D	25-Apr-15	313078	5494664	21.0	3395.6	0.9	14.0	17.1	Andesite Bedrock	Bedrock
MW15-06S	3-Mar-15	312992	5494684	24.1	3400.4	0.8	1.8	3.7	Silty Gravel with Sand (Medium Dense)	Fill
MW15-06D	3-Mar-15	312992	5494684	24.1	3400.5	0.8	16.8	19.8	Gravel, Silt and Sand (Dense)	Lateral Till
MW15-07S	16-Mar-15	312935	5494716	8.8	3405.9	0.8	5.8	7.3	Gravel with Sand (Medium Dense)	Colluvium
MW15-07M	16-Mar-15	312934	5494716	33.2	3405.9	0.8	18.3	21.3	Gravel with Sand and Silt (Very Dense)	Basal Till
MW15-07D	16-Mar-15	312934	5494716	33.2	3405.9	0.8	27.1	31.7	Gravel with Sand and Clay (Very Dense)	Basal Till
MW15-08S	22-Apr-15	312925	5494694	30.2	3399.7	0.9	13.7	18.3	Clay, Sand, Gravel and Cobbles (Dense)	Lateral Till
MW15-08D	22-Apr-15	312925	5494694	30.2	3399.7	0.9	22.9	27.4	Sandy Clay with Gravel (Hard)	Basal Till
MW15-09S	28-Feb-15	312866	5494740	30.2	3409.7	0.7	6.7	9.8	Clay, Sand, Gravel and Cobbles (Medium Dense)	Fill/Colluvium/Lateral Till
MW15-09D	28-Feb-15	312866	5494740	30.2	3409.7	0.7	17.7	20.7	Gravel with Sand and Clay (Very Dense)	Basal Till
MW15-10S	25-Feb-15	312787	5494756	19.5	3416.5	0.8	4.4	7.5	Gravel and Cobbles (Medium Dense)	Waste Rock
MW15-10D	25-Feb-15	312787	5494756	19.5	3416.5	0.8	10.4	13.4	Clay, Sand, Gravel and Cobbles (Dense)	Lateral Till
MW15-11S	26-Feb-15	312796	5494737	27.1	3414.4	0.9	8.8	11.9	Gravel and Cobbles over Wood Debris (1m) (Medium Dense)	Waste Rock/Fill
MW15-11D	26-Feb-15	312796	5494737	27.1	3414.4	0.9	21.0	22.6	Clay, Sand and Gravel (Dense)	Lateral Till
MW15-12S	21-Apr-15	312798	5494707	31.7	3400.7	0.8	13.4	16.5	Gravel with Clay and Sand (Dense)	Lateral Till
MW15-12D	21-Apr-15	312798	5494707	31.7	3400.7	0.9	23.5	28.0	Sandy Gravelly Clay (Very Dense)	Basal Till
MW15-13S	14-Mar-15	312688	5494717	34.4	3399.1	0.9	11.6	14.6	Gravel and Cobbles with Silt (Medium Dense)	Waste Rock
MW15-13D	14-Mar-15	312688	5494717	34.4	3399.1	0.9	22.7	25.8	Clay, Sand and Gravel (Dense)	Lateral Till
MW15-14	1-Mar-15	313163	5494643	7.3	3391.0	-0.1	1.5	4.6	Silt, Sand and Gravel (Medium Dense)	Fill
MW16-01	4-Oct-16	312113	5494445	4.5	3362.6	0.80	0.8	3.8	Sandy gravel matrix (waste rock)/alluvial sediments (sandy clay/sandy g	Waste rock/Alluvial
MW16-02	4-Oct-16	312093	5494458	5.6	3363.7	0.80	2.2	5.2	Natural - Landslide Deposit (sandy gravel matrix)	Landslide
MW16-03	5-Oct-16	312069	5494447	4.5	3363.8	1.05	1.1	4.2	Natural - Landslide Deposit (sandy gravel matrix)	Landslide
MW16-04	5-Oct-16	312044	5494431	5.0	3364.3	0.95	1.7	4.6	Natural - Landslide Deposit (sandy gravel matrix)	Landslide
MW16-05	13-Oct-16	312015	5494424	5.0	3364.9	1.00	1.8	4.8	Natural - Landslide Deposit (sandy gravel matrix)/Alluvial Sediments (sa	Landslide
MW17-1	20-Sep-17	312241	5494571	31.39	-0.073	3383.14	20.73	23.77	Well graded sand and gravel, 5% fines	Colluvium
MW17-2S	22-Sep-17	312186	5494491	42.67	-0.113	3381.7	32.61	34.14	Well graded sand (5-10% fines)	Colluvium
MW17-2D	22-Sep-17	312186	5494491	42.67	-0.099	3381.714	21.67	23.19	Well graded sand (0-10% fines)	Glaciofluvial
MW17-3	21-Sep-17	312382	5494472	42.98	-0.1	3383.655	39.27	40.79	Well graded sand with gravel & well graded sand	Glaciofluvial
MW17-4	28-Sep-17	312540	5494312	10.67	-0.052	3362.929	8.23	9.75	Well graded sand with gravel & well graded sand	Glaciofluvial
MW17-5	27-Sep-17	312697	5494244	12.19	-0.06	3360.908	7.01	8.53	Well graded sand with gravel & well graded gravel with silt and sand	Glaciofluvial
MW17-6	24-Sep-17	312673	5494303	30.48	0.813	3378.621	24.08	25.60	Well graded sand with gravel & well graded gravel with sand	Glaciofluvial
MW17-7	28-Sep-17	312888	5494258	10.67	-0.084	3359.685	7.62	9.14	Cobbles with sand and gravel	Colluvium
MW17-8	24-Sep-17	312543	5494248	9.14	0.771	3360.49	5.49	7.01	Well graded gravel with sand & well graded sand	Colluvium
MW17-9	25-Sep-17	313503	5494515	14.63	0.947	3359.375	10.67	12.19	Bedrock (Dacite)	Bedrock
MW17-10S	1-Oct-17	313462	5494351	21.95	0.861	3360.814	9.45	10.97	Well graded gravel with silt	Till
MW17-10D	1-Oct-17	313462	5494350	21.95	0.937	3360.89	18.29	21.34	Bedrock (Dacite)	Bedrock
MW17-11S	29-Sep-17	313623	5494257	19.20	0.881	3358.538	12.19	13.72	Well graded sand & well graded sand with clay and gravel	Glaciofluvial
MW17-11D	29-Sep-17	313623	5494257	19.20	0.9	3358.557	15.54	18.59	Bedrock (Dacite)	Till/bedrock
MW17-13S	3-Oct-17	313604	5494367	35.05	0.887	3356.487	15.85	17.37	Well graded sand	Glaciofluvial
MW17-13D	27-Sep-17	313604	5494366	18.29	0.926	3356.545	28.96	30.48	Well graded gravel with silt and sand & well graded sand with gravel	Glaciofluvial
MW17-14S	2-Oct-17	313845	5494249	30.48	0.886	3358.384	13.72	15.24	Well graded gravel with silt and sand	Glaciofluvial
MW17-14D	2-Oct-17	313845	5494249	30.48	0.897	3358.395	23.77	25.30	Well graded sand with gravel	Glaciofluvial
MW17-15S	30-Sep-17	313854	5494589	18.90	0.996	3359.35	9.14	10.67	Well graded gravel with sand	Glaciofluvial
MW17-15D	30-Sep-17	313854	5494589	18.90	0.981	3359.335	15.24	18.29	Bedrock (Dacite)	Bedrock
MW18-06S	11-May-18	311917	5494405	18.29	-11.58	3367.31	6.71	9.75	gravel with silt and sand	Colluvium
MW18-06D	11-May-18	311917	5494405	18.29	-3.05	3367.21	15.24	18.29	sand with silt and gravel	Glaciofluvial
MW18-07S	10-May-18	311966	5494382	17.07	-12.50	3366.02	4.57	7.62	silty gravel with sand	Colluvium
MW18-07D	10-May-18	311966	5494382	17.07	-3.51	3366.01	13.56	15.09	silty gravel with sand	Glaciofluvial
MW18-08S	10-May-18	312002	5494417	18.29	-15.24	3366.03	3.05	6.10	clayey gravel with sand	Berm Fill
MW18-08D	10-May-18	312003	5494417	18.29	-10.97	3366.04	7.32	10.36	gravel with sand	Glaciofluvial
PW18-01	12-May-18	312050	5494425	11.28	-9.75	3364.27	1.52	10.67	clayey sand with gravel	Berm Fill/Colluvium
PW18-02	12-May-18	312041	5494422	11.28	-9.75	3364.76	1.52	10.67	silty gravel with sand	Berm Fill/Colluvium
PW18-03	13-May-18	312033	5494418	11.28	-9.75	3364.39	1.52	10.67	clayey gravel with sand	Berm Fill/Colluvium
PW18-04	13-May-18	312025	5494415	11.58	-10.06	3364.83	1.52	10.67	sand with gravel	Berm Fill/Colluvium
PW18-05	14-May-18	311947	5494395	11.28	0.57	3366.61	1.52	10.67	sand, gravel with sand	Berm Fill/Colluvium
MW19-01S	06-Dec-19			24.40			6.10	7.60	Gravel	-
MW19-01D	06-Dec-19			24.40			16.50	19.50	Sand	-
MW19-02S	04-Dec-19			31.40			5.20	9.80	Gravel	-
MW19-02D	04-Dec-19			31.40			22.30	26.40	Silty sand	-
MW19-03S	03-Dec-19			18.80			7.20	5.20	Gravel	-
MW19-03D	03-Dec-19			18.80			14.90	18.00	Gravel	-

Notes:
m bgs = m below ground surface

4.2 Groundwater and Surface Water Monitoring Programs

Voluntary and required monitoring activities are detailed in the Surface Water and Groundwater Monitoring Plan. A summary of key monitoring programs that are pertinent to this report is provided below for ease of reference.

4.2.1 *Voluntary Groundwater Monitoring*

Voluntary groundwater sampling and seepage sampling and water level monitoring is undertaken to support Site-Wide SIS performance monitoring. Seepage samples in key areas are collected monthly when seepage expressions are observed. Groundwater samples are collected annually, semi-annually, quarterly, or monthly, depending on their proximity to the Phase I Lynx SIS and Interim Phase II Lynx SIS.

Thirteen data loggers have also been installed to continuously monitor groundwater level fluctuations in key wells in the Lynx Reach and downgradient in the Lower Old TDF Reach. Manual water level surveys are also conducted routinely to infer groundwater flow fields and capture zones near the Phase I Lynx SIS and Interim Phase II Lynx SIS.

Water levels are collected manually from each well that is sampled for water quality using an electronic water level tape prior to any purging.

4.2.2 *Voluntary Surface Water Monitoring*

Creek surveys are conducted routinely (when safe to do so) in support of SIS performance monitoring. Samples are analyzed for a full suite of water quality parameters that includes total metals in addition to dissolved metals. Surveys allow incremental changes in water quality in the Lynx Reach and the Upper Old TDF Reach to be detected. Creek surveys involve collecting samples every 50 m from Arnica Creek to chainage marker MC+1350 and in areas where seepage is known to express at surface and/or to Myra Creek. This sampling is typically conducted in the summer and fall because high creek levels in the winter and spring make it unsafe to access the creek.

4.2.3 *Required Groundwater and Seepage Water Quality Monitoring for Permit M-26*

Permit M-26 requires routine seepage and groundwater monitoring to assess the performance of the Old TDF under-drains and monitor known seepage areas (see **Table 4-3**). In total, six seeps are sampled when flowing and five riser pipes and eight monitoring wells near Myra Creek are sampled quarterly. Each sample is analyzed for a full suite of physical parameters, including pH and EC, alkalinity, acidity, major ions, and dissolved metals. Further details are provided in MFM (2019).

Table 4-3

Required Groundwater and Seepage Sampling for Permit M-26

Well ID	EMS	Type	Monitoring Status (Water Levels)	Monitoring Status (Water Quality)	Obligation	Rationale	Parameters
Car bridge seep	n/a	Seepage near carbridge	n/a	When flowing	Required (Permit M-26)	Baseline monitoring	Groundwater analytics[1]
Pipe bridge seep	n/a	Seepage near pipebridge	n/a	When flowing	Required (Permit M-26)	Baseline monitoring	Groundwater analytics[1]
Warehouse seep	n/a	Small seep in upper warehouse yard	n/a	When flowing	Required (Permit M-26)	Source terms	Groundwater analytics[1]
DDSD (Main Spring)	n/a	Conveys Main Spring	n/a	When flowing	Required (Permit M-26)	Source terms	Groundwater analytics[1]
TP4-A (or TP4-UPPER)	n/a	Upper Pumphouse Seep	n/a	When flowing	Required (Permit M-26)	Source terms	Groundwater analytics[1]
TP4-B (or TP4-LOWER)	n/a	Lower Pumphouse Seep	n/a	When flowing	Required (Permit M-26)	Source terms	Groundwater analytics[1]
Old Drain IN	n/a	Riser pipe	n/a	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
Old Drain OUT	n/a	Riser pipe	n/a	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
Drain LONG	n/a	Riser pipe	n/a	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
Drain MED	n/a	Riser pipe	n/a	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
Drain SHORT	n/a	Riser pipe	n/a	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
MW13-14S	n/a	Monitoring well	Quarterly	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
MW13-14D	n/a	Monitoring well	Quarterly	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
MW13-15S	n/a	Monitoring well	Quarterly	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
MW13-15D	n/a	Monitoring well	Quarterly	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
MW-A	n/a	Monitoring well	Quarterly	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
MW-B	n/a	Monitoring well	Not routinely monitored	Not routinely monitored	Not required	-	-
MW-C	n/a	Monitoring well	Quarterly	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
MW-D	n/a	Monitoring well	Quarterly	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
MW-E	n/a	Monitoring well	Not routinely monitored	Not routinely monitored	Not required	-	-
MW-F	n/a	Monitoring well	Quarterly	Quarterly	Required (Permit M-26)	Under-drain monitoring	Groundwater analytics[1]
MW-G	n/a	Monitoring well	Not routinely monitored	Not routinely monitored	Not required	-	-

Notes:
Annual samples collected in Q4 (e.g. November) and semiannual samples collected in Q1 (e.g. February) and Q3 (e.g. August)
[1] Field pH, Field EC, Lab pH, Lab EC, Alkalinity, Acidity, Major Cations and Anions, Dissolved Metals

4.3 PRECIPITATION

Precipitation data for Myra Falls are summarized in **Table 4-4**. These data are recorded at the climate station on site (MYR-CLIMATE) and were compiled by Swiftwater Consulting Ltd. The annual precipitation amount in 2021 was 2,764 mm. This amount is approximately 8% higher than the long-term annual average (2,549 mm) and approximately 9% higher than precipitation in 2020. Monthly precipitation amounts for January (532.3 mm), September (323.0 mm), October (532.4 mm), and November (641.0 mm) are significantly higher than long-term monthly means. Precipitation in February (143.8 mm), April (69.7 mm), June (38.8 mm), July (0.3 mm), August (3.6 mm), and December (99.1 mm) are significantly lower than monthly means (between 40% in June to 100% in July).

Table 4-4

Precipitation Data for Station MYR-CLIMATE, 1979 to 2021

YEAR	Jan mm	Feb mm	Mar mm	Apr mm	May mm	Jun mm	Jul mm	Aug mm	Sept mm	Oct mm	Nov mm	Dec mm	TOTAL
*1979	374.3	254.4	245.5	161.0	102.8	70.8	124.8	46.7	383.8	343.0	187.0	619.8	2913.9
1980	269.8	296.2	89.5	240.7	51.7	87.3	69.5	36.9	181.0	179.9	496.8	706.4	2705.7
1981	346.4	427.8	117.7	277.7	114.3	125.2	78.1	62.6	310.2	450.3	466.3	412.0	3188.6
1982	298.5	505.4	109.9	193.2	22.4	27.1	18.5	34.5	89.4	778.9	212.7	492.7	2783.2
1983	529.5	624.4	375.3	83.5	41.5	130.0	94.7	59.6	59.7	217.8	619.3	192.8	3028.1
*1984	399.3	519.5	245.5	262.9	192.7	31.5	8.8	40.3	95.0	576.1	339.8	220.1	2931.5
*1985	64.0	175.2	147.5	114.2	85.2	21.1	32.3	21.2	76.9	319.1	455.5	362.0	1874.1
*1986	374.3	254.4	418.1	88.2	238.9	89.2	41.3	4.0	54.0	589.7	455.5	390.0	2997.5
*1987	374.3	336.8	425.3	262.7	223.2	184.0	59.4	18.3	98.4	83.8	591.8	437.4	3095.4
1988	343.2	202.8	211.9	215.4	215.4	80.0	25.4	29.1	114.2	246.4	581.5	201.2	2466.5
1989	329.3	102.3	224.0	198.0	62.5	71.8	41.7	41.8	17.6	339.4	249.8	252.6	1930.8
1990	372.0	282.9	122.5	58.6	81.9	129.8	31.3	70.3	18.6	565.0	806.4	343.9	2883.2
1991	353.0	542.7	85.9	126.1	80.1	27.9	33.3	206.8	8.0	59.9	596.4	610.0	2730.1
1992	859.7	305.2	45.2	244.4	6.0	41.2	10.9	35.6	89.9	390.0	257.2	241.2	2526.5
1993	57.4	55.0	288.5	207.3	148.0	64.4	77.2	92.4	1.3	179.7	141.2	393.0	1705.4
1994	258.2	254.4	203.0	149.3	79.0	137.1	6.2	47.4	74.1	218.5	379.6	498.7	2305.5
*1995	374.3	254.4	245.5	159.1	93.2	65.0	40.6	56.4	121.9	321.4	455.5	362.0	2549.1
*1996	374.3	254.4	245.5	159.1	93.2	65.0	40.6	56.4	121.9	321.4	455.5	362.0	2549.1
1997	374.3	64.3	259.2	216.9	124.2	182.8	72.0	114.4	0.0	442.0	348.0	374.2	2572.3
1998	571.3	418.5	158.6	20.6	36.8	14.2	67.2	2.6	3.0	130.0	472.5	279.4	2174.7
1999	219.2	295.1	173.5	96.0	50.0	16.0	1.0	114.1	54.5	138.0	666.5	183.1	2007.0
2000	50.2	218.3	98.6	75.8	131.5	49.9	123.6	51.6	61.9	324.6	168.2	125.2	1479.4
*2001	332.6	123.4	144.4	107.3	132.1	38.4	38.0	163.2	67.0	199.8	519.2	367.1	2232.5
2002	194.6	133.5	56.4	92.9	41.4	22.9	28.3	26.8	50.6	33.8	588.0	288.2	1557.4
2003	471.1	61.1	412.0	176.9	50.3	51.4	44.0	30.0	45.1	557.8	94.0	347.5	2341.2
2004	327.0	133.6	159.9	39.5	24.1	42.0	23.0	73.5	156.5	218.0	488.5	340.0	2025.6
2005	433.0	70.0	223.0	396.2	305.9	57.5	100.3	54.0	98.0	514.9	268.2	521.5	3042.5
2006	615.5	315.5	378.5	125.0	75.5	46.0	28.0	5.2	76.5	139.0	811.0	560.5	3176.2
2007	538.0	287.9	438.3	207.8	75.4	128.8	71.0	69.0	167.1	409.6	491.3	415.5	3299.7
2008	250.0	176.0	188.4	59.0	79.5	29.2	8.0	161.6	21.8	260.4	457.6	162.8	1854.3
2009	139.6	138.5	290.5	91.4	171.0	43.5	34.9	17.0	164.7	321.0	882.4	258.0	2552.5
2010	666.1	353.0	380.8	222.5	171.0	60.4	2.4	18.5	268.7	477.6	284.7	629.3	3535.0
2011	283.6	327.1	528.2	165.9	80.1	11.9	81.9	42.0	339.8	295.4	478.1	199.8	2833.8
2012	600.5	241.1	424.1	199.3	54.7	86.0	10.0	14.4	15.6	317.0	525.2	264.3	2752.2
2013	96.0	273.2	168.4	111.6	124.6	65.6	3.0	124.6	277.0	57.4	226.7	99.8	1627.9
2014	170.3	243.3	341.1	170.4	47.9	32.4	32.4	17.3	143.5	589.4	404.2	547.9	2740.1
2015	262.8	337.5	460.5	105.4	35.1	14.9	20.3	148.8	217.0	262.3	259.5	634.8	2758.9
2016	492.5	394.2	521.3	80.9	17.2	63.4	30.7	44.4	103.5	507.9	928.2	250.4	3434.6
2017	374.3	178.0	361.5	253.8	55.3	33.8	8.7	1.8	32.2	319.3	830.3	85.8	2534.8
2018	602.0	110.9	75.2	256.3	8.1	130.6	9.7	13.0	298.9	137.4	407.0	733.2	2782.3
2019	384.0	74.2	41.4	212.3	11.9	32.1	63.6	64.7	149.6	227.7	199.3	377.2	1838.0
2020	762.3	177.7	142.3	84.7	74.8	53.8	9.4	88.3	191.7	226.4	398.4	321.9	2531.7
2021	532.3	143.8	284.3	69.7	96.1	38.8	0.3	3.6	323.0	532.4	641.0	99.1	2764.4
# Years	35	37	38	40	40	40	40	40	40	40	38	39	42
Mean	374.3	254.4	245.5	159.1	93.2	65.0	40.6	56.4	121.9	321.4	455.5	362.0	2549.1
Median	344.8	242.2	211.9	161.0	79.0	51.4	32.3	42.0	89.9	317.0	466.3	345.7	2572.3
AVEDEV	157.9	119.2	123.8	68.4	53.4	35.3	27.3	37.5	85.0	142.7	173.0	142.2	412.6
Max	859.7	624.4	528.2	396.2	305.9	184.0	124.8	206.8	383.8	778.9	928.2	733.2	3535.0
Min	50.2	55.0	41.4	20.6	6.0	11.9	0.3	1.8	0.0	33.8	94.0	85.8	1479.4

*year denotes that average month precipitation values were used in lieu of missing data (updated to reflect averages to 2021)

Note: Data compiled from daily observations recorded at MFO's Powerhouse - Environment Canada Meteorological Station - Code #4 (360m A.S.L)

4.4 SITE-WIDE SIS PERFORMANCE

4.4.1 *Phase I Lynx SIS Performance*

The Phase I Lynx SIS consists of pumping wells PW14-01, PW14-03, and PW14-04. Each of these pumping wells is screened in the upper portion of the MVA in the Mill Area and near the Lynx TDF and Superpond (see **Figure 4-2**). The Phase I Lynx SIS has been operating since September 30th, 2017, as part of the Site-Wide SIS. The Phase I Lynx SIS captures ARD/ML-impacted groundwater that is inferred to originate primarily from (i) buried mine waste materials in the Mill area, (ii) surface waste near the Superpond, and (iii) seepage from the Lynx TDF embankment berm. Groundwater quality varies seasonally, with higher metal concentrations in groundwater in the Lynx Reach observed during high rainfall periods from November to April. The deterioration in groundwater quality during these periods is attributed to the flushing of ARD/ML-related constituents from local mine waste materials to groundwater in the MVA in the Lynx Reach.

Routine (synoptic) groundwater level surveys have been completed since the Phase I Lynx SIS has been operating under a variety of conditions, including extreme rainfall events and dry periods during the summer. The data from these surveys allow capture zones in the Lynx Reach to be inferred and for the degree of well interference between the pumping wells to be determined. The most recent groundwater level survey was completed during RGC's site visit in November 2021. Note, the monthly rainfall for November 2021 was 641 mm, or approximately 40% higher than the monthly mean precipitation amount for November from 1979 to 2021. Precipitation in October 2021 was also unusually high, i.e., 532 mm (see Section 4.3 for other data and long-term averages).

The inferred flow field and capture zones for November 2021 are shown in **Figure 4-4**. Groundwater levels were elevated during the survey but only at approximately 80% of the levels observed during previous high flow periods. The pumping rate for pumping well PW14-03 (Mill area) was 19.0 L/s during the survey and the pumping rate for pumping well PW14-04 was 6.5 L/s. Pumping well PW14-01 was not operating, as it was disconnected for all of 2021[6]. Hence the system was only operated at a reduced capacity. The observed pumping rate and hence inferred width of the capture zone for pumping well PW14-03 is comparable to previous surveys during low and high flow conditions. The capture zone for pumping well PW14-03 was therefore inferred to extend to the north and capture impacted groundwater flows from the Mill area and part of the ETA/Cookhouse area near Myra Creek in November 2021.

Previously (2018 to 2020), the inferred capture zone for pumping well PW14-04 covered the downstream portion of the Lynx TDF berm and the MVA beneath the Superpond. The inferred capture zone for pumping well PW14-04 was significantly reduced in 2021, mainly due to the reduced pumping rate in 2021. The pumping rate at pumping well PW14-04 has been decreasing since 2017, suggesting a decrease in well efficiency over time, possibly due to clogging of the well screen with. During the site visit in November 2021,

[6] Fault codes suggest the motor for the pump has seized, so this pumping well cannot be operated without repair or replacement of the pump.

the set level in PW14-04 was decreased from 3 ft to 1 ft resulting in an increase in the pumping rate from 6.5 L/s to 10.1 L/s.

In 2021, pumping well PW14-04 did not appear to provide full hydraulic capture, hence some bypass of ARD/ML-impacted groundwater most likely occurred. This is supported by groundwater levels observed in November 2021 and routine groundwater water quality results for wells downstream of the Phase I Lynx SIS (see discussion below). Note, the Interim Phase II Lynx SIS was not operating at the time of the groundwater level survey in November 2021 and shallow groundwater was likely discharging to Myra Creek, as indicated by horizontal hydraulic gradients directed towards the creek.

Pumping wells PW14-01, PW14-03, and PW14-04 are equipped with a Variable Frequency Drive (VFD) that adjusts the pumping rate for each pumping well to maintain a near-constant (pre-determined) groundwater level within the well. The groundwater level that is maintained is intended to ensure the Phase I Lynx SIS operates as intended, assuming all three of the pumping wells are operating. In 2021, the Phase I pumping wells were operated as follows:

- *Pumping Well PW14-01.* The battery of the data logger died on August 24th, 2020, and hence recording of the pumping rate and dynamic water level in this pumping well stopped in mid-2020. MFM personnel reported that pumping well PW14-01 has not been operated since November 2020. The last water quality sample collected at pumping well PW14-01 was on October 28th, 2020. The wellhead was reconnected in September 2021 and electrical systems restored in November 2021 after RGC’s site visit. Restarting of the system, however, failed with fault codes reading a stall prevention error indicating potential seizing of the motor.
- *Pumping Well PW14-03.* The data logger stopped recording on November 16th, 2020, due to a dead battery. The battery was replaced in March 2021, but recording did not resume. The flow logger was restarted in March 2022. However, routine monthly water quality samples collected throughout 2021 suggest this pumping well was operated as intended in 2021. MFM personnel further observed the pump operating normally throughout 2021 and a pumping rate of 19 L/s was observed at the system’s flow meter during a site visit in late November 2021, which is consistent with previous observations made during similar flow conditions.
- *Pumping Well PW14-04.* No flow records exist beyond October 24th, 2020, due to dead batteries for the data logger. Batteries were replaced and the flow logger restarted in March 2022. However, water quality observations for late 2020 and 2021 suggests that pumping well PW14-04 continued to operate for most of 2021. Water quality sampling and observations by MFM field personnel suggest that pumping well PW14-04 was not operating for some time in October 2021 but resumed after this interruption. The pump likely operated at an increased set level throughout most of 2021 resulting in a decrease of pumping rates by around 35% (relative to 2020 rates).

In 2021, the Phase I Lynx SIS continued to capture impacted groundwater from the MVA but at a reduced combined rate compared to previous years due to not operating the system at full capacity. **Figures 4-5** to **4-7** show pumping rates and Zn concentrations observed at pumping wells PW14-01, PW14-03, PW14-04, respectively. The estimated combined pumping rate for all three pumping wells is shown in **Figure 4-8**. Average flow rates, pumped volumes, and captured contaminant loads for pumping wells PW14-01, PW14-03, PW14-04, and the PW14 pumping wells combined are summarized in **Tables 4-5** to **4-8**. Note that no records of pumping rates were available for 2021 (see above), so estimated flow rates based on comparison with previous years were used to estimate pumped volumes and captured contaminant loads. It is emphasized that pumped volumes of groundwater and captured loads reported for 2021 are approximate estimates only.

Pumping well PW14-01 was not operating in 2021, so no groundwater flows or contaminant loads were captured. Pumping well PW14-03 was assumed to have operated normally in 2021 with an estimated volume of approximately 409,000 m^3 of groundwater captured in 2021. The flow logger was restarted in early March 2022. No logger records for pumping well PW14-04 exist for 2021. To estimate captured impacted groundwater volumes, rates observed in 2020 were decreased by 35% due to the increased set level in 2021. Pumping well PW14-04 appears to have operated for most of 2021 except for October based on field observations. The total estimated groundwater volume captured is around 216,000 m^3.

Figure 4-6 and **Figure 4-7** indicate that the Phase I Lynx SIS continues to capture highly impacted groundwater. Zn concentrations in groundwater captured by pumping well PW14-03 ranged from 12.4 mg/L at the end of the dry summer period to 35.8 mg/L in winter following a period of sustained high precipitation. In 2021, pumping well PW14-04 captured groundwater with similar Zn concentrations, ranging from 10 mg/L to 40.5 mg/L. Zn concentrations vary seasonally with the highest concentrations observed during high rainfall periods in the winter (November to February). Zn concentrations subsequently decline in the spring and reach their lowest levels in late summer, i.e., August or September. This seasonal trend supports the assertion that Zn and other metals are flushed from sources in the Lynx Reach to groundwater during high rainfall periods.

In 2021, average Zn concentrations in groundwater at pumping wells PW14-03 and PW14-04 were 24.3 mg/L and 21.8 mg/L, respectively. The total Zn load captured by the Phase I Lynx SIS in 2021 is estimated to be approximately 16 t (see **Table 4-8**). This Zn load represents about 58% of the total Zn load captured by the Old TDF under-drains and delivered to the Superpond via Pumphouse No.4 (see Section 4.4.3). Approximately two thirds of the estimated Zn load captured by the Phase I Lynx SIS was captured by pumping well PW14-03, and one third was estimated to be captured by pumping well PW14-04 in 2021. Note, contaminant loads captured by the Old TDF under-drains have gradually decreased since start of operating the Phase I Lynx SIS (see Section 4.4.3) indicating a reduction of loading from the Lynx reach to the downstream aquifer. Effects of operating the Phase I Lynx SIS on Myra Creek water quality are discussed in Section 4.6.

Figure 4-8 shows time trends of the combined daily average pumping rate and Zn concentrations observed downgradient of the Phase I Lynx SIS at monitoring wells MW17-02D and MW17-03. Note, the first groundwater quality samples (since the Phase I Lynx has been operating) were collected from wells MW17-02D and MW17-03 in early October 2017, i.e. at the end of a dry summer period and before any significant precipitation events. The Phase I Lynx SIS had started operating some days prior, but travel times are in the range of months and hence these samples are considered to represent dry summer conditions pre-Lynx SIS. At that time, zinc concentrations were 13.7 mg/L and 18.5 mg/L at MW17-02D and MW17-03, respectively. Zinc concentrations in groundwater from these monitoring wells show a seasonal trend that is similar to the trend upgradient at the PW14 pumping wells. That is, the highest concentrations in winter following prolonged periods of high precipitation and lowest concentrations at the end of summer and in fall following months of drier conditions.

In the first years of operating the Phase I Lynx SIS, Zn concentrations at wells MW17-02D and MW17-03 at the end of summer and in the fall have been consistently lower than Zn concentrations observed before the Phase I Lynx started operation. Zn concentrations at well MW17-02D decreased to 1.1 mg/L in November 2020 which is consistent with previous years and significantly lower than the pre-Lynx SIS concentration of 13.7 mg/L. In 2021, Zn concentrations downgradient of the Phase I Lynx SIS increased again to levels similar to pre-Lynx SIS conditions during low flow conditions. This reversal to pre-Lynx SIS water quality conditions is believed to be caused by stoppage of pumping well PW14-01 and reduced pumping of pumping well PW14-04. Note that no water quality samples were collected during winter high flow conditions prior to operation of the Phase I Lynx SIS. Hence an assessment of performance of the Phase I Lynx SIS during winter high flow conditions is not possible.

Water quality data suggest that the Phase I Lynx SIS effectively captures impacted groundwater within the Lynx Reach and limits downgradient migration during summer baseflow conditions when it is operated at full capacity (e.g. in 2019/20). Hence the increased bypass inferred to have occurred in 2021 is mainly due to not operating the Phase I Lynx SIS at full capacity. At well MW17-03, Zn concentrations have been consistently higher than at well MW17-02D since October 2020, suggesting that local groundwater quality may be influenced by additional (lateral) inflows or (vertical) recharge of impacted groundwater from WRD1 or other local sources (see RGC, 2020). Zn concentrations at well MW17-03 were consistent with this trend in 2021.

Table 4-5

Performance Summary for Pumping Well PW14-01

Year	Average Pumping Rate [L/s]	Days Operating [days]	Pumped Volume [m^3]	Average Observed Concentrations, mg/L				Load [t/yr]			
				SO_4	Cd-d	Cu-d	Zn-d	SO_4	Cd-d	Cu-d	Zn-d
2017	30.0	58	150,335	306	0.02	0.20	14.8	48.2	0.003	0.030	2.30
2018	28.2	276	672,542	350	0.03	0.31	15.7	210.9	0.015	0.182	9.25
2019	20.6	334	595,762	287	0.02	0.36	12.8	157.1	0.012	0.187	6.99
2020	17.6	296	540,469	751	0.07	2.66	36.6	149.5	0.011	0.285	6.06
2021	0.0	0	0	-	-	-	-	-	-	-	-
Total	**22.3**	**964 (81%)**	**1,959,108**					**565.7**	**0.041**	**0.684**	**24.61**

Table 4-6

Performance Summary for Pumping Well PW14-03

Year	Average Pumping Rate [L/s]	Days Operating [days]	Pumped Volume [m^3]	Average Observed Concentrations, mg/L				Load [t/yr]			
				SO_4	Cd-d	Cu-d	Zn-d	SO_4	Cd-d	Cu-d	Zn-d
2017	13.9	70	84,055	402	0.04	1.24	32.6	27.2	0.003	0.110	2.32
2018	12.7	334	367,085	376	0.04	1.52	28.6	125.7	0.013	0.519	9.67
2019	12.0	365	378,317	256	0.02	1.03	14.9	114.3	0.011	0.452	6.80
2020	12.6	364	404,212	287	0.03	1.26	16.2	126.5	0.014	0.560	7.28
2021	18.1	365	408,686	471	0.05	1.77	24.3	204.8	0.021	0.761	10.54
Total	**12.5**	**1,133 (95%)**	**1,642,356**					**598.5**	**0.062**	**2.401**	**36.62**

Table 4-7

Performance Summary for Pumping Well PW14-04

Year	Average Pumping Rate [L/s]	Days Operating [days]	Pumped Volume [m^3]	Average Observed Concentrations, mg/L				Load [t/yr]			
				SO_4	Cd-d	Cu-d	Zn-d	SO_4	Cd-d	Cu-d	Zn-d
2017	14.9	70	90,187	825	0.08	2.56	29.1	75.9	0.008	0.240	2.72
2018	16.8	311	450,132	816	0.07	2.33	26.3	288.1	0.024	0.772	9.13
2019	15.7	362	494,143	572	0.04	1.32	17.2	276.0	0.020	0.679	8.99
2020	11.1	351	355,352	767	0.06	2.16	21.3	318.2	0.026	0.940	8.97
2021	13.0	320	215,910	1,052	0.06	1.82	21.8	271.8	0.015	0.490	5.46
Total	**14.0**	**1,094 (92%)**	**1,605,724**					**1230.0**	**0.093**	**3.121**	**35.26**

Table 4-8

Performance Summary for Phase I Lynx SIS

Year	Average Pumping Rate [L/s]	Pumped Volume [m^3]	Load [t/yr]			
			SO_4	Cd	Cu	Zn
2017	58.8	324,577	151.3	0.014	0.380	7.34
2018	57.7	1,489,760	624.7	0.052	1.473	28.05
2019	48.3	1,468,222	547.5	0.043	1.318	22.78
2020	41.3	1,300,033	594.2	0.051	1.785	22.31
2021	31.1	624,596	476.6	0.036	1.251	16.00
Total	**47.4**	**5,207,188**	**2394.3**	**0.196**	**6.207**	**96.48**

4.4.2 *Interim Phase II Lynx SIS Performance*

The Interim Phase II Lynx SIS consists of a fence of four shallow pumping wells (PW18 series) immediately downstream of the Car Bridge on the left (northern) creek bank (see **Figure 4-2**). The PW18 pumping wells were installed in 2018 to prevent the discharge of acidic (impacted) seepage to Myra Creek, which was first observed in early 2018 following high rainfall periods. An unlined surface runoff storage pond (called the "Duck Pond") and associated channels were identified to be the most likely source of these acidic seeps. Initial operation and testing of the Interim Phase II Lynx SIS were completed in May/June 2018 and the system has been operating since March 2019.

Table 4-9 summarizes the volumes of water and contaminant loads captured by the Interim Phase II Lynx SIS since March 2019. Note, contaminant loads are expressed in kg/month, as they are much lower than the contaminant loads captured by the Phase I Lynx SIS. In early 2021, the Interim Phase II Lynx SIS operated intermittently and pumping ceased some time in August when water levels decreased below the well screens and the system was subsequently disconnected. Also, it appears that pumping wells PW18-01 and PW18-02 did not operate in 2021.

Totalizer readings from the PW18 pumping wells were collected in March 2020 and then again in March 2021 and November 2021. This allows for determination of total captured volumes but monthly variations in pumping rates can only be estimated from previously observed rates. The combined pumping rate from pumping wells PW18-03 and PW18-04 was inferred to range between 3.3 L/s and 5.5 L/s in 2021. An estimated 81,000 m^3 of impacted groundwater and 146 kg Zn were captured by the Interim Phase II Lynx SIS in 2021. This Zn load is less than 1% of the Zn load recovered by the Phase I Lynx SIS over the same period.

An inspection of the creek bank on December 2nd, 2021, indicated shallow groundwater (seepage) discharging to the creek along the Interim Phase II Lynx SIS, which was not operating at the time (see more details below). The "Car Bridge Seep" was sampled during the inspection, according to MFM staff, but all other seepage was diffuse and could therefore not be sampled for water quality.

Zn concentrations in groundwater captured by the Interim Phase II Lynx SIS were approximately 3 mg/L in early 2021, suggesting some flows of moderately impacted groundwater in the shallow aquifer. Zn concentrations decreased over the summer months to around 0.5 mg/L Zn, suggesting some seasonality in groundwater quality in the shallow aquifer in this area. Groundwater monitoring wells MW11-04 and MW16-04 (adjacent to an unlined channel conveying runoff from the ETA/Duck Pond to the 25-Sump) showed a strong seasonal behaviour in 2021 with Zn concentrations ranging from approximately 3 mg/L to 41 mg/L. These concentrations likely reflect the infiltration of acidic runoff from this unlined channel to the shallow aquifer following high rainfall events.

At well MW18-07S, Zn concentrations up to 14 mg/L were observed in 2021 and concentrations varied seasonally. Zinc concentrations at well MW18-07D, however, were much lower by comparison, ranging from 0.1 mg/L to 2.4 mg/L. This suggests a shallow local source, e.g., infiltration of runoff from the Duck Pond and/or local mine waste materials. Furthermore, the higher concentration in the shallower aquifer suggests only limited vertical migration of the impacted groundwater and/or significant dilution in the portion of the aquifer screened by the deeper well. Other nested MW18 monitoring wells also show consistently higher Zn concentrations in the shallow well in 2021.

During a seep survey completed by MFM personnel in December 2021, seepage was identified along the creek bank downstream of the Car Bridge with a Zn concentration of 2.7 mg/L Zn (see Section 4.5.1). Routine groundwater sampling showed that shallow groundwater immediately upgradient of the Interim Phase II Lynx SIS is moderately to strongly impacted during the wet winter months and that the Interim Phase II Lynx SIS captures moderately impacted groundwater suggesting some dilution. Previous water level surveys further showed that the Interim Phase II Lynx SIS effectively prevents shallow groundwater from discharging into Myra Creek immediately downgradient of the Car Bridge during low and moderate flow conditions when it is operating. It is, however, difficult to quantify the effects of operating the PW18 wells on water quality in Myra Creek during winter high flow conditions as the creek is considered not safe to be sampled during winter high flows.

Table 4-9

Performance Summary for Interim Phase II Lynx SIS

Month	Pumping Rate [L/s]	Pumped Volume [m^3/month]	Captured Load [kg/month]							
			Dissolved Sulphate (SO_4)	Dissolved Cadmium (Cd)	Dissolved Copper (Cu)	Dissolved Zinc (Zn)	Dissolved Aluminum (Al)	Dissolved Calcium (Ca)	Dissolved Iron (Fe)	Dissolved Magnesium (Mg)
Mar-19	15.7	42,051	1,522	0.05	0.76	25	0.7	830	0.42	108
Apr-19	15.8	40,851	1,368	0.05	0.98	24	0.9	695	0.41	99
May-19	16.0	42,854	1,274	0.04	0.90	21	0.9	713	0.55	89
Jun-19	13.4	34,642	885	0.03	0.53	13	0.4	539	0.35	69
Jul-19	13.6	36,357	785	0.02	0.33	11	0.2	563	0.36	58
Aug-19	13.6	36,426	766	0.02	0.36	11	0.2	535	0.36	60
Sep-19	13.6	35,251	721	0.02	0.38	11	0.2	489	0.35	61
Oct-19	7.9	21,159	455	0.01	0.23	7	0.1	319	0.21	35
Nov-19	7.9	20,477	505	0.02	0.41	9	0.3	315	0.20	38
Dec-19	7.0	18,749	453	0.02	0.37	8	0.2	290	0.19	35
2019	**12.4**	**328,818**	**8,732**	**0.28**	**5.26**	**141**	**4.1**	**5,288**	**3.41**	**650**
Jan-20	7.0	18,749	2,835	0.40	16.45	135	12.4	712	0.19	181
Feb-20	3.6	8,588	747	0.07	3.01	25	0.5	245	0.09	46
Mar-20	3.6	9,508	758	0.05	1.65	18	2.3	261	0.10	44
Apr-20	4.3	11,146	781	0.05	1.59	18	1.6	312	0.11	45
May-20	4.3	11,517	663	0.05	1.72	17	2.3	281	0.12	44
Jun-20	4.3	11,146	573	0.03	0.95	10	0.1	223	0.17	35
Jul-20	4.3	11,517	464	0.02	0.53	8	0.2	197	0.12	30
Aug-20	4.3	11,517	166	0.01	0.25	5	0.2	212	0.12	25
Sep-20	4.3	11,146	366	0.01	0.32	6	0.2	208	0.11	26
Oct-20	5.7	15,133	499	0.02	0.40	9	0.3	274	0.15	38
Nov-20	6.2	15,941	1,033	0.08	2.59	31	3.7	427	0.16	78
Dec-20	6.8	18,213	1,327	0.11	3.32	46	8.0	505	0.18	87
2020	**4.9**	**154,120**	**10,214**	**0.93**	**32.79**	**329**	**31.9**	**3,859**	**1.60**	**680**
Jan-21	5.5	14,731	1,089	0.09	0.99	45	4.0	453	0.15	82
Feb-21	5.0	12,096	797	0.06	0.63	30	2.3	351	0.13	59
Mar-21	4.0	10,714	572	0.03	0.36	18	1.1	271	0.11	41
Apr-21	3.3	8,450	373	0.01	0.14	8	0.1	190	0.08	25
May-21	3.3	8,839	610	0.05	1.59	20	3.4	240	0.09	47
Jun-21	3.3	8,450	499	0.04	1.13	15	1.2	217	0.08	33
Jul-21	3.3	8,732	334	0.01	0.08	6	0.1	176	0.09	23
Aug-21	3.3	8,732	279	0.01	0.05	4	0.1	172	0.02	20
Sep-21	0.0	0	0	0.00	0.00	0	0.0	0	0.00	0
Oct-21	0.0	0	0	0.00	0.00	0	0.0	0	0.00	0
Nov-21	0.0	0	0	0.00	0.00	0	0.0	0	0.00	0
Dec-21	0.0	0	0	0.00	0.00	0	0.0	0	0.00	0
2021	**2.6**	**80,743**	**4,553**	**0.30**	**4.96**	**146**	**12.3**	**2,070**	**0.75**	**330**

4.4.3 *Old TDF Under-Drain Performance*

The Old TDF under-drain system is designed to capture impacted groundwater downstream of the Old TDF, thereby preventing it from discharging to Myra Creek. Groundwater captured by the under-drains flows by gravity to Pumphouse No. 4, from which it is pumped to the Superpond for treatment. **Figure 4-1** shows the location of the various elements that comprise the Old TDF under-drain system. The NOD consists of a system of three separate drain sections referred to as (i) Short Drain, (ii) Medium Drain, and (iii) Long Drain. The NOD was constructed to (i) replace the Old Outer Drain should it be damaged by the Seismic Upgrade Work and (ii) to improve overall performance of the original under-drain system that was installed as part of the construction of the Old TDF.

Sluice gates control the flow out of the individual drain sections and each of the NOD drains is typically run well below full capacity, i.e. the NOD system is mostly run at a setting of "10-0-10", representing 10% opening for the Medium Drain, 0% opening for the Short Drain and 10% opening for the Long Drain. Note that the Short Drain at a 0% setting is equivalent to 0.5% opening. The Old Outer Drain is functional between Stations MC 0+450 and MC 1+1350 but the various sections can no longer be controlled individually. The Inner Drain was placed in the foundation soils along the north valley slope (near the toe of WRD1) to intercept seepage/impacted groundwater emanating from WRD1.

The long-term average pumping rate from Pumphouse No. 4 is approximately 206 L/s (see **Table 4-10**). Note that the operation of the Phase I Lynx SIS has not resulted in decreased groundwater flows to the Old TDF under-drains due to increased leakage from Myra Creek and/or lateral inflows from the MVA to the under-drains. In 2021, the average pumping rate for Pumphouse No. 4 was approximately 145 L/s. This rate is approximately 30% (or 60 L/s) less than the long-term average pumping rate (see above). An abrupt decrease in the pumping rate from Pumphouse No. 4 occurred on February 21st, 2021, following the commissioning of a new sump level transmitter for Pumphouse No. 4. Upon investigation by MFM staff, it was determined that this decrease in the pumping rate was related to the new logger not being adjusted to equate to the previous sump level setting, which resulted in an increased sump level. Prior to this change, the outer drains were allowed to drain freely into the sump, with flows only restricted by valves. The higher sump level in 2021 reportedly rose above the inlets of the drain pipes, resulting in reduced hydraulic gradients and hence reduced flow rates within the individual drains.

Table 4-10 summarizes estimated drain flows and Zn loads captured by the Old TDF under-drains. Note that flow rates are continuously recorded at Pumphouse No. 4 but contributions from the individual drains are not measured. Hence the contributions by individual drains are estimated from quarterly water quality samples collected from Pumphouse No.4 and the individual drains via a load balance calculation. The fixed flow contribution is provided in **Table 4-10** and further details on this calculation are provided in RGC (2020). It should be noted that the individual flow contribution percentages had to be adjusted for 2021 to reflect the changed flow contributions of the individual drains caused by changes in operation of Pumphouse No.

4. It appears that the increase in sump level resulted in reduced flows from the Inner Drain and Old Outer Drain. In 2021, the Inner Drain was estimated to capture 7.4 t Zn, which accounts for approximately 25% of the combined Zn load captured by the under-drain system and delivered to the Superpond for treatment. The average annual Zn concentration in groundwater captured by the Inner Drain in 2021 was 32.4 mg/L Zn. The Old Outer Drain was estimated to capture around 5.5 t Zn in 2021, or approximately 20% of the total Zn load to Pumphouse No. 4. The average annual Zn concentration at the Old Outer Drain increased twofold from previous years to 6 mg/L. In 2021, an average Zn concentration of 5.2 mg/L Zn was observed in groundwater captured by the Medium Drain, which is the segment of the NOD that is situated in the center of the main Zn plume in the Lower Old TDF Reach near Myra Creek. This Zn concentration is also elevated compared to previous years. Zinc loads captured by the Medium Drain in 2021 are, however, lower than the historical average due to the reduced pumping rate from Pumphouse No. 4.

An average Zn concentration of 3.3 mg/L Zn was observed at the Short Drain segment compared to the long-term average of 1.7 mg/L. The Zn load captured by the Short Drain segment in 2021, however, was comparable to the historic average due to the overall lower pumping rates observed in 2021. Flows and loads to the Short Drain are generally small, however, representing only about 8% of the estimated total Zn load to the under-drain system. The average Zn concentration in groundwater captured by the Long Drain segment was 6 mg/L in 2021 which is approximately two times the long-term average. The estimated Zn load captured by the Long Drain (8.3 t Zn) in 2021 is about twofold compared to loads captured in previous years.

The annual average Zn concentration in all drain flows combined pumped from Pumphouse No. 4 in 2021 was 6.1 mg/L Zn. This value is close to the multi-year average Zn concentrations, despite some substantial differences in Zn concentrations for individual drain segments. However, the total estimated captured Zn load at Pumphouse No. 4 in 2021 (28 t Zn) is significantly less than in previous years due to the reduced pumping rate. Also, the decreasing trend in Zn concentrations at the various drain segments and Pumphouse No.4 observed in prior years did not continue in 2021, as concentrations in captured groundwater were higher than in 2020. The cause of the increase in Zn concentrations in captured drain flow is most likely reduced dilution by creek water due to lower pumping rates and elevated drain levels since the new sump level transmitter was installed for Pumphouse No.4.

Table 4-10

Groundwater Flows, Concentrations, and Captured Loads by Old TDF Under-Drains, 2010 to 2021

				2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Average Annual Observed Zn Concentration, mg/L															
Inner Drain				29	28	28	29	35	27	28	25	27	21	28	32
Old Outer Drain				6.3	6.4	6.3	5.4	6.1	7.6	5.9	5.6	3.1	2.3	3.3	6.0
Short Drain				1.7	2.7	1.4	1.2	1.7	1.8	1.4	1.0	2.9	0.6	0.7	3.3
Medium Drain				7.9	6.1	6.4	5.2	4.4	7.8	7.4	7.5	3.7	5.7	3.2	5.2
Long Drain				3.0	3.1	3.1	2.0	1.5	2.4	3.3	3.4	3.9	1.7	1.9	6.0
Pumphouse No. 4			**Average:**	**6.7**	**8.6**	**7.5**	**6.2**	**6.6**	**6.7**	**6.7**	**6.9**	**5.8**	**5.4**	**5.3**	**6.1**
Average Flow Rates, L/s*	Flow contribution, %														
	2012 to 2020	2021													
Inner Drain	10%	5%		21	21	23	21	20	21	21	21	20	22	22	7
Old Outer Drain	30%	20%		63	63	69	64	59	62	64	63	59	67	65	29
Short Drain	10%	15%		21	21	23	21	20	21	21	21	20	22	22	22
Medium Drain	20%	30%		42	42	46	42	40	41	43	42	40	44	43	44
Long Drain	30%	30%		63	63	69	64	59	62	64	63	59	67	65	44
Pumphouse No. 4*	**100%**	**100%**	**Total:**	**210**	**210**	**230**	**212**	**198**	**207**	**214**	**209**	**198**	**222**	**216**	**145**
Calculated Zn Load, t Zn															
Inner Drain				19.5	18.7	20.4	19.6	21.7	17.8	18.8	16.4	16.6	15.0	19.0	7.4
Old Outer Drain				12.6	12.7	13.7	10.9	11.5	14.8	11.9	11.1	5.9	4.8	6.7	5.5
Short Drain				1.1	1.8	1.0	0.8	1.0	1.2	0.9	0.6	1.8	0.4	0.4	2.3
Medium Drain				10.5	8.1	9.4	6.9	5.4	10.2	10.0	9.9	4.6	8.0	4.3	7.1
Long Drain				6.0	6.2	6.8	4.1	2.8	4.7	6.7	6.8	7.3	3.7	3.8	8.3
Pumphouse No. 4**			**Total:**	**44.4**	**57.0**	**52.7**	**41.2**	**41.5**	**43.6**	**45.3**	**45.4**	**36.2**	**38.0**	**36.2**	**27.5**

* Flowrates for individual drain segments are calculated from fixed percentages except for 2021.

**Total Pumphouse No.4 loads are calculated with water quality data observed at Pumphouse No. 4 rather than summing up the individual drain components.

4.5 Required Water Quality Results (Permit M-26)

Water quality results for required wells and seeps are provided in **Appendix D**. Results are discussed in the sub-sections below.

4.5.1 *Seepage Water Quality Results*

Table 4-11 summarizes water quality results for seeps sampled on site in 2021. The Car Bridge Seep is required to be sampled when flowing while other seeps were monitored and sampled voluntarily in 2021. A seep survey including field parameters and water quality sampling was completed by MFM personnel on December 2nd, 2021, following a period of sustained rainfall (210 mm in eight days). Groundwater levels were elevated during the survey, and the Myra Creek level had decreased from peak levels, so flow conditions were “favorable” for groundwater seepage towards Myra Creek. The northern creek bank along the Interim Phase II Lynx SIS including some portions upstream and downstream of the pumping wells was inspected.

Four seeps were identified visually during the seep survey and confirmed by elevated Electrical Conductivity (EC) and lower field pH values compared to Myra Creek. The Car Bridge Seep was acidic (pH 5.6) and characterized by a Zn concentration of 2.7 mg/L, which is consistent with previous data. Note that seeps near well MW13-19 and near pumping well PW18-01 downstream of the Car Bridge Seep had lower pH and higher conductivity readings but could not be sampled due to low and diffuse flows. These field values suggest that the impacted shallow groundwater observed discharging downstream of the Car Bridge Seep along the Interim Phase II Lynx SIS may have similar or higher Zn concentrations than the sample obtained at the Car Bridge Seep.

The Road Seep Pond 4 was noted during the seep survey completed on December 2nd, 2021, and sampled voluntarily. This seep was observed to emerge from the wetland adjacent to Ponds 2 and 4 and seep into Pond 4. The Road Seep Pond 4 did not enter Myra Creek and is characterized by low Zn of 0.2 mg/L. 3-Runoff is a small seep in the Lynx switchback area that is monitored voluntarily. Zn concentrations ranged from 1.6 to 3.2 mg/L of Zn in 2021, which is consistent with previous monitoring results.

Table 4-11

Seep Water Quality Results for 2021

Sample ID	Sampling Date	pH*	EC* µs/cm	SO_4 mg/L	Cd-d mg/L	Cu-d mg/L	Zn-d mg/L
Required samples							
Car Bridge Seep	2-Dec-2021	5.6	177	-	0.005	0.06	2.7
Voluntary samples							
Road Seep Pond 4	2-Dec-2021	-	-	10.5	0.001	0.007	0.2
3-RUNOFF	3-Mar-2021	7.1	231	74.8	0.01	0.1	3.2
3-RUNOFF	14-Apr-2021	-	199	52.2	0.009	0.08	2.2
3-RUNOFF	7-Jul-2021	-	219	45.5	0.007	0.09	1.6
3-RUNOFF	10-Nov-2021	-	142	51.3	0.010	0.181	2.3

*pH and EC records for required sample is from field measurements and for the voluntary samples they are laboratory measurements.

The Main Spring was the largest of the springs near the APA and was the focus of a hydrogeological investigation to determine seepage patterns and support the upgrade of the LLDD project (RGC, 2016). Flows from the Main Spring are now collected by the DDSD and monitored routinely for Permit M-26 (and as station TDF-EFF for Effluent Permit PE-6858). Selected water quality results for the DDSD (TDF-EFF) are summarized in **Table 4-12**. Flows are only observed during high rainfall periods and any flows in the DDSD are conveyed to the water treatment system. Samples are collected (and compared to an effluent limit) for future reference, as this water may eventually be directed to Myra Creek if concentrations meet discharge criteria. In 2021, grab samples were collected in October (n=3), November (n=3), and December (n=1).

Zn-d concentrations at station TDF-EFF exceeded the 0.25 mg/L Zn-d discharge limit during the initial flushing period in October and November 2021. Zn-t concentrations exceeded the 0.5 mg/L Zn-t discharge limit in the first two samples collected in November. Metal concentrations in the third sample collected at TDF-EFF in October and November, e.g., 0.144 mg/L Zn-d on October 26th and 0.161 mg/L Zn-d on November 28th, were lower than discharge limits. TSS data are not available for 2021 so exceedances for this parameter could not be checked. All flows from the DDSD are conveyed to the water treatment system and are not directly released to the receiving environment. The discharge limits do not apply to water reporting to treatment so exceedances for Zn-d and Zn-t are not a compliance issue. Further details are provided in the 2021 Monitoring Report for Effluent Permit PE-6858.

Table 4-12

Water Quality Results for DDSD (at Station TDF-EFF), 2021

Station	Date	Lab pH	TSS mg/L	Cd-d mg/L	Cu-d mg/L	Cu-t mg/L	Pb-d mg/L	Zn-d mg/L	Zn-t mg/L
Discharge Limit		*-*	*20*	*0.003*	*0.1*	*0.3*	*0.03*	*0.25*	*0.5*
TDF-EFF	22-Oct-2021	7.4	-	0.00163	0.0452	0.0709	0.00035	0.391	0.483
TDF-EFF	25-Oct-2021	7.3	-	0.00147	0.0408	0.0471	0.000057	0.357	0.355
TDF-EFF	26-Oct-2021	7.5	-	0.000703	0.0173	0.0262	0.000106	0.144	0.149
TDF-EFF	5-Nov-2021	6.8	-	0.00271	0.0631	0.162	0.00324	0.609	0.95
TDF-EFF	15-Nov-2021	7.1	-	0.0026	0.0581	0.131	0.000986	0.581	0.731
TDF-EFF	28-Nov-2021	7.2	-	0.000773	0.02	0.0237	0.000052	0.161	0.173
TDF-EFF	1-Dec-2021	6.9	-	0.00103	0.0374	0.0491	0.000056	0.223	0.266

Note: Highlighted values exceed the discharge limit.

4.5.2 *Groundwater Reporting to Old TDF Under-Drains*

Water quality time trends for individual segments and components of the Old TDF under-drain system are shown in **Figure 4-9** and **Figure 4-10** (see **Appendix D** for complete water quality results). The various drains and their performance are described in Section 4.4.3. As mentioned earlier, operation of the under-drain system changed in February 2021, complicating the comparison of concentrations with prior years. Groundwater captured by the Inner Drain is characterized by the highest concentrations of Zn and other constituents, as this drain is located along the toe of the WRD1 and is therefore strongly-impacted by ARD/ML generated by waste rock. Compared to previous years, concentrations were elevated in February and May in response to rainfall and the flushing of metals to groundwater. Zn concentrations in groundwater captured by the Old Outer Drain in 2021 were higher than concentrations observed in 2018 to 2020.

Zn concentrations in groundwater captured by the Long Drain segment of the NOD range between 2.8 mg/L and 13.4 mg/L in 2021 which is elevated compared to previous years. Zn concentrations in the Short Drain and Medium Drain segments have decreased in recent years (starting in 2018), although these trends were reversed in 2021 with generally elevated concentrations. Peak concentrations in groundwater from the Medium Drain segment are now 9 mg/L Zn, which is around twofold of the peak concentrations observed since 2018. The most recent increase in concentrations is likely caused by changes made in the beginning of 2021 to the operation of the system of underdrains resulting in less dilution by creek water.

4.5.3 *Groundwater Quality Downgradient of Old TDF Under-Drains*

Groundwater quality observations for 2021 are provided in **Appendix D**. Time trends for selected parameters are provided in **Figures 4-11** to **4-14**. Each of the wells shown is screened in the MVA near the

Old Outer Drains and NOD near Myra Creek in the Lower Old TDF Reach. Monitoring well MW-D is screened in the Shallow MVA (6.1 to 7.6 m bgs) upgradient of the NOD and represents highly-impacted groundwater (up to 25 mg/L Zn) that is mainly captured by the drain system. Zn concentrations are elevated in 2021, ranging from around 13 mg/L Zn to 23 mg/L. Hence the trend towards lower Zn concentrations (observed in 2019 and 2020) was reversed in 2021. This is consistent with increasing trends observed at Pumphouse No. 4 and the various under-drain components. Monitoring well MW-A is screened beneath MW-D in the Shallow MVA from 11.6 to 13.1 m bgs. Zn concentrations in groundwater from well MW-A are consistently lower than well MW-D in 2021, ranging between 5.8 mg/L and 13.4 mg/L Zn.

At well MW-F, located immediately downgradient of well MW-D and the NOD (4.3 to 5.8 m bgs, “Shallow MVA”), Zn concentrations varied between 0.3 mg/L and 5.6 mg/L in 2021, suggesting some bypass. Well MW-C (11.6 to 13.1 m bgs, “Shallow MVA”) is located downgradient of well MW-A and the NOD (between the NOD and Myra Creek). These wells monitor impacted groundwater bypassing the NOD. Zn concentrations in the deeper well MW-C are generally higher than at well MW-F, suggesting greater bypass of the NOD at greater depths at this location. An average concentration of 5 mg/L Zn is observed in 2021 with no apparent trend. Zn concentrations at well MW-F (4.3 to 5.8 m bgs, “Shallow MVA”) varied between 0.3 mg/L and 5.6 mg/L in 2021 also suggesting some bypass.

Monitoring well MW13-14S (8.0 to 11.0 m bgs, “Shallow MVA”) is situated between the Medium Drain segment of the NOD and Myra Creek. In 2021, groundwater from this well was characterized by elevated SO_4 of 87 mg/L to 246 mg/L and Zn concentrations of up to 4.3 mg/L. This suggests some impacted groundwater is occasionally bypassing the Medium Drain; however, peak concentrations appear to have been generally decreasing over the last years. Groundwater from well MW13-14D (14.7 to 17.7 m bgs, “Shallow MVA”) was characterized by up to 6.7 mg/L Zn and 290 mg/L SO_4 in 2021. This is comparable to concentrations in the shallower MVA at this location suggesting similar occasional bypass.

Monitoring well MW13-15S (9.5 to 12.5 m bgs, “Shallow MVA”) is located between the downstream end of the Medium Drain and Myra Creek. Zn concentrations of up to 2.7 mg/L are observed, suggesting some occasional bypass at the Medium Drain at this location. There is no noticeable seasonal trend in 2021 but peak concentrations are higher than in previous years. Groundwater from well MW13-15D (16.2 to 19.2 m bgs, “Deep MVA”) is characterized by lower Zn concentrations than in the shallower MVA, suggesting only minor bypass.

In general, concentrations in groundwater near the drains are elevated in 2021 compared to previous years. This is likely related to the increased sump level at Pumphouse No. 4, which appears to have reduced hydraulic gradients within the drains and hence reduced groundwater capture. It is likely that dilution with creek water is reduced and bypass of groundwater beneath the drains increased. Note, however, that there was no evidence of bypass beneath Myra Creek to the downstream wells that were monitored voluntarily in 2021.

4.6 WATER QUALITY IMPACTS TO RECEIVING ENVIRONMENT

Loads and recent water quality trends for Myra Creek are discussed below, as they are directly affected by the operation of the site-wide SIS, including the under-drains, Phase I Lynx SIS, and Interim Phase II Lynx SIS. Water quality in Buttle Lake and Thelwood Creek are discussed in the 2021 Monitoring Report for Effluent Permit PE-6858 and not repeated here.

4.6.1 *Myra Creek Quality – Inferences from Creek Surveys*

Creek surveys have been routinely conducted since April 2012 to support baseline investigations of Myra Creek water quality and estimated loads to the creek from different reaches of the site. A comprehensive description of estimated Zn loads in groundwater to Myra Creek is provided in RGC (2016b), where loads in the creek are used to define the major site reaches, i.e. the Lynx Reach, Upper Old TDF Reach, and Lower Old TDF Reach. As of December 31st, 2021, a total of forty-nine surveys have been completed in Myra Creek for a range of streamflows. These surveys involve collecting water quality samples from the Car Bridge (station MC-S11 or MC-100) to station MC-TP4 (at MC+1350) (see **Figure 4-3** for chainage markers). More recently, samples are also collected upstream of the Car Bridge along the ETA when time permits. Samples are collected in 50 m intervals on the left-hand creek bank, i.e. on the north side of the creek towards the WRDs and TDFs. A total of ten (10) surveys were completed that included samples from the right-hand creek bank. The most recent survey (August 2021) was completed in 100 m intervals and includes one sample upstream of the Car Bridge. The surveys are only completed when it is safe for site staff to access the creek, so most of the surveys are completed during lower (summer) streamflow conditions.

Figure 4-15 shows the average Zn concentrations in Myra Creek from all of the surveys completed to date (n=49). Also provided are the average Zn concentrations in surveys completed before the Phase I Lynx SIS was operating (n=36) and during the operation of the Phase I Lynx SIS since September 30th, 2017 (n=13). Note that concentrations increase substantially immediately downstream of the Car Bridge, where impacted groundwater is known to discharge to Myra Creek. An increase in concentrations at around Stations MC+150 and MC+200 also suggest additional (discrete) seepage zones in these areas. Zn concentrations also increase between Stations MC+500 and MC+800, which is another known groundwater discharge zone. Concentrations remain fairly constant along the NOD, suggesting the under-drain system effectively captures the contaminant plume migrating towards Myra Creek in the Lower Old TDF Reach.

Recent surveys completed when the Lynx SIS was operating show a less pronounced increase in concentrations in the Lynx Area. This can only partially be attributed to the operation of the Phase II Lynx SIS as more recent samples are biased towards dry summer low flow conditions when precipitation runoff and shallow seepage/groundwater flows near the Car Bridge contribute less load to the creek. **Figure 4-16** shows Zn concentrations from creek surveys completed since April 2012 when the daily average streamflow in the creek (at the Car Bridge) is comparable to the streamflow during the latest survey on August 18th,

2021. These data are plotted here so concentrations in the creek under similar streamflow conditions in the creek can be directly compared.

Estimated daily Zn loads in Myra Creek and from treated effluent during the low flow creek surveys are provided in **Table 4-13**. Streamflows range from 609 L/s in late September (just before Phase I Lynx SIS began operating) to 1,422 L/s in August 2013. Note that these creek surveys are biased towards low flow conditions and are only representative of conditions at the time of the individual survey in a highly transient system. These surveys are, however, useful in determining areas where loading to the creek occurs and should be evaluated together with daily composite creek samples collected at the downstream end of the site (analysis provided in Section 4.6.2 below). The latest survey completed on August 18th, 2021, shows a substantial increase in Zn concentrations between Stations MC+700 and MC+800 and along the Medium NOD (between stations MC+1200 and MC+1300) where concentrations nearly double in magnitude. This increase along the NOD is very unusual and suggests groundwater bypass along the Medium NOD. Elevated concentrations were also observed at monitoring wells MW13-14 and MW13-15 (see Section 4.5.3) which monitor groundwater between the NOD and Myra Creek. This bypass is most likely due to the changes made to the operation of the under-drains in February 2021 (see Section 4.4.3). Note that the sample collected at Station MC+1300 (with Zn concentration of 893 ug/L) is most likely representative of a discrete seepage zone further suggesting insufficient capture by the Medium Drain and Short Drain.

Table 4-13

Estimated Daily Zn Loads in Myra Creek and Treated Effluent – Low Flow Creek Surveys

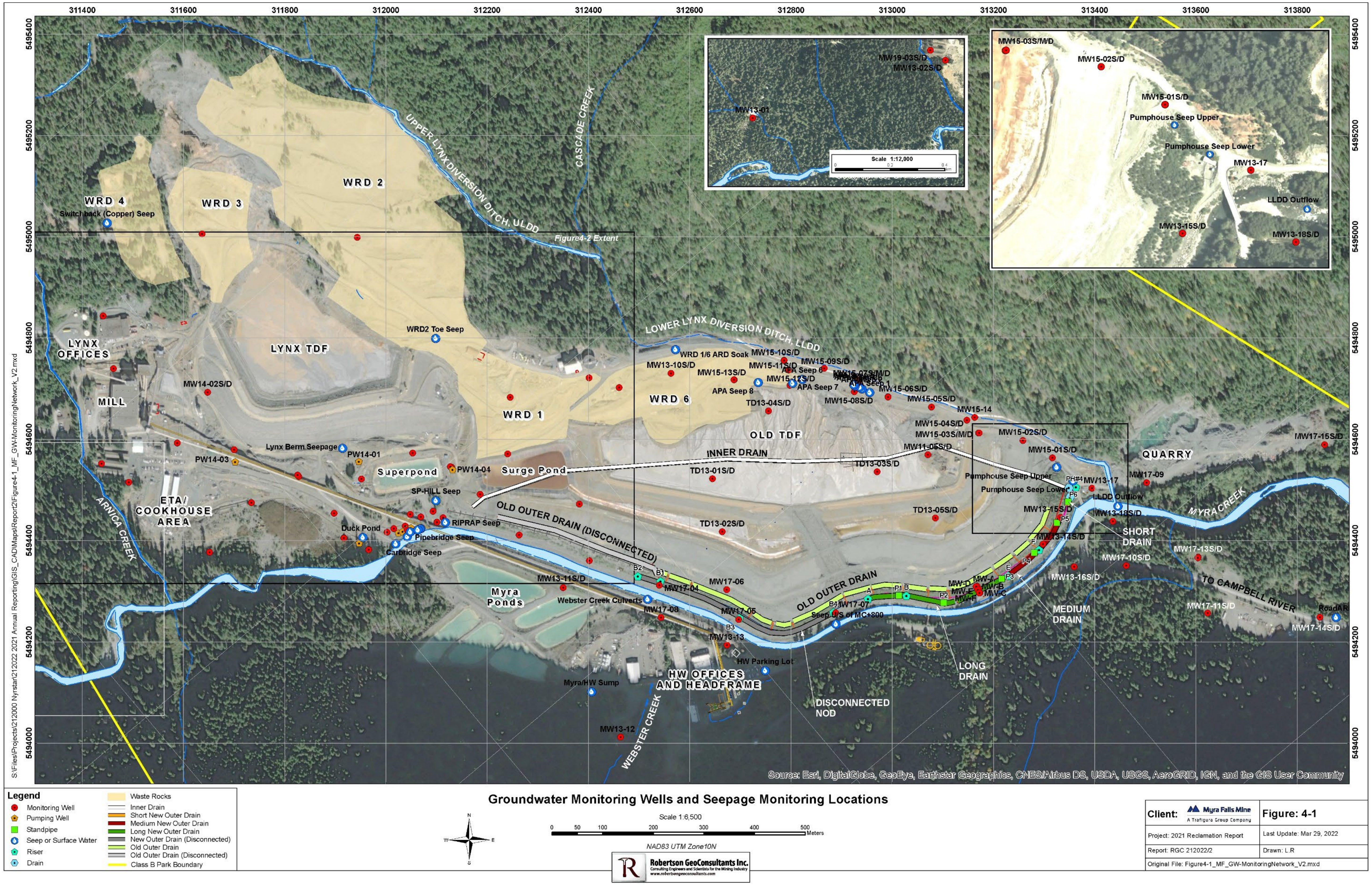
Creek survey date:	22-Aug-13	9-Sep-14	29-Jul-15	27-Sep-17	28-Aug-19	11-Aug-20	18-Aug-21
Streamflow (at carbridge), L/s:	1,422	637	692	609	760	827	1,134
Sampling Location	**Estimated Daily Load in Myra Creek, kg/day**						
MC-S11	0.9	0.3	11.8	1.3	0.6	0.3	
MC-50	1.6	0.6	12.4	0.3	0.5		
MC+0	1.5	0.8	9.1		0.5	0.4	0.6
MC+50	1.1	0.7	7.6	1.7	0.4		
MC+100	1.6	0.8	6.7	4.8	0.9	0.5	1.2
MC+150	10.3	6.4	21.3	8.3	1.0	1.3	
MC+200	5.8	3.7	15.1	8.4	0.6	0.5	1.6
MC+250	3.3	2.5	10.0	7.8	4.0	0.4	
MC+300	3.2	2.0	9.1	4.9	0.6	0.4	1.2
MC+350	3.9	2.0	8.6	4.3	0.7	0.4	
MC+400	2.9	1.7	7.6	3.9	0.5	0.4	1.3
MC+450	2.7	2.0	8.3	3.8	0.7	0.5	
MC+500	2.3	3.6	10.5	3.9	1.2	0.5	1.8
MC+550	3.3	5.1	10.8	4.3	2.3	1.2	
MC+600	3.3	6.3	11.7	4.4	2.5	1.4	3.4
MC+650	7.2	8.1	21.2	7.2	3.4	2.3	
MC+700	5.5	7.4	14.1	5.5	3.7	2.3	19.1
MC+750	7.1	10.0	15.2	7.0	0.5	2.6	
MC+800	15.8	10.8	18.5	7.3	4.1	3.5	9.0
MC+850	6.9	8.7	15.9	7.3	4.6	3.2	
MC+900	6.3	8.4	15.2	7.2	4.7	3.0	5.6
MC+950	6.3	8.3	14.8	7.4	4.6	3.3	
MC+1000	6.1	8.2	14.8	7.2	4.3	3.0	5.2
MC+1050	6.1	8.2	14.5	6.8	4.3	2.7	
MC+1100	6.0	8.3	14.5	6.5	4.2	2.5	5.2
MC+1150	6.0	7.9	13.4	6.7	4.2	2.7	
MC+1200	6.1	8.0	14.2	6.7	4.3	2.7	11.4
MC+1250	6.3	8.1	14.2	6.7	4.5	2.9	
MC+1300	7.2	8.1	15.4	9.5	4.2	2.7	87.5
MC-TP4	8.4	7.9	15.1	6.9	4.5	3.0	11.4
Treated effluent load, kg/day	2.0	7.8	1.4	1.5	2.4	2.2	2.7
Load contribution by treated effluent, %	24%	99%	9%	22%	54%	74%	24%

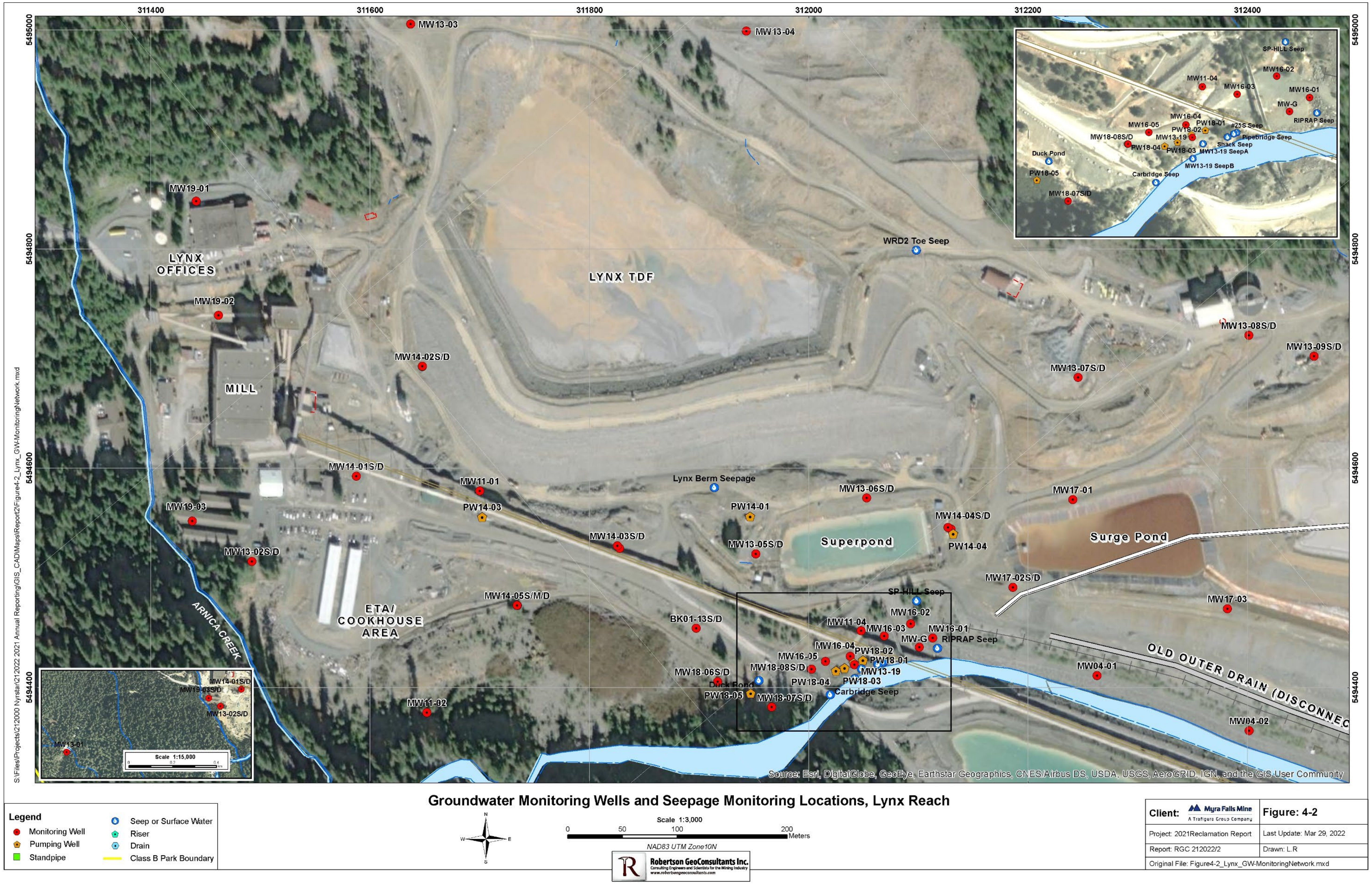
4.6.2 *Water Quality Trends in Myra Creek*

Figure 4-17 shows Cd, Cu, and Zn in Myra Creek at station MC-TP4 and in effluent from the Polishing Ponds (MP-EFF) for 2021. Cd, Cu, and Zn concentrations are plotted because concentrations of each consistently exceed acute BC WQGs for the creek (at all times of the year), hence these parameters are considered the key contaminants of concern in the creek. Time trends for other constituents are provided in the 2021 Monitoring Report for Effluent Permit PE-6858 and further discussion of WQG exceedances in 2021 is provided there. Time trends for Cd, Cu, and Zn in Myra Creek at stations MC-TP4 (2017 to 2021) and MC-M2 (2012 to 2021) are provided in **Figures 4-18** and **4-19**, respectively**.** These data are provided to illustrate longer-term time trends in water quality.

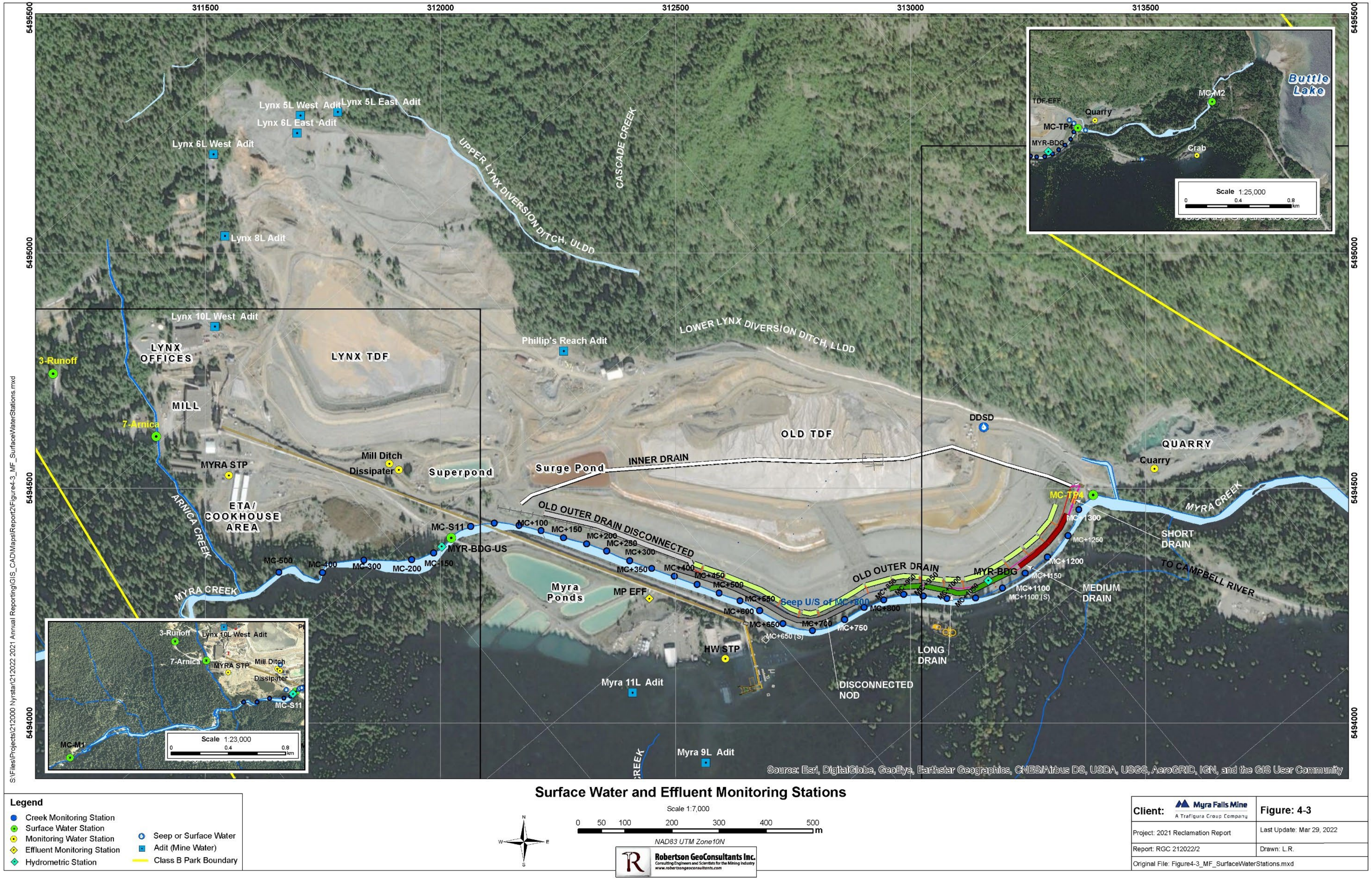
Figure 4-18 compares Zn concentrations at the downstream end of the site at MC-TP4 for 2017 to 2021. Myra Creek streamflow rates for 2019 to 2021 are also shown in **Figure 4-18** for reference. Concentrations are usually elevated in wet winter months, then decrease in the spring and early summer when loading from groundwater is reduced and streamflow rates are high. In late summer, concentrations increase when streamflows are lowest providing only little dilution. In early 2021, Zn concentrations at MC-TP4 were fairly constant and lower than in previous years. The change in operation of the Old TDF under-drains was made on February 21st, 2021, as indicated on **Figure 4-18.** Travel time (Darcy) calculations suggest that bypass at the NOD is starting to reach the creek after approximately 1 month. Zn concentrations in Myra Creek at MC-TP started to noticeably increase in late July and remained unusually high throughout the summer when streamflow was lowest providing less dilution. For the remainder of the year Zn concentrations remained elevated. Effluent Zn concentrations decreased in August (**Figure 4-17**) and loading from effluent represented less than 10% of the total load observed at MC-TP4 during that dry summer period.

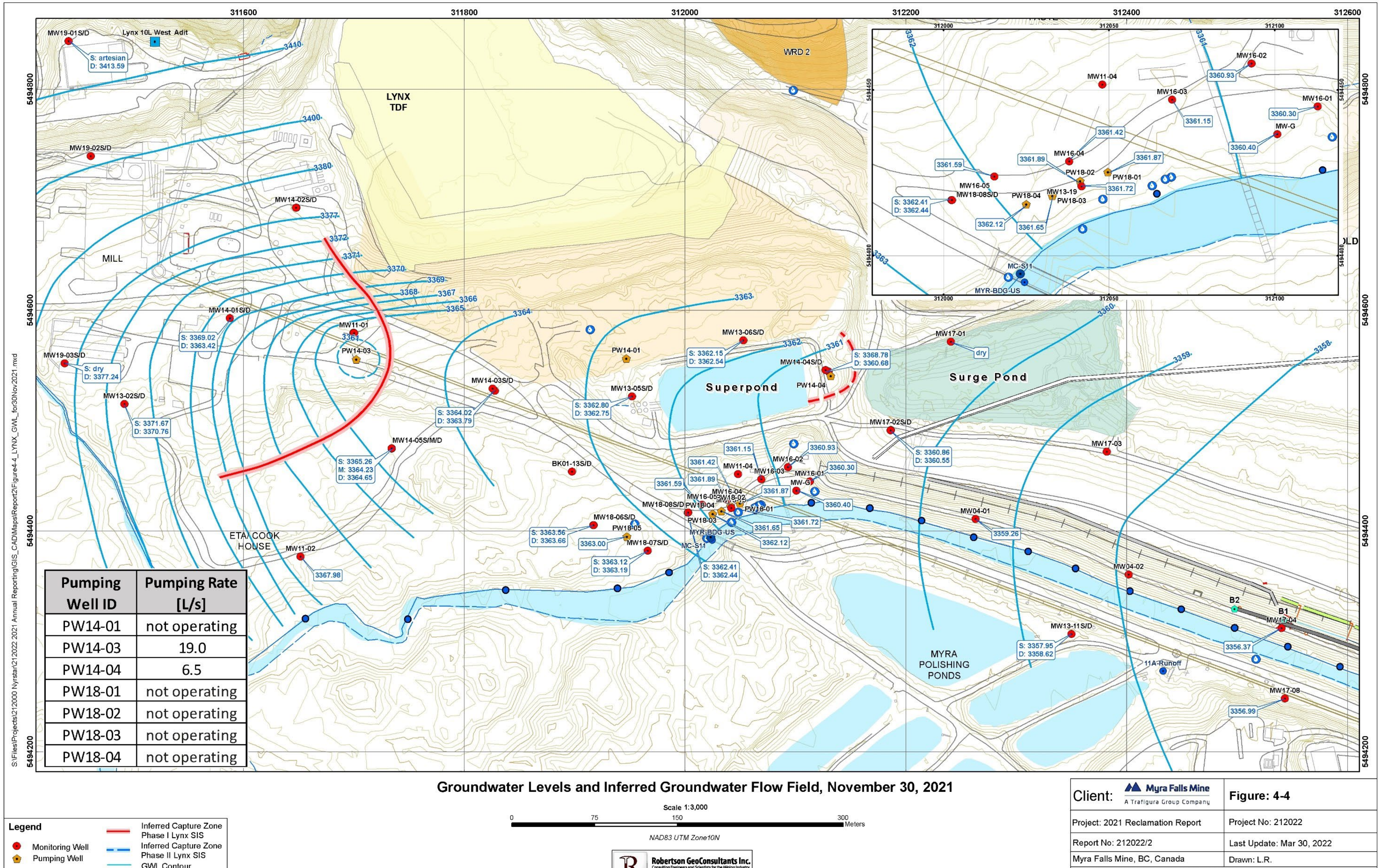
Figure 4-19 shows water quality time trends for station MC-M2 (see **Figure 4-3** for location). These time trends also suggest an increase in concentrations in Myra Creek in 2021. Trendlines and standard error intervals (see shading) for Cd, Cu, and Zn concentrations are provided for reference. This increase is most likely caused by the changes in operation of the system of Old TDF under-drains (as of February 2021), which may have allowed greater bypass to the creek. The operation of the Phase I and Interim Phase II Lynx SIS at reduced capacity since end of 2020 and/or inter-annual variation in loading from the WRDs may have also resulted in some additional loading to the creek.


WRD 4
WRD 3
WRD 2
WRD 1
WRD 6
LYNX TDF
OLD TDF
LYNX OFFICES
MILL
ETA/ COOKHOUSE AREA
Superpond
Surge Pond
Myra Ponds
HW OFFICES AND HEADFRAME
QUARRY
UPPER LYNX DIVERSION DITCH, ULDD
LOWER LYNX DIVERSION DITCH, LLDD
CASCADE CREEK
ARNICA CREEK
WEBSTER CREEK
MYRA CREEK
TO CAMPBELL RIVER
INNER DRAIN
OLD OUTER DRAIN (DISCONNECTED)
OLD OUTER DRAIN
SHORT DRAIN
MEDIUM DRAIN
LONG DRAIN
DISCONNECTED NOD
Figure4-2 Extent
Switchback (Copper) Seep
WRD2 Toe Seep
WRD 1/6 ARD Soak
Lynx Berm Seepage
SP-HILL Seep
RIPRAP Seep
Pipebridge Seep
Carbridge Seep
Duck Pond
Webster Creek Culverts
HW Parking Lot
Myra/HW Sump
APA Seep 8
APA Seep 7
APA Seep 6
Pumphouse Seep Upper
Pumphouse Seep Lower
LLDD Outflow
PW14-01
PW14-03
PW14-04
MW14-02S/D
MW13-10S/D
MW15-13S/D
MW15-10S/D
MW15-11S/D
MW15-12S/D
MW15-09S/D
MW15-07S/M/D
MW15-06S/D
MW15-05S/D
MW15-08S/D
MW15-14
MW15-04S/D
MW15-03S/M/D
MW15-02S/D
MW15-01S/D
MW11-05S/D
TD13-04S/D
TD13-01S/D
TD13-03S/D
TD13-02S/D
TD13-05S/D
MW13-17
MW13-15S/D
MW13-18S/D
MW13-14S/D
MW13-16S/D
MW13-11S/D
MW13-13
MW13-12
MW17-04
MW17-05
MW17-06
MW17-07
MW17-08
MW17-09
MW17-10S/D
MW17-11S/D
MW17-13S/D
MW17-14S/D
MW17-15S/D
MW19-03S/D
MW13-02S/D
MW13-01
Seep U/S of MC+800
Scale 1:12,000
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
S:\Files\Projects\212000 Nyrstar\212022 2021 Annual Reporting\GIS_CAD\Maps\Report2\Figure4-1_MF_GW-MonitoringNetwork_V2.mxd
Legend
Monitoring Well
Pumping Well
Standpipe
Seep or Surface Water
Riser
Drain
Waste Rocks
Inner Drain
Short New Outer Drain
Medium New Outer Drain
Long New Outer Drain
New Outer Drain (Disconnected)
Old Outer Drain
Old Outer Drain (Disconnected)
Class B Park Boundary
Groundwater Monitoring Wells and Seepage Monitoring Locations
Scale 1:6,500
0 50 100 200 300 400 500 Meters
NAD83 UTM Zone10N
Robertson GeoConsultants Inc.
Client: Myra Falls Mine A Trafigura Group Company
Figure: 4-1
Project: 2021 Reclamation Report
Last Update: Mar 29, 2022
Report: RGC 212022/2
Drawn: L.R
Original File: Figure4-1_MF_GW-MonitoringNetwork_V2.mxd



Groundwater Monitoring Wells and Seepage Monitoring Locations, Lynx Reach


Surface Water and Effluent Monitoring Stations
Scale 1:7,000
NAD83 UTM Zone10N
Legend
Creek Monitoring Station
Surface Water Station
Monitoring Water Station
Effluent Monitoring Station
Hydrometric Station
Seep or Surface Water
Adit (Mine Water)
Class B Park Boundary
Client: Myra Falls Mine A Trafigura Group Company
Figure: 4-3
Project: 2021 Reclamation Report
Last Update: Mar 29, 2022
Report: RGC 212022/2
Drawn: L.R.
Original File: Figure4-3_MF_SurfaceWaterStations.mxd
Robertson GeoConsultants Inc.
LYNX TDF
OLD TDF
LYNX OFFICES
MILL
MYRA STP
ETA/ COOKHOUSE AREA
Superpond
Surge Pond
Myra Ponds
QUARRY
INNER DRAIN
OLD OUTER DRAIN DISCONNECTED
OLD OUTER DRAIN
SHORT DRAIN
MEDIUM DRAIN
LONG DRAIN
DISCONNECTED NOD
UPPER LYNX DIVERSION DITCH, ULDD
LOWER LYNX DIVERSION DITCH, LLDD
CASCADE CREEK
ARNICA CREEK
MYRA CREEK
TO CAMPBELL RIVER
Buttle Lake
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Pumping Well ID	Pumping Rate [L/s]
PW14-01	not operating
PW14-03	19.0
PW14-04	6.5
PW18-01	not operating
PW18-02	not operating
PW18-03	not operating
PW18-04	not operating

Groundwater Levels and Inferred Groundwater Flow Field, November 30, 2021

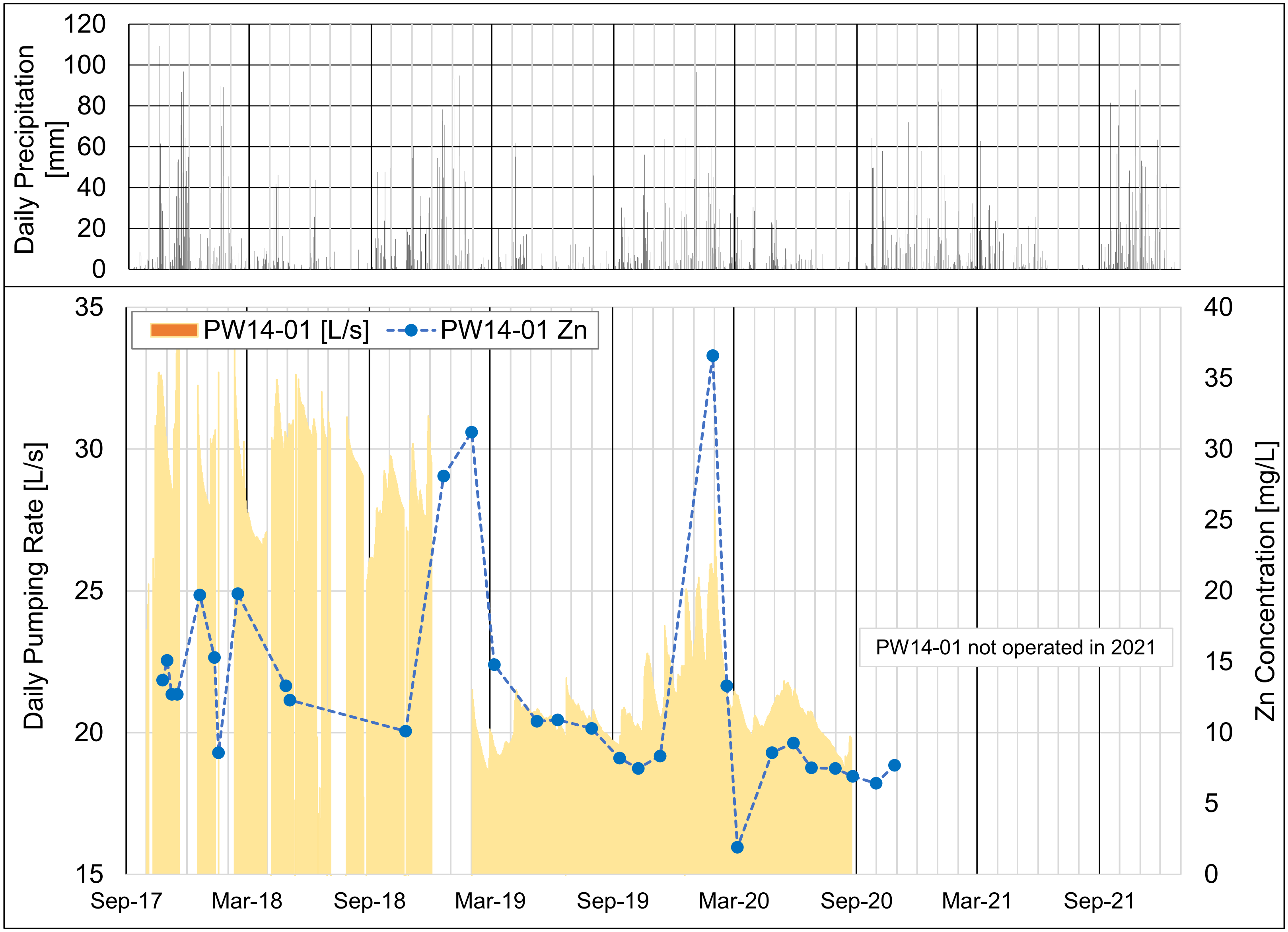


Figure 4-5. Observed Pumping Rate and Zn Concentration at Pumping Well PW14-01. Note: This pumping well was not operated in 2021

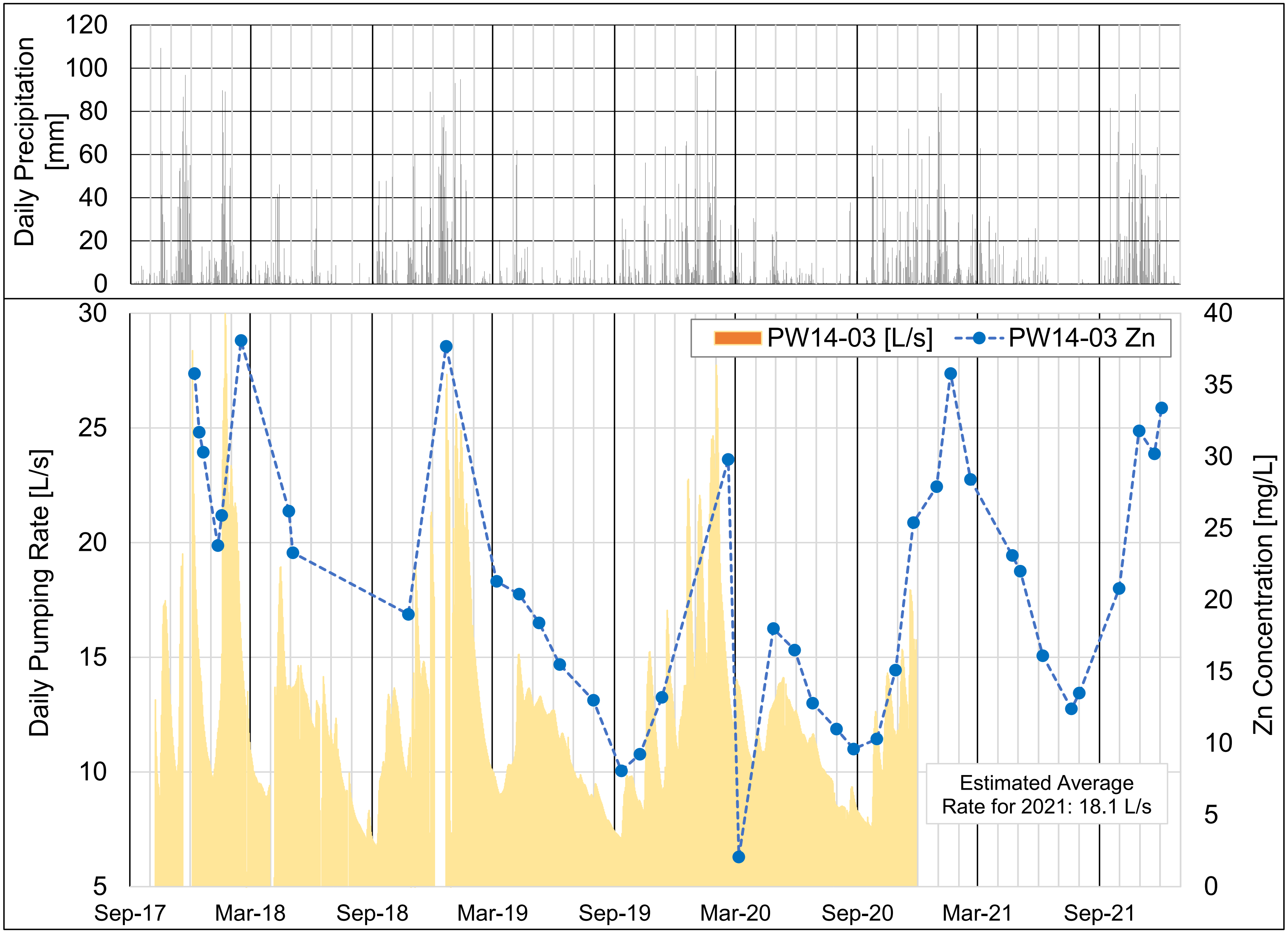


Figure 4-6. Observed Pumping Rate and Zn Concentration at Pumping Well PW14-03

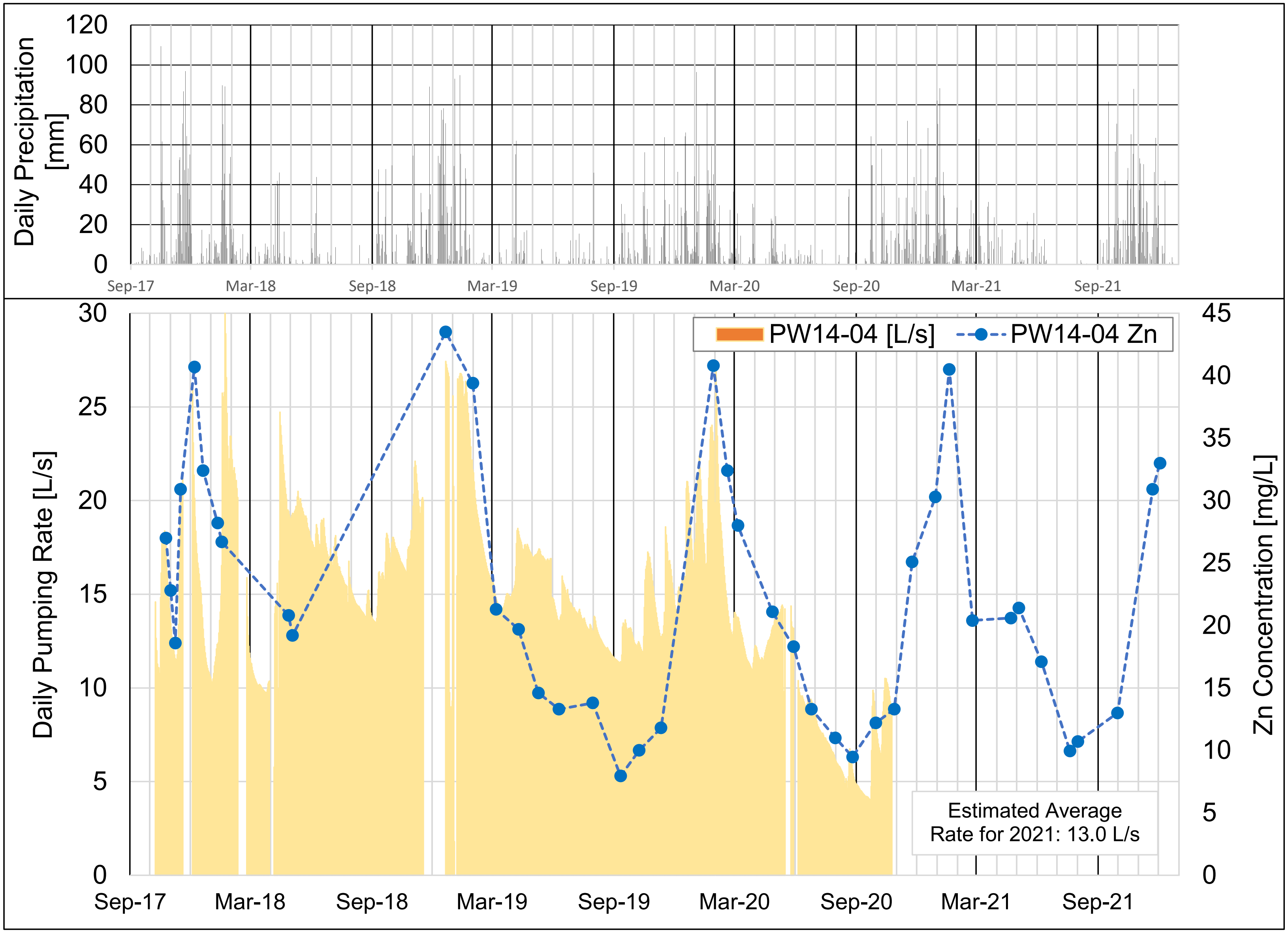


Figure 4-7. Observed Pumping Rate and Zn Concentration at Pumping Well PW14-04

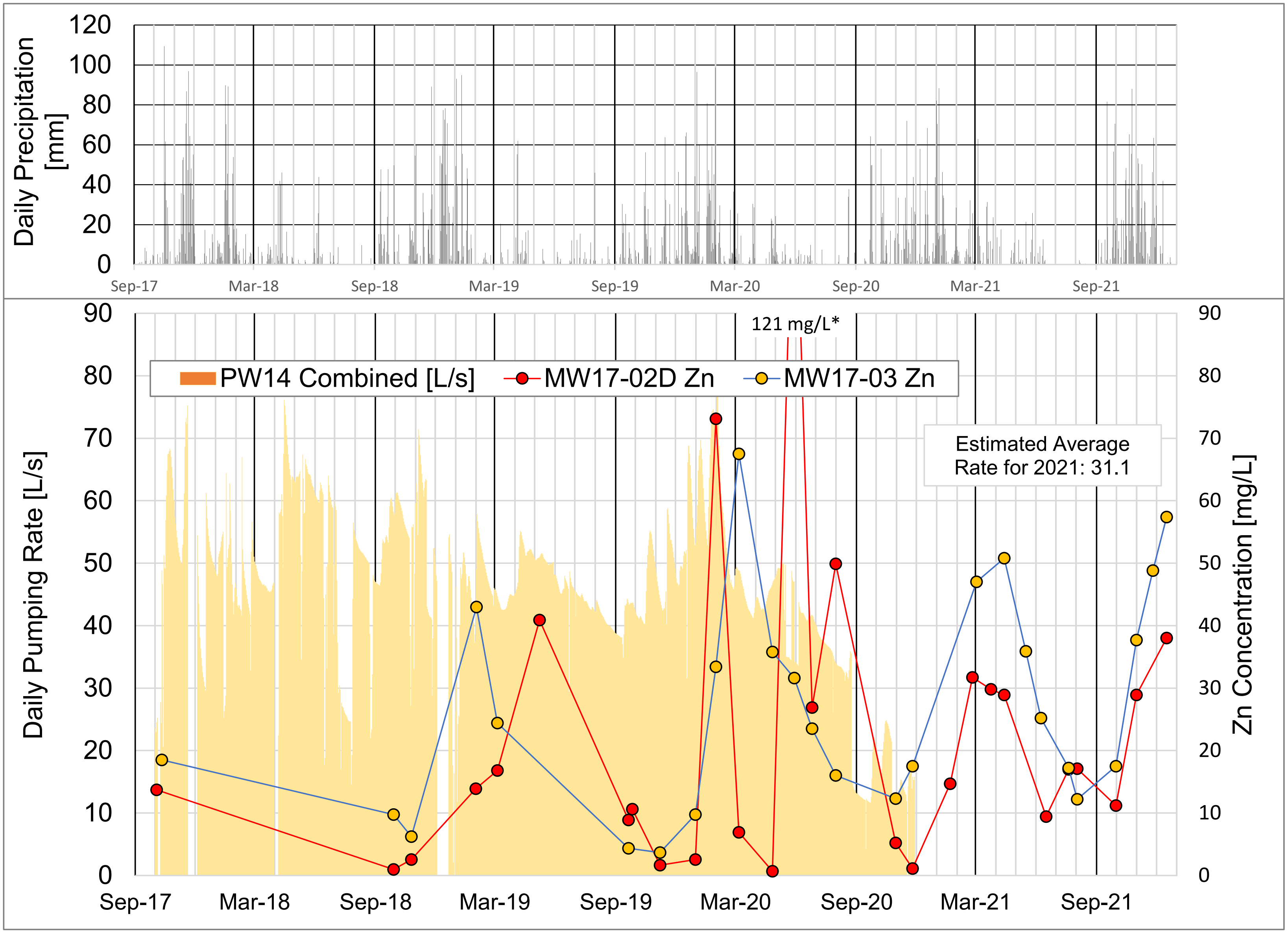


Figure 4-8. Combined Phase I Lynx SIS Pumping Rate and Zn Concentrations at Monitoring Wells MW17-02D and MW17-03

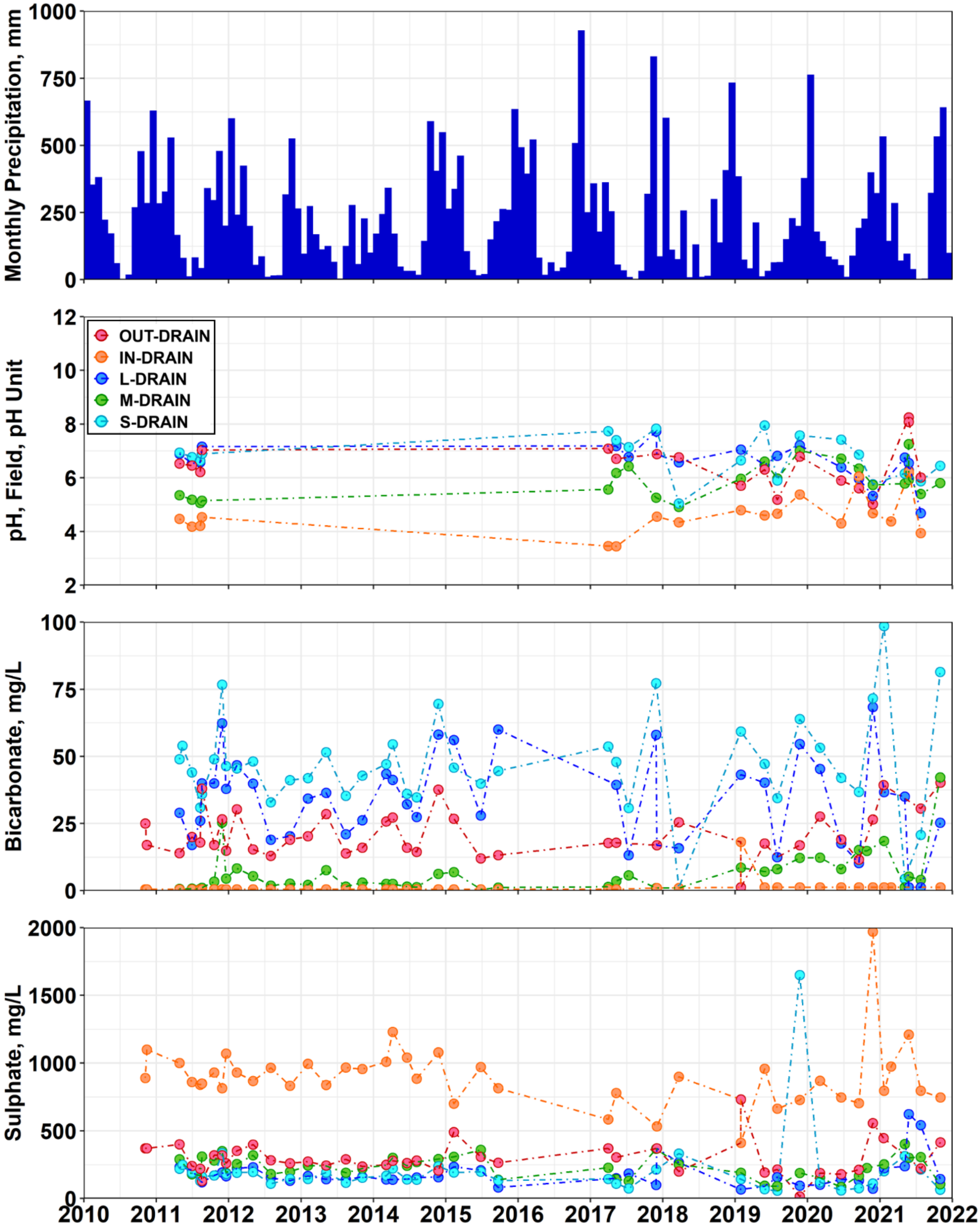


Figure 4-9. pH, Bicarbonate, and Sulphate Concentrations in Groundwater Samples from Old TDF Under-Drains, 2010 to 2021

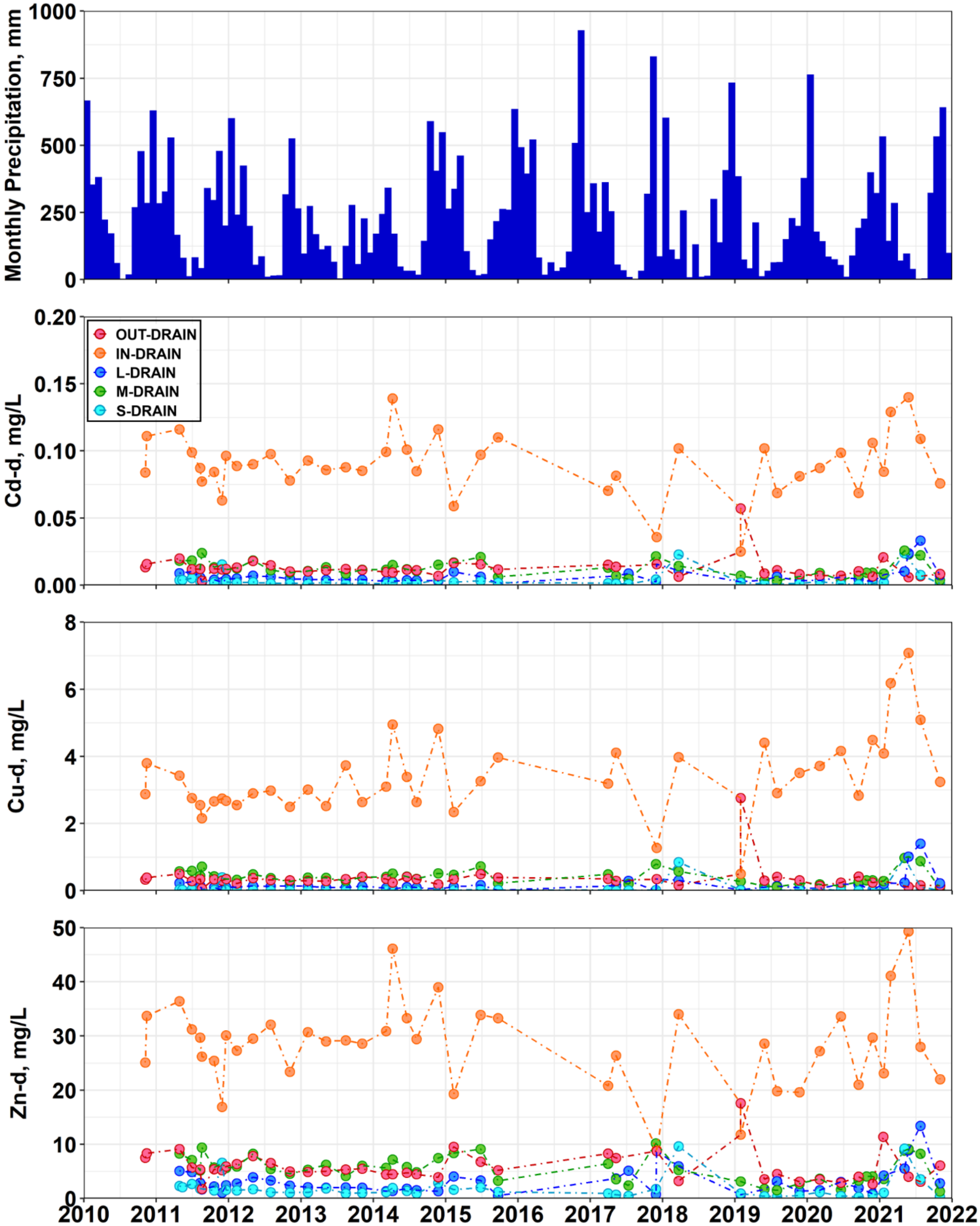


Figure 4-10. Cd, Cu, and Zn Concentrations in Groundwater Samples from Old TDF Under-Drains, 2010 to 2021

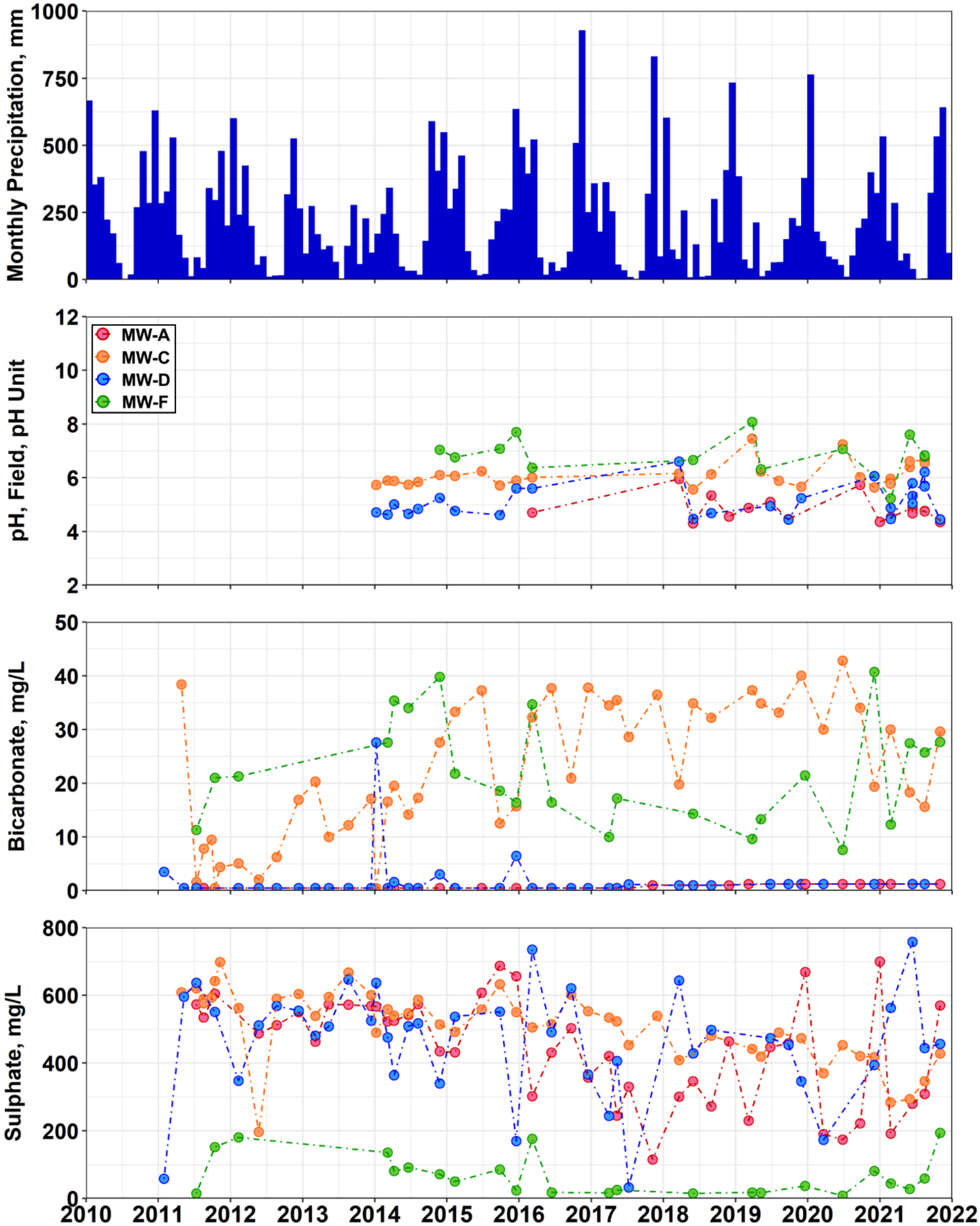


Figure 4-11. pH, Bicarbonate, and Sulphate Concentrations in Groundwater from Wells MW-A, MW-C, MW-D, and MW-F, 2011 to 2021

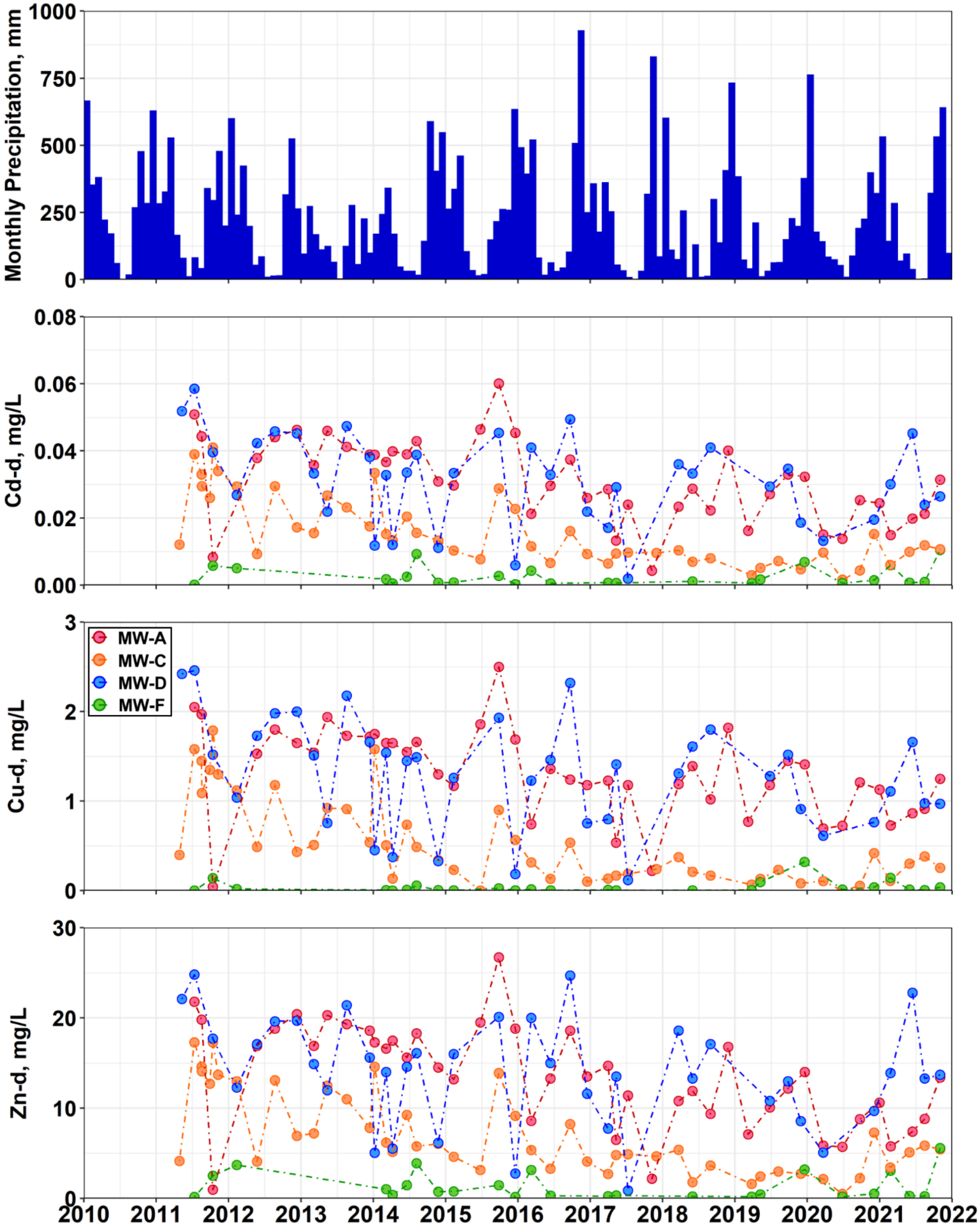


Figure 4-12. Cd, Cu, and Zn Concentrations in Groundwater from Wells MW-A, MW-C, MW-D, and MW-F, 2011 to 2021

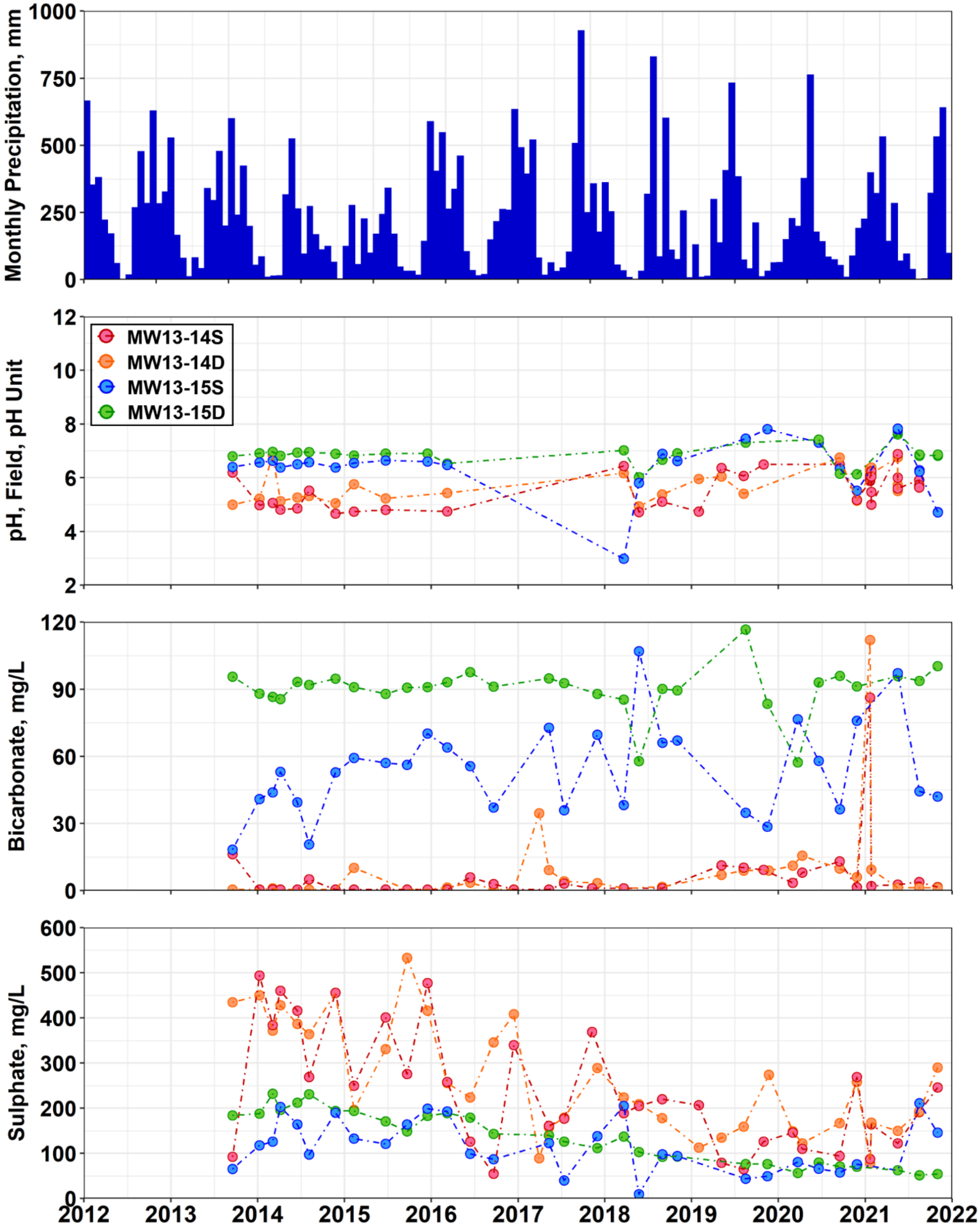


Figure 4-13. pH, Bicarbonate, and Sulphate Concentrations in Groundwater from Wells MW13-14S/D and MW13-15S/D, 2013 to 2021

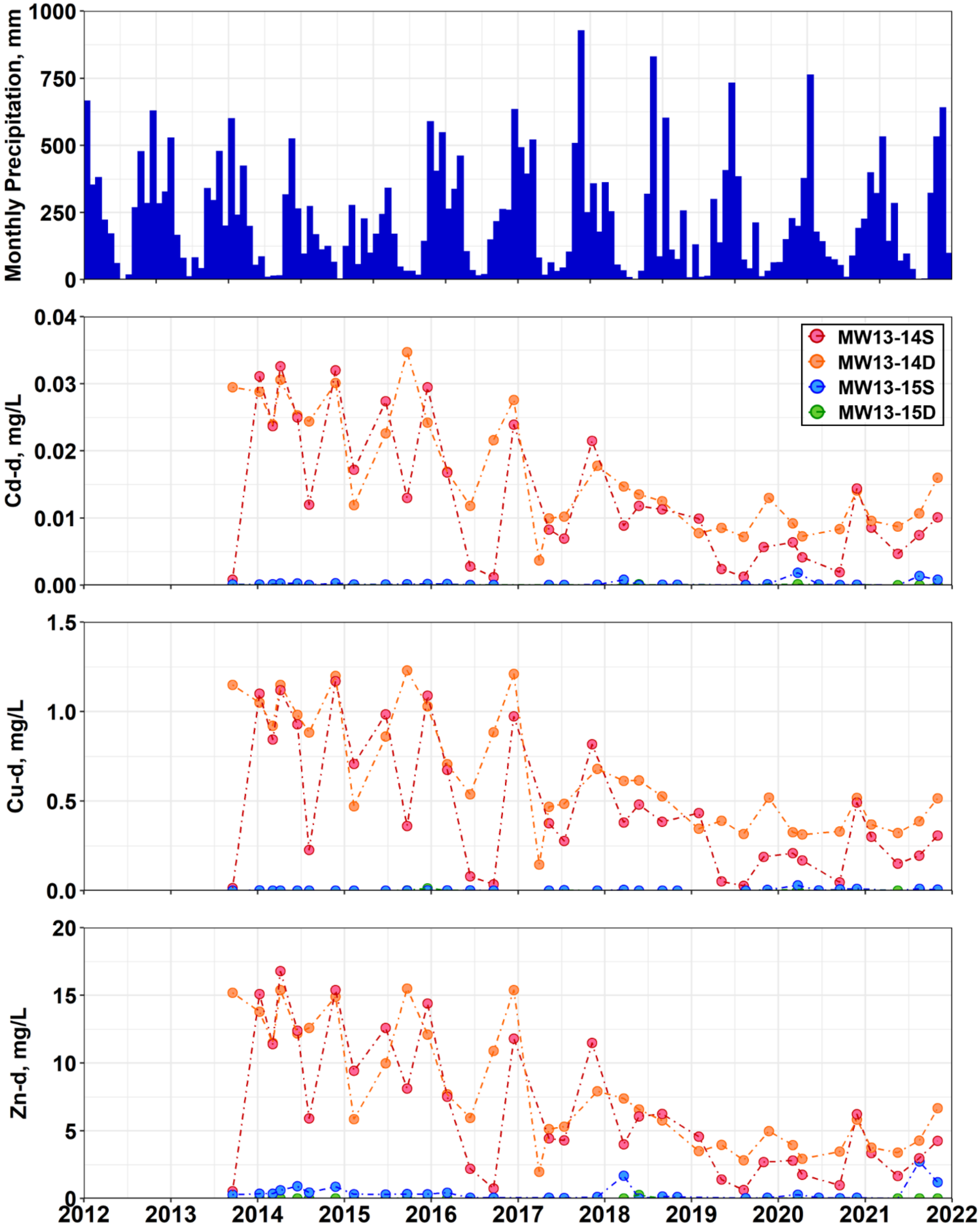


Figure 4-14. Cd, Cu, and Zn Concentrations in Groundwater from Wells MW13-14S/D and MW13-15S/D, 2013 to 2021

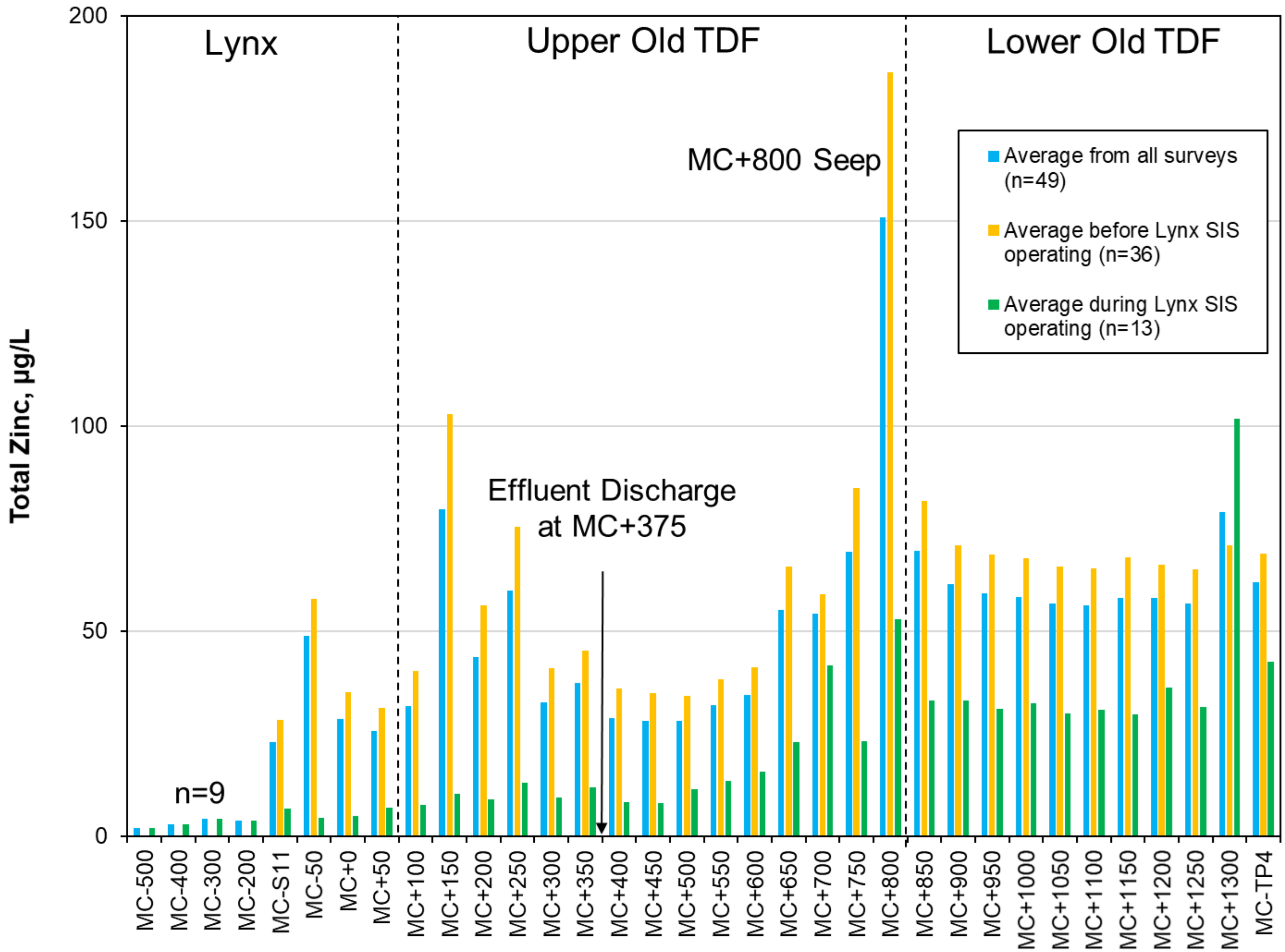


Figure 4-15. Average Zn-t Concentrations in Myra Creek from Creek Surveys from Arnica Creek to MC-TP4, 2012 to 2021. 9 Surveys Included Stations Upstream of MC-S11

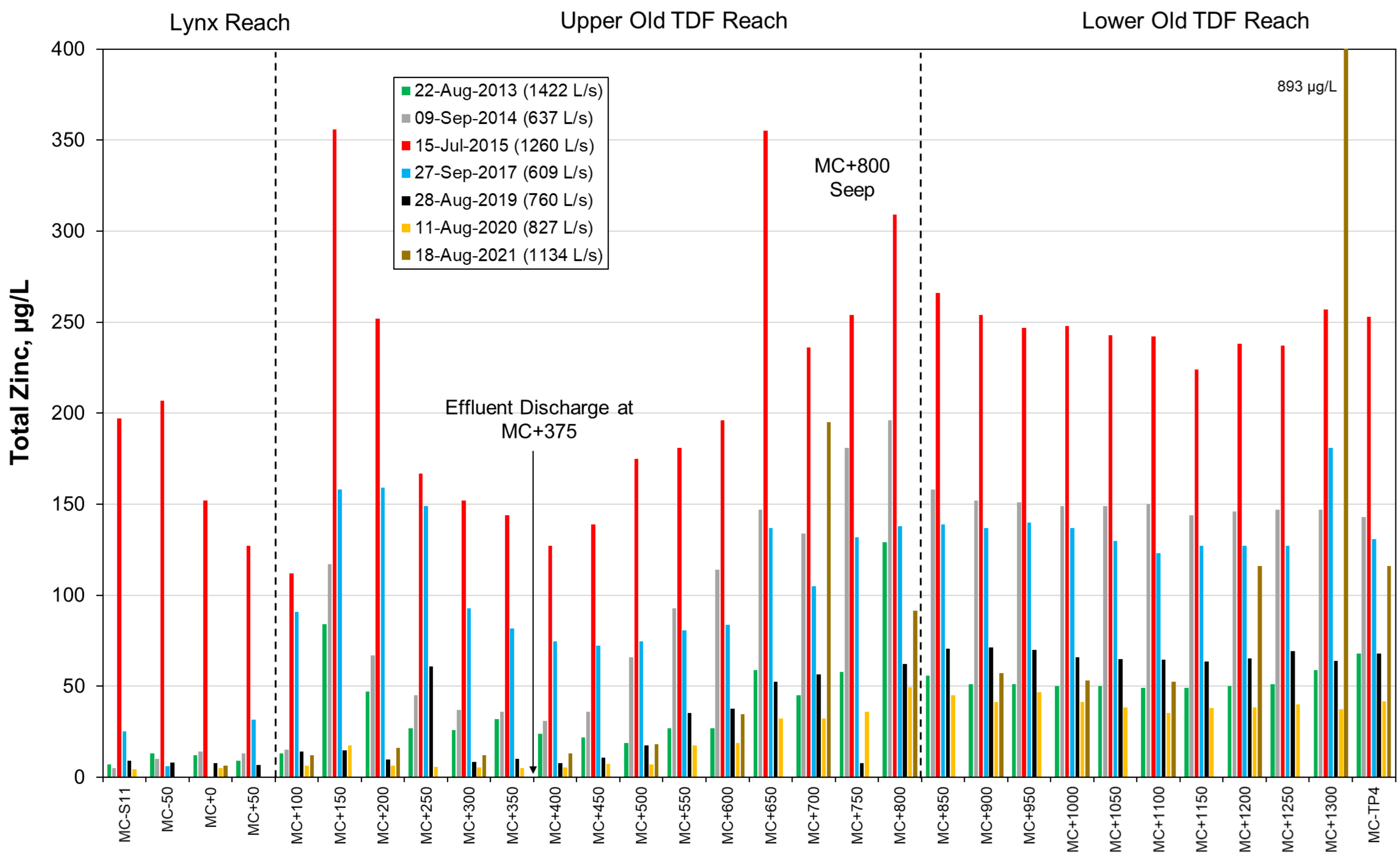


Figure 4-16. Average Zn Concentrations in Myra Creek from Creek Surveys Completed During Low Streamflow Conditions – Left Bank (North Side) of Creek, 2012 to 2021

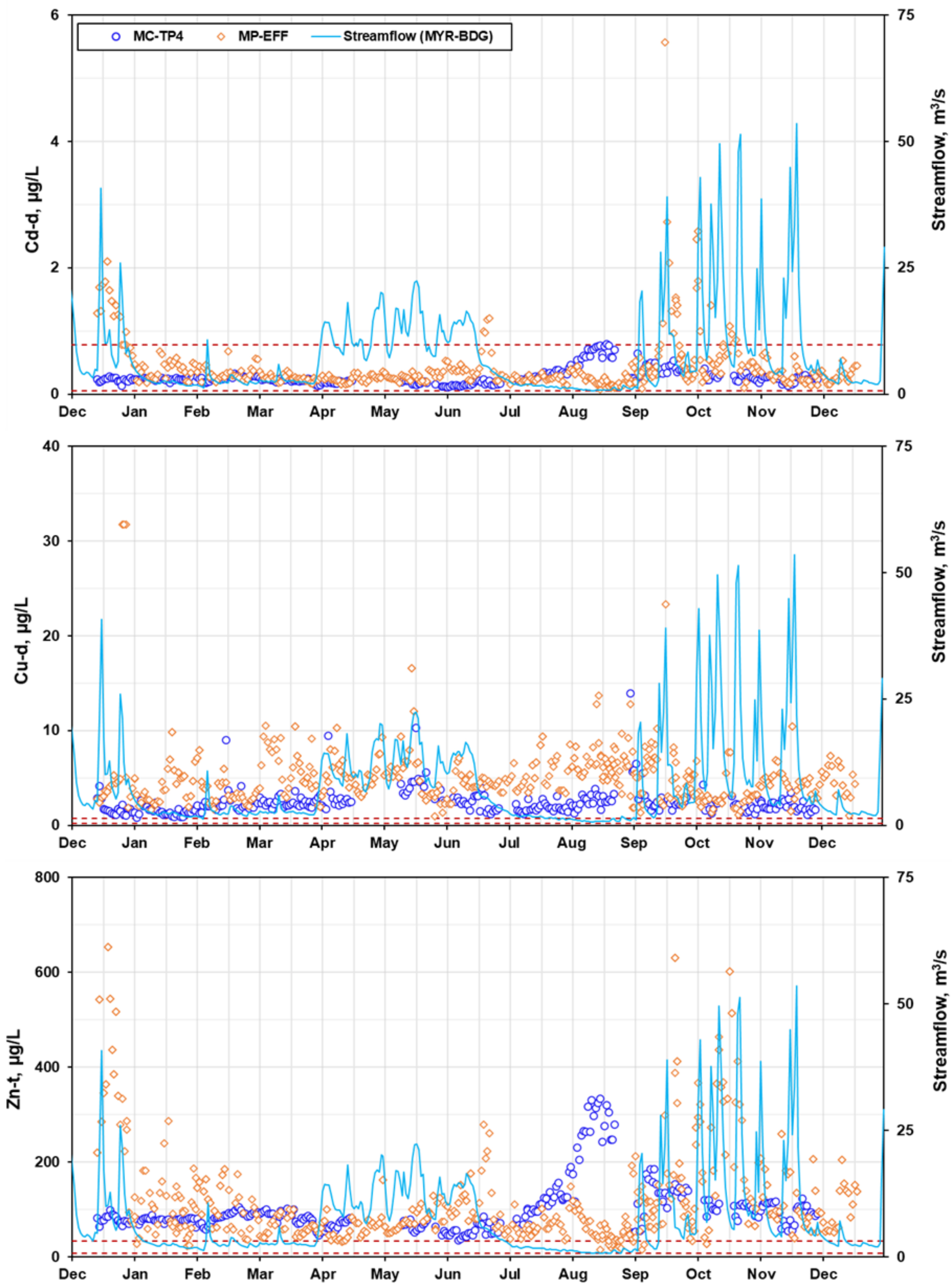


Figure 4-17. Cd-d, Cu-d, and Zn-t Concentrations in Myra Creek at MC-TP4, Treated Mine Effluent at MP-EFF, and Streamflow at MYR-BDG station, 2021. Red dashed lines indicate BC GWQ Acute (upper line) and Chronic (lower line).

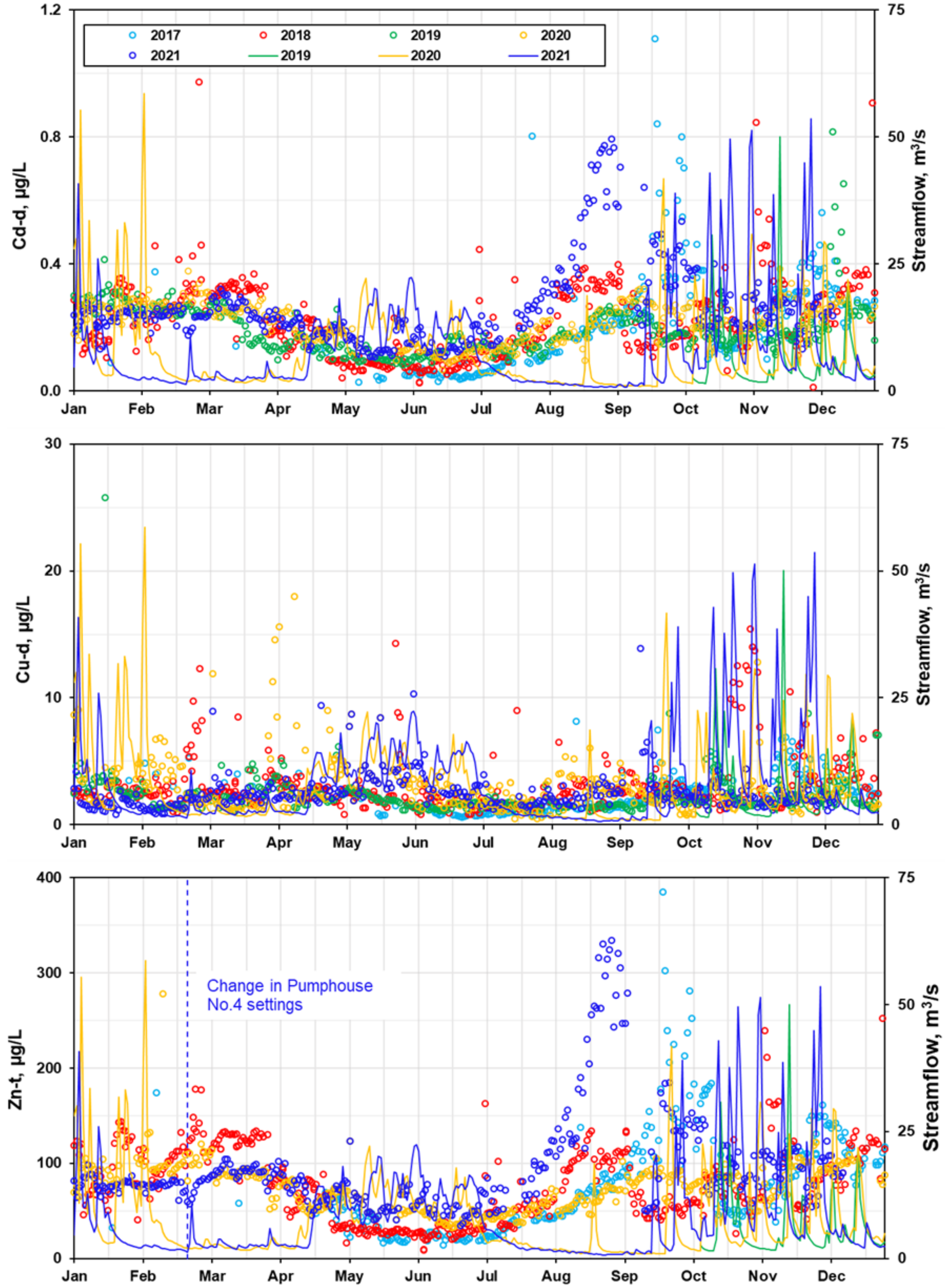


Figure 4-18. Cd-d, Cu-d, and Zn-t Concentrations in Myra Creek at MC-TP4 and streamflow (lines) at MYR-BDG, 2017, 2018, 2019, 2020 and 2021.

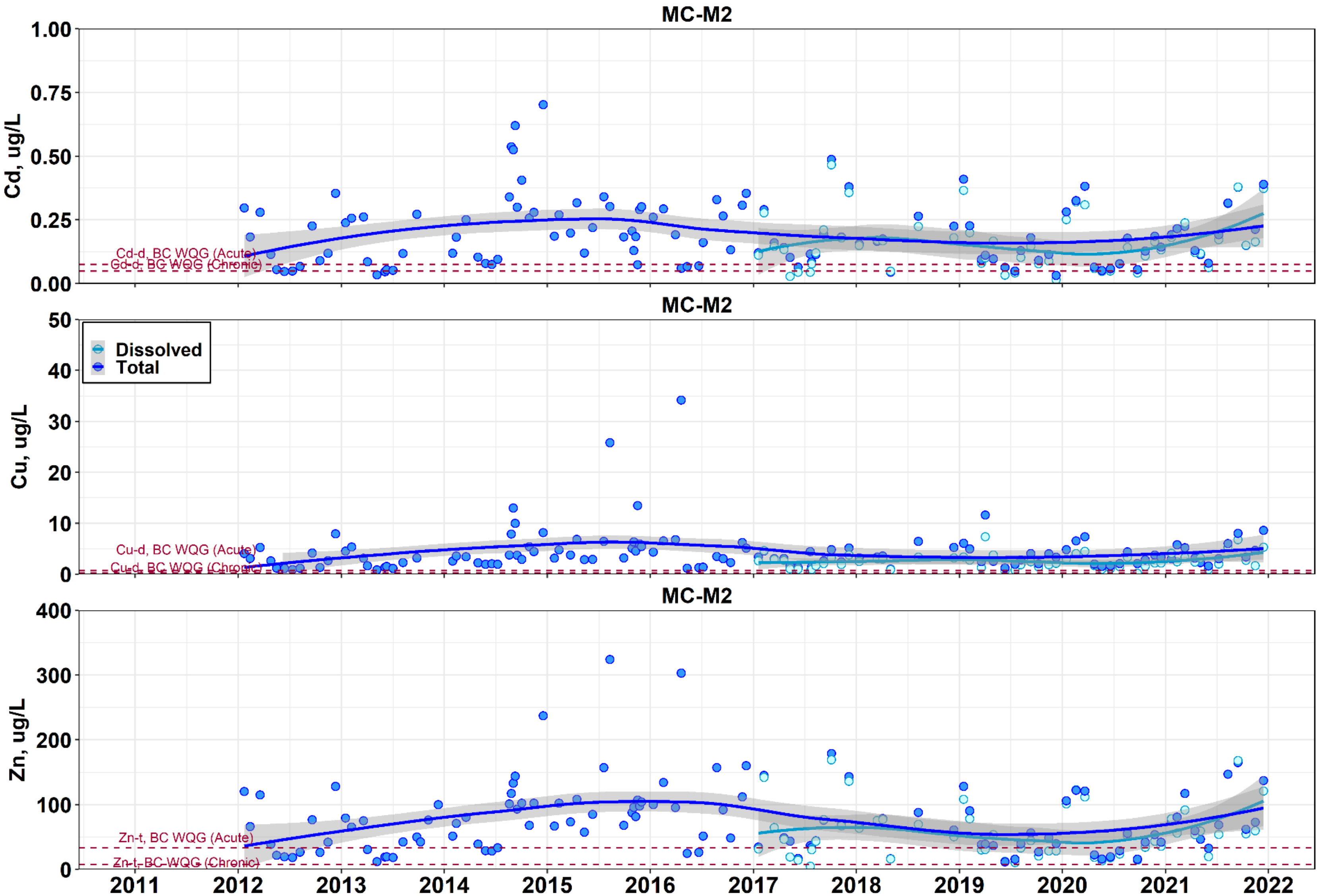


Figure 4-19. Cd, Cu, and Zn Concentrations in Myra Creek at MC-M2, 2012 to 2021

5 2021 RECLAMATION ACTIVITIES

This section was prepared by Nicole Pesonen, MFM's Manager, Environment and Community Engagement.

5.1 PROGRESSIVE RECLAMATION

Progressive reclamation is targeted to complete the site-wide closure plan in small, manageable projects. Very little progressive reclamation has occurred since the removal of the tailings pipeline to Buttle Lake as the majority of the surface works were required for active mining and milling. More recently several facilities have reached the planned life and are slated for progressive reclamation works over the next five years. These include the Old TDF, WRDs 2, 3, and 6, and buildings such as the old backfill plant and the older camp buildings.

MFM has committed to develop new infrastructure with progressive and final reclamation in mind. To facilitate this effort, Myra Falls commissioned Wood Environment & Infrastructure Solutions (Wood) to develop a closure cover design for the Lynx TDF (Amec Foster Wheeler, December 2016 a) that can be constructed with each progressive lift of the facility developing the final revegetated landform during initial construction. This design was permitted in 2021, and a small section was placed as a cover trial during construction season 2021 (see Wood, 2022, for further details).

Infrastructure that is no longer used for active mining is assessed for closure potential biannually through a corporate driven Provision Review Process; areas that will not be disturbed again during operations are prioritized for final reclamation in the internal five-year closure plan and budget. Where these areas have approved closure designs these plans are implemented. In areas that required additional engineering work and permitting effort a permit level design is developed and issued for permitting consideration.

5.2 OPEN PIT RECLAMATION

Planning for reclamation to be conducted on the Upper Lynx Open Pit is underway. Waste rock from Waste Rock Dump 2 (WRD2) was removed from the Upper Lynx Pit and utilized as construction materials for the 2021 Lynx TDF raise.

Waste Rock Dump 3 (WRD3) was largely located in the Lower Lynx Open Pit; waste from WRD3 continued to be utilized for construction materials in the 2021 Lynx Tailings Dam construction. It is expected that all material in WRD3 above the current paste elevation will be removed for construction in 2022, eliminating this facility and returning it to a pitwall where exposed above the Lynx TDF.

The highwalls were machine scaled as they were exposed and were assessed by an engineer from Onsite Engineering as the waste rock dump was removed (Onsite Engineering, 2020). The highwall is monitored monthly at a minimum (bi-monthly during freeze thaw) with the results reviewed by a Professional Engineer. . Minor movement was recorded along a known fractured area during the freeze thaw cycle in winter of

2021 – 2022; MFM is working with Onsite Engineering to develop an action plan to ensure this area is monitored and appropriately addressed for worker safety during the 2022 construction season. Any recommendations for long-term stabilization will be implemented as required.

5.3 Tailings Storage Facilities / Impoundment Reclamation

A section of the closure cover was installed on the Lynx TDF at the end of the construction season in 2021. This section is serving as a cover trial to test various compaction and material placement methods, as well as planting prescriptions and metal uptake analysis in vegetation (see Wood, 2022, for further details). No active reclamation work was completed on the Old (Myra) TDF in 2021.

5.4 Environmental Management System

The objective of the Myra Falls Environmental Management System (EMS) is to provide a manual for employees, contractors, and other stakeholders; establish a 'road-map' for the site's environmental documents; and to facilitate best management practices in environmental activities. As members of the Mining Association of Canada (MAC), MFM has focused on continued operational and environmental improvements that incorporate Towards Sustainable Mining (TSM) principles and initiatives. The EMS is also being guided by ISO 14001 requirements, and so structured to align environmental policy with planning, implementation, and operation, checking and corrective actions, and management reviews towards continued operational and environmental improvements.

5.5 Erosion and Sediment Control

Erosion prevention works completed in 2021 focussed on maintenance of operational sediment traps on the waste rock dumps and adjacent to construction areas and erosion prevention in the Old TDF.

Ditches on the waste rock dumps and along construction access roads were maintained through periodic removal of debris and sediment build-up to restore the channels to intended functional capacity. Coarse rock check dams were maintained in the ditches on the "A-Ramp" and "Paste-plant Hill" on WRD1, and these were checked daily by the Surface Supervisor with sediment build-up dug out as required.

5.6 Soil and Salvage Stockpiling

There was no significant addition to or removal of stockpiled topsoil at Myra Falls during 2021. The closure cover trial on the Lynx TDF utilized borrow materials from the Core Rack Area Borrow, rather than a stockpile location.

5.7 Vegetation Management

Vegetation Management at Myra Falls consists of two major components; monitoring of regenerating vegetation (planted or natural ingress) following remediation works and management of invasive species

(Integral Ecology Group, 2018). These programs are informed by recommendations provided by Integral Ecology Group (IEG), who perform periodic site visits to assess the success of the revegetation efforts to date. The last site visit by IEG was performed in 2021 and noted that many of the observations made during the 2021 site visit were similar to those made in the 2020 visit (see IEG, 2022; **Appendix E**). Monitoring results as reported were mixed, with the natural ingress of vegetation on the previously reclaimed Old TDF continuing to progress along the trajectory toward the final climax ecosystem. The area of WRD2 that was reclaimed in 2017 to natural till and left to naturally revegetate as prescribed by the Habitat Loss Mitigation Plan (Wood 2019) has continued to show natural ingress adjacent to the undisturbed forest, however, it was recommended that upon completion of the WRD2 stabilization that the area be planted with pioneering species to increase the rate of revegetation in the area.

5.8 Wildlife Protection

Wildlife and habitat assessments, including breeding bird nesting surveys, are carried out before any new surface development occurs. Myra Falls employs an anecdotal wildlife sightings notification system, largely focused on sightings of bears and cougars, to warn employees of potential hazards and disseminate information regarding appropriate actions to take when encountering wildlife.

An introductory general Wildlife Habitat and specific Bat Habitat Survey was conducted by Stantec in 2018 as part of the work completed in support of the Wildlife Management Plan (Stantec, 2019).

Myra Falls had significant concerns noted about a resident bear habituating to the site camp facility due to issues with litter, access to the kitchen grey water inlet to the sewage system, and dumpsters with broken or underutilized locking mechanisms. Working with Conservation officers, MFM was able to deter the bear by bringing in new bear-resistant dumpsters and doing a large site clean-up for litter in the area, including the BC Parks parking lot, and spraying PineSol on the covers of the grey water intake system and dumpsters. In addition, a security guard was posted on bear watch to use air horns and other noise makers to dissuade the bear. Myra Falls has purchased fencing for the area that will be installed in early 2022 and bear aware training will be revisited for the site and camp staff prior to bear season in 2022 to ensure the bears are not unintentionally habituated going forward.

5.9 Archaeological Resources

A site-wide archaeological site potential assessment was performed in 2019 for all Myra Falls mining leases and Crown grants by Baseline Archaeological Services Ltd (Baseline). The recommendation of the assessment was that any developments in Mining Leases 201323 or 1069356 be reviewed by an archaeologist, while all other grants and leases are of low archaeological potential. No new archaeological resources were identified in 2021 (Baseline Archaeological Services Ltd., 2019).

5.10 Growth Medium

No growth medium was added or removed from stockpiles in 2021.

5.11 Watercourse Reclamation

No watercourse reclamation was conducted in 2021. Planning for reclamation along the Arnica and Myra creek banks has started and will continue to be developed to detailed design as areas become available for reclamation works.

5.12 Road Reclamation

No active reclamation of roadways was conducted in 2021.

5.13 Structures and Equipment

No active removal of buildings or structures was implemented in 2021.

5.14 Securing Openings

Mine openings are secured with gates when not in active use. Areas on the mine-site are controlled with barricades and signage. Signs are placed at points on the public road indicating restricted access to prevent inadvertent access by park users. Access to the site is controlled through a security gate and electronic rostering system.

5.15 Disposal of Chemicals and Reagents

Chemical disposal is controlled by the onsite warehouse. Warehouse staff is Transportation of Dangerous Goods (TDG) and Workplace Hazardous Materials Information System (WHMIS) trained; all chemicals for disposal are sent to an accredited disposal site by a licenced transport company.

5.16 Reclamation Research

In 2019, Myra Falls submitted a reclamation research program including a knowledge gap analysis, post closure mapping, reclamation methodology evaluation, and monitoring program (Stantec + Integral Ecology Group, 2019). Preliminary studies in support of these programs were started in 2020, including plans for a 2021 Elk Collaring program in conjunction with Forests, Lands, Natural Resource Operations (FLNRO) and BC Parks. Construction of test plots for field trials was completed on the Lynx TDF. These trials will be further detailed in future reports.

5.17 5 Year Reclamation Plan

The 5-Year Mine and Reclamation Plan was submitted to EMLI in January 2021; a revised report was submitted in July 2021.

5.18 Reclamation Cost Assessment

The 2021 reclamation cost assessment will be submitted as a separate confidential assessment, and will be based on the 2018 approved reclamation costing as the 2021 revision has not yet been reviewed with EMLI.

6 SUMMARY

6.1 2021 Construction and Mining Operations Overview

MFM produced 741,320 tonnes in 2021, with an average of 42,400 tonnes of ore per month. Monthly production rates increased in late 2021, when the average monthly production rate increased to 53,600 tonnes per month from September to December. Approximately 85% of the ore produced in 2021 was produced from the HW Zone, which includes the Marshall, Ridge, and Battle Gap ore bodies. The other 15% was produced from the Price Zone, which actively mined throughout 2021. No active mining took place in the Lynx or Myra zones underground in 2021.

Approximately 232,700 tonnes of waste rock were produced in 2021, more than 90% of which was produced from the HW Zone. Approximately 17,600 tonnes of waste were mined in Price Zone and subsequently utilized to backfill mined out stopes. Approximately 501,200 tonnes were milled in 2021. The monthly milling rate ranged from 16,665 tonnes in February 2021 to 55,540 tonnes in July 2021, with an average monthly milling rate of 41,769 tonnes per month.

6.2 Mine Disturbance Area

The expansion of the Clean Quarry (approved in 2020) involved logging of approximately 2.2 ha in January 2021. Construction efforts in 2021 focused on areas within the existing mine footprint, in particular the Lynx TDF dam raise. The raise was completed using some waste rock from underground, waste rock stored in construction stockpiles located on the Old TDF, WRD1 and WRD6 and re-purposed waste rock from WRD2 and WRD3. Boulders from the waste rock dumps were crushed as required for use as fine materials as needed for bedding material and to blend with waste rock when it did not meet the material specifications for fine content. The total disturbed area, as of December 31st, 2021, is 184.9 ha, or approximately 0.1 ha larger than in 2020.

6.3 Mine Waste Characterization Results

Approximately 888,000 t (or approximately 444,000 m^3) of existing waste rock from the historic WRDs was re-located to the Lynx TDF berm in 2021 (see Section 2.4). Approximately 85% of the waste rock re-located was re-located from WRD2, with far lesser amounts re-located from WRD1, WRD3, and WRD6. Approximately 56% of the waste rock samples collected from WRD2 and WRD3 in 2021 are classified as Non-Potentially Acid Generating (PAG) material. Waste rock samples collected from WRD3 and each of the samples from WRD6 are classified as PAG material. 2021 mine waste characterization results suggest a mixture of PAG and Non-PAG materials continue to be used to construct the Lynx TDF berm. Each of the monthly tailings samples and a sample of raw (beached) tailings collected from the Lynx TDF in 2021 are classified as PAG material. The number of samples of existing (re-located) waste rock collected in 2021 was lower than recommended in the ARD/ML Management Plan and no samples of ROM waste rock were collected in 2021.

6.4 Effluent Water Quality Monitoring

Eight grab samples of treated effluent (at 11A-Runoff) exceeded MDMER limits in 2021. Six of the exceedances were related to elevated TSS values in January 2021 and there were two exceedances recorded for Zn-t.

6.5 Unauthorized Discharge Events

There were two unauthorized discharge events in 2021. One occurred on September 17th, when turbid runoff from the public road reported to Myra Creek during a high intensity rainfall event. In total, an estimated 54,000 L of runoff reported to Myra Creek during the event. TSS and some metal concentrations in the flows to the creek exceeded MDMER limits and the samples showed no acute toxicity. Concentrations of Cu and Zn in Myra Creek exceeded BC WQGs but these exceedances cannot be attributed to the spill event, as both of these metals typically exceed BC WQGs in Myra Creek.

The other unauthorized discharge event occurred when the 25-Sump overtopped on October 25th during a high rainfall event. Discharge ceased when a back-up pump was started by the Tailings Operator while flows were being sampled by MFM staff. TSS and some metal concentrations in the flows to the creek on October 25th exceeded MDMER limits. A grab sample showed acute toxicity for trout but samples collected downstream showed 100% survival.

Concentrations of Cu and Zn in Myra Creek on October 25th exceeded BC WQGs on October 25th, 2021. These exceedances cannot, however, be attributed to the spill event, as both of these metals typically exceed BC WQGs in Myra Creek. The overtopping event on October 25th appears to have been caused, in part, by debris that obstructed the float switch that turns the back-up pumps on, and additional flows to the 25-Sump from the project office area during this high rainfall event. Pumps have since been serviced and additional back-up pumps have been ordered.

6.6 Routine Water Quality Monitoring Results – Permit M-26

A sample from the Car Bridge Seep was collected in 2021. No samples of the Pipe Bridge Seep, Warehouse Seep, Lower Pumphouse No. 4 Seep (or “PH4 Seep B), or Upper Pumphouse No. 4 Seep were collected in 2021, as no flows were observed at these seep locations by site staff. Flows from the Main Spring (now collected by the DDSD) were sampled on several occasions in 2021. Most of the samples collected in 2021 were characterized by metal concentrations lower than discharge criteria from Effluent Permit PE-6858. However, Zn-d and Zn-t concentrations in samples collected when flows in the DDSD are first observed by site staff were higher than discharge limits from Effluent Permit PE-6858 due to the “first flush” of oxidation products from local waste rock and fill. All flows from the DDSD are currently routed to the water treatment system and not to Myra Creek, as the decant structure required to convey these flows to Myra Creek has not been constructed.

In recent years (starting in 2018), Zn concentrations in groundwater captured by the Old TDF under-drains have decreased due to the operation of the Phase I Lynx SIS upgradient in the Lynx Reach. This trend did not continue in 2021, as Zn concentrations in groundwater captured by the Old Outer Drain and each segment of the NOD were higher in 2021 than in recent years. These increases are attributed to a change in how the Old TDF under-drain system was operated for most of 2021, as a sump setting was changed in February 2021. Groundwater quality immediately downgradient of the Old TDF under-drains also deteriorated in 2021 due to increased groundwater bypass since early 2021 when the change to the operation of the Old TDF under-drains were made.

6.7 SITE-WIDE SIS PERFORMANCE

Previous hydraulic testing of the NOD (RGC, 2016a) during a variety of flow conditions showed that hydraulic gradients are usually directed towards the drains, meaning that some creek water is discharging into the drains rather than groundwater discharging to Myra Creek (see RGC, 2020, for further details). In early 2021, the Old TDF under-drains (particularly the NOD segments) continued to be effective in preventing ARD/ML-impacted groundwater in the Lower Old TDF Reach from discharging to Myra Creek. However, in February 2021, the operation of the under-drain system was changed, following the commissioning of a new sump level transmitter at Pumphouse No. 4. The water level in the sump increased above the drain inlets as a result, which prevented the drains from draining freely into the sump. This resulted in reduced hydraulic gradients and hence reduced flow rates within the individual drain segments. Hence the under-drain system did not perform as effectively in 2021 as it has in recent years, implying greater bypass of ARD/ML-impacted groundwater to the creek.

The Phase I Lynx SIS was operated at reduced capacity in 2021, as pumping well PW14-01 was not operating at all in 2021. Moreover, pumping rates for pumping well PW14-04 were estimated to be about 35% less than in 2020 due to an increased set level. Note that data loggers were not recording in 2021 and captured groundwater volumes and loads are approximate estimates only based on performance in previous years. The combined Zn load captured by the Phase I Lynx SIS in 2021 is estimated to be approximately 16 t, which represents about 58% of the total Zn load captured by the Old TDF under-drains and delivered to the Superpond via Pumphouse No.4. The Phase I Lynx SIS therefore captured substantial contaminant loads from groundwater in the Lynx Reach in 2021, albeit lower loads than in 2018, 2019, and 2020. In recent years, the system appears to have reduced contaminant loads in groundwater to the Old TDF under-drains. This could not be confirmed for 2021, due to the change in operation of the Old TDF under-drains, which has affected groundwater quality near the under-drains and water quality in Myra Creek (see Section 6.8).

In early 2021, the Interim Phase II Lynx SIS operated intermittently and pumping ceased some time in August when water levels decreased below the well screens and the system was subsequently disconnected. Also, it appears that pumping wells PW18-01 and 18-02 did not operate in 2021. Pumping rates at pumping wells PW18-03 and PW18-04 were inferred to range between 1 L/s and 4 L/s in 2021. An estimated 77,000 m^3/month of impacted groundwater and 138 kg/month Zn were captured by the Interim Phase II Lynx SIS in 2021. This Zn load is less than 1% of the Zn load recovered by the Phase I Lynx SIS over the same period. The load captured by the Interim Phase II Lynx SIS is therefore much smaller than the load captured by the Phase I Lynx SIS, although the system has proven to be effective in capturing moderately impacted groundwater, particularly during the winter months.

Data loggers at the Phase I Lynx SIS pumping wells were restarted in March 2022 and recording of flow and level data resumed. A contractor is further scheduled to provide comprehensive maintenance and repairs for the PW14 pumps to ensure operation at full design capacity. This includes repairs at PW14-01 which is currently not operating and an inspection of the well screen at PW14-04 which operates at reduced capacity.

MFM is in the process of recommissioning the Phase II Lynx SIS including repairs to the PW18 pumps that may have been damaged by freezing.

RGC has recommended to MFM to decrease the sump level at Pumphouse No. 4 and operate the system at previously established settings that maximize capture of contaminated groundwater. MFM is in the process of changing the operation of the under-drains and RGC will be on site in April 2022 to monitor the hydraulic response.

6.8 WATER QUALITY IMPACTS TO MYRA CREEK

Water quality in Myra Creek deteriorated in 2021 due to the changes in operation of the system of Old TDF under-drains (as of February 2021), which allowed greater bypass of ARD/ML-impacted groundwater to the creek. The highest metal concentrations in Myra Creek (up to 350 µg/L Zn-t) were observed in late August 2021 when streamflows were lowest and subsequently decreased during the wetter months of late 2021. Metal concentrations in late 2021 remained higher than observed in early 2021 before the change in the operation of the Old TDF under-drain system. Further monitoring is needed to confirm whether water quality will improve once the under-drain system is operated at the recommended settings and if any improvement will be realized once the Phase I Lynx SIS is operated continuously and at full capacity.

6.9 2021 RECLAMATION ACTIVITIES COMPLETED

Key reclamation activities completed in 2021 are summarized below:

- *Open Pit Reclamation*
  - Waste rock from WRD2 in the Upper Lynx Open Pit was removed in 2021. The highwall of the pit was machine-scaled as it was exposed and stability was assessed by an engineer

from Onsite Engineering as waste rock was removed. The relocation of waste rock from WRD3 (in the Upper Lynx Open Pit) will continue in 2022.

- Planning for the reclamation of the Upper Lynx Open Pit continued in 2021, as MFM works towards returning the area to an exposed pitwall above the Lynx TDF.

- *Reclamation Research*
  - An Elk Collaring program in conjunction with FLNRO and B.C. Parks started in 2021.
  - A cover trial for the Lynx TDF closure cover was established in 2021.
- *Vegetation Monitoring*
  - Ongoing monitoring of regenerating vegetation suggests the 2016 hydro-seed in the CRAB has been largely unsuccessful. This is consistent with monitoring results for 2021. The natural ingress of vegetation on the previously-reclaimed Old TDF continues to progress towards the final climax ecosystem for this area.
  - Several areas with invasive species were identified in 2021. Canada Thistle, Bull Thistle, and Himalayan Blackberry were noted in several areas; hand-pulling, mowing and other manual controls have been implemented and the affected areas will be monitored for recurrence over the next few years to maintain the controls.
- *Reclamation and Closure Plan Update*
  - The 5-Year Mine and Reclamation Plan was submitted in January 2021 and is under review by the EMLI now. Public engagement on the plan is ongoing by MFM.

7 CLOSURE

Robertson GeoConsultants Inc. (RGC) is pleased to submit this report entitled '2021 Reclamation Report for Mines Act Permit M-26, Myra Falls Mine"'. Should you have any questions, please contact the undersigned or the MFM Environment Department.

Respectfully Submitted,

ROBERTSON GEOCONSULTANTS INC.

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Appendix A

2021 Mine Waste Characterization Results

Table A1. ABA Results, 2021

Sample ID	Sampling Date	Source	From	To	Paste pH	S_{total}	S_{SO4}	$S_{sulphide}$	AP	NP	NNP	NPR	Class	Notes
Units					pH Units	wt%	wt%	wt%	kg $CaCO_3$/T	kg $CaCO_3$/T	kg $CaCO_3$/T			
23034	11-Jun-2021	Waste rock (APA stockpile)	APA stockpile		8.0	4.1	0.1	4.0	124	40	-85	0.3	PAG	Construction 2021
23035	11-Jun-2021	Waste rock (APA stockpile)	APA stockpile		8.8	0.2	0.03	0.2	6.3	74	68	12	Non-PAG	Construction 2021
23036	11-Jun-2021	Waste rock (APA stockpile)	APA stockpile		8.1	3.9	0.1	3.8	118	41	-77	0.3	PAG	Construction 2021
23037	11-Jun-2021	Waste rock (APA stockpile)	APA stockpile		8.1	3.0	0.1	2.9	89	47	-42	0.5	PAG	Construction 2021
23038	11-Jun-2021	Waste rock (APA stockpile)	APA stockpile		8.2	2.8	0.1	2.7	85	34	-51	0.4	PAG	Construction 2021
23039	11-Jun-2021	Waste rock (APA stockpile)	APA stockpile		8.2	3.1	0.1	3.0	94	35	-59	0.4	PAG	Construction 2021
				Min.	8.0	0.2	0.03	0.2	6.3	34	-85	0.3	-	
			2021	Max.	8.8	4.1	0.1	4.0	124	74	67.7	12	-	
				Avg.	8.2	2.8	0.1	2.8	86	45	-41	2.3	-	
				Min.	5.4	3.3	0.5	2.8	87	5.5	-162	0.3	-	
			2020	Max.	8.8	4.1	0.9	4.0	124	74	68	12	-	
				Avg.	8.2	2.7	0.7	2.6	81	45	-35	2.6	-	
21261	29-Apr-2021	WRD2	WRD2		8.3	0.04	0.03	0.02	0.6	22	22	37	Non-PAG	Sample obtained underneath WRD2; suspected non-pag original material
23027	11-Jun-2021	WRD2	WRD2		9.2	3.0	0.01	3.0	95	9.0	-86	0.1	PAG	Construction 2021
23028	11-Jun-2021	WRD2	WRD2		9.2	3.1	0.01	3.1	97	9.7	-87	0.1	PAG	Construction 2021
23029	11-Jun-2021	WRD2	WRD2		7.3	3.7	0.6	3.2	99	24	-76	0.2	PAG	Construction 2021
23030	11-Jun-2021	WRD2	WRD2		7.9	0.2	0.2	0.02	0.6	44	44	73	Non-PAG	Construction 2021
23031	11-Jun-2021	WRD2	WRD2		8.5	0.7	0.04	0.7	21	28	7.2	1.3	PAG	Construction 2021
23032	11-Jun-2021	WRD2	WRD2		8.5	0.2	0.03	0.2	5.9	28	22	4.7	Non-PAG	Construction 2021
23033	11-Jun-2021	WRD2	WRD2		8.1	0.2	0.1	0.2	5.0	39	34	7.8	Non-PAG	Construction 2021
30277	19-Jun-2021	WRD2	WRD2	Lower Panels	8.6	0.3	0.3	0.02	0.5	59	58	112	Non-PAG	Construction 2021
30278	23-Jun-2021	WRD2	WRD2	Lower Panels	8.0	0.8	0.4	0.4	14	62	48	4.5	Non-PAG	Construction 2021
4393	30-Jun-2021	WRD2	WRD2	Upstream Bench	7.6	0.4	0.2	0.2	5.3	21	16	3.9	Non-PAG	Construction 2021
4397	5-Jul-2021	WRD2	WRD2	Lower Panels	8.1	1.4	0.5	0.8	26	43	17	1.7	PAG	Construction 2021
30281	9-Jul-2021	WRD2	WRD2	Upstream Lower Bench	8.4	0.6	0.4	0.2	7.0	50	43	7.2	Non-PAG	Construction 2021
30282	10-Jul-2021	WRD2	WRD2	Lower Panels	8.5	0.8	0.4	0.4	12	49	37	4.1	Non-PAG	Construction 2021
4394	21-Jul-2021	WRD2	WRD2	Lower Panels	7.8	0.4	0.2	0.1	3.4	20	17	5.9	Non-PAG	Construction 2021
30283	21-Jul-2021	WRD2	WRD2	Lower Panels	7.8	1.8	0.8	1.0	32	38	5.3	1.2	PAG	Construction 2021
30288	7-Oct-2021	WRD2	WRD2	DS East Arm & US Bench	8.2	1.6	0.5	1.1	35	42	7.1	1.2	PAG	Construction 2021
30289	7-Oct-2021	WRD2	WRD2	Lower Panels, US Upper Bench, Spillway	8.2	0.5	0.3	0.1	4.6	41	37	9.1	Non-PAG	Construction 2021
30290	7-Oct-2021	WRD2	WRD2	Lower Panels, US Upper Bench, Spillway	8.0	0.8	0.4	0.4	13	48	35	3.7	Non-PAG	Construction 2021
30291	7-Oct-2021	WRD2	WRD2	Lower Panels, US Upper Bench,	6.0	6.1	1.9	4.1	129	4.1	-125	0.03	PAG	Construction 2021
30292	7-Oct-2021	WRD2	WRD2	Crest Raise East Arm, Spillway	7.7	1.0	0.5	0.6	18	31	12	1.7	PAG	Construction 2021
30293	7-Oct-2021	WRD2	WRD2	Spillway, Lower Panels	7.9	0.4	0.3	0.1	4.0	47	43	12	Non-PAG	Construction 2021
30294	7-Oct-2021	WRD2	WRD2	Dam crest	7.6	1.2	0.7	0.5	15	27	12	1.8	PAG	Construction 2021
30295	7-Oct-2021	WRD2	WRD2	Crest Raise East Arm, Dam Crest	7.9	0.4	0.3	0.04	1.1	26	25	22	Non-PAG	Construction 2021
				Min.	6.0	0.04	0.01	0.02	0.5	4.1	-125	0.03	-	
			2021	Max.	9.2	6.1	1.9	4.1	129	62	58	112	-	
				Avg.	8.0	1.2	0.4	0.9	27	34	7.0	13	-	
				Min.	7.8	1.0	0.1	0.9	29	46	-60	0.5	-	
			2020	Max.	8.3	3.7	0.1	3.6	111	84	55	2.9	-	
				Avg.	8.1	2.0	0.1	1.9	61	61	-0.3	1.2	-	
30287	7-Oct-2021	WRD3	WRD3	Dam Crest	4.0	8.8	2.1	6.7	209	0	-209	<0.005	PAG	Construction 2021
				Min.	-	-	-	-	-	-	-	-	-	
			2021	Max.	-	-	-	-	-	-	-	-	-	
				Avg.	-	-	-	-	-	-	-	-	-	
				Min.	4.8	1.9	0.1	1.5	46	-2	-172	0.1	-	
			2020	Max.	7.5	7.4	1.9	5.8	183	39	-11	0.8	-	
				Avg.	6.4	3.9	0.8	3.0	95	16	-79	0.3	-	
30284	7-Oct-2021	WRD6	WRD6	Zone J Filter & Spillway	3.5	4.1	2.0	2.1	65	0	-65	<0.005	PAG	Construction 2021
30285	7-Oct-2021	WRD6	WRD6	Dam Crest	4.0	2.9	1.5	1.4	43	0	-43	<0.005	PAG	Construction 2021
30286	7-Oct-2021	WRD6	WRD6	Zone J Filter & Dam Crest	5.1	11	2	8.9	278	0	-278	<0.005	PAG	Construction 2021
				Min.	3.5	2.9	1.5	1.4	43	0	-278	-	-	
			2021	Max.	5.1	11	2	8.9	278	0	-43	-	-	
				Avg.	4.2	5.9	1.8	4.1	129	0	-129	-	PAG	
				Min.	5.8	1.1	0.2	0.9	28	4.2	-24	0.2	-	
			2020	Max.	5.8	1.1	0.2	0.9	28	4.2	-24	0.2	-	
				Avg.	5.8	1.1	0.2	0.9	28	4.2	-24	0.2	PAG	
21251	21-Jan-2021	Tailings	Mill Processing	Lynx TDF	7.1	5.6	0.1	5.5	173	18	-155	0.1	PAG	At spigot point for Jan 2021 (centre of south embankment)
21253	19-Feb-2021	Tailings	Mill Processing	Lynx TDF	8.1	4.6	0.1	4.5	140	68	-72	0.5	PAG	At spigot point for Feb 2021 (2/3 the way east of south embankment)
21257	18-Mar-2021	Tailings	Mill Processing	Lynx TDF	6.7	5.9	0.2	5.7	179	31	-148	0.2	PAG	At spigot point for Mar 2021 (1/2 the way east of south embankment)
21260	29-Apr-2021	Tailings	Mill Processing	Lynx TDF	7.8	6.7	0.1	6.7	208	27	-181	0.1	PAG	At spigot point for Apr 2021 (1/2 way on west embankment)
21266	20-May-2021	Tailings	Mill Processing	Lynx TDF	7.6	5.2	0.1	5.0	158	37	-120	0.2	PAG	At spigot point for May 2021 (1/2 way on south embankment)
21267	14-Jun-2021	Tailings	Mill Processing	Lynx TDF	7.8	5.9	1.3	4.6	143	42	-100	0.3	PAG	At spigot point for Jun 2021 (2/3 way on west embankment)
21268	14-Jun-2021	Tailings	Mill Processing	Lynx TDF	7.7	6.7	1.1	5.7	177	31	-146	0.2	PAG	Beached raw tails sample at back of dam (dessicated)
21269	17-Jul-2021	Tailings	Mill Processing	Lynx TDF	7.5	4.5	1.3	3.3	102	28	-73	0.3	PAG	At spigot point for Jul 2021 (1/2 way on south embankment)
21270	28-Aug-2021	Tailings	Mill Processing	Lynx TDF	7.2	4.6	0.9	3.7	116	18	-98	0.2	PAG	At spigot point for Aug 2021 (Near SW Corner)
21271	25-Sep-2021	Tailings	Mill Processing	Lynx TDF	7.9	4.8	0.7	4.2	130	34	-96	0.3	PAG	At spigot point for Sep 2021 (1/2 way on south embankment)
21272	29-Oct-2021	Tailings	Mill Processing	Lynx TDF										At spigot point for Oct 2021 (1/2 way on south embankment)
21273	17-Nov-2021	Tailings	Mill Processing	Lynx TDF										
21274	21-Dec-2021	Tailings	Mill Processing	Lynx TDF										
				Min.	6.7	4.5	0.1	3.3	102	18	-181	0.1	-	
			2021	Max.	8.1	6.7	1.3	6.7	208	68	-72	0.5	-	
				Avg.	7.5	5.5	0.6	4.9	153	34	-119	0.2	-	
				Min.	7.2	4.7	0.1	4.6	143	14	-242	0.1	-	
			2020	Max.	8.1	8.4	0.1	8.3	261	42	-115	0.3	-	
				Avg.	7.7	6.7	0.1	6.7	208	24	-184	0.2	-	
21252	29-Jan-2021	Superpond	Superpond	Myra 1	8.4	2.3	0.6	1.7	54	286	232	5.3	Non-PAG	Sludge from Myra 1 (surface in NW corner)
21259	8-Apr-2021	Price	Price	Price Pond	8.8	0.1	0.1	0.1	2.5	60	57	24	Non-PAG	Sludge from Price 13 Pond - mostly rocky

Note: Red values represent detection limits indicating that the measured parameter is below detection limit.

Table A2

Selected Near-Total Metal Results, 2021

Sample ID	Sampling Date	Source	Wgt WGHT KG	TOT/S TC000 %	Mo AQ200 PPM	Cu AQ200 PPM	Pb AQ200 PPM	Zn AQ200 PPM	Ni AQ200 PPM	Co AQ200 PPM	Mn AQ200 PPM	Fe AQ200 %	As AQ200 PPM	U AQ200 PPM	Au AQ200 PPB	Cd AQ200 PPM
		MDL	0.01	0.02	0.1	0.1	0.1	1	0.1	0.1	1	0.01	0.5	0.1	0.5	0.1
23034	11-Jun-2021	APA	2.3	4.1	7.9	952	570	7,817	25	13	705	4.6	106	0.5	128	40
23035	11-Jun-2021	APA	2.3	0.2	1.1	86	52	380	19	17	945	4.0	8.8	0.2	11	1.5
23036	11-Jun-2021	APA	3.7	3.9	11	1,422	1,573	>10000	31	13	670	4.1	111	0.7	147	73
23037	11-Jun-2021	APA	3.6	3.0	8.3	859	700	5,764	41	14	691	3.7	145	0.8	60	32
23038	11-Jun-2021	APA	3.3	2.8	6.4	705	374	3,684	33	15	857	3.9	38	0.6	66	19
23039	11-Jun-2021	APA	2.4	3.1	7.6	1,097	661	8,174	19	13	835	3.7	135	0.6	90	43
21261	29-Apr-2021	WRD2	6.8	0.04	0.6	58	17	197	14	21	1,080	5.1	3.5	0.2	4.8	0.5
23027	11-Jun-2021	WRD2	2.2	3.0	7.6	487	358	2,134	22	16	836	5.5	44	0.2	99	11
23028	11-Jun-2021	WRD2	3.6	3.1	5.9	1,052	521	4,268	24	19	1,048	5.0	41	0.2	88	19
23029	11-Jun-2021	WRD2	3.2	3.7	6.0	676	627	5,264	20	18	1,038	5.0	30	0.2	99	22
23030	11-Jun-2021	WRD2	4.2	0.2	0.8	107	86	387	19	20	979	4.5	8.1	0.1	20	1.4
23031	11-Jun-2021	WRD2	4.6	0.7	1.3	264	315	2,563	23	21	981	4.7	12	0.2	40	10
23032	11-Jun-2021	WRD2	4.7	0.2	0.7	90	56	436	16	17	908	4.0	8.4	0.1	11	1.9
23033	11-Jun-2021	WRD2	3.3	0.2	1.3	115	84	553	17	18	906	4.3	9.4	0.3	16	2.4
30277	19-Jun-2021	WRD2	2.8	0.3	-	-	-	-	-	-	-	-	-	-	-	-
30278	23-Jun-2021	WRD2	2.3	0.8	-	-	-	-	-	-	-	-	-	-	-	-
4393	30-Jun-2021	WRD2	2.0	0.4	-	-	-	-	-	-	-	-	-	-	-	-
4397	5-Jul-2021	WRD2	2.9	1.4	-	-	-	-	-	-	-	-	-	-	-	-
30281	9-Jul-2021	WRD2	2.5	0.6	-	-	-	-	-	-	-	-	-	-	-	-
30282	10-Jul-2021	WRD2	2.3	0.8	-	-	-	-	-	-	-	-	-	-	-	-
4394	21-Jul-2021	WRD2	2.4	0.4	1.0	182	173	919	20	25	1,133	5.8	7.7	0.2	30	3.5
30283	21-Jul-2021	WRD2	2.7	1.8	-	-	-	-	-	-	-	-	-	-	-	-
30288	7-Oct-2021	WRD2	1.5	1.6	-	-	-	-	-	-	-	-	-	-	-	-
30289	7-Oct-2021	WRD2	1.1	0.5	-	-	-	-	-	-	-	-	-	-	-	-
30290	7-Oct-2021	WRD2	1.4	0.8	-	-	-	-	-	-	-	-	-	-	-	-
30291	7-Oct-2021	WRD2	1.1	6.1	-	-	-	-	-	-	-	-	-	-	-	-
30292	7-Oct-2021	WRD2	0.9	1.0	-	-	-	-	-	-	-	-	-	-	-	-
30293	7-Oct-2021	WRD2	0.8	0.4	1.5	199	167	846	21	21	1,123	4.9	13	0.3	25	3.9
30294	7-Oct-2021	WRD2	0.8	1.2	-	-	-	-	-	-	-	-	-	-	-	-
30295	7-Oct-2021	WRD2	0.8	0.4	-	-	-	-	-	-	-	-	-	-	-	-
30287	7-Oct-2021	WRD3	0.7	8.8	26	1,136	513	2,772	27	10	402	9.8	139	0.5	586	15
30284	7-Oct-2021	WRD6	0.9	4.1	-	-	-	-	-	-	-	-	-	-	-	-
30285	7-Oct-2021	WRD6	1.7	2.9	-	-	-	-	-	-	-	-	-	-	-	-
30286	7-Oct-2021	WRD6	1.1	11	28	946	456	2,303	29	10	387	11	169	0.6	698	12
21251	21-Jan-2021	Tailings	5.5	5.6	16	778	1,098	4,264	27	6.8	246	4.5	175	1.0	260	15
21523	19-Feb-2021	Tailings	3.9	4.6	13	609	737	3,282	69	14	764	4.8	70	1.0	227	13
21257	18-Mar-2021	Tailings		5.9	24	1,170	3,518	>10000	43	9.4	747	4.7	155	1.6	328	56
21260	29-Apr-2021	Tailings		6.7	22	899	1,300	6,582	38	9.4	712	5.2	158	2.4	437	30
21266	20-May-2021	Tailings		5.2	19	892	1,456	8,079	33	8.7	668	4.5	220	2.1	165	41
21267	14-Jun-2021	Tailings	5.5	5.9	26	1,254	2,282	>10000	36	9.3	782	4.8	163	1.6	358	60
21268	14-Jun-2021	Tailings	8.3	6.7	20	754	1,126	6,525	39	11	732	5.6	168	1.6	194	31
21269	17-Jul-2021	Tailings	3.6	4.5	26	530	1,700	5,997	49	9.1	556	3.8	107	2.4	280	28
21270	28-Aug-2021	Tailings	4.2	4.6	15	459	964	4,181	23	7.7	629	4.0	94	1.2	217	18
21271	25-Sep-2021	Tailings	4.5	4.8	26	547	1,003	4,166	33	10	1,018	4.6	94	2.3	355	17
21272	29-Oct-2021	Tailings														
21273	17-Nov-2021	Tailings														
21274	21-Dec-2021	Tailings														
21275	27-Jan-2022	Tailings														
21252	29-Jan-2021	Superpond	1.6	2.3	11	2,638	1,035	>10000	55	37	4,469	4.1	92	1.8	234	82
21259	8-Apr-2021	Price		0.1	1.4	68	70	305	7.6	13	707	4.2	5.5	0.2	2.0	1.1

Appendix B.

2021 Toxicity Testing Results from Nautilus

Year 2021 - Acute test results for Nyrstar Myra Falls

Sample Date	**Sample ID**	**Trout LC50 % (v/v) [95% CL]**	**Trout single-concentration test Result (% Survival in undiluted conc.)**	***Daphnia magna* LC50 % (v/v) [95% CL]**
January 06, 2021	11A-RUNOFF	> 100	-	> 100
February 10, 2021	11A-RUNOFF	> 100	-	> 100
March 17, 2021	11A-RUNOFF	> 100	-	> 100
April 13, 2021	11A-RUNOFF	> 100	-	> 100
May 11, 2021	11A-RUNOFF	> 100	-	> 100
June 09, 2021	11A-RUNOFF	> 100	-	> 100
July 14, 2021	11A-RUNOFF	> 100	-	> 100
August 10, 2021	11A-RUNOFF	> 100	-	> 100
September 15, 2021	11A-RUNOFF	> 100	-	> 100
September 17, 2021	Spill Source	-	100	-
September 17, 2021	MC-Near 25	-	100	-
October 13, 2021	11A-RUNOFF	> 100	-	> 100
October 25, 2021	Spill-Source	-	0	-
October 25, 2021	MC-Near 25	-	100	-
November 15, 2021	11A-RUNOFF	> 100	-	> 100
December 14, 2021	11A-RUNOFF	> 100	-	> 100

LC = Lethal Concentration; CL = Confidence Limits

Year 2021 – Sub-lethal test results for Nyrstar Myra Falls

Test Species	Sample Date	Sample ID	End point	Result % (v/v) [95% CL]
Ceriodaphnia dubia	May 11, 2021	11A-RUNOFF	Survival LC50	> 100
			Reproduction IC25	> 100
			Reproduction IC50	> 100
Oncorhynchus mykiss			Embryo viability IC25	> 100
			Embryo viability IC50	> 100
Lemna minor			Frond Count IC25	13.5 [9.3 – 19.1]
			Frond Count IC50	> 97 *
			Dry weight IC25	34.1 [15.0 – 72.8]
			Dry weight IC50	> 97 *
Pseudokircheneriella subcapitata			Growth IC25	79.8 [69.0 – 84.0]
			Growth IC50	> 95.2 *
Ceriodaphnia dubia	September 15, 2021	11A-RUNOFF	Survival LC50	> 100
			Reproduction IC25	> 100
			Reproduction IC50	> 100
Lemna minor			Frond Count IC25	2.5 [0.6 – 27.0]
			Frond Count IC50	61.3 [33.6 – 91.2]
			Dry weight IC25	2.3 [0.7 – 43.6]
			Dry weight IC50	> 97 *
Pseudokircheneriella subcapitata			Growth IC25	72.4 [55.4 – 94.2]
			Growth IC50	> 95.2 *
Ceriodaphnia dubia	November 15, 2021	11A-RUNOFF	Survival LC50	> 100
			Reproduction IC25	> 100
			Reproduction IC50	> 100
Oncorhynchus mykiss			Embryo viability IC25	> 100
			Embryo viability IC50	> 100
Lemna minor			Frond Count IC25	19.9 [n/a – 69.0]
			Frond Count IC50	> 97 *
			Dry weight IC25	53.2 [n/a – n/a]
			Dry weight IC50	> 97 *
Pseudokircheneriella subcapitata			Growth IC25	34.0 [31.6 – 35.4]
			Growth IC50	48.6 [44.1 – 52.6]

LC = Lethal Concentration; IC = Inhibition Concentration; CL = Confidence Limits; * = Highest Concentration Tested.

Appendix C

Reports Related to Unusual Events in 2021

Myra Falls Mine
A Trafigura Group Company

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Campbell River, BC
V9W 5E2

T: +1 250-287-9271

October 18, 2021

To whom it may concern,

Re: DGIR 212283, September 17, 2021

Please find enclosed the final report for a September 17, 2021 non-compliance event at Myra Falls Mine Ltd, which was initially reported on Sept 18, 2021. The event was related to highly turbid road-runoff entering Myra Creek during a high intensity precipitation event. The Dangerous Goods Incident Report number associated with this event is 212283.

Description of Events

Myra Falls Mine had not recorded a significant rain event (>20 mm/ 24 hours) since May 28, 2021, and the site had been under a prolonged dry period prior to the event. Weather preparations for fall had started, however the roadways and other surfaces were dusty from the dry summer.

On September 17, 2021 Myra Falls Mine recorded a high-intensity precipitation event, with 34.4 mm of measured rainfall between 13:00 and 17:00 (1:00 pm and 5:00 pm). Any precipitation measured at site over 4 mm/hour is considered moderate, rainfall over 8 mm/hr is considered high, and above 15 mm/hr is considered extreme, based on the performance of the infrastructure at site following an event.

Table 1: Precipitation Data

Intensity Precipitation Interval	1 Hour	1 Hour	1 Hour	1 Hour	Peak 24 hr Intensity
Precipitation (mm)	6.2	8.6	9.2	10.4	82.0
Time measured	13:59	14:59	15:59	16:59	Sept 16 23:00 - Sept 17 22:59

At approximately 14:30 it was observed by the Environmental Staff that turbid water was running down the packed gravel section of the public road and entering Myra Creek between the car bridge and 25 sump (see Figure 1). The road run-off was measured to be flowing at a rate of 5 L/s.

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The source water was entering the creek at the approximate location of the orange star and was sampled at this location. The mixing zone was sampled just under the conveyor, at approximately the location marked by the blue star in Figure 1.

Figure 1: Sampling locations September 17, 2021

Figure 2 shows the water flowing down the road near 25 sump (horizontal arrow), with the drainage ditch indicated in the background by the vertical blue arrow.
Figure 3 shows the 25 sump inlet ditch berm (horizontal arrow) in the background, with the pooled water in the foreground. The vertical arrow shows the location the water was draining to Myra Creek.

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Figure 2: Water running down road, with ditch in background

Figure 3: Water discharge location, with ditch berm in background

Myra Falls Mine Response

Upon observing the discharge, the Environmental staff member contacted the surface crew for assistance. While waiting for the surface crew to mobilize to the location, samples were collected for Acute Toxicity and general chemistry, and field parameters were measured in both the discharge flow and Myra Creek, approximately 10 m downstream of the inflow.

When the equipment arrived at the discharge location, the Environmental Staff member directed the operator to create water bars and cross trenches from the road surface to the existing storm ditch network to direct the turbid water into the water treatment system. In addition, the operator removed any sills left by the grader, which were preventing water from flowing into the ditch upslope of the discharge.

Following the changes to the water flow, the discharge continued at a reduced rate between 1.5 and 2 hours from the build-up in the pool that could not be re-routed and *in situ* rain. The duration of the flow is estimated to be 3 hours (14:30 – 17:30). Using the 5 L/s flow rate measured, it is estimated that the spill was between 50,000 L and 54,000 L in total.

Analytical Results

Results of the water chemistry analysis compared to the prescribed limits of Schedule 4 of the Metal and Diamond Mines Effluent Regulations (MDMER) are presented below in Table 2. Please see schedule A for a PDF copy of the sample results.

The samples taken on September 17 from the discharge and Myra Creek did not show toxicity at 100% concentration. Please see Schedule B for a PDF copy of the toxicity report.

Table 2: Sample Results relative to MDMER and BC Water Quality Guidelines

Parameter	Total concentration (mg/L)				
	MDMER Limit	Lab Results			BC Max WQG
		Discharge	MC - Mix Zone	MC-TP4 site	
Arsenic	0.6	0.05870	0.00079	<0.00050	0.005
Copper	0.6	1.31000	*0.00212*	*0.00648*	*0.0002*
Lead	0.2	1.7400	0.0158	0.0010	0.00447
Nickel	1	0.0395	0.000388	0.00053	0.025
Zinc	1	6.6000	0.0552	0.1120	0.033
Suspended Solids	30	980	27	N/C	-
Un-iodized Ammonia	1	0.051	<0.050	N/C	8.24

The chemical results indicate that the discharge was above MDMER definitions for a deleterious release to an aquatic environment for copper, lead, zinc and suspended solids. Recorded concentrations within the Myra Creek mixing zone (10 meters from the discharge site) were elevated above the BC short-term water quality guideline for copper (dissolved), lead (total) and zinc (total).

It is noted that the concentrations noted for zinc and copper are consistent with similar values during high flows, and higher concentrations were measured for both parameters in a composite sample collected at the MC-TP4 site 1 kilometer downstream. Accordingly, it is difficult to determine if the elevated levels of copper and zinc are a direct result of the discharge, or a combination with other sources in Myra Creek during the event.

Mitigating Actions

The following measures have been taken, or are intended to be taken, to prevent any similar occurrence of an unauthorized deposit:

- Myra Falls Mine has cleaned out the road ditching network, including cut-outs in the berm that drain water from the roadway, in order to ensure flows are channeled to the ditching network instead of the roadway;

- Myra Falls Mine will increase the frequency of inspections of the ditching network; and

- Myra Falls Mine is working to identify opportunities to improve water management across site, directing water away from the public road upslope of this area, and opening the downslope ditching to allow passive flow into the existing works.

If you require any additional information with respect to this matter, please do not hesitate to contact us at your convenience.

Sincerely,

Nicole Pesonen
Environmental Superintendent
Myra Falls Mine Ltd.

Myra Falls Mine
A Trafigura Group Company

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November 24, 2021

To whom it may concern,

Re: DGIR 212856, October 25, 2021

Please find enclosed the final report for the October 25, 2021 non-compliance event at Myra Falls Mine Ltd, which was initially reported on October 25, 2021. The event was related to the overtopping of “25-Sump” to Myra Creek during a high intensity precipitation event. The Dangerous Goods Incident Report number associated with this event is 212856.

Description of Events

Myra Falls Mine was experiencing a significant rain event (>20 mm/ 24 hours) that started on the evening of October 24th, and continued through to mid-day October 27th. During the event a total of 185.8 mm fell, with a maximum hourly intensity of 7.6 mm / hour (measured between 3 and 4 pm October 25th) and a maximum 24 hour intensity of 95mm / 24 hours (occurred between 4 an 5 pm October 25th). During this time frame it was observed that high intensity precipitation would occur for short durations (10 minutes or so) by employees out in the field.

Any precipitation measured at site over 4 mm/hour is considered moderate, rainfall over 8 mm/hr is considered high, and above 15 mm/hr is considered extreme, based on the performance of the infrastructure at site following an event.

Table 1: Precipitation Data

Intensity Precipitation Interval	1 Hour	1 Hour	1 Hour	Peak 24 hr Intensity
Precipitation (mm)	6.0	7.6	6.3	95.00
Time measured	14:59	15:59	16:59	Oct 24 17:00 - Oct 25 16:59

At approximately 16:20 it was observed by the Environmental Superintendent that turbid water was entering the overflow channel for 25 sump (see Figure 1). Turbidity was not observed in Myra Creek upon initial observation. A small turbidity cloud had formed in Myra Creek at the confluence with the overflow ditch by the time the Environmental Superintendent had arrived at the 25 sump location.

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The sump water was entering the creek at the approximate location of the orange star and was sampled directly from the sump. The mixing zone was sampled just under the conveyor, at approximately the location marked by the blue star in Figure 1.

Figure 1: Sampling locations October 25, 2021

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Myra Falls Mine Response

Upon observing the discharge, the Environmental Superintendent immediately attended the scene to respond, and were joined by the tailings operator almost immediately upon arrival. The tailings operator was alerted to the high level alarm on the sump and was on his way to start the emergency back-up pump. A second member of the environmental team (Environmental Technician) joined shortly after the Tailings Operator arrived, having seen the vehicles in the location.

Upon arrival, the Environmental Superintendent measured the depth of the flow over the weir in the sump. The Environmental Superintendent then collected samples from the mixing zone in Myra Creek, while the Environmental Technician collected samples from the sump discharge. During this time the tailings operator started the back-up pump and left the scene once the discharge had ceased to continue his rain-event rounds.

The discharge from the sump ceased shortly after the pump started (1 – 2 minutes), and samples from the sump flow were taken partially from the outflow from the weir, partly from the ponded water in the sump box as a result.

It is estimated that the sump overtopped for approximately 15 minutes, from the initial observation to when the water flow ceased. In the initial observation the flow had not yet reached Myra Creek, indicating it was observed very close to the start of the overflow. Based on the duration of the spill and the depth of the water over the rectangular weir it is estimated that the total flow to Myra Creek was between 3000 and 3500 L in total.

The flow rate for Myra Creek during the event was relatively high. It was measured at 49.017 m^3/s at 14:15 and at 53.215 m^3/s at 14:30. For the timeframe of the sump overtopping, approximately 60,231 m^3 flowed through the Myra Creek Channel at the measurement location at the Red Pipe Bridge (downstream of 25 Sump, Effluent and HW Sump). The outflow from the sump would have been approximately 0.006% of the total flow of Myra Creek at the measurement point.

Analytical Results

Results of the water chemistry analysis compared to the prescribed limits of Schedule 4 of the Metal and Diamond Mines Effluent Regulations (MDMER) are presented below in Table 2. Please see Schedule A for a PDF copy of the sample results.

The samples taken on October 25 from Myra Creek did not show toxicity at 100% concentration, however the 100% concentration was acutely toxic from the 25 Sump sample (taken from the sump after flow had ceased). Please see Schedule B for a PDF copy of the toxicity report.

Table 2: Sample Results relative to MDMER and BC Water Quality Guidelines

Parameter	Total concentration (mg/L)				
	MDMER Limit	Lab Results			BC Max WQG
		Discharge	MC - Mix Zone	MC-TP4 site	
Arsenic	0.6	0.04750	<0.00050	<0.00050	0.005
Copper	0.6	1.18000	*0.00170*	*0.00259*	*0.0002*
Lead	0.2	0.98700	0.00165	0.000587	0.00447
Nickel	1	0.02200	<0.00040	0.000343	0.025
Zinc	1	7.96	0.0705	0.0969	0.033
Suspended Solids	30	487	2.2	N/C	-
Un-iodized Ammonia	1	0.102	<0.050	N/C	8.24

The results indicate that the discharge was above MDMER definitions for a deleterious release to an aquatic environment for aquatic toxicity, copper, lead, zinc and suspended solids. Recorded concentrations within the Myra Creek mixing zone (10 meters from the discharge site) were elevated above the BC short-term water quality guideline for copper (dissolved) and zinc (total).

It is noted that the concentrations noted for zinc and copper are consistent with similar values during high flows, and higher concentrations were measured for both parameters in a composite sample collected at the MC-TP4 site 1 kilometer downstream. Accordingly, it is difficult to determine if the elevated levels of copper and zinc are a direct result of the discharge, or a combination with other sources in Myra Creek during the event.

Contributing Factors

The pumps and alarms in the 25 sump are triggered by floating switches. It appears the time between the high alarm and the overtopping was shorter than previously experienced.

- Debris had washed into the sump and may have impacted the float switch for the high level alarms the trigger turning on the emergency back-up pumps.
- Additional flows from the project office area have been routed a into the road ditching that leads to 25 sump, this may have lead to increased flow rates and shortened response times.

Mitigating Actions

The following measures have been taken, or are intended to be taken, to prevent any similar occurrence of an unauthorized deposit:

- Myra Falls Mine ordered additional emergency back-up pumps for all locations that the overflow discharge would flow to Myra Creek directly.

- Myra Falls Mine did a full service on the pumps, alarms and other components of the sump and water treatment systems to ensure all starter and alarm floats were properly staged and pumps are functioning as designed.

- Additional pumps were ordered for flows that are directed to 25 Sump during high flow events, and are staged in such a way to discharge to either to Superpond directly or to the mine's Tailings Disposal Facility (currently has upward of a 1:1000 return event probability storage), to reduce pressure on 25 sump during these events. One of these pumps is located at the mill yard where the flows from the project office area and the concentrate load-out area pools prior to entering the road ditches. This water is now directed to the tailings facility through the mill pumping systems.

If you require any additional information with respect to this matter, please do not hesitate to contact us at your convenience.

Sincerely,

Nicole Pesonen
Environmental Superintendent
Myra Falls Mine Ltd.

Schedule A
Laboratory Results from CARO Analytical

Schedule B

Laboratory Results from Nautilus Environmental.

Appendix D

2021 Groundwater and Seepage Water Quality Results

Station or Well ID	Sampling Date	Lab pH	EC	Hardness	HCO_3	SO4	Cl	Ca	Mg	Na	K	Al-d	Cd-d	Co-d	Cu-d	Fe-d	Mn-d	Ni-d	Pb-d	Se-d	Zn-d
		-	uS/cm	-	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW-A	25-Feb-21	4.88	391	-	1.22	192	1.35	44.4	11.4	3.15	1.08	1.96	0.0149	0.013	0.728	0.056	1.63	0.0142	0.00285	0.0005	5.79
MW-A	14-Jun-21	4.79	508	-	1.22	280	1.17	67.2	18.9	3.66	1.22	3.14	0.0198	0.0172	0.864	0.026	2.32	0.0192	0.00181	0.0005	7.41
MW-A	15-Aug-21	4.72	610	-	1.22	309	1.23	70.3	18.5	3.69	1.25	3.29	0.0212	0.0189	0.915	0.0106	2.82	0.0211	0.000411	0.0001	8.82
MW-A	01-Nov-21	4.71	870	-	1.22	570	1.44	90.1	31.1	4.67	1.36	5.24	0.0314	0.0295	1.25	0.162	4.03	0.0319	0.00101	0.0004	13.4
MW-C	31-May-21	5.48	620	-	18.3	293	1.16	82.9	21.5	3.81	0.78	0.486	0.00993	0.0108	0.303	2.96	3.19	0.0112	0.0004	0.0005	5.12
MW-C	23-Feb-21	6.33	570	-	30.012	284	1.25	72.6	18.7	3.98	0.6	0.116	0.00598	0.00964	0.111	2.97	2.91	0.00849	0.00103	0.0005	3.43
MW-C	15-Aug-21	6.26	691	-	15.616	346	1.24	85.9	21.2	4.09	0.857	0.83	0.0119	0.0133	0.383	2.64	3.67	0.0139	0.000128	0.0001	5.86
MW-C	01-Nov-21	6.43	846	-	29.646	428	1.3	102	30.8	5.08	0.756	0.636	0.0107	0.0134	0.256	4.06	4.66	0.0142	0.000215	0.00011	5.45
MW-D	24-Feb-21	4.88	945	-	1.22	563	1.62	123	39.1	6.76	1.8	4.14	0.0301	0.0235	1.11	0.021	3.76	0.0334	0.00564	0.0005	13.9
MW-D	14-Jun-21	4.67	1100	-	1.22	758	1.84	162	52.7	7.73	2.05	7.54	0.0452	0.0408	1.66	0.01	6.11	0.0534	0.00053	0.0005	22.8
MW-D	15-Aug-21	4.78	832	-	1.22	444	1.57	99.8	26.8	5.54	1.56	4.02	0.0239	0.0155	0.976	0.0041	2.43	0.0251	0.000187	0.0001	13.3
MW-D	01-Nov-21	4.83	831	-	1.22	457	1.82	94	25.9	6.69	1.65	3.86	0.0264	0.0209	0.969	0.019	3.2	0.0267	0.000296	0.00013	13.7
MW-F	31-May-21	6.16	127	-	27.45	28.5	0.92	18.1	2	1.25	0.42	0.0129	0.000767	0.0001	0.0127	0.01	0.013	0.00053	0.0002	0.0005	0.29
MW-F	24-Feb-21	6.5	132	-	12.322	44.5	1.32	22.9	6.76	1.41	0.31	0.788	0.00593	0.00734	0.143	3.22	0.984	0.00915	0.00422	0.0005	3.08
MW-F	01-Nov-21	6.72	450	-	27.694	194	1.21	63.6	14.8	3.37	1.23	0.0423	0.0105	0.000391	0.0381	0.0514	0.145	0.00959	0.0003	0.00029	5.58
MW-F	15-Aug-21	6.78	174	-	25.742	59.1	1.37	23.2	2.49	3.31	0.852	0.0086	0.000976	6.97E-05	0.00686	0.0109	0.016	0.000508	0.000259	0.00046	0.272
MW13-14D	17-May-21	5.22	329	-	1.22	150	1.2	39.1	7.53	2.57	1.02	0.798	0.00872	0.00982	0.322	0.01	1.02	0.00874	0.0002	0.0005	3.4
MW13-14D	26-Jan-21	5.97	346	-	9.394	168	1.1	46.1	9.21	2.7	0.97	0.96	0.00957	0.0114	0.37	0.01	1.24	0.00974	0.0002	0.0005	3.76
MW13-14D	21-Jan-21	7.38	305	-	112	77.4	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW13-14D	15-Aug-21	5.03	400	-	1.22	193	1.17	49.2	9.61	3.29	1.22	1.03	0.0107	0.0125	0.388	0.0024	1.44	0.0115	0.00011	0.0001	4.28
MW13-14D	01-Nov-21	5.22	601	-	1.22	290	1.39	71.2	17	4.12	1.28	1.54	0.016	0.0188	0.516	0.0067	2.28	0.018	0.000112	0.00052	6.67
MW13-14S	26-Jan-21	5.3	328	-	2.074	164	1.2	42.7	7.87	2.7	1	0.725	0.00857	0.00898	0.301	0.01	1.06	0.00856	0.0002	0.0005	3.35
MW13-14S	17-May-21	5.7	285	-	2.684	122	1.21	36.5	5.7	2.7	0.9	0.351	0.00467	0.00547	0.151	0.081	0.659	0.00484	0.0002	0.0005	1.67
MW13-14S	21-Jan-21	7.09	299	-	86.254	87.3	0.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW13-14S	01-Nov-21	5.34	517	-	1.586	246	1.36	58.7	13	4.25	1.14	0.779	0.0101	0.0126	0.309	0.139	1.64	0.0117	0.0001	0.00042	4.26
MW13-14S	15-Aug-21	5.69	403	-	3.782	191	1.4	51	10.1	4.02	1.12	0.377	0.00746	0.00942	0.196	0.258	1.32	0.00897	0.000068	0.0001	2.97
MW13-15D	17-May-21	7.64	262	-	95.892	62.9	0.72	34.9	4.87	1.45	0.41	0.005	0.000013	0.0001	0.00081	0.01	0.00032	0.0004	0.00065	0.00111	0.004
MW13-15D	01-Nov-21	7.45	254	-	100.28	54.2	0.79	36.3	5.55	1.76	0.487	0.0071	2.39E-05	1.55E-05	0.0007	0.0039	0.0015	0.00004	0.00005	0.00151	0.0077
MW13-15D	16-Aug-21	7.39	232	-	93.696	51.8	0.83	38.3	5.36	1.66	0.533	0.001	1.29E-05	7.4E-06	0.00056	0.002	0.00101	0.00004	0.00005	0.00103	0.0034
MW13-15S	17-May-21	7.62	260	-	97.234	62.8	0.72	37.3	5.2	1.54	0.44	0.005	0.000011	0.0001	0.0006	0.01	0.0002	0.0004	0.0002	0.00129	0.004
MW13-15S	01-Nov-21	6.7	368	-	42.09	146	0.9	54.4	6.83	3.33	1.12	0.0095	0.000797	2.02E-05	0.00591	0.0043	0.0137	0.0021	0.000097	0.00011	1.21
MW13-15S	16-Aug-21	6.63	492	-	44.408	211	1.07	68	9.87	4.08	1.3	0.0082	0.00139	7.1E-06	0.00968	0.002	0.00824	0.00456	0.00005	0.0001	2.74

Station or Well ID	Sampling Date	Lab pH	EC uS/cm	Hardness	HCO_3 mg/L	SO4 mg/L	Cl mg/L	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Al-d mg/L	Cd-d mg/L	Co-d mg/L	Cu-d mg/L	Fe-d mg/L	Mn-d mg/L	Ni-d mg/L	Pb-d mg/L	Se-d mg/L	Zn-d mg/L
IN-DRAIN	25-May-21	4.27	1480	-	1.22	1210	1.71	141	85.1	5	1.8	36	0.14	0.109	7.08	23.2	11.6	0.108	0.00307	0.00201	49.3
IN-DRAIN	25-Jul-21	3.85	1340	-	1.22	796	1.75	129	60	4.87	1.51	21	0.109	0.0765	5.09	3.83	8.83	0.076	0.00428	0.0005	28
IN-DRAIN	21-Jan-21	4.48	1190	-	1.22	795	1.14	133	44	3.47	1.68	19.1	0.0845	0.0535	4.09	37.2	5.38	0.0601	0.00427	0.0005	23.1
IN-DRAIN	25-Feb-21	4.38	1520	-	1.22	974	1.53	140	78.7	4.51	1.8	30.3	0.129	0.102	6.18	26.2	10.6	0.106	0.00872	0.0005	41.1
IN-DRAIN	01-Nov-21	4.15	1090	-	1.22	747	1.24	120	45.7	5.3	1.79	14.5	0.0758	0.0477	3.24	37.1	6.24	0.049	0.00342	0.00017	22
OUT-DRAIN	19-Jan-21	6.5	813	-	39.284	446	1.43	117	30.8	5.12	1.28	0.474	0.0208	0.00453	0.282	0.387	1.41	0.0228	0.0002	0.0005	11.4
OUT-DRAIN	25-May-21	-	-	-	0	-	-	68.3	15.2	3.53	0.96	0.23	0.00586	0.00151	0.112	0.212	0.378	0.00809	0.00023	0.0005	4
OUT-DRAIN	25-Jul-21	6.7	396	-	30.622	222	1.06	47.8	10.3	2.71	0.7	0.164	0.0066	0.00599	0.156	0.409	0.784	0.00864	0.0002	0.0005	3.1
OUT-DRAIN	01-Nov-21	6.66	684	-	40.26	415	1.64	88.8	19.9	5.04	1.08	0.414	0.00831	0.00244	0.148	0.315	0.352	0.0101	0.000088	0.0003	6.09
L-DRAIN	21-Jan-21	6.59	527	-	36.722	223	1.12	76.4	14	3.27	0.85	0.428	0.00777	0.00288	0.205	0.01	0.57	0.00792	0.0002	0.0005	4.26
L-DRAIN	06-May-21	6.85	527	-	35.014	239	1.1	65.6	16.5	3	0.74	0.277	0.0102	0.00631	0.238	0.01	0.999	0.0122	0.0002	0.0005	5.54
L-DRAIN	25-May-21	4.87	663	-	1.22	622	1.64	86	23.2	6.02	1.94	3.31	0.0237	0.0196	1.01	0.45	3.02	0.0233	0.00035	0.0005	8.88
L-DRAIN	25-Jul-21	4.71	909	-	1.22	541	1.92	107	34.5	6.62	1.92	5.13	0.0332	0.0366	1.4	0.67	5.24	0.0376	0.00054	0.0005	13.4
L-DRAIN	31-Oct-21	6.67	342	-	25.254	144	0.94	47.8	9.8	2.61	0.668	0.301	0.00744	0.00514	0.217	0.123	0.603	0.00649	0.00054	0.00018	2.83
M-DRAIN	21-Jan-21	6.12	557	-	18.544	253	1.32	84.6	13.3	3.53	1.31	0.799	0.00861	0.00422	0.283	0.15	0.751	0.00792	0.00021	0.0005	3.59
M-DRAIN	25-May-21	5.64	568	-	5.246	301	1.64	70.6	23.4	3.3	0.93	1.27	0.0229	0.0159	1.01	2.41	1.96	0.0213	0.00041	0.0005	9.12
M-DRAIN	25-Jul-21	5.6	592	-	4.026	307	1.28	70.7	21	3.75	1.02	1.58	0.0222	0.0163	0.88	1.56	2.25	0.0203	0.00028	0.0005	8.25
M-DRAIN	06-May-21	4.87	764	-	1.22	402	1.65	94.5	24	5.96	1.88	3.27	0.0258	0.0218	0.978	0.381	3.19	0.0252	0.00046	0.0005	8.87
M-DRAIN	31-Oct-21	6.81	283	-	42.212	105	0.87	39.6	5.79	1.57	0.452	0.0374	0.00377	0.00116	0.0789	0.0204	0.139	0.00297	0.000445	0.00023	1.31
S-DRAIN	06-May-21	5.71	646	-	4.392	313	1.16	78.1	24.6	3.42	0.92	1.61	0.0238	0.0166	0.977	3.18	2.02	0.0223	0.00037	0.0005	9.21
S-DRAIN	21-Jan-21	6.81	436	-	98.576	202	0.87	77.7	8.03	1.91	0.69	0.108	0.0021	0.00012	0.0384	0.051	0.0614	0.00159	0.0002	0.0005	1.07
S-DRAIN	25-Jul-21	6.54	482	-	20.74	214	1.19	52.2	11.1	2.73	0.72	0.0815	0.00754	0.0043	0.113	0.307	0.741	0.0115	0.00034	0.0005	3.56
S-DRAIN	31-Oct-21	7.38	262	-	81.496	65.4	0.78	41.4	3.39	1.15	0.278	0.0127	0.00122	7.56E-05	0.00598	0.0272	0.013	0.000773	0.000169	0.0001	0.334

Station or Well ID	Sampling Date	Lab pH	EC uS/cm	Hardness	HCO_3 mg/L	SO4 mg/L	Cl mg/L	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Al-d mg/L	Cd-d mg/L	Co-d mg/L	Cu-d mg/L	Fe-d mg/L	Mn-d mg/L	Ni-d mg/L	Pb-d mg/L	Se-d mg/L	Zn-d mg/L
TDF-EFF	22-Oct-21	7.4	174	78.4	1.25	-	-	28.6	1.66	0.82	0.2	0.0189	0.00163	0.00137	0.0452	0.01	0.131	0.00212	0.00035	0.00068	0.391
TDF-EFF	25-Oct-21	7.26	143	65.3	1.25	-	-	23.6	1.54	0.871	0.148	0.0457	0.00147	0.00116	0.0408	0.0097	0.0963	0.00211	0.000057	0.0001	0.357
TDF-EFF	26-Oct-21	7.45	122	58.3	1.25	-	-	21.7	0.958	0.787	0.112	0.0338	0.000703	0.000305	0.0173	0.0029	0.0329	0.000687	0.000106	0.0001	0.144
TDF-EFF	05-Nov-21	6.79	176	75.4	1.25	-	-	26.7	2.07	0.832	0.125	0.0306	0.00271	0.00195	0.0631	0.002	0.15	0.00261	0.00324	0.0001	0.609
TDF-EFF	15-Nov-21	7.13	168	84.9	1.25	-	-	30.1	2.32	0.914	0.154	0.0294	0.0026	0.00238	0.0581	0.0099	0.19	0.00325	0.000986	0.0001	0.581
TDF-EFF	28-Nov-21	7.2	109	49.3	1.25	23.3	-	17.9	1.11	0.667	0.103	0.0418	0.000773	0.000457	0.02	0.0113	0.0414	0.000912	0.000052	0.0001	0.161
TDF-EFF	01-Dec-21	6.93	104	45.6	1.25	26	-	16.2	1.24	0.62	0.108	0.0562	0.00103	0.00103	0.0374	0.0201	0.0897	0.00177	0.000056	0.0001	0.223
SEEP MYRA 2S	13-Jan-21	7.2	138	69.6	1.25	-	-	26.6	0.837	1.03	0.18	0.0064	0.000128	0.0001	0.0004	0.01	0.00258	0.0004	0.0002	0.0005	0.027
3-RUNOFF	03-Mar-21	7.1	231	-	1.25	74.8	2.7	-	6.58	2.08	0.15	0.0404	0.0123	0.00511	0.119	0.019	0.448	0.00469	0.00034	0.0005	3.23
3-RUNOFF	14-Apr-21	-	199	92.7	1.25	52.2	2.22	28.2	4.7	1.9	0.11	0.0574	0.00868	0.0036	0.0819	0.015	0.306	0.00338	0.00028	0.0005	2.19
3-RUNOFF	07-Jul-21	-	219	96.8	1.25	45.5	1.68	32.6	5.25	1.7	0.11	0.0998	0.00652	0.00234	0.0851	0.013	0.205	0.00227	0.0002	0.0005	1.58
3-RUNOFF	10-Nov-21	-	142	58.6	1.25	51.3	1.72	17.3	3.77	1.39	0.1	0.0354	0.00989	0.0038	0.181	0.016	0.292	0.00342	0.0002	0.0005	2.3
Road Seep Pond 4	02-Dec-21	-	-	69.8	-	10.5	0.66	31.5	0.955	0.875	0.171	0.0038	0.00139	3.73E-05	0.00739	0.0024	0.00344	0.000173	0.00131	0.00181	0.247
MC+950 SEEP	18-May-21	7.21	41.3	16.6	1.25	6.5	-	5.99	-	-	-	-	-	-	-	-	-	-	-	-	-
MC+800 SEEP	18-Aug-21	7.36	167	74.4	1.25	39.4	-	26.7	2.7	1.94	0.38	0.005	0.000261	0.0001	0.00096	0.01	0.0002	0.0004	0.0002	0.00056	0.178
Spill-Source	17-Sep-21	7.55	172	65.7	1.25	56.7	0.62	36.8	1.56	1.16	0.424	0.111	0.00036	0.000323	0.00338	0.0594	0.107	0.000542	0.00285	0.00015	0.026
Car Bridge Seep	09-Dec-21	6.18	-	101	1.25	-	-	36.6	4.76	2.79	0.519	0.0664	0.00493	8.02E-05	0.0605	0.002	0.0328	0.00483	0.00103	0.00015	2.65

Appendix E

2021 IEG Site Inspection Memo

Integral Ecology Group
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MEMORANDUM

March 17, 2022

TO:	Nicole Pesonen, Myra Falls Mine Ltd.
FROM:	Justin Straker
RE:	IEG 2021 site inspection
COPY:	Joshua Fry, Myra Falls; Jeff Anderson, IEG

On November 11, 2021, Justin Straker of IEG conducted a site inspection of the Myra Falls mine related to reclamation areas and activities. The inspection covers four primary areas/topics:

1. revegetation in the Emergency Tailings Area (ETA);
2. revegetation in the Waste Rock Dump 2 area;
3. observations of cover materials on the Lynx Tailings Disposal Facility (TDF) Closure Cover Trial; and
4. an overview of developing revegetation along the old Tailings Disposal Facility (TDF) seismic berm.

We discuss each of these inspection topics in detail below.

1. Emergency Tailings Area

It is our understanding that there may need to be some materials deposition or movement in the ETA, and there is potential concern over disturbance of existing vegetation during these activities. As Figure 1 shows, portions of the ETA remain bare, while some are revegetating relatively well. Ideally, any new disturbance would be concentrated in the non-vegetated areas, but other than the zones along Myra Creek, the established vegetation is not so well developed that it cannot be re-established if some disturbance needs to occur in vegetated portions of the ETA. However, areas that remain bare, or areas of new disturbance, will require placement of reclamation-cover materials before revegetation, as the unhealthy (e.g., seedling in lower left, Figure 1) or dead seedlings (e.g., Figure 2) in this area suggest that there are physical and/or chemical barriers to revegetation in current surficial materials.

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Figure 1. Bare (foreground) and naturally regenerating (background) areas at the ETA.

Figure 2. Dead seeding in an unvegetated area on the ETA.

2. Waste Rock Dump 2 area

Myra Falls removed waste rock from the historic Waste Rock Dump 2 location in the summer and early fall of 2017. Underlying materials at this location consist of native surficial materials—including soil and other surficial material—onto which the waste rock was dumped (Figure 3). Analysis in 2017 indicated that these materials have the edaphic properties of the 03/HwCw – Salal site series in the CWHmm1 biogeoclimatic unit. Appropriate tree species for early revegetation are Douglas-fir and red alder, and seedlings of both species were observed in non-mined forest directly above the Waste Rock Dump 2 location.

In 2018, surveys of the Waste Rock Dump 2 area found sparse vegetation establishing in the upslope portion directly adjacent to the intact forest above. This vegetation makes up approximately 5% of the ground cover in this area (Figure 3). The most common species are fireweed, miner's lettuce, thimbleberry, and pearly everlasting. Other notable native species present include Douglas-fir, red alder, and red elderberry. Similar observations were made when the area was re-visited in 2019 and 2020, including the establishment of invasive and non-native species (Himalayan blackberry and thistle).

Figure 3. Revegetating upslope area in the previous Waste Rock Dump 2 location.

At this time there are no areas of WD2 that are fully ready for vegetation. Most of WD2 still requires removal of waste rock, and the small section that does not (discussed above) may still be disturbed during relocation operations for the remainder of the waste rock.

When waste rock removal is complete, we recommend that the area be planted with red alder and Douglas-fir, at approximate stem densities of 2500 and 1000 stems per ha respectively. Discussions with AMEC engineers in 2017 indicate that they do not expect erosion to be a primary issue at this site; therefore at this time no additional treatments such as seeding or bioengineering are recommended. Revegetation efforts should be coupled with the removal of invasive species from the area and planning for future control.

Analysis of element concentrations in this material was performed in 2018, which indicated high concentrations (approximately 1-6 times the Canadian parkland/agricultural soil quality guidelines[1]) of cadmium, copper, lead, and zinc, as well as more marginally elevated concentrations of arsenic, barium, and vanadium. Although it is possible that there is some contribution in these concentrations from naturally mineralized materials, it is also very likely that they reflect the effects of either constituent leaching from waste-rock materials or incomplete removal of these materials. Observed concentrations are unlikely to be limiting to reestablishment of vegetation, but vegetation in this area should be sampled for element uptake in the future.

3. Lynx Tailings Disposal Facility Closure Cover Trial

The Lynx TDF closure cover trial was placed between October 20 and October 31, 2021. The intent of this trial is to support development of the most suitable cover design to meet the goals of 1) providing a vegetated surface to minimize erosion, enhance cover stability, and improve aesthetics; and 2) separating clean soils from mine waste rock.

Almost 300 mm of rain fell at the Myra Falls Mine between the date of cover completion on October 31, 2021 and the date of this reclamation inspection on November 11, 2021, including 180 mm of rain in the four-day period from Nov. 2-5, and another 50 mm of rain on Nov. 9. The cover trial consists of a 60-m long section of a 20-m 2H:1V slope length. On this slope length and gradient, surface erosion from the above precipitation was relatively substantial (Figure 4), with formation of rills 5-20 cm deep (Figure 5) and correspondingly large/deep deposition fans at the toe of the covered slope (Figure 6). There was an additional 40-cm deep erosion hole in the cover, likely caused by a combination of local slumping and downward washing of cover materials (Figure 7).

[1] Canadian Council of Ministers of the Environment, CCME Summary Table

Figure 4. Erosion rills and deposition fans on the Lynx TDF closure cover trial.

Figure 5. Erosion rill on the Lynx TDF closure cover trial (multi-tool for scale—tool is 20 cm from one end of the handle to the other).

Figure 6. Erosion fans (background) at the toe of the Lynx TDF closure cover trial.

Figure 7. Erosion hole in cover, 40-cm deep (20-cm multi-tool for scale).

We make the following recommendations based on these early observations of cover-trial performance on the Lynx TDF:

- Some of the erosion is likely caused by overtopping of water from the bench above the cover trial (Figure 8). This is typical for reclamation covers, and indicates that mechanisms should be employed in future to prevent this overtopping (e.g., backsloped benches, crest berms, constructed drainage channels to conduct water away from slopes).
- Fall cover placement is difficult, as fall and winter precipitation is delivered and runs off prior to any establishment of vegetation. Cover performance will likely be enhanced if covers can be placed in the spring, revegetated immediately, and have a full vegetation growing season prior to being subjected to substantial precipitation delivery in the non-growing-season months.
- Although hydroseeding can be expensive and over-used, the configuration and materials of the Lynx cover material lend themselves to this application technique. The combination of some fine materials and steep, relatively short slopes means that hydroseeding is feasible, and would likely be effective at retaining seeds on the cover surface (i.e., resisting erosion of seeds). The addition of mulch in the hydroseed could provide some initial erosion protection, and co-delivery of water at the time of seeding could assist in seed germination in the spring. Seeding species selection or mixes do not have to be altered for hydroseeding, but application rates should be increased to account for damage to seed during the application process.

Figure 8. Erosion initiating at the top of the Lynx TDF closure cover slope, likely caused in part by run-on water flowing off the bench and on to the slope crest.

4. TDF Seismic Berm

Vegetated ecosystems continue to develop slowly on the seismic berm, facilitated in part by red alder establishment in the eastern and central sections.[2] Recent satellite imagery (Figure 9) shows that alder has established vigorously where slope aspects are southerly or east of southerly, and less well on southwest slope aspects. This difference can be seen at ground level in a comparison between the areas where alder is more robust (Figure 10) and less robust (Figure 11). In the sections with a thicker alder cover, the benefits of this species, particularly its production of copious, nutrient-rich litter, and its changing of the understory micro-climate to facilitate colonization by less drought-tolerant mosses can be seen (Figure 12). However, Douglas-fir is reaching heights of 2 m even in the western, less-well-vegetated sections (Figure 13), and natural regeneration can be substantial in portions of these sections, particularly in less-occupied spaces at slope crests (Figure 14).

Figure 9. Satellite image of vegetation on the Old TDF seismic berm, showing locations of following figures (image copyright Maxar Technologies).

[2] A more thorough assessment of revegetation on the berm was conducted in 2020, and is described in detail in the Myra Falls 2020 TDF revegetation assessment report.

Figure 10. Robust vegetation consisting of alder, Douglas-fir, and willow immediately west of the emergency spillway.

Figure 11. Vegetation with lesser alder components on the western section of the Old TDF seismic berm.

Figure 12. Litter and moss established under a thicker canopy of red alder at the eastern end of the Old TDF seismic berm.

Figure 13. Taller Douglas-fir in western sections of the Old TDF seismic berm.

Figure 14. Western section of the Old TDF seismic berm, showing patches of natural conifer regeneration along the slope crest.

Closure

We thank Myra Falls Mine Ltd. for the opportunity to contribute to ongoing reclamation works at the Myra Falls mine, and trust the information provided in this memo meets your requirements at this time. To discuss content of this memo and/or work required going forward, please contact me at jstraker@iegconsulting.com, or at 250 701 0600.