Management Plan

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Valentine Gold Project: Water Management Plan

Update for the Berry Pit Expansion

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August 2023
Revision 2.0 (DRAFT)

Limitations and Sign-off

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Executive Summary

Marathon Gold Corporation (Marathon) initiated construction of the Valentine Gold Project (the Project), an open pit gold mine in central Newfoundland, in October 2022 following release of the Approved Project, with conditions, from provincial and federal environmental assessment (EA) processes in March 2022 and August 2022, respectively. The Water Management Plan for the Approved Project was finalized in July 2022. This updated (Revision 2.0) document incorporates the proposed changes in water management required to address the proposed Berry Pit Expansion (the Project Expansion). Until the Project Expansion is approved by federal and provincial governments, the Water Management Plan finalized in July 2022 is the active plan to be followed.

Based on recent and successful geological exploration and assessment work and associated feasibility assessment, Marathon is proposing the development of a third open pit within the mine site of the Valentine Gold Project (the Approved Project). The Berry Pit Expansion (the Project Expansion) is proposed to include an open pit (Berry pit), a new waste rock pile and topsoil stockpile, expansion of the low-grade ore and overburden stockpiles associated with Marathon pit, and additional water management infrastructure. While the Approved Project planned for tailings to be disposed of in the exhausted Leprechaun pit near the end of mine life, the Project Expansion proposes to instead deposit tailings in the Berry pit from Mine Year 10 of the mine life onwards, reducing the distance that tailings would need to be transported by pipeline. Waste rock will also be deposited in the proposed Berry pit.

This updated Water Management Plan applies to both the Approved Project and the Project Expansion; for simplicity, this document refers to both projects as ‘the Project’. The Project mine site can therefore be viewed as four main complexes, from northeast to southwest: the Marathon Complex; the process plant and Tailings Management Facility (TMF) Complex; the Berry Complex; and the Leprechaun Complex. The major Project facilities include: the Leprechaun, Berry, and Marathon open pits; waste rock piles; low-grade ore stockpiles; topsoil and overburden stockpiles; process plant; TMF; mining services; access road; and accommodations camp.

The key features of the water management plan are as follows:

- Water management infrastructure are designed under a decentralized water treatment framework, operating under gravity drainage to reduce pumping needs
  - Surface runoff upstream of the Project facilities will be diverted away to predevelopment catchments, where possible
  - Perimeter ditches around the piles (i.e., waste rock, topsoil, and overburden stockpiles) will flow into water management ponds and discharge to the Final Discharge Points (FDPs)
  - The Processing Plant Pad runoff will be directed to a water management pond prior to discharge to a watercourse
  - Mine water from dewatering the open pits will be collected in sumps and pumped to a water management pond prior to discharge to the environment

- Perimeter dams will be constructed in downstream raises to impound the tailings and provide flexibility in construction and distribute construction costs over the life of the facility, thus maintaining adequate storage and freeboard during operation
- During operation, the TMF will receive water from the processing plant via tailings slurry water, seepage collection pond discharge (intercepting tailings seepage from the TMF and pumping back into the pond for treatment), runoff from tailings pond un-diverted upstream catchment areas, and direct precipitation
- Water retained in the tailings pond will be exposed to sunlight to accelerate natural cyanide (CN^-) degradation and provide sedimentation of suspended solids in the tailings slurry discharge
- Losses from the TMF include reclaim water to the process plant, discharge to the water treatment system (water treatment plant and submerged attached growth reactor [SAGR®] unit), water retained in the tailings matrix, deep groundwater seepage, and evaporation
- Tailings water not needed for reclaim will be treated in the water treatment plant prior to discharge to the SAGR® unit (for eight months of the year)
- The SAGR® unit will provide additional passive treatment and control the timing and amount of discharge; the SAGR® unit water will be released to a pipeline discharging to Victoria Lake Reservoir
- Mining of the Marathon, Berry and Leprechaun pits will occur simultaneously until Mine Year 9. The Berry pit northern basin will have waste rock start being placed in it in Mine Year 7. In Mine Year 10, tailings deposition to the TMF will switch to subaqueous deposition in the southern basin of Berry pit, and waste rock to Berry pit's central basin (mining in Marathon and Leprechaun pits will continue until Mine Years 13 and 12, respectively)
- Water withdrawal from Victoria Lake Reservoir is proposed as a freshwater make-up source for processing ore at the mill during operation, and to accelerate filling of the Leprechaun pit during closure; water withdrawal from Valentine Lake is proposed to accelerate filling of the Marathon pit during closure; no accelerated filling of the Berry pit is planned using freshwater from Valentine Lake or the Victoria Lake Reservoir
- Progressive rehabilitation activities will include adding a soil cover consisting of overburden and organics and vegetating waste rock pile slopes and benches as they are constructed; stabilizing disturbed areas through vegetation; and depositing waste rock in the central and northern Berry basins and tailings and water in the SW Berry basin after Mine Year 9

Rehabilitation and closure will involve activities to return the site to pre-development conditions to the extent feasible, including stabilizing through vegetated topsoil, overburden, and low-grade ore stockpile areas, vegetated soil overburden cover on waste rock piles and TMF tailings/pond area, dismantling and removing the buildings, and allowing the pits to fill with water. During closure, perimeter seepage collection ditches will be retrofitted to permeable reactive barriers to attain closure and post-closure water quality objectives.

Revision Log

DOCUMENT REVISION	DESCRIPTION OF CHANGE	PAGES
2.0 (DRAFT)	The document has been updated to include changes in water management associated with the Berry Pit Complex Expansion. Changes denoted by vertical lines in the right margin of updated content.	Throughout

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Abbreviations

AEP	Annual Exceedance Probability
ALD	Anoxic Limestone Drain
ARD	Acid Rock Drainage
BC MELP	British Columbia Ministry of Environment, Lands and Parks
CCME	Canadian Council of Ministers of the Environment
CEAA	Canadian Environmental Assessment Agency
CDA	Canadian Dam Association
CWQG	Canadian Water Quality Guidelines
EA	Environmental Assessment
ECSWR	Environmental Control Water and Sewage Regulations
EEM	Environment Effects Monitoring
EIS	Environmental Impact Statement
EQS	Environmental Quality Standards
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
FAL	Freshwater Aquatic Life
FDP	Final Discharge Point
GCDWQ	Guideline for Canadian Drinking Water Quality
HADD	Harmful Alteration, Disruption or Destruction
HCT	Humidity Cell Test
INP	Inlet Point
km	Kilometres
LGO	Low Grade Ore
LNAPL	Light Non-Aqueous Phase Liquids
LOWL	Low Operating Water Level
MAC	Maximum Allowable Concentrations

MAF	Mean Annual Flow
Marathon	Marathon Gold Corporation
MDMER	Metal and Diamond Mining Effluent Regulations
m	Meter
m^3/day	Cubic meters per day
ML	Metal Leaching
Mt/a	Million tonnes per year
NL	Newfoundland and Labrador
NLDECC	Newfoundland and Labrador Department of Environment and Climate Change
NLDIET	Newfoundland and Labrador Department of Industry, Energy and Technology
NLFFA	Newfoundland and Labrador Fisheries, Forestry and Agriculture
NLDMAE	Newfoundland Department of Municipal Affairs and Environment
NOWL	Normal Operating Water Level
OUP	Outlet Point
PAG	Potentially Acid Generating
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
POPC	Parameters of Potential Concern
PRB	Permeable Reactive Barrier
PSS	Pathway-Specific Standards
QA/QC	Quality Assurance and Quality Control
RDL	Reportable Detection Limit
ROM	Run-of-Mine
RQP	Reference Quality Point
RQFP	Reference Quality and Flow Point
SAGR®	Submerged Attached Growth Reactor
SAPS	Successive Alkalinity Producing Systems
TMF	Tailings Management Facility

TSS	Total Suspended Solids
WRP	Waste Rock Pile
WMP	Water Management Plan
WFP	Water Flow Point
WQ	Water Quality
WQP	Water Quality Point
WQFP	Water Quality and Flow Point
WSER	Wastewater System Effluent Regulations
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

This Water Management Plan supports and guides the construction, operation, and decommissioning, rehabilitation, and closure of the Valentine Gold Project (the Project), located in the Central Region of the Island of Newfoundland, south of Valentine Lake. The Project includes three open pits (Marathon, Leprechaun, Berry), waste rock piles, crushing and stockpiling areas, conventional milling, and processing facilities (the mill), a tailings management facility (TMF), personnel accommodations, and supporting infrastructure, including roads, on-site power lines, buildings, and water and effluent management facilities. This Water Management Plan has been prepared by Stantec Consulting Ltd. (Stantec) for Marathon Gold Corporation (Marathon), the Project proponent. Marathon is committed to reducing environmental effects through the implementation of mitigation measures, monitoring, and adaptive water management for the Project. The current Water Management Plan version focuses primarily on water quantity and quality.

Closely integrated documents that supported the preparation of the Water Management Plan can be found in the references section of this document and are listed below:

- 2019 Baseline Hydrology and Surface Water Quality Monitoring Program (Stantec 2020a)
- Valentine Gold Project - Pre-Feasibility Study (Marathon & Ausenco 2020)
- Prefeasibility Study for Tailings Disposal at the Valentine Gold Project (Golder 2020), including the TMF water balance modelling report.
- Basis of Design for Pre-Feasibility Level Water Management Design Input – Final (Stantec 2020b)
- Valentine Gold Project – Geochemistry Report (Stantec 2020c).
- Valentine Gold Project – Fish and Fish Habitat Valued Component Chapter (Stantec 2020d)
- Water Quantity and Water Quality Modelling Reports for the Leprechaun Complex and Processing Plant & TMF Complex, and Marathon Complex (Stantec 2020e, f)
- Valentine Gold Project – Assimilative Capacity Assessment (Stantec 2020g)
- Valentine Gold Project: Acid Rock Drainage/Metal Leaching (ARD/ML) assessment report (Phase II). (Stantec 2020g)
- N.I. 43-101 Technical Report & Feasibility Study on the Valentine Gold Project (Ausenco 2021)
- Valentine Gold Project: Groundwater Monitoring Plan (Stantec 2021a)
- Valentine Gold Project: Surface Water Monitoring Plan (Stantec 2021b)
- 2021 Basis of Design for Feasibility Level Water Management Design Input Marathon and Leprechaun Complexes (Stantec 2021c)
- Design Brief - Water Management Infrastructure – Berry Complex Feasibility Level (Stantec 2022a) Water Balance and Hydraulic Design for Tailings Management Facility. Technical Memorandum. (Golder 2022)
- Valentine Gold Project N.I. 43-101 Technical Report and Feasibility Study (Ausenco 2022)
- Design Brief - Early Works Water Management Infrastructure – Issued for Construction Design (Stantec 2023a)
- Valentine Gold Project: Updated Water Balance and Water Quality Model Report (Stantec 2023b)

- Valentine Gold Project: Assimilative Capacity Study (Stantec 2023c)
- Valentine Gold Project: Hydrogeological Model (Stantec 2023d)
- Valentine Gold Project: Acid Rock Drainage Metal Leaching Management Plan (Proposed Revisions to Address the Addition of the Berry Pit Expansion) (Stantec 2023e)

1.1 OBJECTIVES

The primary objectives of the water management design are to reduce operational risks and environmental effects of the Project. These objectives include:

- Reduce contact water inventory requiring management through perimeter berms to divert external non-contact runoff
- Maintain flow to fish bearing streams and wetlands by maintaining pre-development catchments to the extent feasible.
- Reduce water management costs during operation through grading and gravitational drainage and thereby reduce pumping requirements.

1.2 BACKGROUND

1.2.1 Hydrology

The Project is centered on a topographic ridge that divides the drainage between the Valentine Lake watershed to the west and the Victoria Lake Reservoir and Victoria River watersheds to the south and east, respectively. A series of large waterbodies form the Exploits and Bay d'Espoir watersheds, which are two of the largest watersheds on the Island of Newfoundland and are substantially altered and controlled by hydroelectric developments. Victoria Lake historically drained north to the Victoria River to Beothuk Lake (formerly referred to as Red Indian Lake) and then further downstream to the Exploits River. The construction of a series of dams and connecting channels associated with the Bay d'Espoir Hydroelectric facility diverted Victoria Lake from the Victoria River toward the hydroelectric facility to the east.

The Project facilities are located at the headwaters of several watercourses, waterbodies, and wetlands, as presented in Figure 1.1 with Victoria Lake Reservoir to the south, Victoria River to the east, Valentine Lake, a headwater tributary Lake to the Victoria River to the west, and Victoria River tributaries to the north. Streams denoted in darker blue in Figure 1.1 have been field surveyed as fish bearing or having connectivity to fish bearing waters.

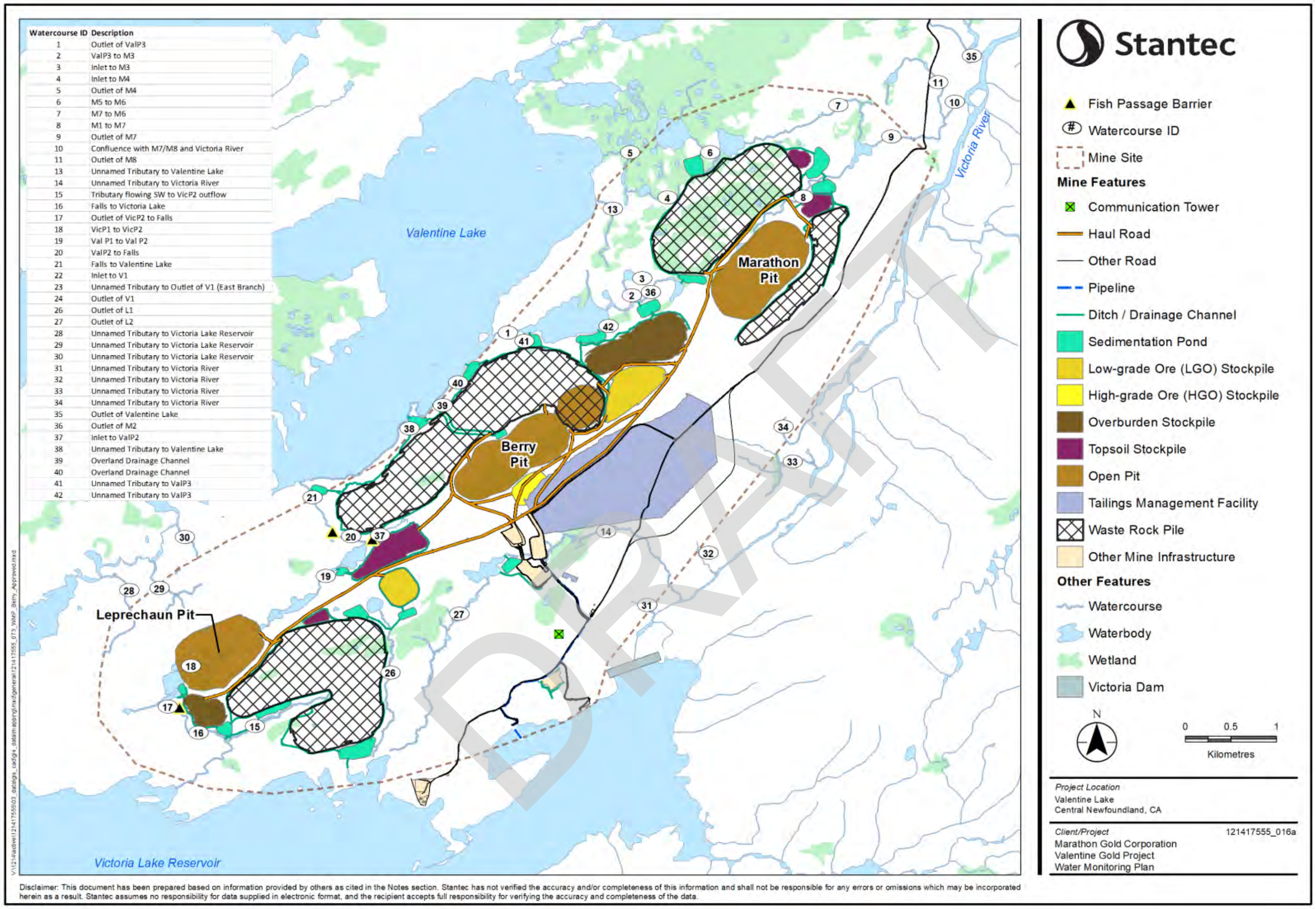


Figure 1.1 Berry Complex and the Approved Valentine Gold Project Site Plan

1.2.2 Hydrogeology

Based on a review of geological maps and aerial photographs, the overburden material in the vicinity of the Project primarily consists of a discontinuous layer of till of variable thickness. Along with glacial deposits, areas of organic and peaty soils are present overlying either till or bedrock in areas of poor drainage. Areas of high ground in the Leprechaun and Marathon deposit areas are characterized by bedrock outcrop exposed within the till veneer and various other surficial deposits characterized by sandy silt. A well-defined northeast-trending regional fault (Valentine Lake Shear Zone) occurs immediately to the south of the Leprechaun deposit (Stantec 2017). As reported in the 2022 Feasibility Study Update Geotechnical and Hydrogeological Investigations report (GEMTEC 2022a), the observed hydrogeological conditions for the Berry deposit were consistent with those for the Leprechaun and Marathon deposit areas.

The prominent topographic ridge that underlies the Project is inferred to act as a regional flow divide for both surface water drainage and groundwater flow and defines an area of groundwater recharge. Overall, the direction of shallow groundwater flow is expected to follow topography and surface runoff, and discharge into the low-lying surface waterbodies that border the property.

Locally, groundwater flow from the Marathon deposit is expected to travel southeast towards the Victoria River and northwest towards Valentine Lake, which flows into Victoria River northeast of the Project, and ultimately discharges into the Exploits River, approximately 100 kilometres (km) to the north. Groundwater flow from the Leprechaun deposit is expected to primarily travel south-southeast towards Victoria Lake Reservoir, with a lesser component flowing north towards Valentine Lake. Shallow groundwater flow, from the Berry deposit, is to the northwest towards Valentine Lake.

As reported in the 2022 Feasibility Study Update Geotechnical and Hydrogeological Investigations report (GEMTEC 2022a), groundwater elevations vary across the site and generally reflect the topographic relief of the area, with higher groundwater elevations occurring in boreholes / wells located at higher topographic elevations. A groundwater elevation change of 100 meters (m) was observed between the topographic highs of the exploration corridor connecting the Marathon and Leprechaun pits (maximum elevation of approximately 420 m) relative to the Canadian Geodetic Vertical Datum of 1928 (CGVD28) to Valentine Lake (elevation of 319 to 326 m CGVD28) and Victoria Lake Reservoir (elevation of 320 m CGVD28) (Stantec 2020b).

Overall, groundwater levels in the Project Area are shallow, ranging from 7.8 metres below ground surface (mbgs) to -0.57 mbgs (artesian). Shallow groundwater flow follows topography and the direction of surface runoff at horizontal hydraulic gradients ranging from 1% (0.01 m/m) in the northern portion of the processing plant, 7% (0.07 m/m) in the area of the Marathon overburden stockpile and low-grade ore stockpile, and 17% (0.17 m/m) from the Berry waste rock pile. Estimated vertical hydraulic gradients determined using paired well systems in the TMF, process plant, and Marathon and Leprechaun waste rock pile areas indicate slight vertical gradients ranging from less than 1% (< 0.01 m/m) in the Marathon waste rock pile and TMF areas, to 3% (0.03 m/m) in the process plant and Leprechaun waste rock pile areas; both downwards and upwards components of flow are identified. Vertical gradients in the nested monitoring wells were measured to range from 0.08 m/m (8%) to 0.26 m/m (26%) (downward) for the Berry waste rock pile area.

1.2.3 Surface Water Chemistry

Regional water quality reported at the Environment and Climate Change Canada (ECCC 2020) managed sites (ID NF02YN0001 Lloyds River at Bridge, RTE 480, Burgeo Road and NF02YO0107 Exploits River Approx. 0.5km Downstream from Dam) between 2003 and 2019 includes metals, nutrients, and physical parameters. Total alkalinity (as $CaCO_3$) ranges from below detection limit 1.22 mg/L to 11 mg/L. Low alkalinity values suggest limited acid buffering potential in streams. Parameters were generally below the applicable Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Aquatic Life (Freshwater) (CWQG-FAL; CCME 2010,2019,2020), with at least one reported exceedance of the maximum value for aluminum, cadmium, copper, iron and lead reported at ECCC station NF02YO0107, and aluminum and selenium at station NF02YN0001.

As noted in the 2019 baseline water quality report (Stantec 2020a), surface water quality was monitored at 26 locations in the mine site between 2011 and 2019. The lab results indicated that pH ranged from 4.61 to 7.78 with a mean value of 6.94. A total of 18 of 26 water quality monitoring stations were lower than the CWQG-FAL lower limit of 6.5 for pH. Local water quality was found to be similar to regional water quality in that both were found to have low alkalinity, and therefore limited acid buffering potential. Some metals were also detected above the CWQG-FAL guidelines at both the regional and local water quality monitoring locations (aluminum, cadmium, copper, iron and lead). These results indicate that metals are found in naturally elevated levels both in local and regional surface water. Local water quality monitoring revealed consistent seasonal concentration trends, and that water quality in larger lakes such as Victoria Lake Reservoir and Valentine Lake was more dilute and lower in constituent concentrations than was observed in tributary watercourses, ponds, and wetlands.

1.2.4 Groundwater Chemistry

Baseline water quality testing to date (Stantec 2020c, 2023a) indicates a calcium-sodium-bicarbonate-chloride-sulphate type groundwater that is characterized as clear (colour overall <15 Total Colour Units or TCU), slightly hard to hard (20.9 mg/L to 122 mg/L as Calcium Carbonate ($CaCO_3$)), slightly alkaline with moderate acid buffering potential and low conductivity, indicating fresh conditions. Langelier Saturation Index values for groundwater samples indicate groundwater is neither strongly corrosive nor scale-forming with respect to solid $CaCO_3$. Metals parameters were generally low with the exception of iron and manganese.

1.2.5 Local Water Users

The Victoria Dam and spillway are located at the north end of Victoria Lake Reservoir, just downgradient of the Project. This dam infrastructure is part of the Bay d'Espoir Hydroelectric Development. The Bay d'Espoir Hydroelectric Generating Facility is the largest hydroelectric plant in Newfoundland and includes three generating stations, six reservoirs, and associated dykes, dams, canals, and hydraulic structures. The generating stations comprising the Bay d'Espoir Development were built in stages beginning in 1967. There are four remote hydraulic structures associated with the Bay d'Espoir Development: Ebbegunbaeg Control Structure, Salmon River Spillway Structure, Victoria Control Structure (or Victoria Dam), and Burnt Dam Spillway (Newfoundland and Labrador Hydro 2012).

The Victoria Control Structure is a dam at the outlet of Victoria Lake Reservoir to the Victoria River, which naturally flowed north to Beothuk Lake (formerly Red Indian Lake). This dam raised the natural lake elevation from 290 to 325 m and has a crest elevation of 326 m. The low supply level of the lake, set by the Victoria Canal, was set at 319 m. In the late 1960s, Victoria Lake Reservoir was diverted to the Victoria Canal, which flows into the White Bear drainage basin to the south (Read & Cole 1972). The Victoria Canal was designed to convey between 34 m^3/s at low supply level and 170 m^3/s at full supply level (Read & Cole 1972).

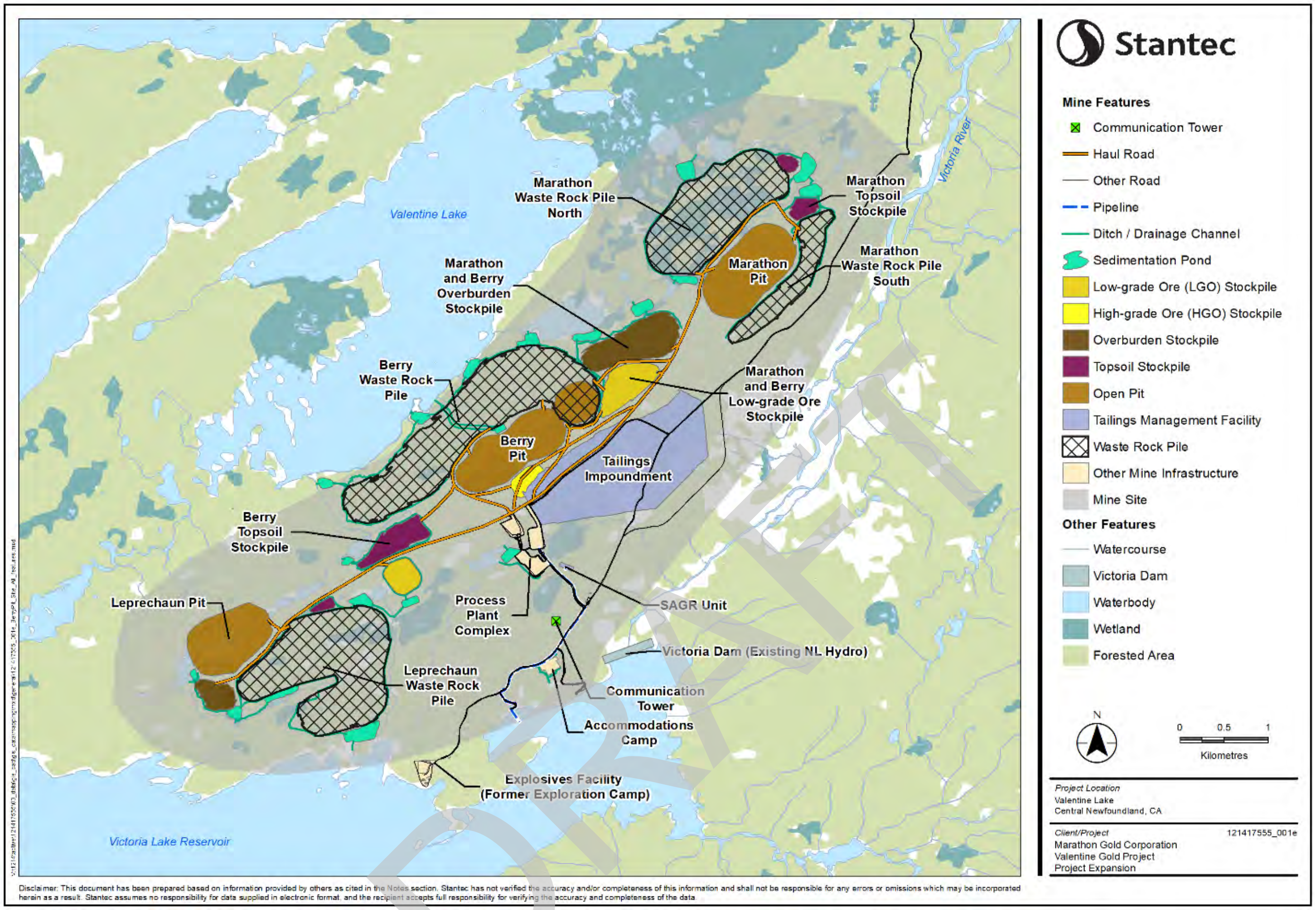


Figure 2.1 Overview of Project Component Areas – Ultimate Footprint

As presented in the Feasibility Study (Ausenco 2022), site selection and location of the Project facilities considered the following:

- Locate the ROM pad between the two open pits, to minimize haul distance
- Locate the process plant and mining truck area outside the flyrock exclusion zone from the Berry Zone resource
- Utilize the natural high ground for the ROM pad as much as possible
- Separate heavy mine vehicle traffic from non-mining, light-vehicle traffic
- Locate the process plant near an existing access road
- Locate the process plant in an area safe from flooding
- Locate the heavy equipment foundation on competent bedrock and utilize rock anchors for foundations design
- Upgrade and utilize the existing access road to reach the site
- Place mining, administration and processing plant staff offices close together to limit the footprint of the Project facilities
- Reduce outdoor walking distances between buildings (important during extreme cold weather)
- Locate the ready line close to the mining admin/office area and change house
- Avoid known fish habitation areas

Additionally, the planned configuration of Project infrastructure in the vicinity of the Marathon pit was adjusted during the EA process for the Valentine Gold Project to improve the permeability of the site for Buchans herd caribou migrating through the Project Area (Marathon 2022).

2.2 MINE PHASES OF DEVELOPMENT

The overall Project development schedule consists of three phases: construction, operation, and decommissioning, rehabilitation, and closure. For convenience, "closure" in this document refers to the first five years of the decommissioning, rehabilitation, and closure phase, while "post-closure" refers to the remainder of this phase. Project activities within these phases are further subdivided for the purposes of this report as discussed in the following sections.

2.2.1 Construction

Construction activities began in 2022 and will continue for 18 to 24 months (2022 to 2024). Construction activities will include site preparation, earthworks, infrastructure construction, equipment, and utilities installation and TMF construction.

Site preparation activities include cutting and clearing of vegetation and removing organic materials and overburden on areas to be developed. Developing construction stage water and erosion control, such as ditching, water management ponds, and construction access roads for the waste rock piles, stockpiles and TMF clearing are also a part of site preparation activities. Earthworks include excavating, preparing excavation bases, placing structural fill, and grading; stripping and stockpiling organic and overburden materials for open pits for future rehabilitation; and use of open pit development rock (waste rock) for infrastructure such as structural fill and road gravels.

Infrastructure construction consists of placing concrete foundations and constructing buildings and Project infrastructure. Concrete is primarily batched on site and some pre-cast building footings may be poured off-site and transported to the site. Coarse aggregates are crushed from mine waste rock and/or site rock quarries and fine aggregate materials such as sand will be sourced from local quarries. Equipment installation includes installing major Project infrastructure equipment such as the ROM hopper and water treatment equipment. Utility installations involve constructing and connecting power, water and fuel supply infrastructure. The TMF will be partially constructed during the construction phase and will be continually raised during operation to meet tailings and water storage requirements and Plant operating criteria.

The waste rock, overburden and topsoil stockpiles will be constructed as follows:

- 10 m lift heights for overburden/topsoil
- 15 m lift heights for waste rock
- 1.5:1 horizontal to vertical (H:V) active slopes of overburden/topsoil lifts
- 1.3H:1V active slopes on waste rock lifts
- Berm allowances push slopes out to approximately 2.7H:1V
- Target achievable reclamation slopes of 3H:1V
- Minimize disturbance to existing waterbodies and watercourses

Additional groundwater wells have been and will continue to be installed around the perimeter of Project facilities to support monitoring of Project interactions.

2.2.2 Operation

Commissioning of the mine is planned to occur in Year 1. The mine will be in operation for 15 years.

2.2.2.1 Marathon, Leprechaun, and Berry Complex

Open Pits

Operation of the open pits will include drilling, blasting, and loading and hauling of ore and waste rock to storage areas using conventional mining equipment. Marathon, Leprechaun, and Berry pits will be mined simultaneously, with plans for the ore rock to be mixed and processed together. Over the first 9-year operation phase, there will be progressive expansion of the open pits, with associated vegetation clearing and overburden removal and storage. Explosives used in mining will be contained in an explosive storage facility onsite. Mining of the Berry pit northern basin will cease at the end of Mine Year 6 (2028) southern and central basins will cease at the end of Mine Year 9 (2031). Mining of the Marathon and Leprechaun pits will end in Mine Year 13 (2036) and Mine Year 12 (2035), respectively.

Ore extracted from the open pits will be hauled to stockpiles or the processing area. Ore grading between 0.38 and 0.80 grams per tonne (g/t) of gold (Au) will be stockpiled in the associated low-grade ore stockpiles. Cut-off grade optimization on the mine production schedule will also send ore above 0.80 g/t Au to a high-grade ore stockpile in certain planned periods. The processing plant will include a pre-processing period at a reduced milling rate of 2.5 million tonnes per year (Mt/a) of ore material from open pit mines, increasing to 4 Mt/a in Mine Year 4.

The open pits will be dewatered throughout active mining operation. The collected contact water will be stored in a sump pit prior to being pumped to a water management pond at the surface. Water from the water management ponds will be discharged to the environment following treatment in the water management ponds as needed to meet discharge quality criteria. The southern Berry pit basin will be used for tailings deposition for six years (Mine Years 10 to 15).

Waste Rock and Overburden Piles

Waste rock from the mining process will be placed in the active Marathon, Berry, and Leprechaun waste rock piles, with waste rock piles located close to each open pit. These waste rock piles will be constructed from the existing ground surface and will be sloped and benched as they are developed, which will result in final safe slopes for closure of 3H:1V once the benches have been rehabilitated. In addition, the waste rock piles will be progressively rehabilitated during closure by covering benches with a vegetated soil cover to reduce infiltration into the piles.

The Marathon north and south waste rock piles are located immediately northwest and southeast of the Marathon pit limits, respectively. Topsoil from the Marathon pit will be stored in topsoil stockpiles 0.5 km north of the pit limits and overburden will be stored in a stockpile southwest of the pit. The Leprechaun waste rock pile is located just southeast of the Leprechaun pit limits. Topsoil from the Leprechaun pit will be stored in a stockpile east of the pit limits and overburden will be stored in a stockpile directly south of the pit. The Berry waste rock pile is located immediately north of the Berry pit limits. Topsoil from the Berry pit will be stored in a stockpile south and west of the pit limits and overburden will be stored in the same stockpile as the Marathon topsoil, located north and east of the Berry pit limits.

Ore will be hauled to a crusher 3.5 km southeast of the Marathon pit, 1.5 km southeast of the Berry pit, and 3.0 km northeast of the Leprechaun pit. Ore will be crushed to feed the process plant; waste rock will be deposited into waste rock piles adjacent to the pits or used as rockfill to construct a tailings dam 2.0 km southeast of the Marathon pit, 4.5 km northeast of the Leprechaun pit, and 0.4 km southeast of the Berry pit.

Contact runoff from the piles will be managed by perimeter ditches and treated in water management ponds prior to release to the environment.

2.2.2.2 Processing Plant and TMF

The pre-production phase of operation will consist of crushing, semi-autogenous and ball milling, gravity recovery, leaching-absorption, carbon elution, and gold recovery. Leach-adsorption tails will be treated for cyanide destruction, thickened and deposited in the TMF. The subsequent full production milling phase will consist of crushing and milling as before, with the addition of a pebble crusher, gravity recovery, floatation, floatation concentrate thickening, floatation concentrate regrind, floatation concentrate leaching-adsorption, floatation tails thickening, floatation tails leaching-adsorption, carbon elution and gold recovery. Reagents used in the milling process include quicklime, sodium cyanide, frother, promoter, hydrochloric acid, copper sulphate pentahydrate, sodium metabisulphite, sodium hydroxide, flocculant, activated carbon and smelting fluxes.

Processing is divided into two periods of operation: the initial processing period and full production period. The initial processing period has a nominal throughput of 6,850 tonnes per day (t/d) or 2.5 Mt/a. As the mill feed grade decreases, and plant capacity is required to increase to maintain gold production, the mill will operate at full production rate of 10,960 t/d or 4.0 Mt/a. At full production, flotation equipment will be employed to recover the majority of the gold to a low mass concentrate stream, and ultra-fine grinding and cyanidation.

The TMF will receive precipitation and the process water discharged with the tailings slurry. Excess water from the open pit dewatering and runoff from waste rock piles are managed separately and do not report to the TMF. A water treatment plant and a SAGR ® effluent treatment unit allows for the treatment and discharge of the excess TMF site water to Victoria Lake Reservoir. Treatment and discharge are only expected to occur typically for eight months each year; however, this may occur up to 12 months a year under wet conditions. The tailings pond, with a maximum storage capacity of 1 Mm^3, has been sized to store the excess water during the non-discharge period. The storage accounts for the environmental design flood and inflow design flood, while maintaining sufficient freeboard within the tailings pond. Reclaim water is pumped from a floating barge and pump in the TMF to the process plant.

The processing plant and TMF will operate as a circuit with tailings being deposited in the TMF as a thickened slurry (60% to 65% solids) and process water being reclaimed during thickening and via a pump and pipeline from a decant barge in the TMF. During year 13, active open pit mining ceases and processing will continue from stockpiled ore. When active mining in the Berry pit ceases in Year 9, tailings deposition is switched from the TMF to the southern Berry pit basin for subaqueous disposal. Process water will continue to be supplemented by TMF reclaim water, in addition to the minimum of 8% freshwater make-up from Victoria Lake Reservoir.

As described below, freshwater make-up and elution water will be pumped from Victoria Lake Reservoir to the process plant, amounting to approximately 13% of process water during pre-production and 8% of process water during full production. Surplus water from the TMF will be discharged to a treatment plant, from which treated water will be sent to the tailings impoundment area and through the SAGR® unit prior to discharge via a pipeline to Victoria Lake Reservoir. Ore rock will be stored on the run-of-mine stockpile and in the high-grade ore stockpile prior to processing.

A continuous downstream raise of the TMF dam will be constructed to meet requirements for water and tailings storage in six stages over the first 10 years of operation. The primary construction material for the TMF is the waste rock from the open pits. The first four stages will be constructed with a crest width of 20 m to facilitate the use of mine haulage equipment in dam construction. The final stage will have a crest width of 10 m and may require smaller earthmoving equipment for the final few metres of the dam raise. The average upstream slope flattens to about 3.5H: 1V accounting for the benches and a 2H:1V downstream slope. On the upstream slope, a 1 m thick (measured perpendicular to the slope) coarse filter/ transition layer will be placed on the prepared waste rock slope followed by a 1 m thick fine filter layer. A 1.5 mm thick liner low-density polyethylene (LDPE) geomembrane will be installed, as the main water retaining element, on the fine filter layer. A 0.3 m thick layer of road surfacing will be placed and compacted along the dam crest to allow for light vehicle traffic during operations.

Dam runoff and seepage will be captured in the perimeter seepage collection ditches and pumped back to the TMF. Water management onsite also includes diversion of non-contact freshwater around the Project and collection of contact water.

2.2.3 Decommissioning, Rehabilitation and Closure

This section outlines the general rehabilitation and closure plan for the Project (GEMTEC 2022b). A formal Rehabilitation and Closure Plan has been developed, as required under the *Newfoundland and Labrador Mining Act* (Chapter M-15.1 Section 8, 9 and 10, Government of Newfoundland 2000). The Rehabilitation and Closure Plan will be updated to include Berry complex components.

The Project will have three key stages of rehabilitation activities that occur over the life span of the mine, which include:

- progressive rehabilitation
- closure and rehabilitation
- post-closure and monitoring

Progressive rehabilitation will occur over the thirteen years of active open pit mining and two years of stockpiled ore to reduce the amount of time runoff comes in contact with the mine facilities. Progressive rehabilitation involves activities that would otherwise be carried out during closure and will be completed proactively wherever possible and practicable. Revegetation studies and trials will commence early in operation to support progressive rehabilitation activities. The following general proactive rehabilitation activities will be implemented in construction and operation activities, to further support progressive rehabilitation measures:

- Disturbances to terrain, soil, and vegetation will be limited to the areas necessary to complete the required work
- Organic soils, mineral soils, glacial till, and excavated rock will be stockpiled separately where practicable, and protected for future use
- Stabilization of disturbances will be completed to reduce erosion and promote natural revegetation
- Demolishing and rehabilitation of construction or exploration-related buildings, roads, laydown areas, etc. will be conducted as part of progressive rehabilitation
- Natural revegetation will be encouraged throughout the Project

Rehabilitation activities will continue during closure at the end of ore processing to restore the property as close to pre-development conditions as practicable, or to an alternate use or condition that is deemed appropriate and acceptable by Newfoundland and Labrador Department of Industry, Energy and Technology (NLDIET). Closure rehabilitation is anticipated to be completed over approximately five years.

General rehabilitation and closure activities include the following:

- On-site wells will be decommissioned. This includes dewatering wells, groundwater monitoring wells, potable drinking water wells and/or industrial water wells. The decommissioning will comply with Government of Newfoundland and Labrador Guidelines for Sealing Groundwater Wells.
- Pre-mining site drainage patterns will be re-established to the extent practicable.
- Disturbed areas will be graded and/or scarified, covered with overburden and organic materials, where required, and seeded to promote natural revegetation.
- Hazardous chemicals, reagents, and similar materials will be removed for re-sale or disposal at an approved facility as per regulations.
- Equipment will be disconnected, drained and cleaned, disassembled, and where possible, sold for re-use to a licensed scrap dealer. If this is not achievable, equipment will be removed from site for disposal or recycled at an approved facility.
- Site buildings and surface infrastructure will be dismantled and removed for disposal or recycling at approved facilities.
- Concrete foundations will be demolished to a minimum of 0.3 m below the surface grade and covered with natural overburden materials to promote re-vegetation. Demolished concrete will be used as fill material for re-grading or removed from site for disposal in an appropriate facility.
- Fuel and explosive storage and dispensing facilities will be removed, and these areas rehabilitated. Phase I and potentially Phase II Environmental Site Assessments may be required to evaluate for potentially impacted soils and groundwater.
- Infrastructure footprint areas will be stabilized with vegetation.

2.2.3.1 Marathon, Leprechaun, and Berry Complexes

The closure activities associated with the major components of the Project for the Marathon, Leprechaun, and Berry complexes are summarized below:

Waste Rock Piles and Stockpiles

- Slopes of waste rock piles will be constructed at 3H:1V requiring no adjustment in slopes for final closure.
- Overburden and topsoil material will be progressively placed on benches and slopes and revegetated as the pile is developed during operation and the remaining areas of pile during closure.
- Overburden and topsoil stockpiles will be depleted during the first two years of closure, and these areas will be seeded to promote natural revegetation.
- The placement of a vegetated soil cover on waste rock piles and unprocessed low grade ore stockpiles will effectively create two water streams: a non-contact surface runoff stream, and a contact seepage stream.

Water Management Infrastructure

- Perimeter ditches will be backfilled with organic compost material, covered with overburden and topsoil, and vegetated creating the following conditions:
  - Non-contact runoff will drain down the pile slopes and benches, over the perimeter ditch footprints and overland to local receivers following natural drainage patterns.
  - Contact seepage will be substantially reduced from the uncovered condition due the increase in runoff and evapotranspiration potential of the vegetated soil cover. The reduced volume contact seepage will migrate across the perimeter ditches and assimilate (attenuate naturally) with local groundwater to discharge into local receiving waters.
  - Passive treatment systems could take the form of subsurface anaerobic units in the ditches acting as permeable reactive barriers or subsurface / surface units that use the water management pond basins as constructed wetland features. A pilot program will be implemented during operations to test, scale, and design the use of permeable reactive barriers as passive treatment in the perimeter ditches.
- Notwithstanding the need for additional passive treatment, water management ponds will be breached to allow drainage to the natural ground and local receivers.
- Water quality monitoring during the operation and decommissioning, rehabilitation and closure phases will inform closure water management. Adaptive management will provide the flexibility to respond to emerging conditions proactively.

Open Pits

- Barricades and signage will be placed along the high-walls of the open pits as part of progressive rehabilitation.
- Dewatering infrastructure will be removed.
- Pits will be allowed to naturally fill with water accelerated by pumping water from Valentine Lake (Marathon) or Victoria Lake Reservoir (Leprechaun pit). The Berry pit is not expected to require accelerated filling. Pit lake overflow discharge is expected to meet regulatory closure water quality discharge requirements.

2.2.3.2 Processing Plant and TMF Complex

The closure activities associated with the major components for the Processing Plant and TMF Complex are summarized below:

Tailings Management Facility

- Grading and revegetation of completed tailings areas, when possible as part of progressive rehabilitation
- Further grading of the existing TMF downstream embankment slopes of 2H:1V will not be required, as the slopes already meet Canadian Dam Association (CDA) closure criteria
- Tailings solids within the TMF impoundment will be capped with overburden, topsoil and revegetated
- Surface of the TMF will be contoured as necessary to promote drainage towards the tailings pond
- Downstream slope of the TMF dam will be left as exposed rockfill to permit drainage of the downstream shell
- A larger closure spillway will be constructed to convey water from within the impoundment
- Reduce pond water storage in the TMF to classify the TMF as a landform and therefore alleviating the requirements for maintaining and inspecting the dams post-closure
- Decant pump will be decommissioned once water quality demonstrates that water collected in the pond is acceptable for direct release to the environment
- Seepage water collection system, including the pumps will be kept in service until water quality monitoring demonstrates that water collected in the system is acceptable for direct release to the environment; at that time, the pumping systems will be removed, and the sumps will be backfilled
- When no longer required, the seepage collection ditches and sump areas will be recontoured to restore the original drainage course to the extent possible and to enhance the area for natural revegetation
- Similar to closure planning for the waste rock piles, surface runoff from the covered and vegetated tailings surface will be non-contact water not requiring further treatment; TMF seepage ditches and sump pits could be repurposed as passive water quality treatment systems, if required, during closure

During the closure phase, contact seepage from the waste rock piles and the TMF that is not expected to be adequately treated via natural attenuation at local receivers to background or CCME CWQG-FAL quality is planned to be treated by passive treatment systems.

Two options for water treatment are considered for closure design at this time. Based on the results of the water quantity and water quality model update (Stantec 2023b) and as previously identified for the Approved Project (Stantec 2020f), seepage quality in the TMF toe seepage collection system during closure is predicted to exceed CWQG-FAL for arsenic, copper, phosphorus, nitrite, fluoride, weak acid dissociable cyanide, total ammonia, and unionized ammonia. Waste rock seepage and pit overflow are predicted to decrease during closure but be above the long-term CWQG-FAL values for aluminum, arsenic, cadmium, chromium, copper, iron, manganese, mercury, phosphorus, zinc, total ammonia, unionized ammonia, weak acid dissociable cyanide, and fluoride. The model update report (Stantec

2023b) recommends future monitoring to confirm these exceedances and the implementation of passive treatment technologies to treat the seepage during closure.

The primary passive treatment technologies for mine related waters include aerobic and anaerobic wetlands, sulfate reducing bioreactors, anoxic limestone drains (ALD), and successive alkalinity producing systems (SAPS). The selection and design of a passive system is based on water chemistry, flow rate, local topography, and site characteristics.

Metal removal via anaerobic passive systems occurs via electrochemical reducing conditions to convert mobile metals (e.g., iron, lead, zinc, copper, cadmium) to more stable, nontoxic forms. The key component of contaminant reduction in an anaerobic filter is a continuous source of organic matter, typically in the form of compost, peat, saw dust, or wood chips. When the organic rich media is flooded, microbial respiration consumes available oxygen and produces alkalinity, driving the redox state towards sulfate reducing conditions. Under these anaerobic conditions, sulfate-reducing bacteria convert sulfate to sulfide by catalyzing the oxidation of organic carbon producing hydrogen sulfide. Metals in solution will precipitate in the presence of hydrogen sulfide to form insoluble metal sulfide precipitates. These precipitates are removed from the water and sequestered within the organic rich treatment media.

Two options were identified as feasible passive treatment options to manage site water post closure (GEMTEC 2022b):

- Convert waste rock pile and TMF seepage collection ditches into anerobic Permeable Reactive Barriers (PRBs).
- Convert waste rock pile and TMF seepage collection ditches into French drains with an anaerobic PRB to passively intercept and convey site water to an anaerobic vertical flow engineered wetlands.

Options will be selected based upon anticipated water quality and results of a pilot study.

2.2.4 Post-Closure

During the post-closure period, site monitoring will be carried out to demonstrate that closure strategies are performing as intended. The post-closure monitoring program will continue after final closure activities are completed for an estimated six to ten years. However, the monitoring period could be adjusted based on the agreement of the regulatory bodies that physical and chemical characteristics are acceptable and stable. When the Project is deemed physically and chemically stable, the site can then be closed out or released by Newfoundland and Labrador Fisheries, Forestry and Agriculture (NLFFA) and an application made to relinquish the property back to the Crown.

In addition to the application to relinquish the property back to the Crown, Marathon would also submit a Notice of Intent to the federal Minister of the Environment and Climate Change under Part 4 of the *Metal and Diamond Mine Effluent Regulations* (MDMER) to be granted recognized closed mine (RCM) status. RCM status can only be granted if the following conditions are met:

- The mine's rate of production was less than 10% of its design-rated capacity for a continuous period of three years starting on the day on which the written notice is received by the federal Minister of Environment and Climate Change; and
- Marathon has conducted a biological monitoring study during the above referenced three-year period in accordance with MDMER Division 3 of Part 2 of Schedule 5.

If Marathon has complied with the requirements set out above from Part 4 under MDMER, the mine becomes an RCM after the expiry of the three-year period referred to above. Once RCM status is achieved, MDMER no longer applies to the mine.

3.0 WATER MANAGEMENT CRITERIA

3.1 SURFACE WATER QUANTITY CRITERIA

The Project will be registered under the MDMER. The MDMER, pursuant to the federal *Fisheries Act*, comes into force on the first day that a mine releases more than 50 cubic metres (m^3) in a single day. The MDMER sets a daily flow volume monitoring requirement at each final discharge point.

Under MDMER, a proponent that proposes to deposit mine waste into a fish bearing watercourse or water body is required to apply for an amendment to Schedule 2 of the MDMER. A criterion in Marathon's design of water management infrastructure was to not be overlaying fish-bearing watercourses or water bodies with mine waste, and this objective was achieved. Mine effluent will be compliant with effluent criteria set out in MDMER.

Design criteria for water management ponds and ditching will refer to the Newfoundland and Labrador (NL) *Mining Act* and *Water Resources Act,* regulation requirements, and guidance. Where a water management pond requires a dam that meets the definition of a dam in the NL *Water Resources Act* and CDA, then further criteria become relevant.

Water use is regulated by the NL Department of Environment and Climate Change (NLDECC) through permitting requirements for activities within 15 m of a water body related to withdrawal of water, installation of intake structures, dams and culverts, and discharge of wastewater. A 15 m setback from field-identified fish bearing or assumed fish bearing streams and bogs/ponds was applied. This design criterion aligns with the Newfoundland and Labrador Policy on Flood Plain Management (Newfoundland and Labrador Department of Municipal Affairs and Environment 2014).

The Provincial EIS Guidelines issued for the Approved Project (Government of NL 2020) required that climate change be considered in design. The climate change assessment requirement has also been applied to the Project Expansion in the 2023 Environmental Registration / EA Update. The Representative Concentration Pathway 4.5 (RCP4.5) was applied to climate records to simulate rainfall over the next 20 years for the Approved Project and Project Expansion. This resulted in higher precipitation events and higher associated design flows than those based on historical climate conditions. The higher design flows will be incorporated into the design of the water management infrastructure as part of detailed design.

Regulation of dam safety in Canada is primarily a provincial responsibility. Design criteria for the water management design was to meet the most stringent requirements of the CDA and the NL *Mining Act*. The CDA classifies a dam as an embankment of 2.5 m or greater from the toe of the downstream slope to the dam crest and 30,000 m^3 of liquid storage. A criterion was to design dams, where feasible, to avoid the CDA dam classification. Notwithstanding the 2.5 m CDA criterion, the province regulates all dams exceeding 1 m in height from toe to crest.

As part of the EA (2020 EIS and 2023 Environmental Registration / EA Update) and in order to comply with the *Fisheries Act*, a maintenance flow to fish-bearing streams is required to reduce environmental effects to fish and fish habitat. Therefore, flow to fish bearing streams and wetlands was maintained in design, where possible, by draining mine site components to pre-development catchment areas and using low flow outlet structures to augment baseflow to receiving waters. Predicted surface water quantity changes to fish habitat during construction and operation (e.g., watershed drainage area changes, pit dewatering, harmful alteration, disruption or destruction (HADD) via predicted indirect losses in watercourses) require an authorization pursuant to the *Fisheries Act* (including implementation of an offsetting project to counterbalance residual adverse effects to fish and fish habitat) with conditions established by the Minister of Fisheries and Oceans Canada (Fisheries Minister).

Consistent with industry best practice, efficient water management is accomplished by reducing mine site water inventory as much as feasible through separation of groundwater and surface water flows, by setting water management infrastructure at or above the groundwater table. Additionally, the mine site's water inventory will be reduced by construction of perimeter diversion berms around the Marathon, Leprechaun and Berry pits to divert overland flow from entering the pits. Placement of infrastructure will reduce stranded areas of runoff and allow for diversion of overland flow of non-contact water away from the site.

Water management features were designed under a decentralized water treatment framework, operating under gravity drainage to reduce pumping needs. Water management design considered optimization of cuts and fills to reduce initial trucking cost and utilize local materials.

Water quantity control criteria applied in design of water management ponds, include:

- Store runoff from the Project component areas for storm events up to 1:100 Annual Exceedance Probability (AEP) with spring snowmelt and accommodate climate change by providing flood relief or up to the 1:200 AEP in the spillway
- Slowly release water management pond effluent to the environment to provide flood attenuation and reduce downstream scour and erosion
- Augment baseflows through the installation of a low-level outlet to maintain an environmental maintenance flow

3.2 SURFACE WATER QUALITY CRITERIA

The primary water quality criteria applicable to the Project FDPs are the following:

- Schedule 4 of the MDMER under the *Fisheries Act* when the mine discharges at an effluent flow rate of ≥50 m^3/day, based on effluent deposited from all mine FDPs
- General provisions of Section 36(3) of the *Fisheries Act* regarding the deposit of deleterious substances in water frequented by fish
  - During the period prior to the mine discharging effluent at ≥50 m^3/day, based on effluent deposited from all mine FDPs; or
  - When the mine has attained RCM status

- Schedule C of NL Regulation 65/03 *Environmental Control Water and Sewage Regulations*, 2003 under the *Water Resources Act* (O.C. 2003-231).
- The conditions of a Certificate of Approval issued by Pollution Prevention Division of the NLDECC
- Environmental effects of mine effluent in relation to receiving watercourses or waterbodies baseline water quality, to satisfy requirements of the federal and provincial EIS guidelines for the original Project and current Berry expansion Project (CEAA, 2019 and NLDMAE 2014).

Schedule C of NL Reg. 65/03 states:

"A person primarily in the Metal Mining Industry shall comply with sections 3 and 19.1 and 20 and Schedule 4 of the Metal Mining Effluent Regulations (Canada) SOR/2002-222, including any changes or amendments to those sections of and that schedule to those regulations over time."

Therefore, the primary surface water quality criteria applied to mine activity effluent discharge at the site are those in MDMER Schedule 4 and Certificate of Approval conditions.

The sanitary wastewater treatment plant (WWTP) discharge has the following applicable surface water quality criteria:

- Section 6 and *Schedule A of NL Regulation* 65/03 Environmental Control Water and Sewage Regulations (ECSWR), 2003 under the *Water Resources Act*
- Wastewater Systems Effluent Regulations under the *Fisheries Act*
- The conditions of a Permit to Operate issued by Water Resources Management Division of the NLDECC

Water quality results will also be evaluated in comparison to the following criteria:

- CWQG-FAL
- Baseline surface water quality results from the original EIS Chapter 7 (Marathon 2020) and Chapter 8 of the EIS Update (Marathon 2023).
- Predicted surface water quality information from the original EIS Chapter 7 (Marathon 2020) and Chapter 8 of the EIS Update (Marathon 2023).
- Reference surface water quality concentrations at appropriate Project Reference Quality Point (RQP)/Reference Quality and Flow Point (RQFP) sites

Regulatory criteria and guideline values for parameters assessed in the baseline and predicted surface water quality studies and identified parameters of potential concern (POPC) (Stantec 2021b, 2023a) are presented in Table 3.1.

Water management ponds will be installed to treat runoff in contact with Project facilities for sediment removal. Additional measures to control erosion and prevent sedimentation into fish bearing watercourses or waterbodies of conveyance features was accomplished in design through ditch and berm lining for erosion protection and energy dissipation measures, such as sediment traps and energy dissipation pools.

Water quality control criteria applied in design of water management ponds, include:

- Runoff from the Project component areas for storm events up to 1:10 AEP to allow settlement of sediments to meet the MDMER
- The water management ponds were designed to treat a silt sized particle of 5.0×10^{-3} mm in diameter (BC MELP 1996), which is a typical particle size in design of a sedimentation pond.
- Ponds were designed primarily to meet the minimum residence time required for sediment to drop 1 m reaching a trapping efficiency of 80%.
- Runoff from the water quality design storm event will be detained in the water management pond for a minimum of 24 hours.
- A submerged type low-level outlet will also act as a hydrocarbon and Light Non-Aqueous Phase Liquids (LNAPL) containment feature as well as to reduce thermal discharge effects.
- A minimum length to width ratio of the water management pond of 2:1 to minimize short circuiting.

Table 3.1 Surface Water Monitoring Parameters, Guideline Values and Regulatory Criteria

Parameters	Units	Reportable Detection Limit (RDL)	CWQG-FAL Guidelines		Newfoundland and Labrador ECWSR	Federal Wastewater Systems Effluent Regulations Maximum Quarterly Mean Concentration (<2,500 m^3/day discharge)	MDMER Effluent Criteria at Final Discharge Points		
			Short-term	Long-term			Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
Metal and Diamond Mine Effluent Regulation (MDMER) Schedule 4, Table 1									
Total Arsenic (As) [2]	mg/L	0.001	ND	0.005	MDMER		0.1	0.15	0.2
Total Copper (Cu) [2]	mg/L	0.001	ND	0.002	MDMER		0.1	0.15	0.2
Total Cyanide (CN^- Total)	mg/L	0.01	ND	ND	MDMER		0.5	0.75	1
Total Lead (Pb) [2]	mg/L	0.0005	ND	0.001	MDMER		0.08	0.12	0.16
Total Nickel (Ni)	mg/L	2	ND	Equation [a]	MDMER		0.25	0.38	0.5
Total Zinc (Zn) [2]	mg/L	0.005	Narrative [b]	Narrative [b]	MDMER		0.4	0.6	0.8
Total Suspended Solids (TSS)	mg/L	1	ND	Narrative [c]	MDMER		15	22.5	30
Radium 226	Bq/L	0.005	ND	ND	MDMER		0.37	0.74	1.11
Un-ionized Ammonia (as N) [1] (NH3 UN as N)	mg/L	NA	ND	0.016	MDMER		0.5	NA	1
Total Ammonia (as N) (NH3 Tot as N)	mg/L	0.05	ND	Table [d]	2		-	-	-
Field pH	-	NA	ND	6.5 – 9	MDMER		6.5 – 9.5		
Field Temperature	°C	±0.5	-	-	<32		-	-	-
MDMER EFFLUENT CHARACTERIZATION									
Total Aluminum (Al) [2]	µg/L	5	ND	Narrative [e]	-				
Total Cadmium (Cd) [2]	µg/L	0.017	Equation [f]	Equation [g]	50				
Chloride (Cl)	mg/L	60	640	120	-				
Total Chromium (Cr) [3]	µg/L	1	ND	(III) – 8.9; (VI) - 1 [h]	50[a]				
Total Cobalt (Co)	µg/L	1.25	ND	ND	-				
Total Iron (Fe) [2]	µg/L	50	ND	300	10,000				
Total Manganese (Mn) [3]	µg/L	2	Equation [i]	Variable [j]	-				
Total Mercury (Hg) [3]	µg/L	0.013	ND	0.026	5				
Total Molybdenum (Mo)	µg/L	36.5	ND	73	-				
Nitrate (as N) (NO_3-N)	µg/L	50	124,000	3,000	10				
Total Phosphorus (as P) (TP) [3]	µg/L	4	ND	Guidance Framework [k]	-				
Total Selenium (Se)	µg/L	0.5	ND	1	10				
Total Thallium (Tl)	µg/L	0.4	ND	0.8	-				
Total Uranium (Ur)	µg/L	0.1	33	15	-				
Dissolved Oxygen (DO)	mg/L	0.05	-	Narrative [l]	-				
Alkalinity	mg/L	2	-	-	-				

Table 3.1 Surface Water Monitoring Parameters, Guideline Values and Regulatory Criteria

Parameters	Units	Reportable Detection Limit (RDL)	CWQG-FAL Guidelines		Newfoundland and Labrador ECWSR	Federal Wastewater Systems Effluent Regulations Maximum Quarterly Mean Concentration (<2,500 m^3/day discharge)	MDMER Effluent Criteria at Final Discharge Points		
			Short-term	Long-term			Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
Hardness	mg/L	1	-	-	-				
Field Conductivity	µS/cm	1	-	-	-				
NL Certificate of Approval									
Dissolved Oxygen (DO)	mg/L	0.05	-	Narrative [l]	-				
Nitrate + Nitrite as Nitrogen (NO_3 + NO_2 as N)	mg/L	0.05	-	-	-				
Turbidity	NTU	1	-	Narrative[s]	-				
Colour	TCU	5	-	Narrative [p]	-				
Sodium (Na)	mg/L	0.1	-	-	-				
Potassium (K)	mg/L	0.1	-	-	-				
Calcium (Ca)	mg/L	0.1	-	-	-				
Total Sulphide (S_2^-)	mg/L	0.0018	-	-	-				
Magnesium (Mg)	mg/L	0.1	-	-	-				
Orthophosphate as P (PO43- as P)	mg/L	0.01	-	-	-				
Dissolved Organic Carbon (DOC)	mg/L	1	-	-	-				
Total Dissolved Solids (calculated)	mg/L	1	-	-	1,000				
Phenolics	mg/L	0.0015	-	-	0.1				
Carbonate alkalinity	mg/L	1	-	-	-				
Bicarbonate alkalinity	mg/L	1	-	-	-				
Reactive Silica (SiO_2)	mg/L	0.5	-	-	-				
Total Antimony (Sb)	µg/L	1	ND	ND	-				
Total Barium (Ba)	µg/L	1	ND	ND	5,000				
Total Beryllium (Be)	µg/L	1	ND	ND	-				
Total Bismuth (Bi)	µg/L	2	-	-	-				
Total Boron (B)	µg/L	50	29,000	1,500	5,000				
Total Silver (Ag)	µg/L	0.1	No Reportable Guideline	0.25	50				
Total Strontium (Sr)	µg/L	2	ND	ND	-				
Tin (Sn)	µg/L	2	ND	ND	-				
Titanium (Ti)	µg/L	2	-	-	-				
Vanadium (V)	µg/L	2	ND	ND	-				

Table 3.1 Surface Water Monitoring Parameters, Guideline Values and Regulatory Criteria

Parameters	Units	Reportable Detection Limit (RDL)	CWQG-FAL Guidelines		Newfoundland and Labrador ECWSR	Federal Wastewater Systems Effluent Regulations Maximum Quarterly Mean Concentration (<2,500 m³/day discharge)	MDMER Effluent Criteria at Final Discharge Points		
			Short-term	Long-term			Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
Environmental Impact Statement (EIS) Parameters of Potential Concern (Marathon 2020; Stantec 2023b)									
Weak Acid Dissociable Cyanide (CN^- WAD) [3]	µg/L	1	ND	5 (as Free CN^-)	-				
Total Fluoride (Fl) [3]	µg/L	60	ND	120	-				
Nitrite (as N) (NO_2–N) [2]	µg/L	10	ND	60	-				
Sulphate (SO_4) [3]	µg/L	600	ND	Table [m]	-				
Acute Lethality Test							**Maximum Grab Sample Result**		
Rainbow Trout (EPS 1/RM/13 Section 5 or 6)	-	-	-	-	-		Acutely Lethal		
Daphnia magna (EPS 1/RM/13 Section 5 or 6)	-	-	-	-	-		Acutely Lethal		
Field pH	-	NA	ND	6.5 – 9	MDMER		6.5 – 9.5		
Field Temperature	°C	±0.5	-	-	-		-		
Sublethal Toxicity Test									
Test of Larval Growth and Survival Using Fathead Minnows (Report EPS 1/RM/22 **or** Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout) (Reference Method EPS 1/RM/28)	-	-	-	-	-				
Test of Reproduction and Survival Using the *Cladoceran Ceriodaphnia dubia* (Report EPS 1/RM/21)	-	-	-	-	-				
Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte, *Lemna minor* (Reference Method EPS 1/RM/37) as it applies to the biological endpoint based on the number of fronds	-	-	-	-	-				
Biological Test Method: Growth Inhibition Test Using a Freshwater Alga (Report EPS 1/RM/25) **or** Inhibition de la croissance chez l'algue Pseudokirchneriella subcapitata, (Méthode de référence MA 500 – P. sub. 1.0, rév. 3), published by the Centre d'expertise en analyse environnementale du Québec du ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques du Québec.	-	-	-	-	-				

Table 3.1 Surface Water Monitoring Parameters, Guideline Values and Regulatory Criteria

Parameters	Units	Reportable Detection Limit (RDL)	CWQG-FAL Guidelines		Newfoundland and Labrador ECWSR	Federal Wastewater Systems Effluent Regulations Maximum Quarterly Mean Concentration (<2,500 m³/day discharge)	MDMER Effluent Criteria at Final Discharge Points		
			Short-term	Long-term			Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
Newfoundland and Labrador (NL) Environmental Control and Wastewater System Regulation (ECWSR) Schedule A									
Biochemical Oxygen Demand (BOD)	mg/L				20				
Fecal Coliform	CFU/100 mL		ND	ND	1,000				
Total Dissolved Solids (TDS) [n]	mg/L	1	-	-	1,000				
Oils (Ether extract)	mg/L				15				
Boron (B)	mg/L	0.05	29	1.5	5				
Cadmium (Cd)	mg/L	0.000017	Equation [f]	Equation [g]	0.05				
Chromium VI (Cr VI)	mg/L				0.05				
Chromium III (Cr III)	mg/L				1				
Copper (Cu)	mg/L	0.001	ND	Equation [q]	MDMER		0.1	0.15	0.2
Cyanide (CN^-)	mg/L	0.01	ND	ND	MDMER		0.5	0.75	1
Iron (Fe)	mg/L	0.05	ND	300	10				
Lead (Pb)	mg/L	0.0005	ND	Equation [r]	MDMER		0.08	0.12	0.16
Mercury (Hg)	mg/L	0.000013	ND	0.000026	0.005				
Nickel (Ni)	mg/L	2	ND	Equation [a]	MDMER		0.25	0.38	0.5
Phenols	mg/L	0.0015	-	-	0.5				
Phosphates (as P_2O_5)	mg/L	0.01	-	-	10				
Phosphorus (elemental)	mg/L		-	-	0.0005				
Zinc	mg/L	0.005	Narrative [b]	Narrative [b]	MDMER		0.4	0.6	0.8
Newfoundland and Labrador (NL) Wastewater Characterization									
Total Phosphorus	µg/L	4	ND	Guidance Framework [k]	-				
Total Coliforms	CFU/100 mL	1	-	-	5,000				
E. coli	CFU/100 mL	1	ND	ND	-				
Field temperature	°C	±0.5	-	-	<32				

Table 3.1 Surface Water Monitoring Parameters, Guideline Values and Regulatory Criteria

Parameters	Units	Reportable Detection Limit (RDL)	CWQG-FAL Guidelines		Newfoundland and Labrador ECWSR	Federal Wastewater Systems Effluent Regulations Maximum Quarterly Mean Concentration (<2,500 m^3/day discharge)	MDMER Effluent Criteria at Final Discharge Points		
			Short-term	Long-term			Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
Wastewater Systems Effluent Regulations (WSER)									
5-day Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	mg/L	2	-	-	-	25			
Total Suspended Solids (TSS)	mg/L	1	ND	Narrative [c]	WSER	25			
Total Residual Chlorine	mg/L	0.01	-	-	1	0.02			
Total Ammonia (as N) (NH_3 Tot as N)	mg/L	0.05	ND	Table [d]	2	-			
Un-ionized Ammonia (as N) [1] (NH_3 UN as N)	mg/L	NA	ND	0.016	WSER	1.25 [o]			
Field pH	-	-	NA	ND	5.5 to 9.0	-			

Notes:
- no value
NA not applicable
ND no data
MDMER Metal and Diamond Mining Effluent Regulation
[1] Un-ionized ammonia is calculated using the following equation: A $(1/(1 + 10^{pKa-pH}))$ where A is the concentration of total ammonia — which is the sum of un-ionized ammonia (NH3) and ionized ammonia (NH4+) — expressed in mg/L as nitrogen (N); pH is the pH of the effluent sample; and pKa is a dissociation constant calculated in accordance with the following formula: 0.09018 + 2729.92/T where T is the temperature of the effluent sample in kelvin. (MDMER 12(4))
[2] EIS baseline surface water quality program CWQG-FAL exceedance parameter (EIS Chapter 7, Section 7.3.5.2 (Marathon 2020; Stantec 2023b))
[3] EIS mine effluent characterization CWQG-FAL exceedance parameter (EIS Chapter 7, Section 7.3.5.2 (Marathon 2020))
[a] Ni equation: Hardness ≤60 mg calcium carbonate (CaCO3)·L-1, CWQG-FAL is 0.025 mg/L, Hardness >60 to ≤180 mg CaCO3·L-1 use equation $e^{0.76[\ln(hardness)]+1.06}$, Hardness >180 mg CaCO3·L-1, CWQG-FAL is 0.15 mg/L
[b] Zn (dissolved) equation: short-term = exp(0.833[ln(hardness mg·L-1)] + 0.240[ln(DOC mg·L-1)] + 0.526 for hardness 13.8 and 250.5 mg CaCO3·L−1 & DOC 0.3 and 17.3 mg·L−1, long-term = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625) for hardness 23.4 and 399 mg CaCO3·L−1, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg·L−1
[c] TSS narrative "clear flow: Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d)."
[d] Total Ammonia as N table is temperature and pH dependent. Measurements of total ammonia in the aquatic environment are often expressed as mg/L total ammonia-N. The present guideline values (mg/L NH3) can be converted to mg/L total ammonia-N by multiplying the corresponding guideline value by 0.8224. Consult the CWQG-FAL factsheet for specific table.
[e] Al CWQG = 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5
[f] Cd short-term: 0.11 µg/L if hardness 0 to <5.3 mg CaCO3·L-1, $10^{\{1.016(\log[hardness]) - 1.71\}}$ if hardness ≥5.3 mg CaCO3·L-1 to ≤360 mg CaCO3·L-1, 7.7 µg/L if hardness >360 mg CaCO3·L-1
[g] Cd long-term: 0.04 µg/L if hardness 0 to <17 mg CaCO3·L-1, $10^{\{0.83(\log[hardness]) - 2.46\}}$ if hardness ≥17 to ≤280 mg CaCO3·L-1, 0.37 µg/L if hardness >280 mg CaCO3·L-1
[h] Chromium, trivalent (Cr(III)) = 8.9 µg/L; Chromium, hexavalent (Cr(VI)) = 1 ug/L; Chromium, total = no guideline
[i] Mn (dissolved) short-term: benchmark calculator in Appendix B of Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life: Manganese
[j] Mn (dissolved) long-term: CWQG calculator in Appendix B of the Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life: Manganese.
[k] TP narrative = Trigger Ranges for Total Phosphorus (mg/L) (see Guidance Framework for Phosphorus factsheet): ultra-oligotrophic <0.004, oligotrophic 0.004-0.01, mesotrophic 0.01-0.02, meso-eutrophic 0.02-0.035, eutrophic 0.035-0.1, hyper-eutrophic >0.1.
[l] DO Narrative = Lowest acceptable DO concentrations for the protection of freshwater organisms; 6 mg/L or greater for early life stages of warmwater species, 5.5 mg/L or greater for other life stages of warmwater species, 9.5 mg/L or greater for early life stages of coldwater species, and 6.5 mg/L or greater for other life stages of coldwater species
[m] Sulphate guideline value is from British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life (Guideline: 128 mg/L for hardness 0 to 30 mg CaCO3·L-1; 218 mg/L for hardness 31 to 75 mg CaCO3·L-1, 309 mg/L for hardness 76 to 180 mg CaCO3·L-1, 429 for hardness 181 to 250 mg CaCO3·L-1) (Meays and Nordin 2013)
[n] if water is abstracted from a watercourse, used, treated and subsequently returned to the same watercourse, these solids data mean that the effluent should not contain 1000 mg TDS/L or 30 mg TSS/L more than was in the water originally abstracted (adapted from ECWSR)
[o] at 15°C ± 1°C
[p] The mean absorbance of filtered water samples at 456 nm shall not be significantly higher than seasonally adjusted expect value for the system under consideration.
q Cu long-term: 2 µg/L if hardness 0 to <82 mg CaCO3·L-1, $0.2*e^{\{0.8545[\ln(hardness)]-1.465\}}$ if hardness ≥82 to ≤180 mg CaCO3·L-1, 4 µg/L if hardness >180 mg CaCO3·L-1
r Pb long-term: 1 µg/L if hardness 0 to <60 mg CaCO3·L-1, $e^{\{1.273[\ln(hardness)]-4.705\}}$ if hardness ≥60 to ≤180 mg CaCO3·L-1, 7 µg/L if hardness >180 mg CaCO3·L-1

3.3 GROUNDWATER QUANTITY CRITERIA

A regulatory threshold is not applicable for groundwater quantity. However, a significant adverse residual effect on groundwater quantity is defined in Chapter 6 of the Valentine Gold EIS (Marathon 2020) and Chapter 7 of the EA Update / Environmental Registration (Marathon 2023) as a measurable Project-related environmental effect that results in one or more of the following:

- Decrease in the yield from an existing and otherwise adequate groundwater supply well to the point where it is inadequate for its intended use.
- Physical alteration to an aquifer to the extent that interaction with local surface water results in streamflow changes that adversely affect aquatic life or a down-stream surface water supply.

Measurable parameters related to water quantity include the following:

- groundwater levels in monitoring wells at the site
- reduction in baseflow in surface water features supporting ecological habitat
- well yields for existing well users in the Project Area

Effects on the nearest reported residential groundwater supplies during operations in the vicinity of Buchans and Millertown are negligible due to the distance between the Project and potential well users and the intervening lakes and watershed divides that would act as hydraulic barriers. In the absence of identified domestic well users, the primary receptor of dewatering induced by operation is the surface water receiver. Groundwater discharge to surface water features (i.e., baseflow) will be affected by the dewatering of the open pits and the mounding of the water table in and around the TMF and waste rock piles.

Adaptive management with respect to groundwater quantity would be initiated in the event of the following trigger threshold. The groundwater level in a monitoring well declines below the predicted minimum groundwater level elevation (based on observed minimum groundwater elevation from baseline data and maximum predicted drawdown over the life of the Project).

3.4 GROUNDWATER QUALITY CRITERIA

The groundwater resources are managed by the Pollution Prevention Division of the NLDECC, via issuance of a Certificate of Approval with conditions pertaining to water sampling frequency and testing criteria.

In addition, the Guidelines for Canadian Drinking Water Quality (GCDWQ) published by Health Canada are also applicable to groundwater across Canada and have been adopted by the government of NL for regulated public drinking water supplies. The GCDWQ are "*established based on current published scientific research related to health effects, aesthetic effects and operational considerations*" (Health Canada 2022). As the Project site is not near a current domestic water source, these regulations are not legally binding.

The *Environmental Protection Act* gives the NLDECC the authority to manage contaminated or impacted sites in the province. The NLDECC's *Guidance Document for the Management of Impacted Sites* (2014) outlines the specific process to be followed for all contaminants of concern that have been released into the environment that may require assessment, remediation and/or risk management to ensure protection of human health and the environment. Effective August 30, 2021, the NLDECC requires assessment, remediation and closure reports to utilize Atlantic RBCA Version 4.0 and/or 2021 Atlantic RBCA (Atlantic RBCA, 2021) environmental quality standards (EQS) or pathway-specific standards (PSS). The relevant Atlantic RBCA PSS for groundwater in the Project Area are:

- Human Health-Based Tier II PSS for Groundwater – Potable Groundwater Drinking Water: these guidelines are applicable as aesthetic and health-based guidelines for a variety of chemical parameters for potable water sources at the site (e.g., accommodations camp) and, except for certain petroleum hydrocarbons, are the same as the federal GCDWQ
- Ecological Tier II PSS for Groundwater (>10 metres from Surface Water), Fresh Water: these guidelines are protective of freshwater aquatic life, under the assumption that there is groundwater discharge from an impacted site to a receiving water body

To monitor potential chemical interactions between groundwater and surface water, groundwater quality indicator parameters were chosen based on their relevance to the Project and surface water discharge regulatory criteria, specifically the MDMER (Table 3.2). Although MDMER criteria are specifically discharge guidelines, an exceedance of Schedule 4 MDMER limits for POPCs in groundwater are indicative of potential impacts to receiving surface waters.

Table 3.2 Groundwater Monitoring Parameters, Guideline Values.

Parameters	Units	Reportable Detection Limit (RDL)	Monitoring Wells		Potable Water Sources	
			MDMER Maximum Authorized Mean Monthly Concentration	Tier II PSS for Groundwater (>10 m from Surface Water)	MAC	Other Value
NL Certificate of Approval						
Dissolved Oxygen (DO)	mg/L	0.05	-	-	-	-
Field Temperature	°C	±0.5	-	-	-	AO: ≤ 15
Nitrate + Nitrite as Nitrogen (NO_3 + NO_2 as N)	mg/L	0.05	-	-	-	-
Nitrite (as N) [2]	mg/L	0.05	-	0.6	1	-
Nitrate (as N)	mg/L	0.05	-	130	10	-
Field pH	-	NA	6.5 - 9.5	-	-	7.0 – 10.5
Total Ammonia (as N) [3]	mg/L	0.05	-	10x Table [a]	-	-
Alkalinity	mg/L	1	-	-	-	-
Sulphate [3]	ug/L	600	-	1,280,000	-	AO: ≤ 500
Chloride	mg/L	60	-	1,200	-	AO: ≤ 250
Turbidity	NTU	1	-	-	-	≤ 1.0
Conductance	µS/cm	1	-	-	-	-
Colour	TCU	5		Narrative [b]	-	AO: ≤ 15
Sodium (Na)	mg/L	0.1	-	-	-	AO: ≤ 200
Potassium (K)	mg/L	0.1	-	-	-	-
Calcium (Ca)	mg/L	0.1	-	-	-	-
Sulphide (S_2^-)	mg/L	0.0018	-	-	-	AO: ≤ 0.05
Magnesium (Mg)	mg/L	0.1	-	-	-	-
Orthophosphate as P (PO43- as P)	mg/L	0.01	-	-	-	-

Parameters	Units	Reportable Detection Limit (RDL)	Monitoring Wells		Potable Water Sources	
			MDMER Maximum Authorized Mean Monthly Concentration	Tier II PSS for Groundwater (>10 m from Surface Water)	MAC	Other Value
Dissolved Organic Carbon (DOC)	mg/L	1	-	-	-	-
Total Dissolved Solids (TDS) (calculated)	mg/L	1	-	-	-	AO: ≤ 500
Total Suspended Solids (TSS)	mg/L	1	15	-	-	-
Phenolics	mg/L	0.0015	-	-	-	-
Carbonate alkalinity	mg/L	1	-	-	-	-
Bicarbonate alkalinity	mg/L	1	-	-	-	-
Reactive Silica (SiO_2)	mg/L	0.5	-	-	-	-
Aluminum (Al) [2]	ug/L	5	-	50	0.0029	OG: < 100
Antimony (Sb)	µg/L	1	-	90	6	-
Barium (Ba)	µg/L	1	-	10,000	2,000	-
Arsenic (As) [2]	µg/L	1	100	50	10	-
Beryllium (Be)	µg/L	1	-	1.5	-	-
Bismuth (Bi)	µg/L	2	-	-	-	-
Boron (B)	µg/L	50	-	15,000	5,000	-
Cadmium (Cd) [2]	µg/L	0.017	-	0.9	7	-
Chromium (Cr) [3]	µg/L	1	-	(III) – 89; (VI) - 10 [c]	50	-
Cobalt (Co)	µg/L	1.25	-	10	-	-
Copper (Cu) [2]	µg/L	1	100	20	2,000	AO: 1,000
Iron (Fe) [2]	µg/L	50	-	3,000	-	AO: ≤ 300
Lead (Pb) [2]	µg/L	0.5	80	10	5	-
Manganese (Mn) [3]	µg/L	2	-	4,300	120	AO: ≤ 20

Parameters	Units	Reportable Detection Limit (RDL)	Monitoring Wells		Potable Water Sources	
			MDMER Maximum Authorized Mean Monthly Concentration	Tier II PSS for Groundwater (>10 m from Surface Water)	MAC	Other Value
Mercury (Hg) [3]	µg/L	0.013	-	0.25	1	-
Molybdenum (Mo)	µg/L	2	-	730	-	-
Nickel (Ni)	µg/L	2,000	250	250	-	-
Selenium (Se)	µg/L	0.5	-	10	50	-
Silver (Ag)	µg/L	0.1	-	2.5	-	-
Strontium (Sr)	µg/L	2	-	210,000	7,000	-
Thallium (Th)	µg/L	0.1	-	8	-	-
Tin (Sn)	µg/L	2	-	-	-	-
Titanium (Ti)	µg/L	2	-	-	-	-
Uranium (Ur)	µg/L	0.1	-	150	20	-
Vanadium (V)	µg/L	2	-	1,200	-	-
Zinc (Zn) [2]	µg/L	5	400	70	-	AO: ≤ 5,000
MDMER and Environmental Impact Statement (EIS) Parameters of Potential Concern (Marathon 2020, Stantec 2023a)						
Weak Acid Dissociable Cyanide (CN^- WAD) [3]	µg/L	1	-	50 (as Free CN^-)	-	-
Total Cyanide (CN^- Total)	mg/L	0.01	500	-	0.2	-
Radium 226	Bq/L	0.005	0.37	-		
Un-ionized Ammonia (as N) [1] (NH3 UN as N)	mg/L	NA	0.5	0.16	-	-
Fluoride (Fl) [3]	µg/L	60	-	1,200	1,500	-
Phosphorus (as P) [3]	µg/L	4	-	-	-	-

Notes:

\- = no value; AO = aesthetic objective; MAC = maximum acceptable concentration; NA = not applicable

[1] Un-ionized ammonia is calculated using the following equation: A $(1/(1 + 10^{pKa-pH}))$ where A is the concentration of total ammonia — which is the sum of un-ionized ammonia (NH3) and ionized ammonia (NH4+) — expressed in mg/L as nitrogen (N); pH is the pH of the effluent sample; and pKa is a dissociation constant calculated in accordance with the following formula: 0.09018 + 2729.92/T where T is the temperature of the effluent sample in kelvin. (MDMER 12(4))

[2] EIS baseline surface water quality program CWQG-FAL exceedance parameter (EIS Chapter 7, Section 7.3.5.2 (Marathon 2020; Stantec 2023b))

[3] EIS mine effluent characterization CWQG-FAL exceedance parameter (EIS Chapter 7, Section 7.3.5.2 (Marathon 2020))

[a] Total Ammonia as N table is temperature and pH dependent. Measurements of total ammonia in the aquatic environment are often expressed as mg/L total ammonia-N. The present guideline values (mg/L NH3) can be converted to mg/L total ammonia-N by multiplying the corresponding guideline value by 0.8224. Consult the CWQG-FAL factsheet for specific table.

[b] The mean absorbance of filtered water samples at 456 nm shall not be significantly higher than seasonally adjusted expect value for the system under consideration.

[c] Chromium, trivalent (Cr(III)) = 89 µg/L; Chromium, hexavalent (Cr(VI)) = 10 ug/L; Chromium, total = no guideline

3.5 TMF WATER MANAGEMENT CRITERIA

The TMF water management features have been designed to withstand flooding events using criteria based on level of consequence of the impounding dam infrastructure.

The proposed TMF includes a tailings dam that incorporate current regulatory requirements in the design, including the Canadian Dam Association (CDA 2014, 2019) design standards. Design of the tailings dam crest and invert elevation of associated spillways are determined by considering the Inflow Design Flood, the Environmental Design Flood, the Normal Operating Water Level (NOWL), the Low Operating Water Level (LOWL), and freeboard. As reported by Ausenco (2022), the storage requirements of water retention structures are summarized in Table 3.2 and detailed in subsequent sections.

Table 3.3 Storage Requirements of Major Water Retention Structures

Dam	Selected Inflow Design Flood	Selected Environmental Design Flood	Selected NOWL	Selected LOWL
Tailings Pond Dam	Probable maximum flood (PMF) (generated from 309 mm 24 hr. PMP at 390.3 m elev.) PMF (Passive Closure)	1:100-year storm in 24 hours, allotted up to1 m of depth in TMF	Climate Normal Conditions Dewatering Surplus	Inactive Storage Condition
SAGR® unit Dam	Not specified	Not Applicable	Climate Normal Conditions Discharge Surplus	Inactive Storage Condition

The Inflow Design Flood is the most severe inflow flood (peak, volume, shape, duration, timing) for which a dam and its associated facilities are designed (CDA 2014). The TMF dams were assessed as having a Very High Consequence classification (Golder 2020). As per the CDA requirement for a very high consequence classification, the Inflow Design Flood should be 2/3 between the 1:1000-year flood event and the probable maximum flood (PMF). The PMF is a flood that results from a precipitation event known as the probable maximum precipitation (PMP). The PMP is defined as the most extreme precipitation event physically possible in the area. The PMP was selected in a supporting prefeasibility level design of the tailings management area both completed by Golder (2020). For passive closure phase, the Inflow Design Flood is raised to the PMF.

The Environmental Design Flood is the most severe flood that is to be managed without release of untreated water to the environment (CDA 2014). Retention of water during the Environmental Design Flood requires storage capacity above the NOWL (CDA 2014). An emergency spillway will enhance the safe operation of the TMF by increasing the range of inflows that can be managed in extreme circumstances. The Environmental Design Flood can be defined by the required assimilation of water quality parameters of concern, such as total suspended solids, arsenic, and cyanide.

As defined by Golder (2020), for components that are temporary in nature or are only expected to service the operational period of the Project, the 1:25 year storm is used as the design criteria within the Processing Plant and TMF Complex. These features include the seepage collection ditch around the tailings pond and associated pumping capacity, mill site pond, and ROM Pad. However, the allotted freeboard height of most of this infrastructure would accommodate flows of a higher storm event. Design of the decant structure pumping capacity and pore spacing was based on the required capacity of the maximum water treatment plant treatment rate of 10,800 m^3/d and the average reclaim flows to the mill for process use.

4.0 WATER MANAGEMENT ANALYSIS

4.1 METHODS

Hydrologic conditions, runoff rate volume and flow hydrographs were simulated using the hydrologic model HEC-HMS (USACE 2000, 2010) for the 10-year, 100 year and 200-year return period storm events. The Soil Conservation Service (SCS) Curve Number method (USDA 2010) was used to simulate the runoff hydrograph in each Project component area. The watershed parameters required for simulation of the SCS Curve Number method included catchment areas, SCS Curve Number, Initial abstraction, lag time, and baseflow. Time lag was calculated as 0.6 of the time of concentration. Time of concentration was calculated using the SCS unit hydrograph equation and the travel time in the ditch was calculated using manning's equation for open channel flow. Initial abstraction (mm) was calculated as 0.2 of Storage (potential maximum retention, a measure of the ability of a watershed to retain storm precipitation). Toe seepage was assumed based on baseflow calculations to nearby streams and will be refined through modelling to support the environmental assessment.

As further discussed in the 2019 Hydrology Baseline Report (Stantec 2020a), the Intensity-Duration-Frequency curves developed for the Stephenville climate station (ECCC ID 8403820) were selected to represent precipitation at the site. The Stephenville Intensity-Duration-Frequency curves were developed based on 48 years of data (1967 – 2017) and have been adjusted to account for the effects of climate change for the 2011–2040-time horizon (2020s) for the IPCC RCP4.5 emissions scenario. The average increase of IDF rainfall amounts associated with the various projections are approximately 10% for the 2020s (CRA 2015). In the model, the storms were distributed using a 10-minute timestep over 24 hours based on the SCS Type II distribution.

Snow melt was estimated using an energy balance approach for melt during rainy periods (USDA 2004). Inputs to the calculations included average daily air temperature, wind spend, rainfall for the month of analysis. The SCS curve number was based on a rain on snow melt event assuming the pile was covered with snow and ice. The SCS curve number was assigned based on the proportion of precipitation plus snow melt for the month of April, as April corresponds to the month of the greatest amount of snow melt observed in the Stephenville climate normal record.

Sizing of water management infrastructure was completed in Microsoft Excel using theoretical relationships of geometry and flow. The diameter of a low-level outlet structure of the water management pond was sized based on an orifice equation. The capacity of the ditches was estimated using the Manning's equation and the associated catchment for each substantial change in ditch grade. The required dimensions of the water management pond emergency spillways were sized using a broad crested weir equation.

Water management pond water quality design was dependent upon the minimum size and specific gravity of the sediment / precipitate particle needed to be removed, outflow rate from the water management pond and design event runoff volume. Sediment pond detention time was based on the settling of a 5.0×10^{-3} mm diameter sediment particle to settle a minimum of 1 m depth. To meet this requirement, the relationship (Simon, Li & Associates Inc 1982) between pond surface area, Q10 yea pond outflow rate and sediment particle settling velocity was satisfied. The particle settling velocity was estimated using Stoke's Law and is dependent upon water temperature, particle size, and specific gravity of the particle. The thickness of ice was estimated using Stefan's Equation (MOE 2003) to determine inactive storage volumes in water management ponds.

The design of the water management ponds accounted for climate change, ice thickness during the cold season, operating water levels, inactive storage to promote settling, and freeboard.

4.2 HYDROLOGIC CONDITIONS

Total precipitation for the 10-year, 100-year, and 200-year return period storm events are 100.7 mm, 183.4 mm, and 198.6 mm, respectively. The 100 year and 200-year return period storms include the maximum daily snow melt for the month of April of 38.6 mm/d. Snowmelt was not added to the 1:10 year storm, as snowmelt was not considered to appreciably contribute to total suspended solids loading in the ponds and the 1:10 year storm was used to size the required sedimentation volume. It was assumed that approximately 50% of snow melt and 72% of rainfall would runoff and contribute to the ponds. Based on these assumptions, the resultant curve number of 85 is within the expected curve number range of 71 and 96 of total precipitation for coarse aggregate material (USDA 1986). The design runoff condition of the waste rock pile assumes that layers of ice within the snowpack limit infiltration into the pile during winter and result in additional runoff during winter melt conditions.

Table 4.1 presents the hydrologic model input values used to simulate each Project component hydrological characteristic. The predicted peak flows and runoff volumes from each area of the Project are presented in Table 4.2 for 10-year, 100 year, and 200 year return period storm events. The model assumed an Initial Abstraction of 5 mm. Catchment areas do not include the areas of the pond and conveyance ditches. Water Management Pond IDs and Project areas are noted on Figure 1.1. and 2.1.

Table 4.1 Hydrologic Inputs

Sediment Pond ID	Area of the Project	Catchment Area (m^2)	Time Lag (min)		Toe Seepage (m^3/day)
			Pile	Ditch	
PP-SP-01	Processing Plant	143,098	-	2.5	130
MA-SP-01AB	LGO/ Overburden Stockpile	675,994	24.2	4.1	537
MA-SP-01C	Waste Rock Pile	146,736	21.8	1.2	117
MA-SP-03	Waste Rock Pile	573,690	14.5	3.4	456
MA-SP-04	Waste Rock Pile/ Topsoil Stockpile	747,313	24.1	7.3	593
MA-SP-05	Pit/Waste Rock Pile	595,847	9.6	9.5	473
LP-SP-01A	LGO	152,463	15.9	3.4	121
LP-SP-01B	Waste Rock Pile/ Topsoil Stockpile	380,678	20.4	2.2	302

Table 4.1 Hydrologic Inputs

Sediment Pond ID	Area of the Project	Catchment Area (m^2)	Time Lag (min)		Toe Seepage (m^3/day)
			Pile	Ditch	
LP-SP-02A	Waste Rock Pile	749,783	32.5	4.7	1,273
LP-SP-03A	Waste Rock Pile	492,419	12.1	5.8	391
LP-SP-03C	Waste Rock Pile/ Overburden Stockpile	447,524	20.4	2.6	355
LP-SP-05	Pit	575,381	N/A	N/A	457
BER-SP-01A	Waste Rock Pile	361,368	44.1	5.2	295
BER-SP-01B	Waste Rock Pile	538,555	59.5	2.0	439
BER-SP-02	Waste Rock Pile	467,601	77.5	1.2	384
BER-SP-03	Waste Rock Pile at ValP3	659,693	42.6	6.9	540
BER-SP-04	Waste Rock Pile/Overburden Stockpile	448,576	43.2	7.5	363
BER-SP-05	Pit	1,378,259	3.0	16.8	30
BER-SP-06	Topsoil Stockpile	362,214	20.0	7.0	180
Note: N/A – Not Applicable					

Table 4.2 Hydrologic Outputs

Hydrologic Element	10 Yr. Return Period Peak Discharge m^3/s	10 Yr. Return Period Volume (1000 m^3)	100 Yr. Return Period Peak Discharge m^3/s	100 Yr. Return Period Volume (1000 m^3)	200 Yr. Return Period Peak Discharge m^3/s	200 Yr. Return Period Volume (1000 m^3)
MA-SP-01AB	2.9	17.2	8.0	42.1	8.9	47.0
MA-SP-01C	0.6	5.8	1.7	14.9	1.9	16.7
MA-SP-03	2.9	22.7	8.3	58.2	9.4	65.4
MA-SP-04	2.7	29.6	8.0	75.8	9.2	85.2
MA-SP-05	3.9	27.8	11.2	70.9	12.7	79.7
LP-SP-01A	0.66	6.0	1.95	15.5	2.2	17.4
LP-SP-01B	1.5	15.1	4.4	38.6	5.0	43.4
LP-SP-02	2.3	33.7	6.7	80.1	7.6	89.5
LP-SP-03A	2.6	19.5	7.6	49.9	9	59.3
LP-SP-03C	1.8	15.8	5.2	43.4	5.9	49.1
LP-SP-05	3.2	22.8	9.3	58.3	10.5	65.6
PP-SP-01	2.4	10.6	4.5	18.8	5.0	21
BER-SP-01A	0.6	13.4	2.5	37.4	2.8	42.7

Table 4.2 Hydrologic Outputs

Hydrologic Element	10 Yr. Return Period Peak Discharge m^3/s	10 Yr. Return Period Volume (1000 m^3)	100 Yr. Return Period Peak Discharge m^3/s	100 Yr. Return Period Volume (1000 m^3)	200 Yr. Return Period Peak Discharge m^3/s	200 Yr. Return Period Volume (1000 m^3)
BER-SP-01B	0.8	18.4	2.9	51.5	3.3	58.4
BER-SP-02	0.42	11.5	1.5	31.8	1.7	36.0
BER-SP-03	0.9	22.7	3.3	63.5	3.7	71.9
BER-SP-04	0.9	18.5	3.4	51.9	3.9	58.9
BER-SP-05	4.1	25.6	14.6	76.5	16.7	87.0
BER-SP-06	0.8	10.9	2.2	26.9	25.4	30.1

4.3 WATER QUALITY

The water management ponds were sized to settle approximately 5 micron and coarser particles in the 10-year return period design flow. The analysis assumed that a particle has to settle approximately 1 m from the water surface to descend below the submerged outlet invert and thus have reached the effective sediment trapping depth with an 80% efficiency (British Columbia Ministry of Environment and Climate Change Strategy 1996). The assumed settling velocity of the particles was 2×10^{-5} m/s (assuming the temperature of the fluid in the pond is close to freezing). Given a minimum vertical settling zone of 1 m, it will take 14 hours for a particle to reach the trapped sediment zone below the outlet invert. Ponds will be designed to detain runoff for the design storm event for a minimum of 24 hours.

The invert elevation of the orifice pipe is set to provide an adequate pond volume for settling of the 10-year return period flood volume. The primary outlet pipe inlet will be submerged, reverse sloped and act as a hydrocarbon and Light Non-Aqueous Phase Liquids containment feature, reduce thermal discharge effects and mitigate ice blockage. If FDP effluent quality doesn't meet the MDMER limits through sedimentation ponds, further effluent treatment will be implemented.

4.4 DRAINAGE ANALYSIS

The Project has a total of 20 FDPs. There is a total of five final discharge locations at the Marathon Complex that drain ultimately to the Victoria River either via Valentine Lake or direct tributaries to the river. There are six FDP locations at the Leprechaun Complex that ultimately drain to Victoria Lake Reservoir, either directly to the lake or through tributaries. There are seven FDP locations at the Berry Complex that ultimately drain to the Victoria River via Valentine Lake. The Processing Plant and TMF Complex has an additional two final discharge locations that flow to Victoria Lake Reservoir; this includes the TMF effluent pipeline to Victoria Lake Reservoir and the processing area water management pond discharge to a tributary of Victoria Lake Reservoir.

The Project was designed to maintain pre-development drainage conditions as close as possible throughout the phases of mine life. Water management ponds were designed to drain to pre-development catchments, where possible.

Catchment Areas for the Operations Phase are presented in Figures 4.1 – 4.8 based on the available Project LiDAR (Aethon 2021).

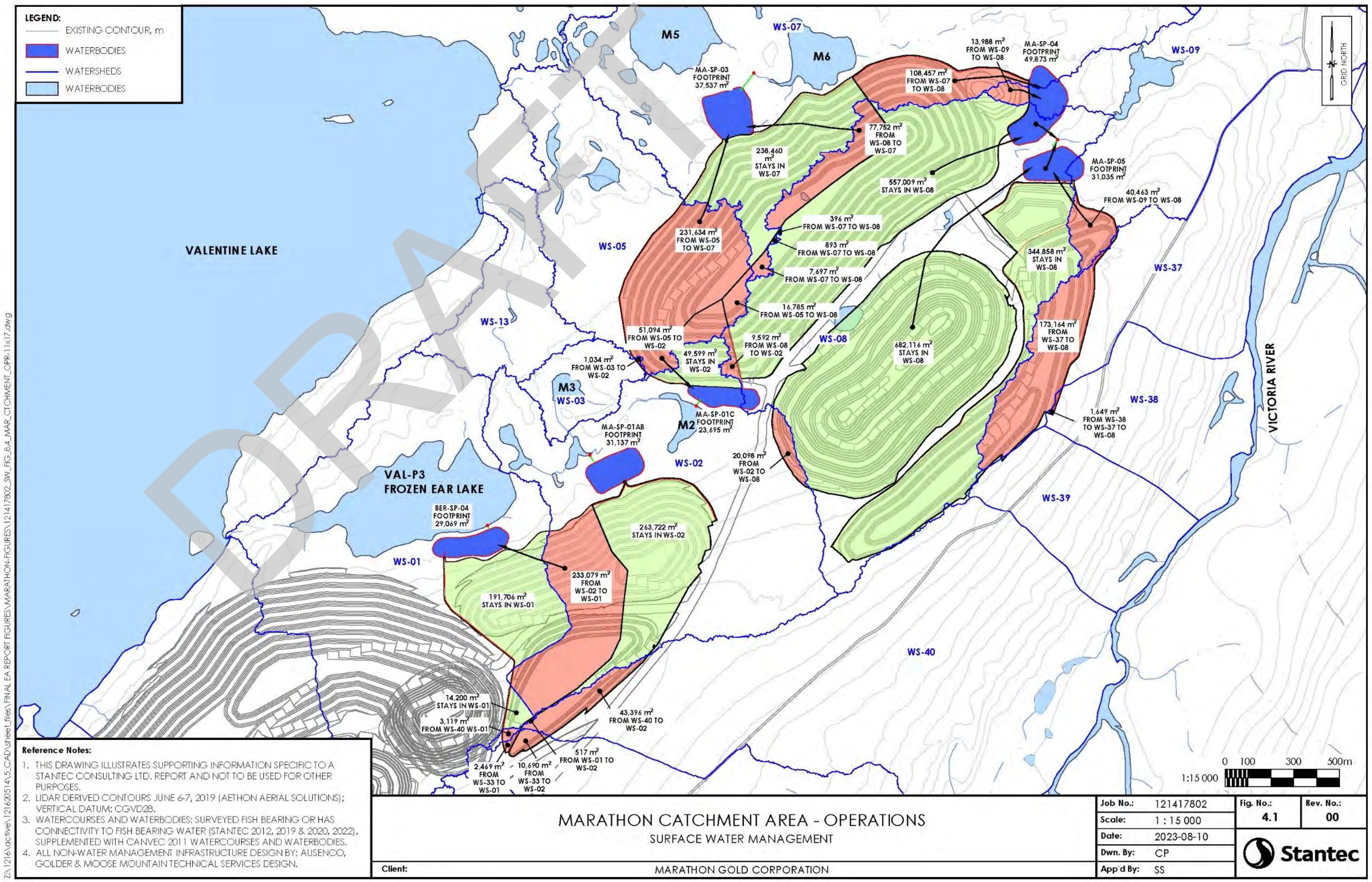


Figure 4.1 Marathon Complex Catchment Areas During Operation

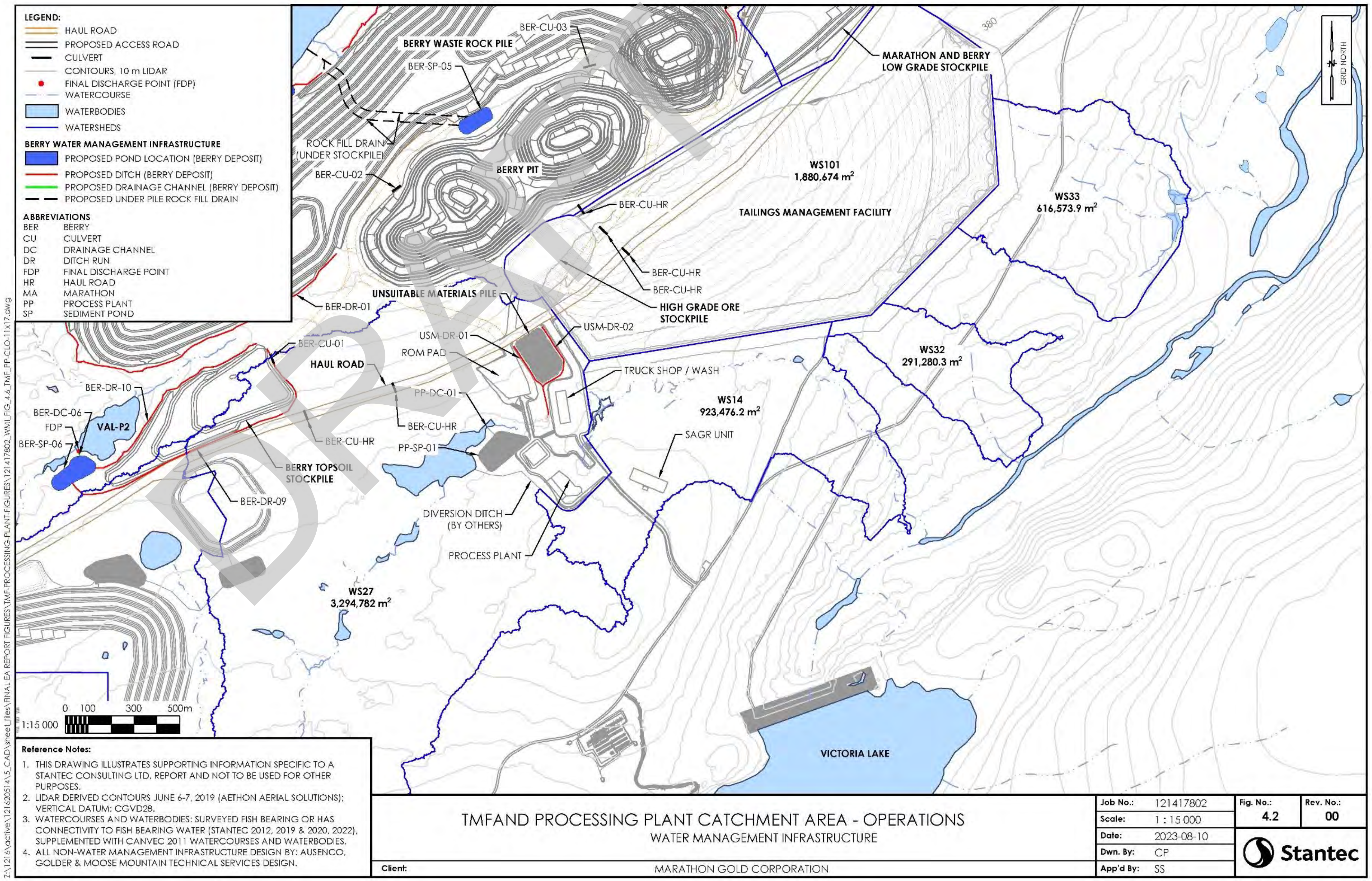


Figure 4.2 Processing Plant and TMF Complex Catchment Areas During Operation

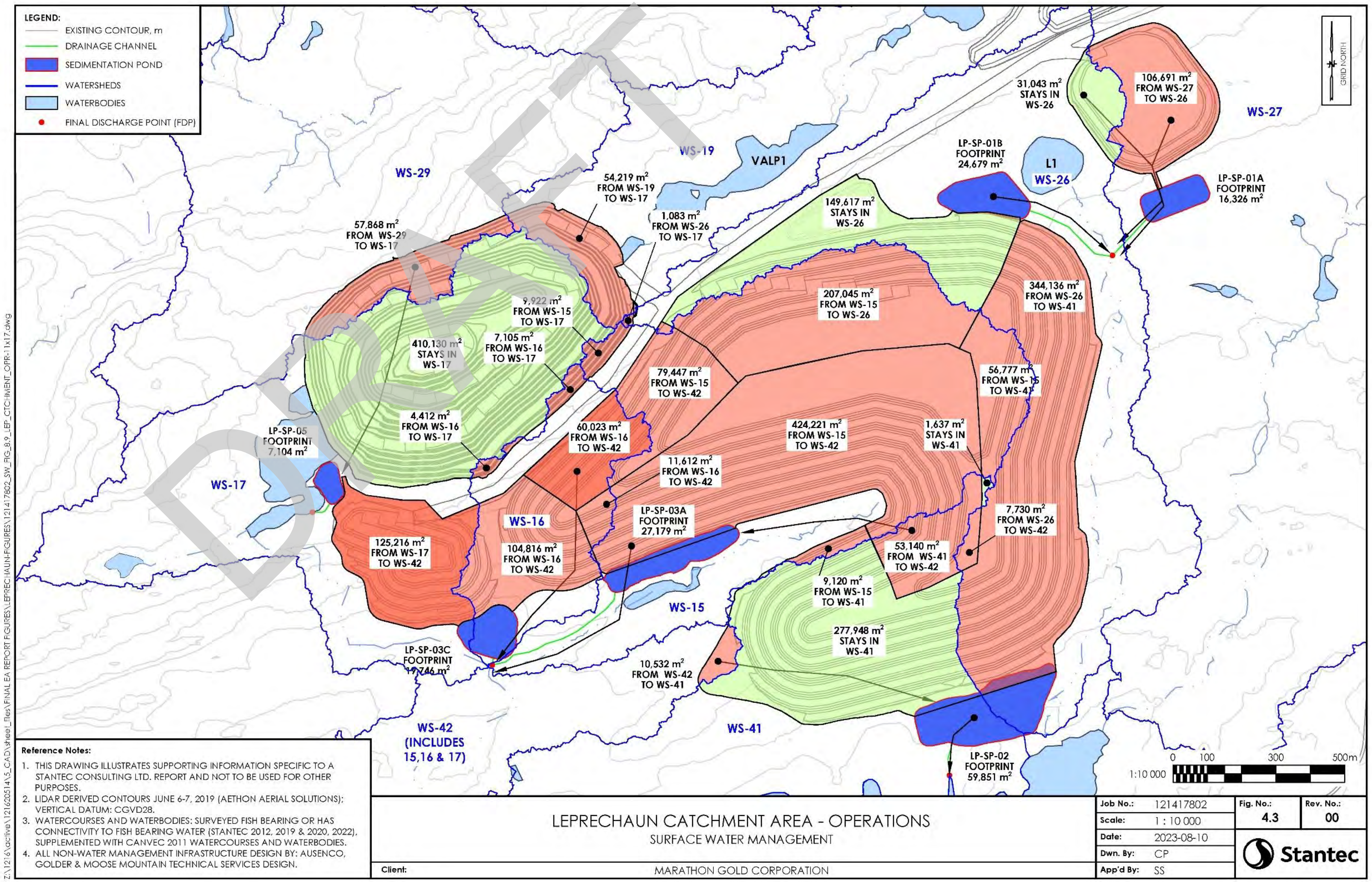


Figure 4.3 Leprechaun Complex Catchment Areas During Operation

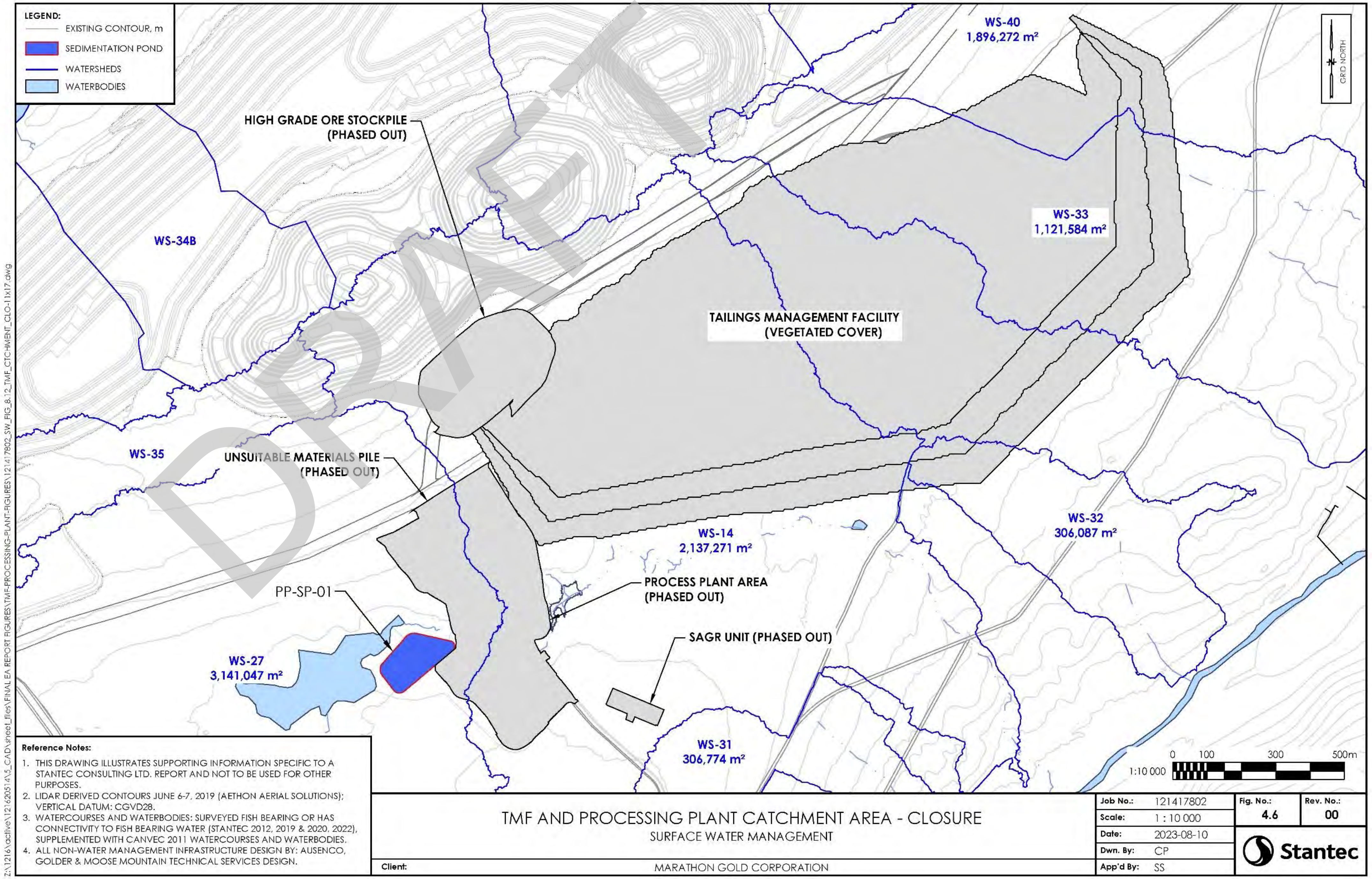


Figure 4.4 Berry Complex Catchment Areas During Operation

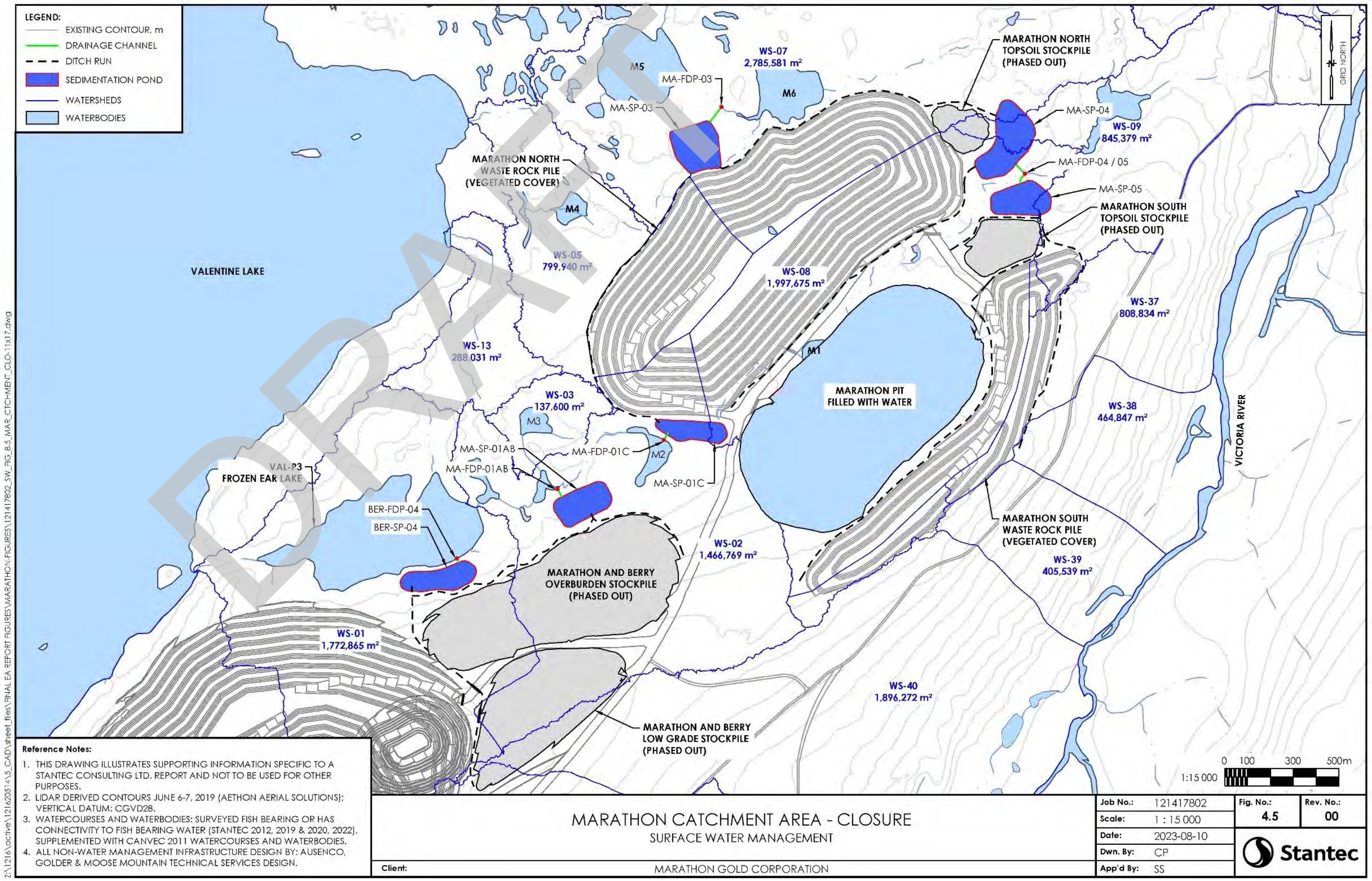


Figure 4.5 Marathon Complex Water Management Catchment Areas During Closure

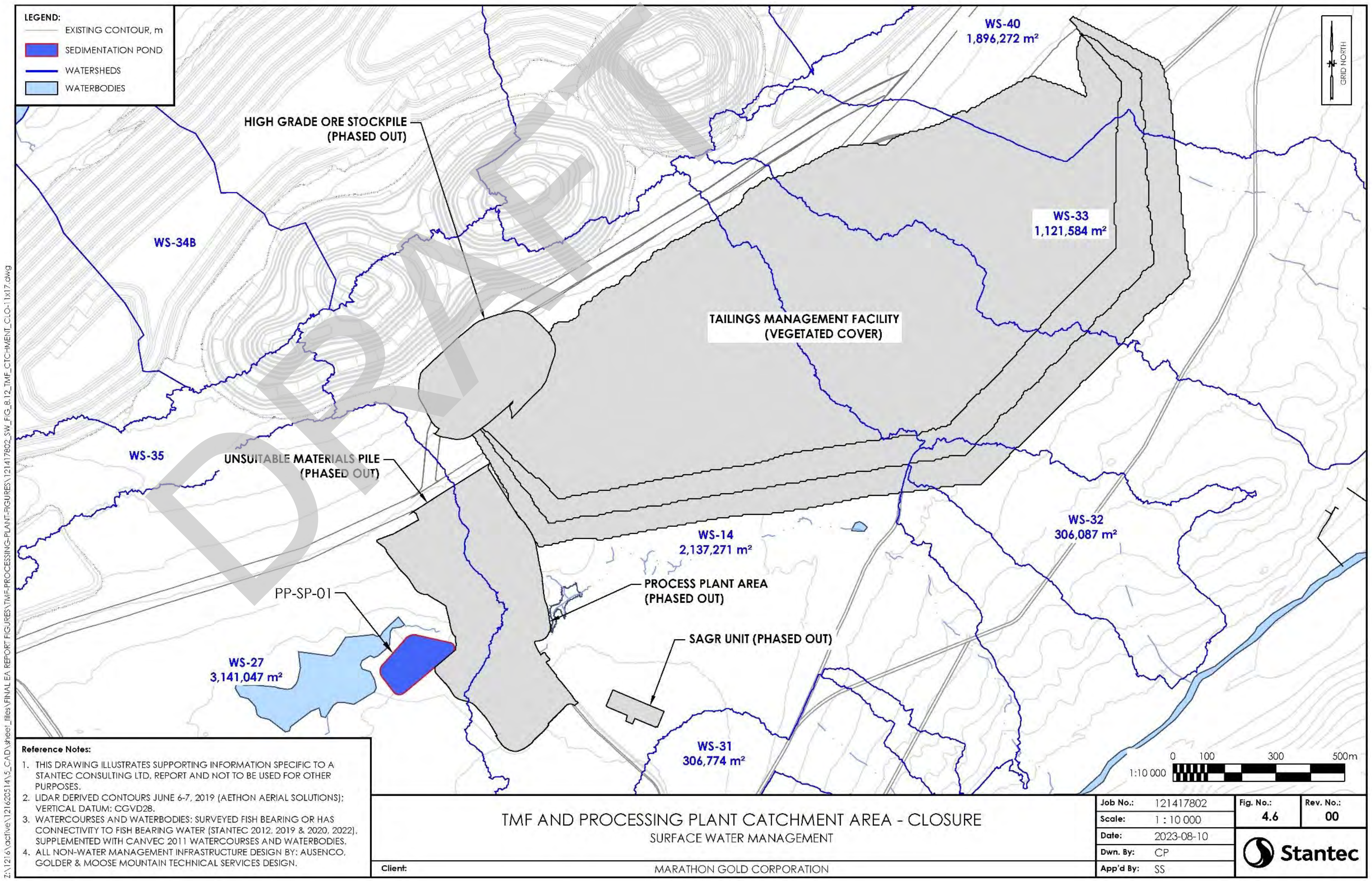


Figure 4.6 Processing Plant and TMF Complex Catchment Areas During Closure

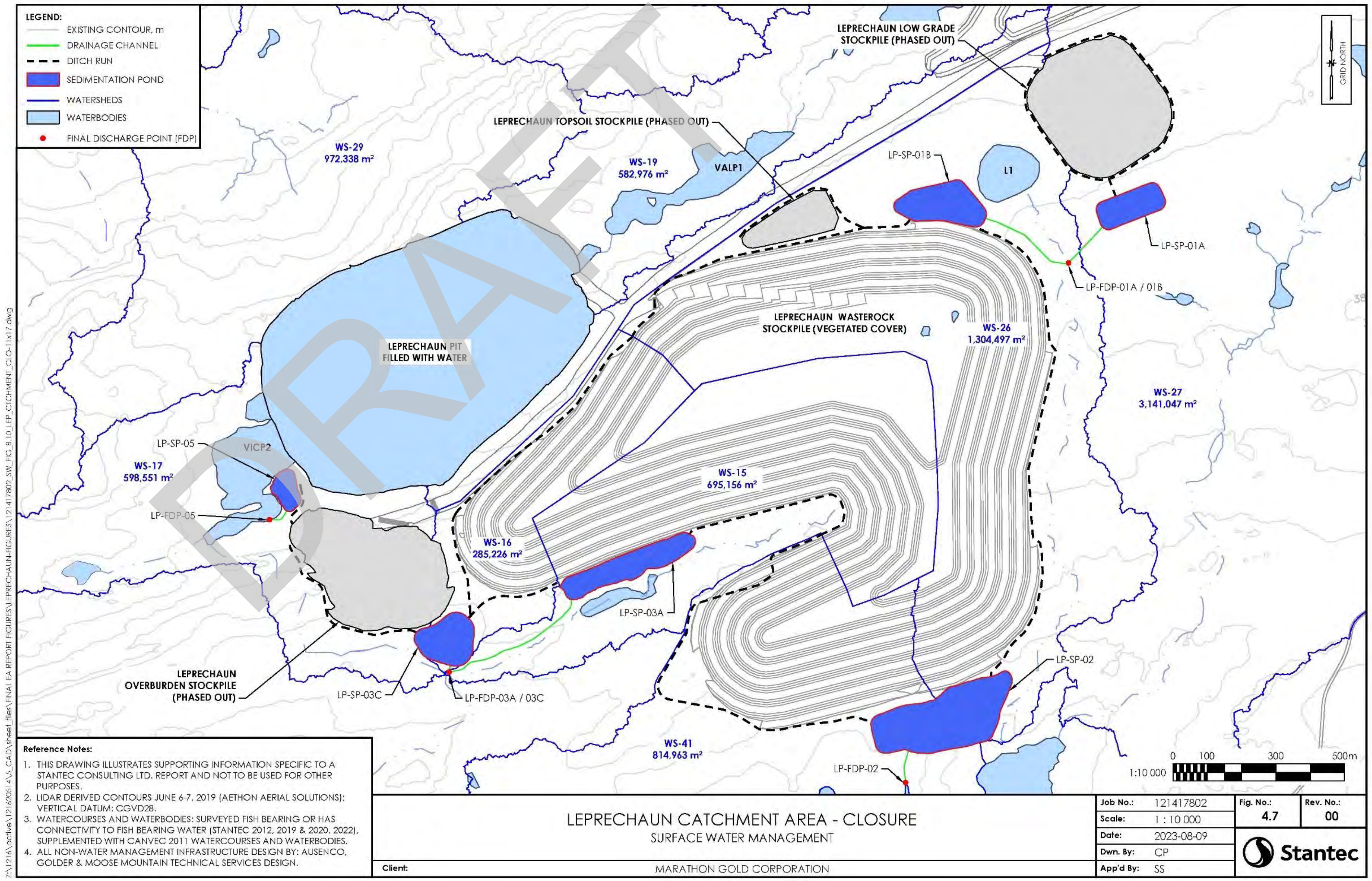


Figure 4.7 Leprechaun Complex Catchment Areas Closure

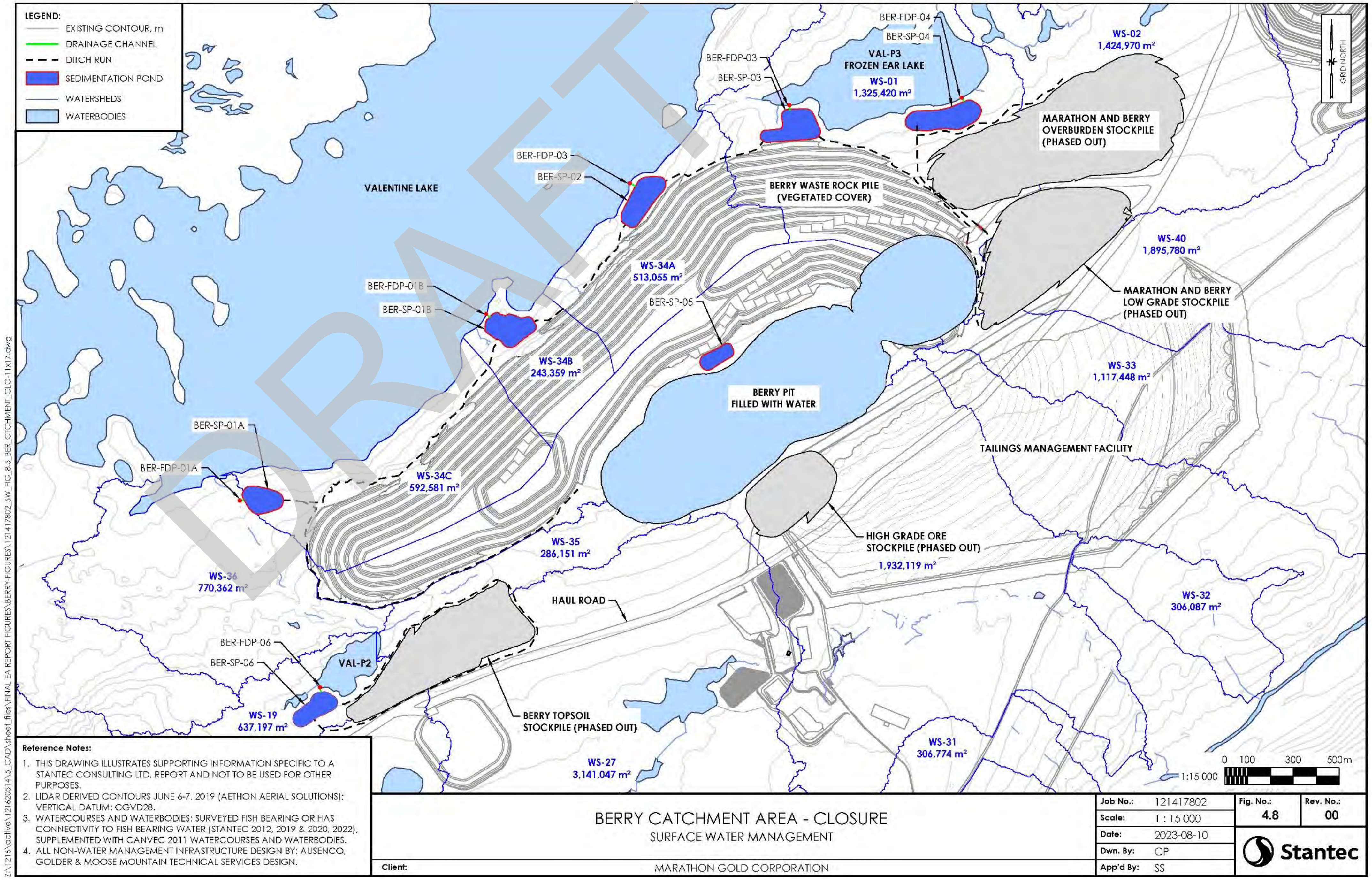


Figure 4.8 Berry Complex Catchment Areas During Closure

5.0 WATER MANAGEMENT DESIGN

The Water Management Design is provided in the next sections at detailed design level for early works during construction and feasibility level for operational and Berry complex components. Design will be subject to change as additional information becomes available such as regulator consultation, refinements in design of facilities and water quality modelling.

5.1 CONSTRUCTION

The primary water management activity during construction will be erosion and sediment control (ESC) measures and mine excavation dewatering. ESC measures will be required for various construction phase activities outlined in Section 2.1 and include clearing, stripping and grubbing of vegetation, excavation and storage of topsoil and overburden, blasting and removal of mine rock and ore, dewatering of the pits and excavations. The primary water management activities during construction of the process plant are expected to include collection, treatment, and discharge of surface runoff from the construction area and surface runoff and groundwater inflow to foundation excavations. Other construction activities include construction of water management infrastructure, road construction, borrow area development and operation, and preparation of surfaces for major Project facilities. Further details on ESC planning are provided in the Construction Environmental Protection Plan (EPP) (Marathon 2021).

ESC will be implemented to reduce environmental impacts involving earthwork activities during the development of the Project. The four basic principles to be adopted in implementation of ESC measures include:

- Direct runoff away from active work areas before construction commences, reducing the volume of sediment-laden water to be managed
- Limit the amount and timing of exposed soil to reduce the potential for erosion
- Control sediment-laden runoff leaving the site, following ESC measures put in place for the construction of the Project
- Protect sensitive receptors from sediment-laden runoff by directing untreated runoff away from these areas

Sensitive receptors on and adjacent to the site will require protection from sediment-laden runoff generated during site development activities. The most sensitive receptors, based on their proximity to active work areas where land disturbance will be encountered, include Victoria River, Valentine Lake, and Victoria Lake Reservoir and the associated tributaries and ponds. Many of these waterbodies and watercourses have been identified as fish habitat (Stantec 2022b).

Standard sediment control features will be used during construction, including installation of silt fencing and construction of diversion ditches and berms to divert and/or collect surface water runoff. During construction, water from construction areas will be directed to temporary sediment ponds, energy dissipation pools, sediment traps or sediment filter bags or proposed operational water management ponds constructed early during construction. Water in the temporary sediment ponds will either be discharged overland or directly local receivers if water quality meets regulatory standards.

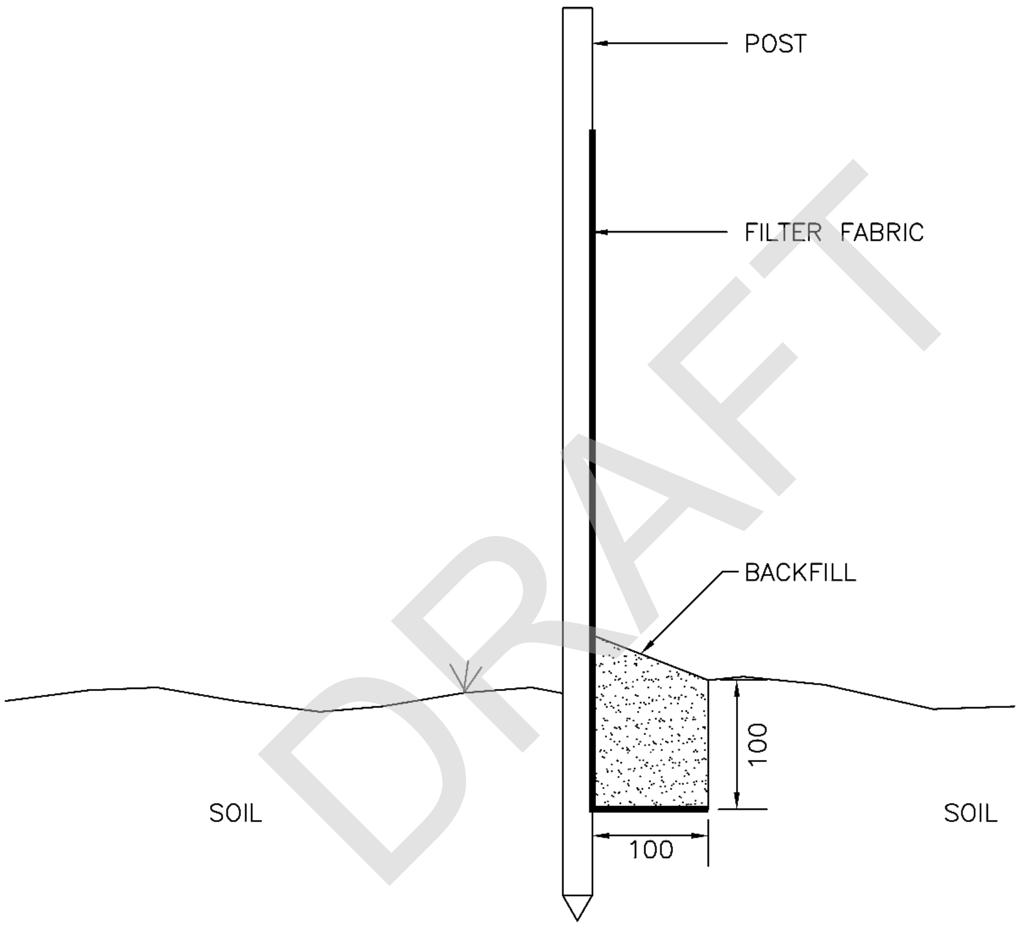
During construction, parameters of potential concern (POPC) in runoff are expected to be total suspended solids (TSS) and potentially elevated metal concentrations resulting from the storage of topsoil, overburden, and waste rock.

During construction, Marathon will endeavor to implement the recommended water best management practices presented in Table 5.1 to manage surface runoff and reduce the erosion and sedimentation potential.

Table 5.1 Best Management Practices during Construction

General	Construct perimeter (or ring) ditches around the footprint of Project facilities areas prior to clearing and grubbing on the site. The ditches will be constructed to collect and treat sediment-laden runoff inside the work area and divert runoff outside the work area offsite. Place check dams consisting of clear stone in ditches to reduce the velocity of flow and deposit sediment load. Construct in the dry, dewatering areas prior to construction or installing temporary flow diversion measures to reduce the amount of sediment. Divert sediment-laden runoff to collection ponds or water management ponds for treatment prior to discharge. Periodic removal of excess sediment from the collection ponds may be required to reinstate the design storage capacity. During topsoil and overburden removal, collect surface water runoff and seepage in excavation sumps and pump to either temporary water management ponds or discharge to the environment through filter bags.
Piles	Store topsoil, overburden, and bedrock removed for construction for rehabilitation and closure purposes in the designated pile areas at each complex. Prior to development of the waste rock piles, construct perimeter ditches and water collection ponds to collect and store surface runoff. The drainage ditches will be constructed to drain by gravity to the sedimentation ponds, where practicable. In low areas where gravity flow to the sedimentation ponds is not practical, sumps will be constructed to collect water and pump it to the water management ponds. Water quality in the ponds will be monitored, treated via sedimentation as necessary, and discharged to the environment once water quality meets regulatory criteria.
Open Pits	During clearing and grubbing activities associated with the open pits, collect surface water runoff and seepage in excavation sumps and pump to either temporary water management ponds (and discharged to the environment if discharge criteria are met) or treat further using additional ponds and/or filter bags prior to discharge. The footprint of the Leprechaun pit overlays VICP2 that flows both to the north and the south from the center of the pit, as the pit is located at a natural drainage divide. These headwaters including VICP2 will be dewatered, and flow discharged further downstream. The footprint of the Marathon pit overlaps the existing Pond M1. Pond M1 and downstream reach will be dewatered as the proximity to the pit will result in loss of flows during active pit dewatering. The footprint of the Berry pit overlaps several small unnamed bog holes. The bog holes will be dewatered, and flow discharged via a discharge channel to Valentine Lake.
Access and Haul Roads	Temporarily divert flow in the watercourses, to replace existing bridges and culverts in the site access road and construct the haul road. Water will be discharged to a vegetated area through a perforated PVC pipe, located more than 60 m from any watercourse, or alternatively into a filter bag. Additional cross culverts under the site access and haul road may be installed as localized drainage dictates.

Implementation and maintenance of the ESC measures will be monitored regularly (once per week) and after a significant storm event. ESC measures will be put in place to ensure that liquid effluent limits are met in the receiving watercourse. Typical details for a silt fence installation, energy dissipation pool, and sediment trap are provided in Figures 5.1 to 5.3, respectively.



INSTALLATION OF GEOTEXTILE SILT FENCE

1. EXCAVATE A 100mm X 100mm TRENCH IN A CRESCENT SHAPE ACROSS THE FLOW PATH WITH ENDS POINTING UPSLOPE.
2. DRIVE STURDY STAKES, SPACED 3000mm APART, INTO THE GROUND ALONG THE DOWNSLOPE SIDE OF THE TRENCH.
3. INSTALL THE FILTER FABRIC FROM A CONTINUOUS ROLL AND CUT TO REQUIRED LENGTH. THE FILTER FABRIC SHOULD BE STAPLED TO THE UPSTREAM SIDE OF THE STAKES, EXTENDING THE BOTTOM 200mm INTO THE TRENCH
4. BACK FILL AND COMPACT THE SOIL IN THE TRENCH OVER THE FILTER FABRIC.
5. CONTRACTOR TO MAINTAIN FENCE FOR THE DURATION OF THE PROJECT AND REMOVE AT THE COMPLETION OF THE PROJECT.

Figure 5.1 Installation of Geotextile Silt Fence (Government of NL 2004)

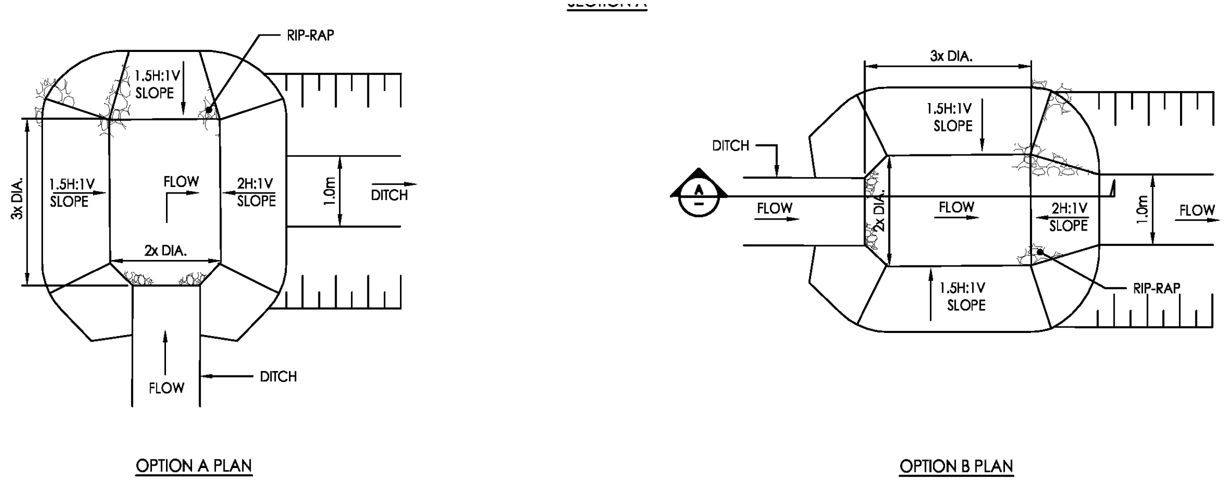


Figure 5.2 Energy Dissipation Pool Typical Detail

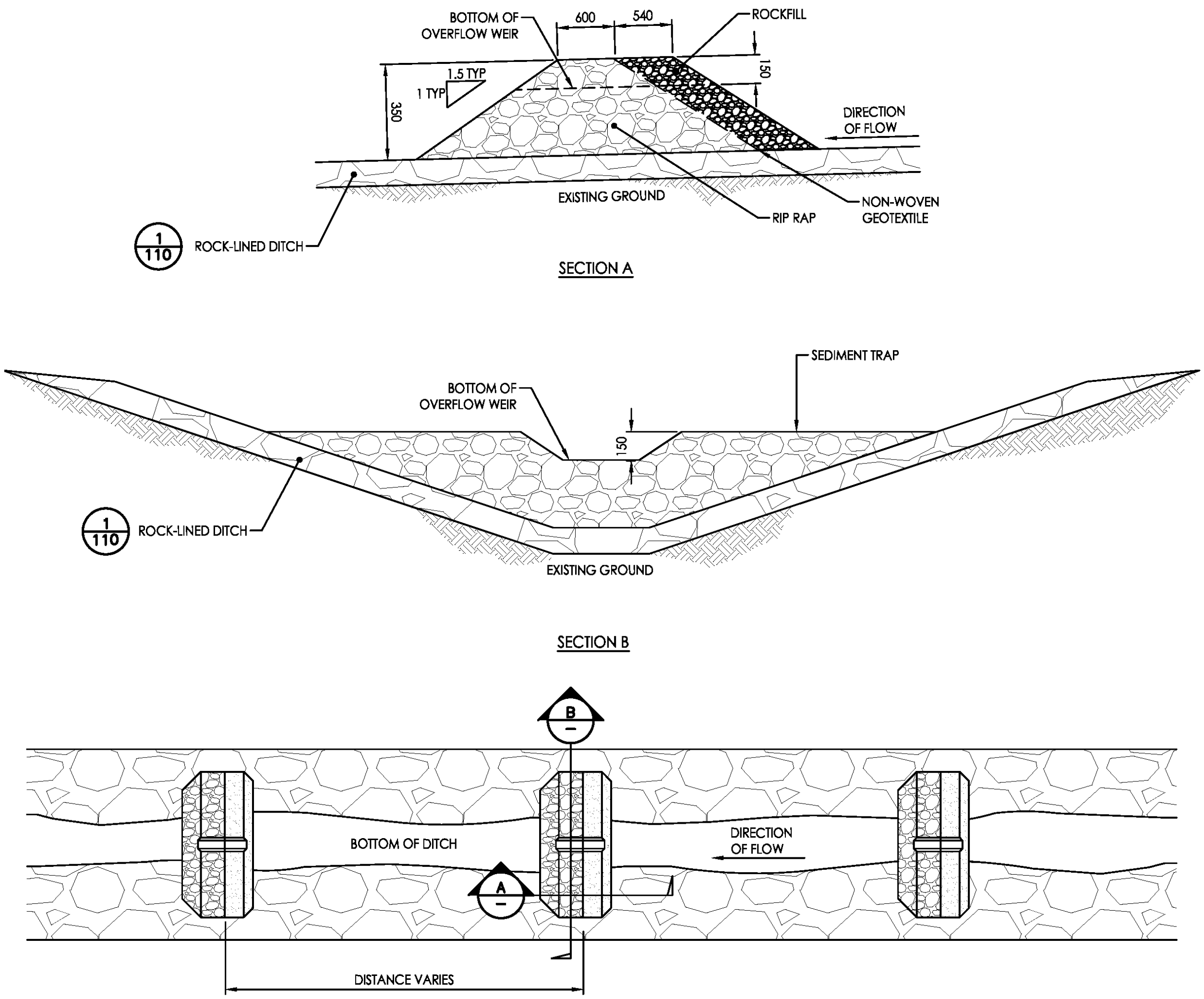


Figure 5.3 Sediment Trap Overflow Weir Typical Detail

5.2 OPERATION

Water management functions independently with decentralized treatment and control in each complex. To reduce the mine water inventory, non-contact runoff is proposed to be diverted using perimeter berms to allow runoff to naturally flow offsite. The operations water management design is presented in Figures 5.4 to 5.7 for the Marathon complex, Processing Plant and TMF complex, Leprechaun complex, and Berry complex, respectively.

The water management design diverts non-contact water from the mine facilities natural water drainage areas, where possible. Diversion of surface flows using berms constructed around the crest of open pits or up-gradient of waste rock piles and perimeter ditching and other developed areas to reduce the contact water inventory. Where possible, water collected in pits or in the water management ponds will be used for other purposes on site rather than discharged to the environment.

The water management design maintained a buffer of approximately 15 m from fish bearing watercourses. Flows to fish bearing streams and bogs were maintained by draining mine site components to pre-development streams and bogs and designing low flow outlets from ponds to receivers to augment baseflow. Flow to these fish bearing watercourses will be maintained by targeting pre-development flows, where feasible. MDMER limits will be met at FDPs prior to release.

The water management design includes 19 water management ponds. MDMER limits will be met at FDPs downstream of the ponds prior to release to the receiver. Effluent will be attenuated through the ponds to enhance baseflow augmentation and reduce the potential for downstream scour and erosion.

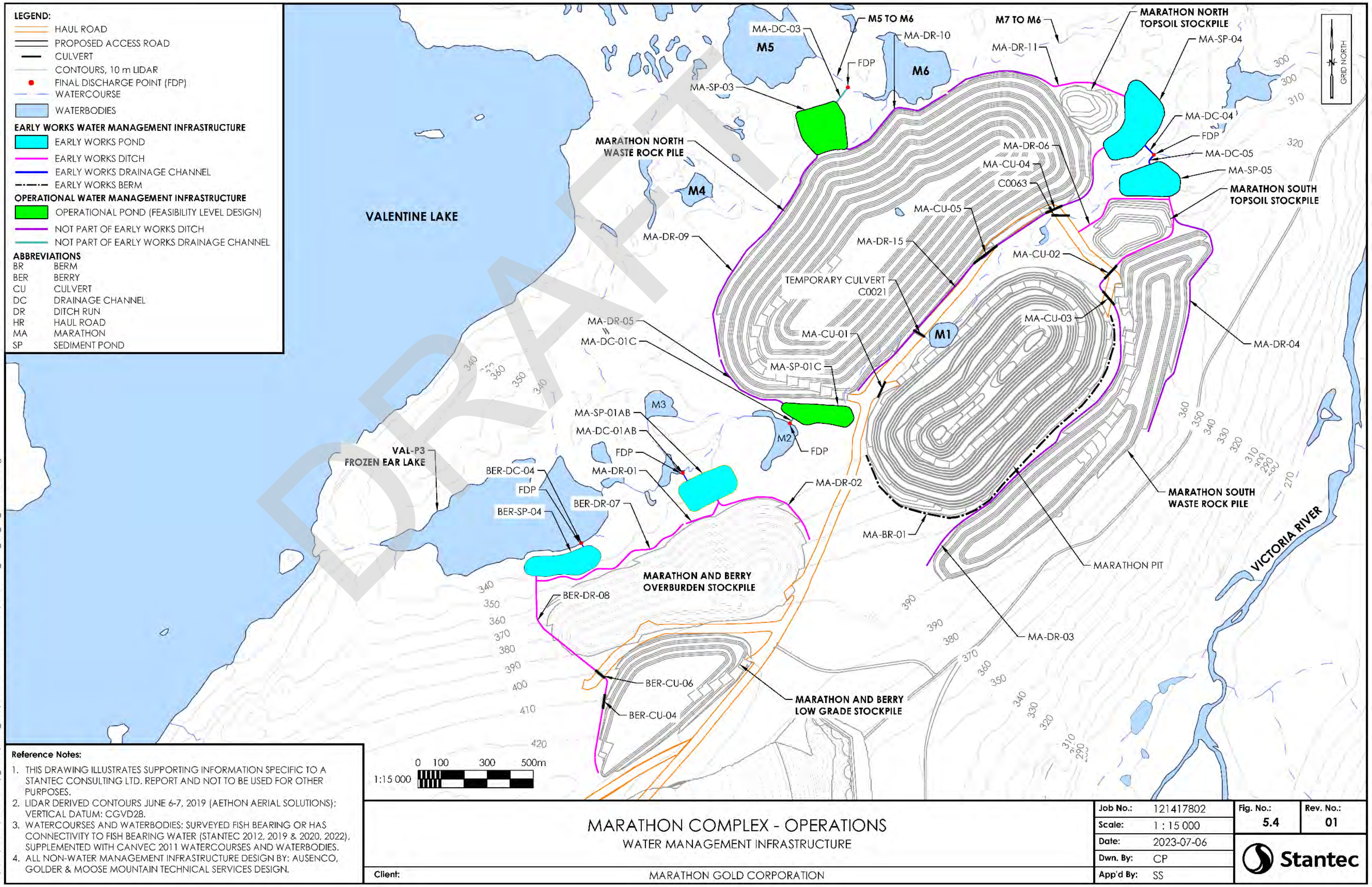


Figure 5.4 Marathon Complex Water Management Infrastructure during Operation

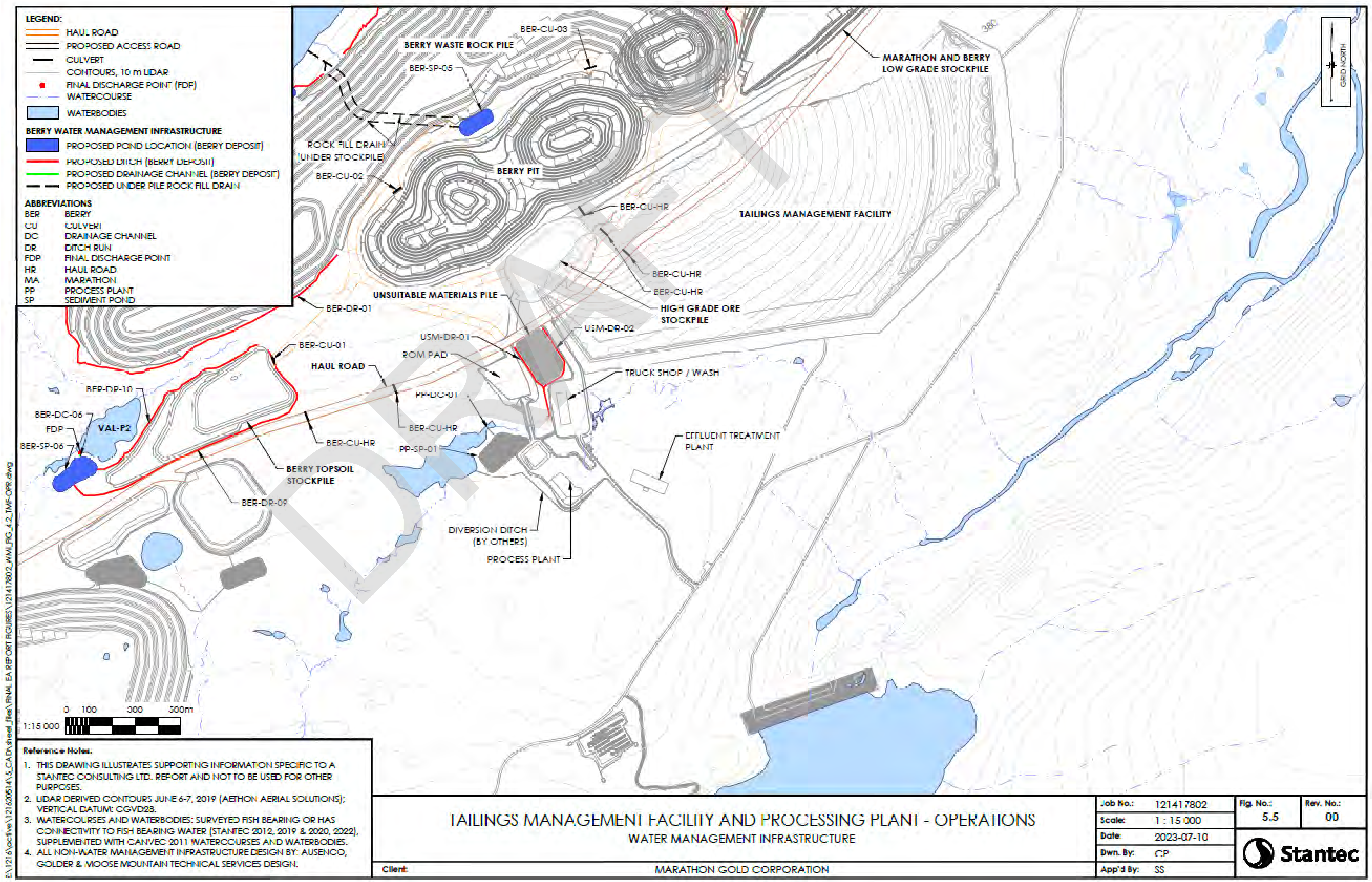


Figure 5.5 TMF and Processing Plant Complex Water Management Infrastructure during Operation

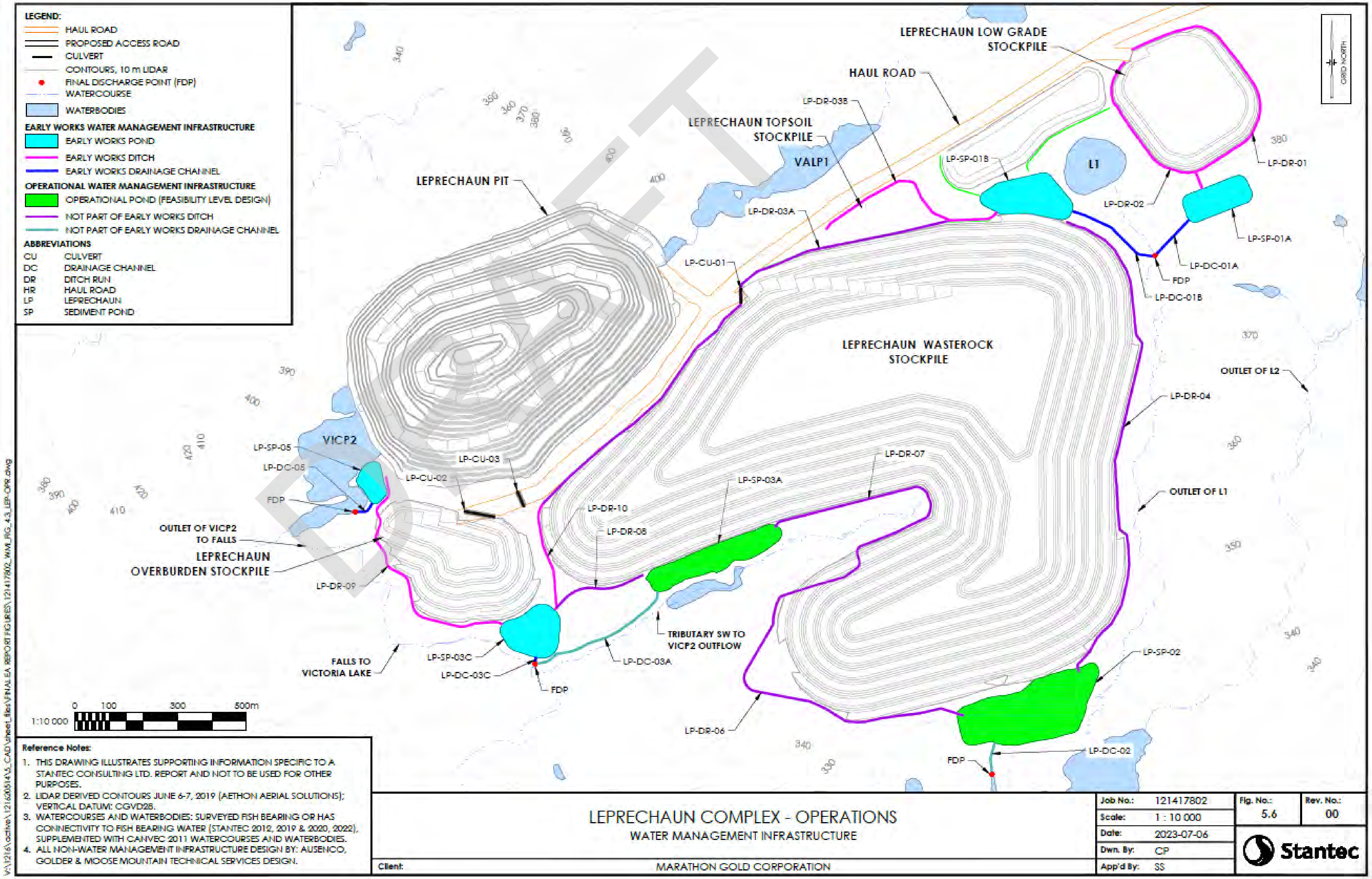


Figure 5.6 Leprechaun Complex Water Management Infrastructure during Operation

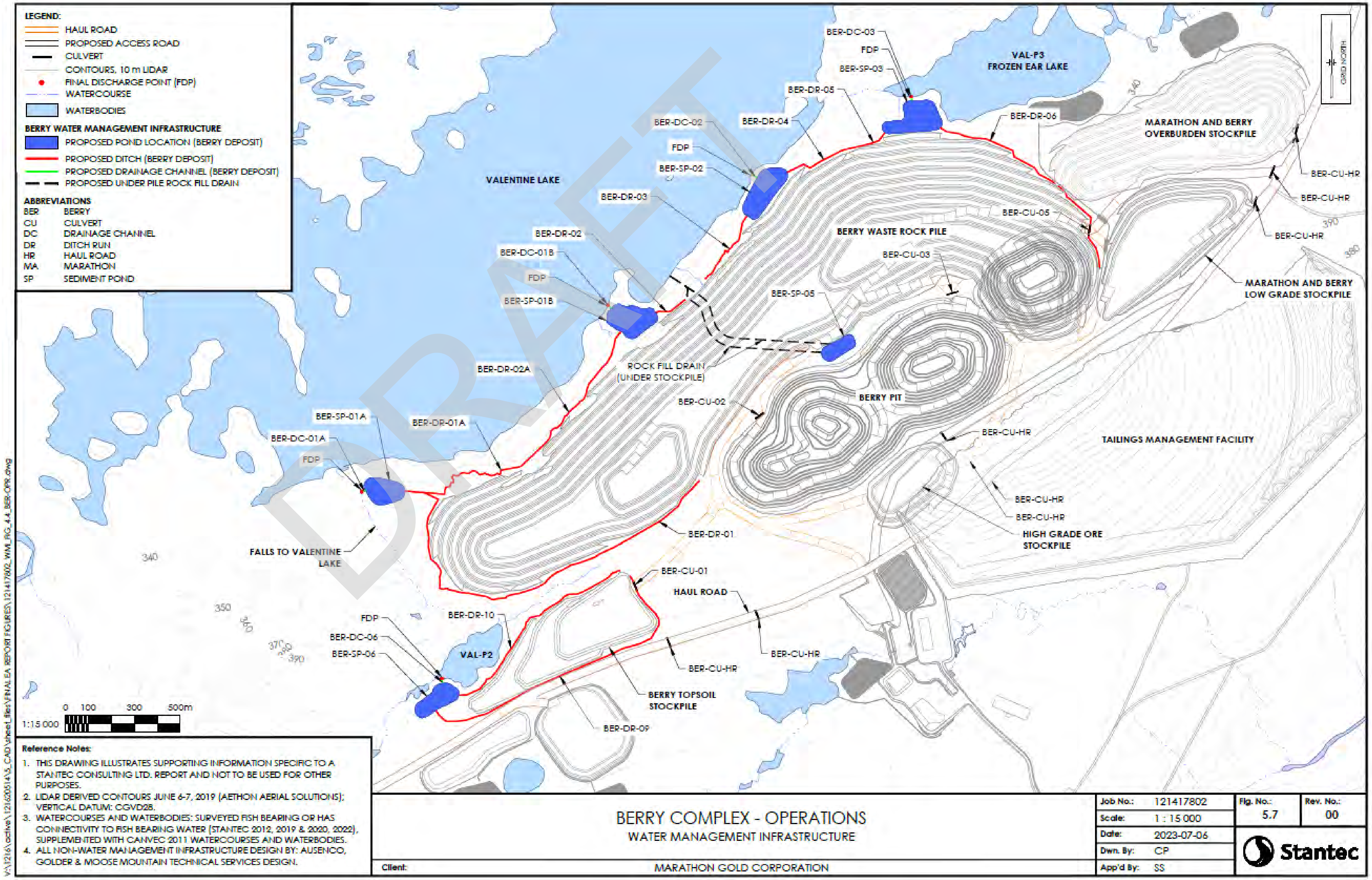


Figure 5.7 Berry Complex Water Management Infrastructure during Operation

5.2.1 Ditch and Water Management Pond Design

Water management infrastructure, exclusive of pond outlet infrastructure and discharge channels, is summarized in Table 5.2 and Table 5.3. Catchment areas for mine site components were delineated in AutoCAD based on the available Project LiDAR (Aethon 2021) and have been included on Figures 4.1 to 4.6 for the operations and closure phases.

Water management ponds provide on-site storage of runoff with controlled releases permitted after appropriate residence time for particulate settling. All permanent pools will be excavated below grade, thus reducing the total berm height required to achieve the storage requirements while improving dam safety. Water management ponds will include multi-stage outlet control through a low-level reverse flow submerged outlet and a spillway.

Water management pond embankments will be constructed out of locally sourced glacial till. Erosion protection will be provided through geomembrane and riprap lining of the berm and spillway and a scour pad at the toe of slope of spillways. A geotextile filter layer will be placed between materials to reduce the opportunity for piping. Where topography allows, the crest of the berm will be 4 m wide and have 2H:1V and/or 3H:1V embankment slopes to allow for light vehicle access on top of the berm to facilitate maintenance and monitoring activities. Typical water management pond design is presented in Figure 5.8.

Ditches will be constructed along the perimeter of piles to convey the 1:100 AEP surface runoff and toe drainage to water management ponds for water quality and quantity control. Ditches will be designed to convey gravity flow to reduce operational costs that would results from pumping. Ditches will follow a standard trapezoidal geometry with a maximum 2H:1V side slope tied into existing grade to reduce cost of construction and maintaining a minimum of 0.5 m freeboard. Materials excavated from ditches will be sidecast, and berms constructed of the sidecast material to reduce cost of construction. Berms will be constructed on the outside bank of the ditches. No berms will be constructed between the ditch and its source stockpile.

Ditches will be lined with riprap (Type 6 fill) in steep sections and seeded in lower sloped zones for erosion protection. In areas with ditch gradients steeper than 8%, in-line sediment traps (i.e., check dams) will be installed at a spacing of 200 m per ditch grade percentage value to provide energy dissipation and reduce erosional flow velocities in the ditch. For the same purpose, energy dissipation pools will be installed at the change in ditch gradient from slopes of 10% or higher to shallower slopes. Ditches are proposed in three general size categories to account for increases in collection drainage over the longer lengths of ditches. Figure 5.9 presents the typical section views for the three ditch size categories. Table 5.2 presents summarized details on water management pond and ditch design, based on early works detailed design for the Marathon and Leprechaun complexes (Stantec 2023a) and FS level design for the Berry, Marathon and Leprechaun complexes (Stantec 2021, 2022a)

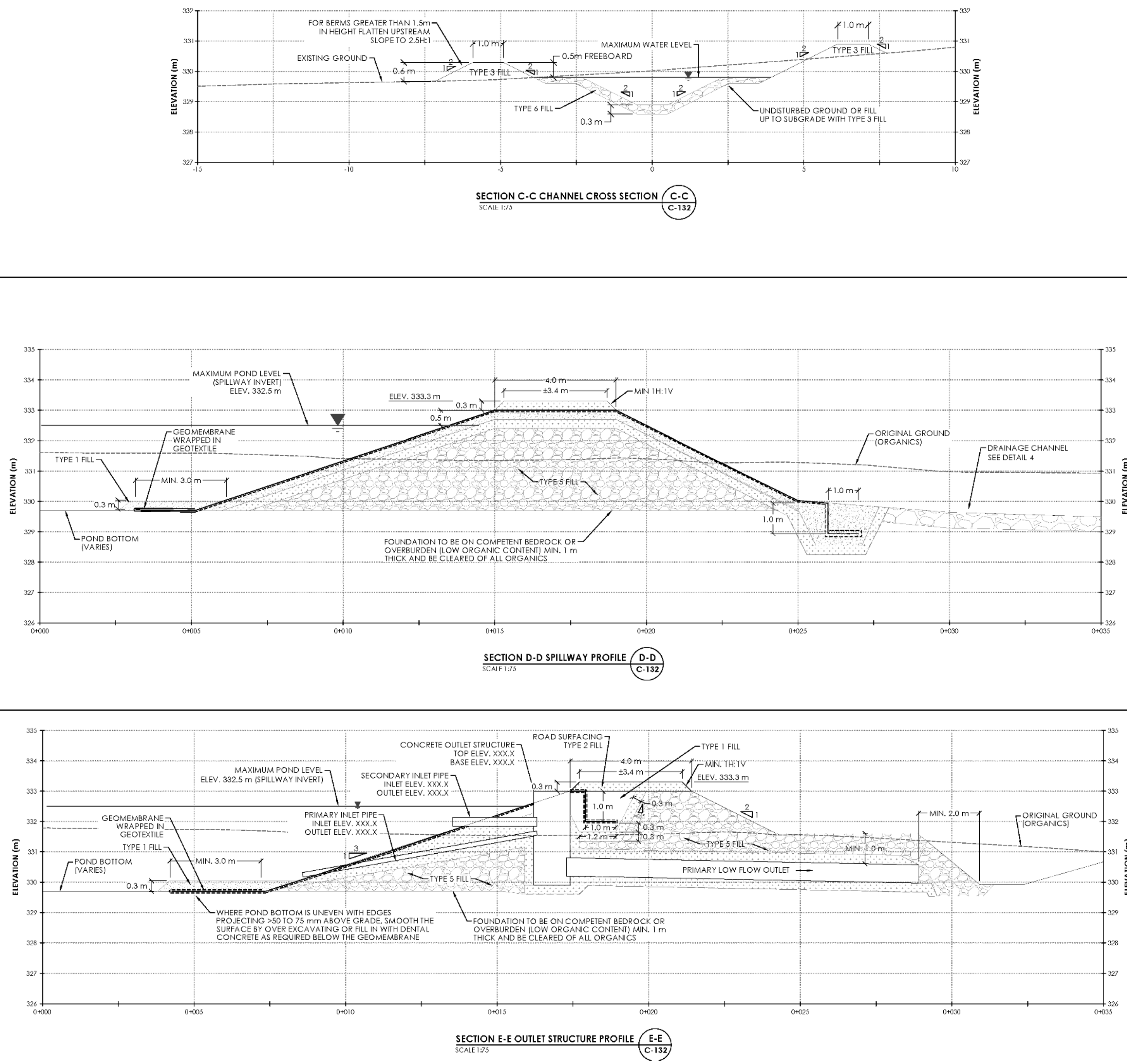
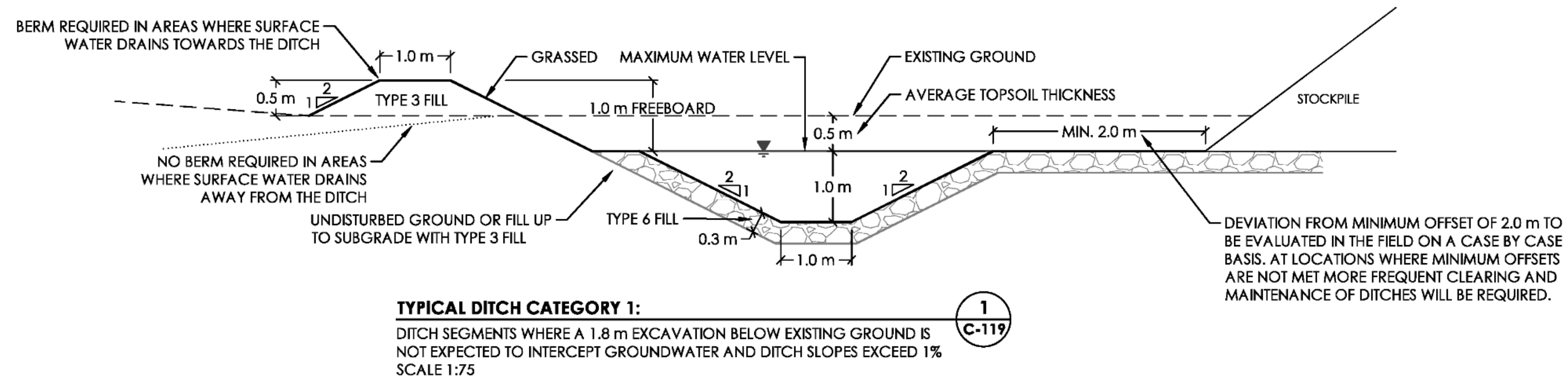
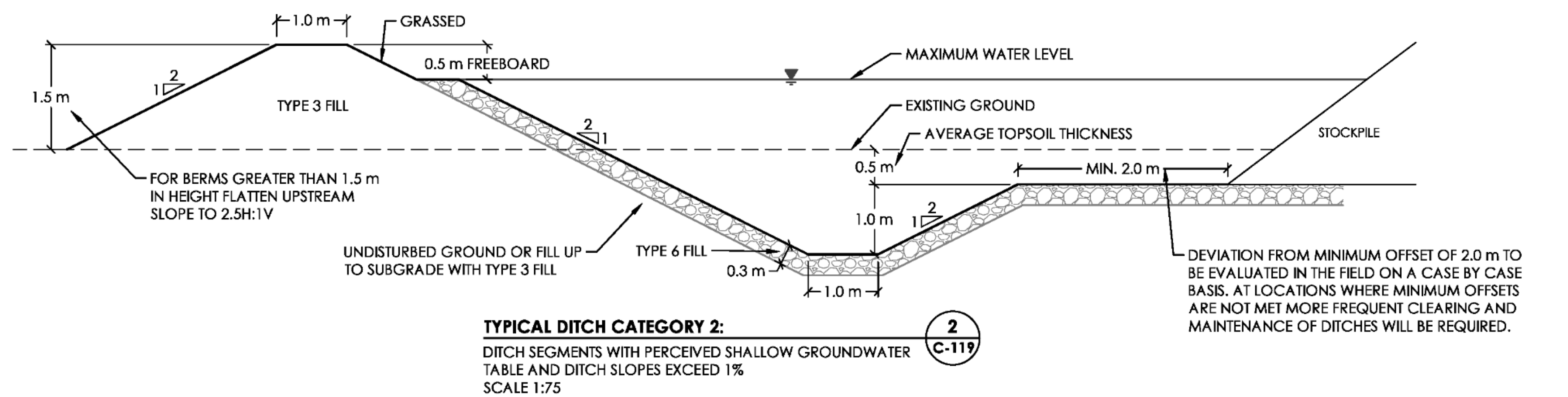


Figure 5.8 Water Management Pond Typical





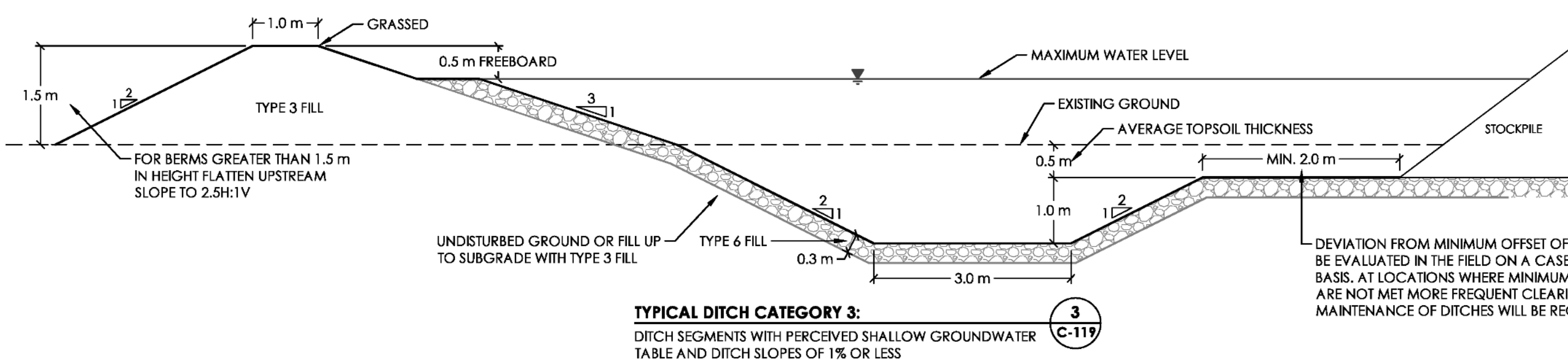


Figure 5.9 Ditch Typical

Table 5.2 Water Management Pond and Ditch Design Management Infrastructure

Mine Facility	Ditch Run	Water Management Pond	FDP	Discharge Location
	AC-DR-02			
Processing Plant ROM Pad & Roadways [13.7 ha]	PP-DR-01	PP-SP-01 \	PP-FDP-02	Pond L2 to Victoria Lake Reservoir
Leprechaun Low Grade Stockpile [12.2 ha]	LP-DR-01	LP-SP-01A	LP-FDP-01A	Stream VIC-26 to Victoria Lake
	LP-DR-02			
Leprechaun Topsoil Stockpile [2.6 ha]	LP-DR-03B	LP-SP-01B	LP-FDP-01B	
Leprechaun Waste Rock Pile [159 ha]	LP-DR-03A	LP-SP-02	LP-FDP-02	Victoria Lake Reservoir
	LP-DR-08			
	LP-DR-10			
Leprechaun Overburden Stockpile [12.2 ha]	LP-DR-09	LP-SP-03C	LP-FDP-03C	Stream VIC-16 to Victoria Lake Reservoir
Leprechaun Pit [56.8 ha]	-	LP-SP-05	LP-FDP-05	Pond VIC-P2; Stream VIC-16; Victoria Lake Reservoir
Marathon Waste Rock Pile North [151ha]	MA-DR-05	MA-SP-01C	MA-FDP-01C	Stream Val-2 Valentine Lake
	MA-DR-09	MA-SP-03	MA-FDP-03	Stream VIC-06; Victoria River
	MA-DR-10			
	MA-DR-15	MA-SP-04	MA-FDP-04	Tributary to Victoria River (VIC8)
Marathon Topsoil Stockpile [3.5 ha]	MA-DR-11			
Marathon Topsoil Stockpile 2 [ha]	MA-DR-12			
Marathon Waste Rock Pile South [27.2 ha]	MA-DR-03	MA-SP-05	MA-FDP-05	
	MA-DR-04			
Marathon Pit [69.8 ha]	MA-BR-01			

Table 5.2 Water Management Pond and Ditch Design Management Infrastructure

Mine Facility	Ditch Run	Water Management Pond	FDP	Discharge Location
Berry Waste Rock Pile [257.5 ha]	BER-DR-01	BER-SP-01A	BER-FDP-01A	Valentine Lake
	BER-DR-01A			
	BER-DR-02A	BER-SP-01B	BER-SP-01B	
	BER-DR-02			
	BER-DR-03	BER-SP-02	BER-FDP-02	
	BER-DR-04			
	BER-DR-05	BER-SP-03	BER-FDP-03	
	BER-DR-06			
Marathon and Berry Overburden Stockpile [40.1 ha]	MA-DR-01	MA-SP-01AB	MA-FDP-01AB	ValP3 to Valentine Lake
	MA-DR-02			
Marathon and Berry Low Grade Ore Pile [23.9]	BER-DR-07	BER-SP-04	BER-FDP-04	
	BER-DR-08			
Berry Pit [83.0ha]	Temporary BER-DR-11	BE-SP-05	BER-FDP-05	Valentine Lake
	Temporary BER-DR-12			
Berry Topsoil Pile [19.2 ha]	BER-DR-09	BER-SP-06	BER-FDP-06	Unnamed Tributary to Valentine Lake
	BER-DR-10			

As noted in Table 5.3, discharge channels were constructed at the outlet of water management ponds to coordinate, where feasible, effluent discharge points and associated downstream MDMER monitoring requirements. Operational costs were reduced as flow was conveyed through additional ditching and grading rather than installing a pipe and pipeline.

Table 5.3 Sediment Pond Discharge Channel Lengths

Discharge Channel Name	Discharge Channel Length (m)	Discharge Channel Name	Discharge Channel Length (m)
LP-DC-01A	145	LP-DC-01B	280
LP-DC-02	80	LP-DC-03A	435
LP-DC-03C	24	LP-DC-05	62
MA-DC-01AB	38	MA-DC-03	83
MA-DC-04	57	MA-DC-05	50
MA-DC-01C	26	BER-DC-01A	18
BER-DC-01B	21	BER-DC-02	28
BER-DC-03	18	BER-DC-04	19
BER-DC-05	767,740,720*	BER-DC-06	22
PP-DC-01	50	---	---
* - piped discharge			

Pond storage, geometry, and outlet configuration are summarized in Table 5.4. The inactive and 100-year return period active pond storage below the spillway are summarized for each sediment pond. Pond geometry includes the designed pond bottom elevation and berm crest elevation in addition to the pond width and length. Outlet configuration of the bottom draw pipes and associated orifice diameter needed to provide residence time and extended discharge attenuation and spillway width were also provided as these dimensions change for each sediment pond.

Pumps will be required to dewater the Marathon, Leprechaun and Berry pits. A pit dewatering pond was designed at a low-lying location adjacent to each pit. It was assumed that a pond volume of 11,190 m³, 10,974 m³, and 37,500 m³ for the Marathon. Leprechaun and Berry pits will be adequate to contain the pit dewatering rates based on the rates reported by GEMTEC (2022a). Pit dewatering discharge directed to the pit dewatering ponds at the surface will be subsequently drained to pre-development catchments.

Table 5.4 Pond Storage, Geometry, and Outlet Configuration

Sediment Pond Name	Inactive Pond Storage (m³)	Active Pond Storage (m³)	Total Pond Storage (m³)	Pond Bottom Elev. (m)	Pond Berm Crest Elev. (m)	10-year Return Period Orifice Diameter (mm)	Spillway Base Width (m)	Spillway Elev. (m)
MA-SP-01C	14,030	22,700	36,730	342.1	345	150	3	-
MA-SP-03	28,730	37,090	65,820	325.9	328.6	250	4	-
MA-SP-04	17,350	81,000	98,350	313.4	317	250	3	316.7
MA-SP-05	2,880	6,800	9,680	329.7	333	100	5	314.7
LP-SP-01A	5,455	16,140	21,595	375	378.5	150	3	378.0
LP-SP-01B	14,590	42,735	57,325	379.3	385	150	3	384.7
LP-SP-02	42,300	112,775	155,075	326.2	333	200	3	-
LP-SP-03A	7,720	56,180	63,900	350.2	355	250	5	-
LP-SP-03C	10,240	39,260	49,500	341.4	347	200	3	346.2
LP-SP-05	4,650	5,020	9,670	385	389	150	4	385.5
PP-SP-01	14,673	16,937	31,610	377	380	150	8	379.2
BER-SP-01A	12,300	34600	46,900	335	339.9	150	3	340.2
BER-SP-01B	18,400	51500	69,900	325.9	331.9	250	3	331.1
BER-SP-02	16,400	45,400	61,800	324.8	333	200	3	332.2
BER-SP-03	22,700	63,500	86,200	333	339	250	3	338.2
BER-SP-04	15,200	42,600	57,800	338.9	343	200	3	340.2
BER-SP-05	25,600	76,500	102,100	418	424	250	7	423.2
BER-SP-06	17,600	26,700	44,300	388	394	200	3	393.2
MA-SP-01AB	14,191	44,596	58,788	338.3	342.8	200	3	341.7

5.2.2 Processing Plant and TMF Complex

The tailings pond will collect direct precipitation, runoff from the tailings surface, water discharged from the mill with the tailings (Mine Years 1 to 9), and water pumped back from the seepage collection sumps around the facility. During the operation phase, water will be pumped from the tailings pond via a reclaim pump system for the operation of the processing plant. Excess TMF effluent and process water is routed through a water treatment plant and SAGR® unit to discharge via a pipeline to Victoria Lake Reservoir. The pipeline extends into Victoria Lake Reservoir at the final discharge point PP-FDP-01. Clean make-up water required in the process plant will be supplied from Victoria Lake Reservoir. In Year 10, when tailings deposition is switched from the TMF to the Berry pit, process water will continue to be supplemented by TMF reclaim water, in addition to the minimum of 8% freshwater make-up from Victoria Lake Reservoir.

Seepage collection ditches will be constructed at the downstream toe of the tailings dam. Seepage from the ditches will be directed to sump pits at various topographic low points around the dams; seepage and runoff collected in the sumps will be pumped back to the tailings pond. The tailings pond is designed to contain the Environmental Design Flood and Inflow Design flood.

The process plant pad will be graded to allow surface runoff water to drain naturally to the internal network of collection swales and ditches sized to handle peak flow resulting from storm events. The pond will be designed to promote settling of solids and provide flow attenuation of peak storm events. The collection ditches will convey the water to a stormwater pond (PP-SP-01), west of the processing plant. The water in the water management pond will be pumped into the process water tank as make-up water as required and excess water will drain toward Victoria Lake Reservoir via a local tributary.

Raw freshwater will be pumped from Victoria Lake Reservoir to supply fire water, cooling water, gland water for pumps, reagent make-up, feed for potable water plant, and the freshwater make-up process water demand. Raw water for the process demand will be pumped from Victoria Lake Reservoir to the tanks and distributed to the required points in the plant and in addition supply the potable water treatment system. Demand for the process plant is 19 cubic metres per hour (m^3/h) in the pre-processing period (2.5 Mt/a) and 29 m^3/h at full production (4 Mt/a). The potable water plant satisfies the demand for the accommodations camp and other onsite building use. Sewage will be collected via an underground sanitary sewer network to an above-grade mechanical sewage treatment package plant. The processing plant will have one sewage treatment plant and the accommodations camp will have a separate sewage treatment plant. Sanitary sludge will be disposed at an approved offsite facility by an appropriate contractor.

5.3 DECOMMISSIONING, REHABILITATION AND CLOSURE

5.3.1 Rehabilitation and Closure

Water management during progressive rehabilitation, and rehabilitation and closure, will be consistent with that during operation. However, due to the ground disturbance associated with the rehabilitation activities, standard ESC measures for construction will also be implemented to supplement the existing water quality treatment infrastructure.

The duration of rehabilitation and closure activities provides adequate time for earthworks activities to be completed, vegetation to establish, and water quality to improve and the open pits to fill and eventually discharge to the environment. Water quality treatment of effluent discharge in water management ponds and TMF effluent in the treatment plant will continue during rehabilitation and closure until water quality monitoring demonstrates that water quality is acceptable to release to the environment and that closure activities are successful. At that time, water management ponds will be breached to allow drainage to the natural ground and local receivers, and all water management features will be removed and restored to natural, pre-development drainage conditions and the water treatment plant decommissioned. Perimeter ditches will be backfilled with organic compost material and covered with overburden and a vegetated soil cover creating the following conditions:

- Non-contact runoff will drain down the pile slopes and benches or beaches, over the perimeter ditch footprints and overland to local receivers following natural drainage patterns.
- Contact seepage will be substantially reduced from the uncovered condition due the increase in runoff and evapotranspiration potential of the vegetated soil cover on the residual stockpiles; the reduced volume of contact seepage will migrate across the perimeter ditches and assimilate (attenuate naturally) with local groundwater to discharge into local receiving waters.
- In cases where natural attenuation of contact seepage will not be adequate to improve groundwater discharge quality at the local receiver to background or CWQG-FAL thresholds, further passive treatment systems may be required.
- Passive treatment systems could take the form of subsurface anaerobic permeable bioreactor units in the ditches. If further treatment is required, subsurface/surface units that use the water management pond basins as engineered wetland features could be employed. In both cases, seepage is transmitted across or within the ditches. French drains will be implemented in ditches to transmit seepage where passive treatment is to be augmented by engineered wetlands. Pilot testing of the permeable bioreactors will take place during operations.

Based on the results of the mixing zone assessment (Stantec 2020g, 2023b), passive treatment systems may be required to be implemented during closure / post-closure at the Marathon, Berry, and Leprechaun waste rock piles and TMF. Seepage quality in the TMF toe seepage collection system was predicted to exceed CWQG-FAL for copper, zinc, and cyanide. For example, perimeter ditches can be maintained to collect seepage and to treat it passively in a permeable reactive barrier and discharge out the opposite side of the ditch as groundwater.

5.3.2 Post-Closure and Monitoring

During the post-closure period, site monitoring will be carried out to demonstrate that closure strategies of Project facilities are performing as intended. Monitoring will be conducted at residual FDPs of the water management facilities and at receiving locations (e.g., Victoria River, Valentine Lake, and Victoria Lake Reservoir) simulated in the groundwater model to intercept seepage from the pits, waste rock piles, and TMF. Post-closure monitoring and maintenance will be carried out at a reduced frequency from the operation phase or closure period.

The post-closure monitoring program will continue after final closure activities are completed. As stated in the Project overview, post-closure monitoring will cease once the Project-related effects are deemed to be physically and chemically stable and accepted by regulatory agencies. The site can then be closed out or released by NLFFA and an application made to relinquish the property back to the Crown.

6.0 SITE-WIDE WATER BALANCE

A site-wide water balance (WB) was completed to estimate the quantity of mine site contact water expected to be managed for each Project complex. The water balance model was built to simulate flows to the water management infrastructure at the Marathon, Berry, and Leprechaun complexes, and Process Plant and TMF complex. The models simulate flows for construction, operation, decommissioning, rehabilitation and closure phases. The water balance represents the mine site facilities at full development during operation.

6.1 METHODS

The water balance and water quality (WQ) models are constructed using GoldSim™ simulation software (GoldSim) with the contaminant transport module extension (Stantec, 2020e, f, 2023a). The water balance model accounts for precipitation, evapotranspiration, infiltration and groundwater gains and runoff at each identified mine facility, with the exception of the open pits and TMF, which are discussed separately.

As presented in Figure 6.1 for a stockpile or waste rock pile, the percentage of precipitation that results in runoff of the Project facility areas was accounted for in the water balance model by the proportion of gains and losses to precipitation. The model assumed that a waste rock pile was fully wetted during operation and did not represent a loss in the accounting associated with the wetting of the pile. Equation 1 presents the accounting of runoff collected in the water management ponds based on the hydrological inputs:

Equation 1

Runoff to Water Management Ponds = Precipitation
– ET (%F)
– Snow Storage
+ Snow Melt Runoff (%F)
– Net infiltration
+ Toe Seepage
+ Shallow Groundwater Infiltration (%F)

Where,
%F = Adjustment factor applies as %

Net Infiltration = Toe Seepage + Shallow Groundwater + Deep Groundwater

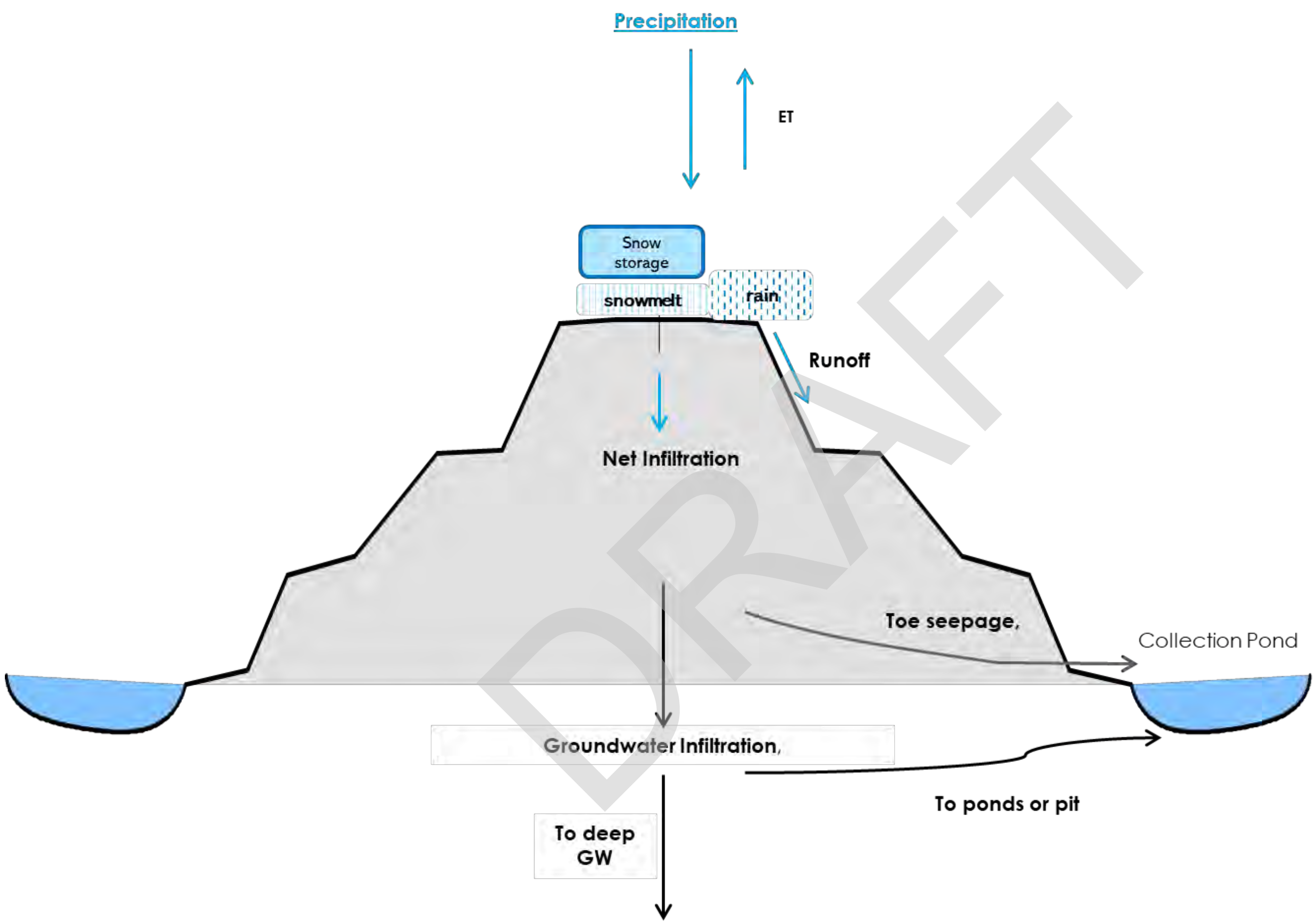


Figure 6.1 Waste Rock Pile Flow Pathways

Waste rock piles are comprised of a range of material grain sizes from fines to large boulders, with most material in the cobble to boulder size classes. Thus, when piles are open and not covered by snow, the pile surface is so coarse and has so much infiltration capacity that the piles do not generate runoff. The primary drainage activity during the open, non-snow-covered period is infiltration. The infiltration that does not evaporate, referred to a net infiltration, seeps through the pile and routes either to toe seepage collected by the perimeter ditches or recharges deeper regional groundwater bypassing the perimeter ditch collection system. During snow-covered conditions, rain on snow and snowmelt can produce runoff over snow and the ice lenses that develop within the snowpack.

The water balance of the TMF was based on a runoff coefficient approach. Runoff from the tailings and SAGR® unit was estimated in the model based on the proportion of total precipitation (rainfall plus snow melt runoff) on the catchment multiplied by a runoff coefficient. This method is consistent with the feasibility level water balance model conducted by Golder for design (2021, 2022). The proportion of precipitation stored as snow was not accounted for at the TMF, as the snow storage in the pond will not be representative of the rest of the site.

As part of the design, runoff coefficients were assigned to different land use type, which includes:

- Natural or undisturbed ground upgradient of the TMF that will continue to gravity flow into the TMF during operation
- Prepared ground associated with areas that have been grubbed and/or graded, such as the perimeter haul roads and TMF embankments
- TMF dry tailings beach along the north dam and the water pond in the south

It was assumed that approximately 20% of the beaches were wet and the remaining 80% of the beaches were dry (Golder 2022). Natural ground runoff coefficient was based on an environmental water balance model based on assumptions of local climate and soil conditions and guidance provided by USGS (McCabe and Markstrom 2007), as presented in the 2019 Hydrology Baseline Report (Stantec 2019, 2020a).

Conceptual water management applied in the water balance models at the Marathon, Berry, Leprechaun, and TMF and Process Plant complexes for the operation phase are presented in Figure 6.2 through Figure 6.14.

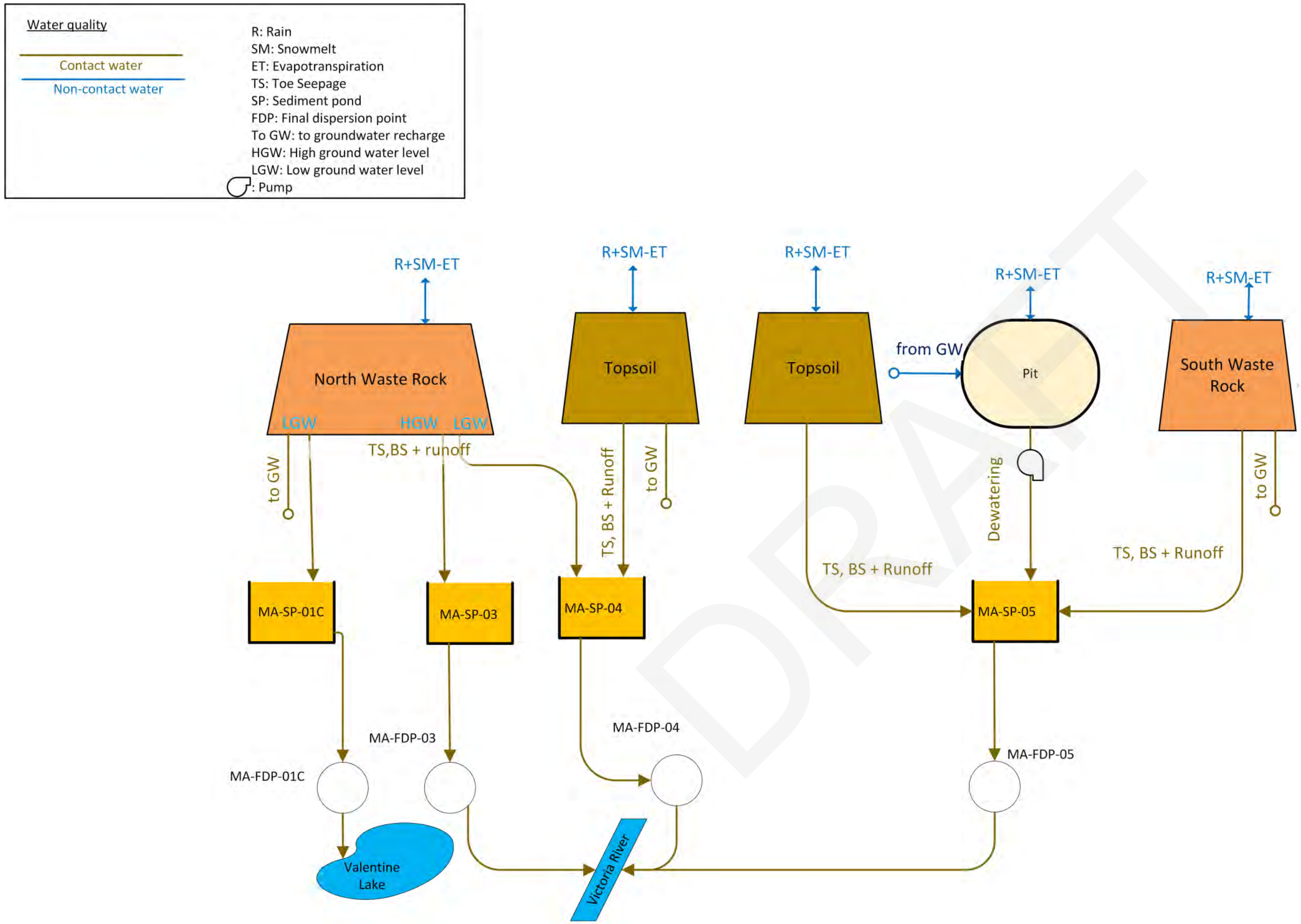


Figure 6.2 Conceptual Model of Mine Water Management – Marathon Complex Construction / Operation (Year -1 to 9)

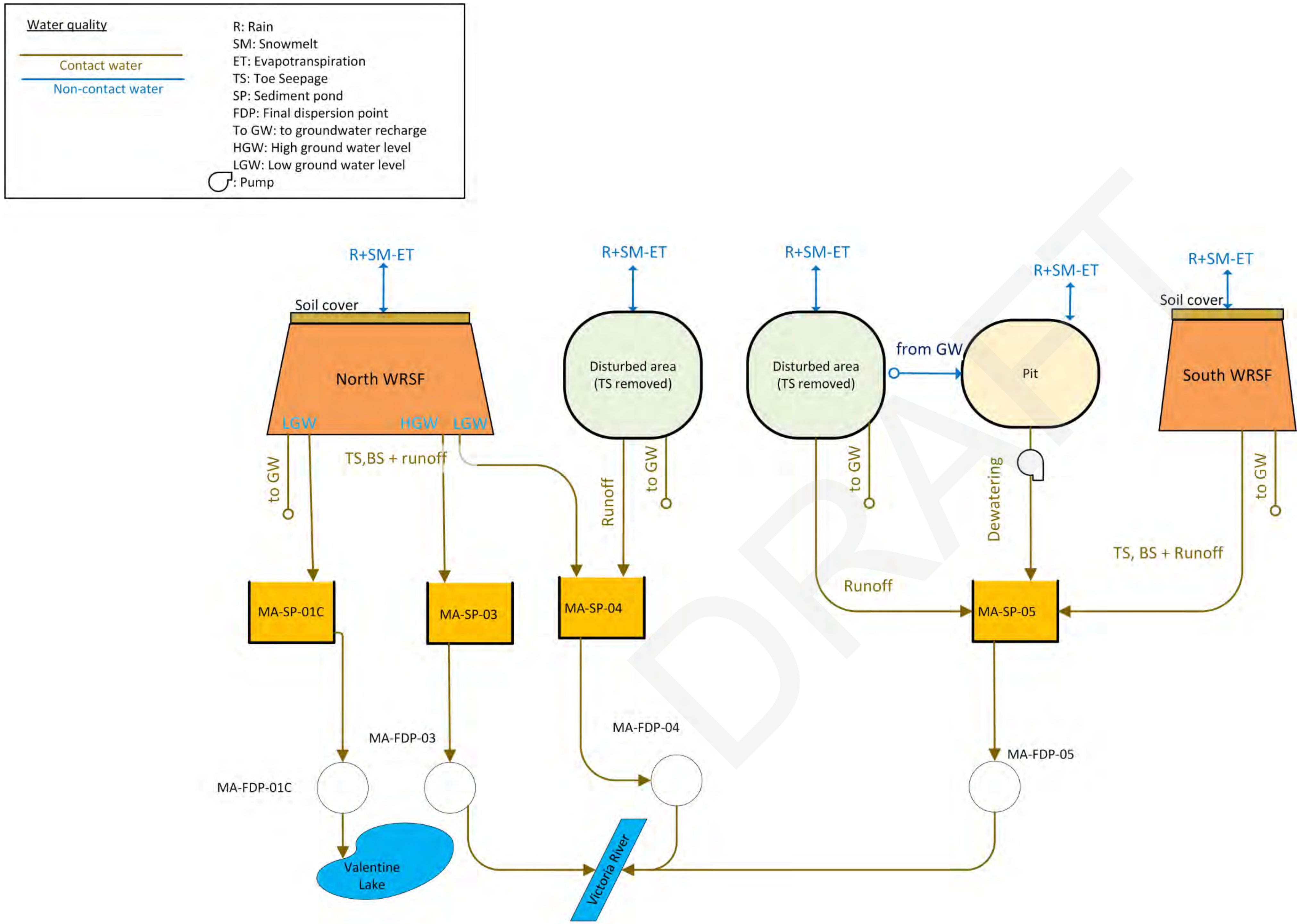


Figure 6.3 Conceptual Model of Mine Water Management – Marathon Complex Operation (Year 10 to 13)

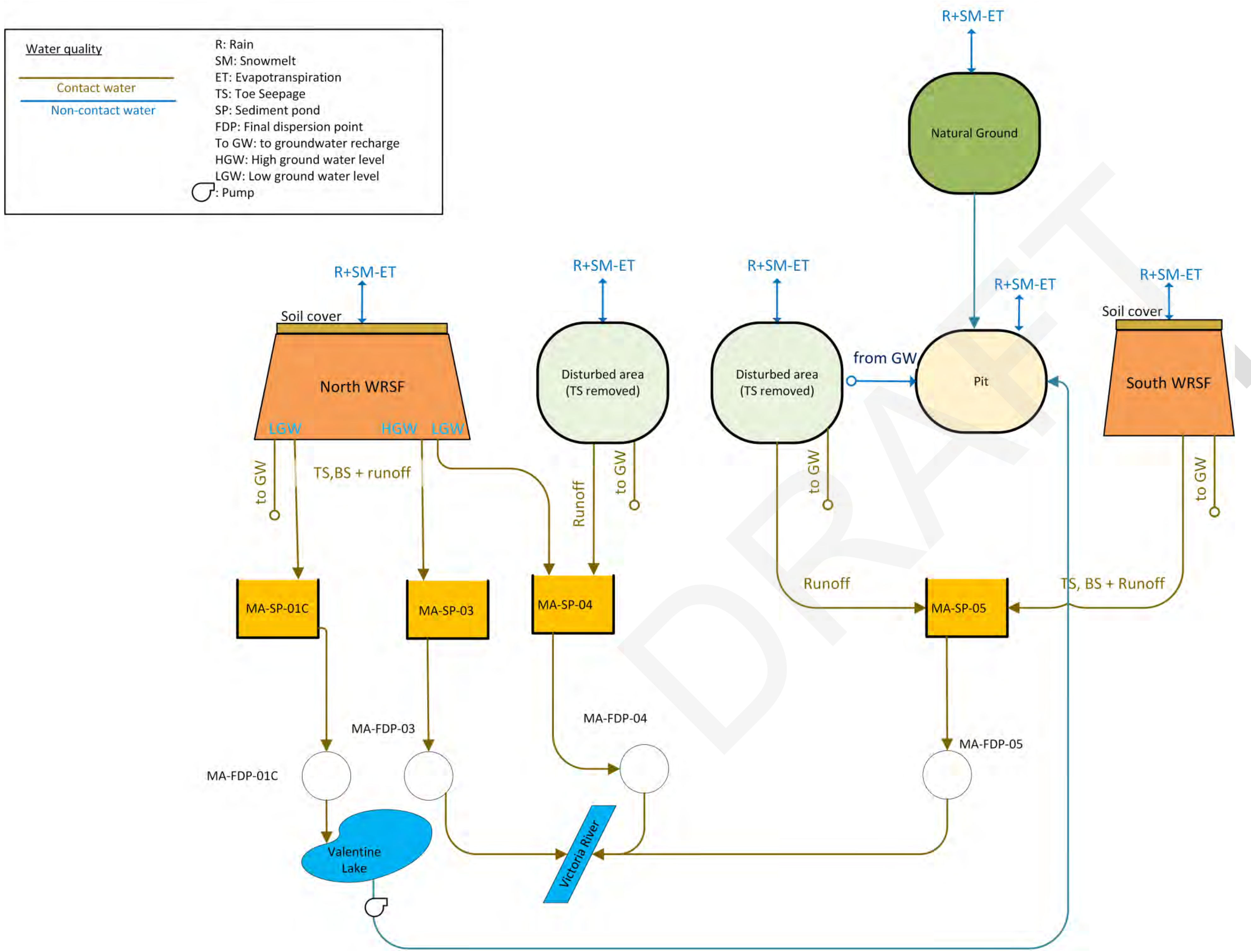


Figure 6.4 Conceptual Model of Mine Water Management – Marathon Complex Closure (Year 14 until Pit is full)

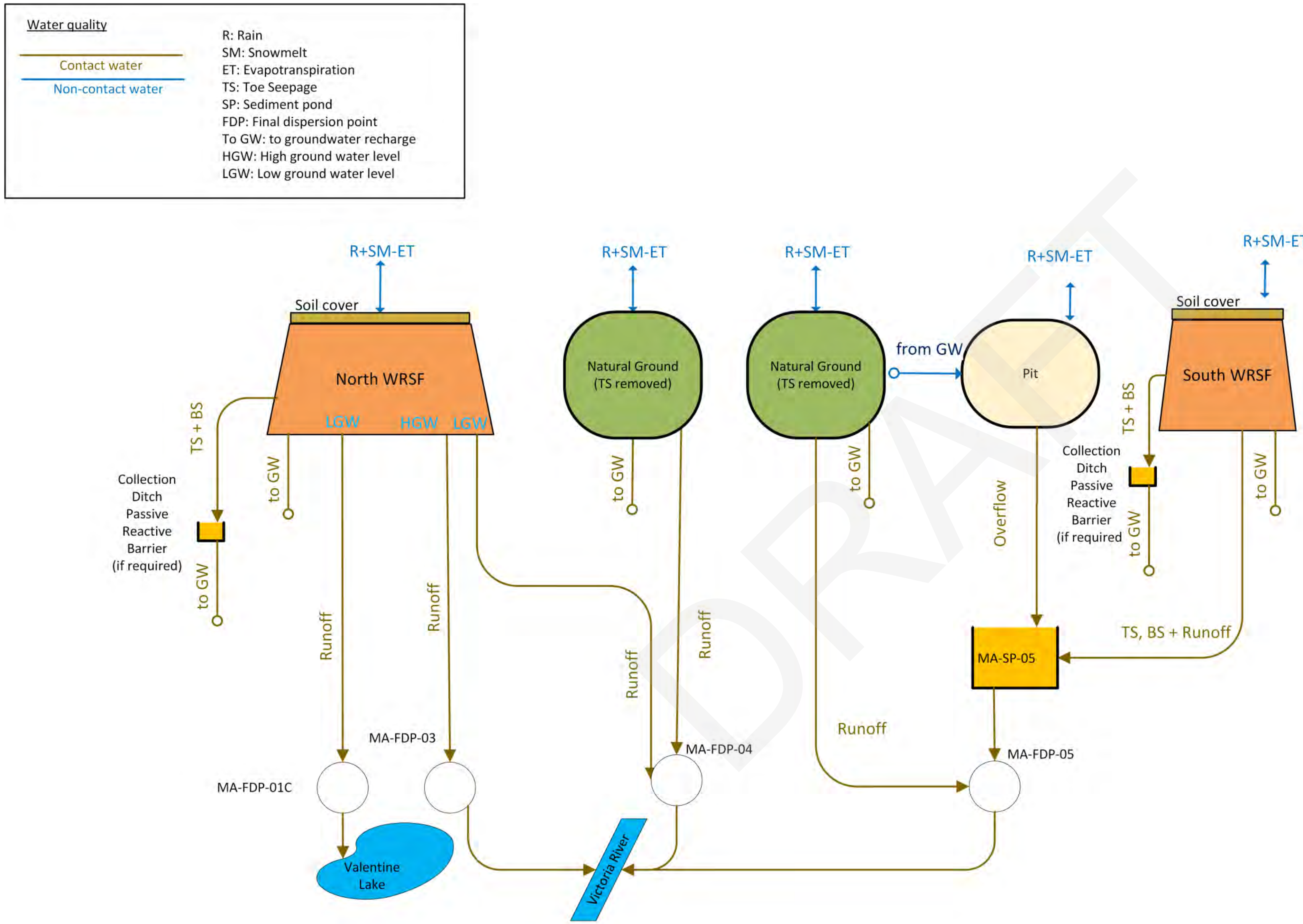


Figure 6.5 Conceptual Model of Mine Water Management – Marathon Complex Post-Closure (Pit is full)

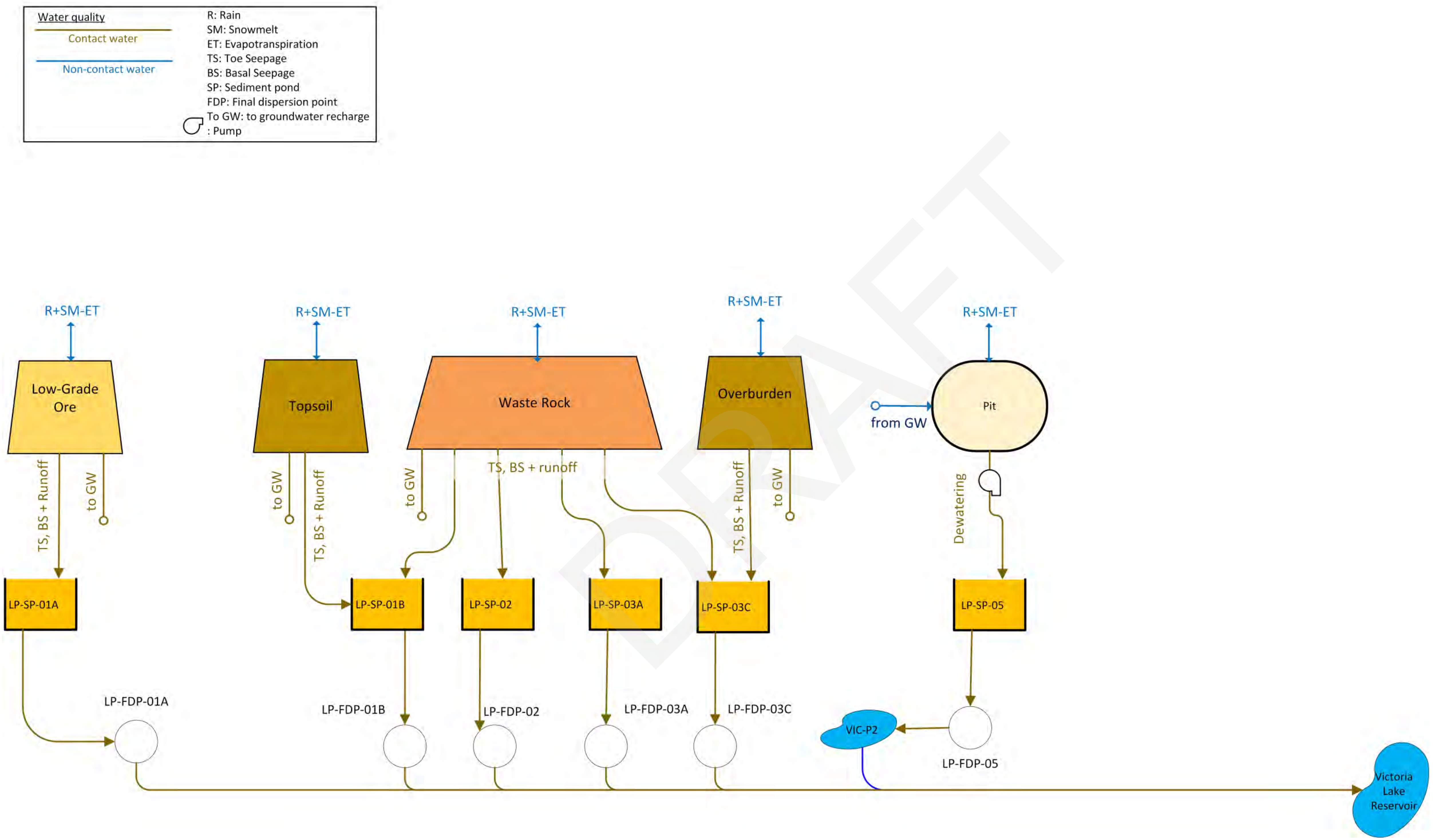


Figure 6.6 Conceptual Model of Mine Water Management – Leprechaun Complex Construction/Operation (Year -1 to 12)

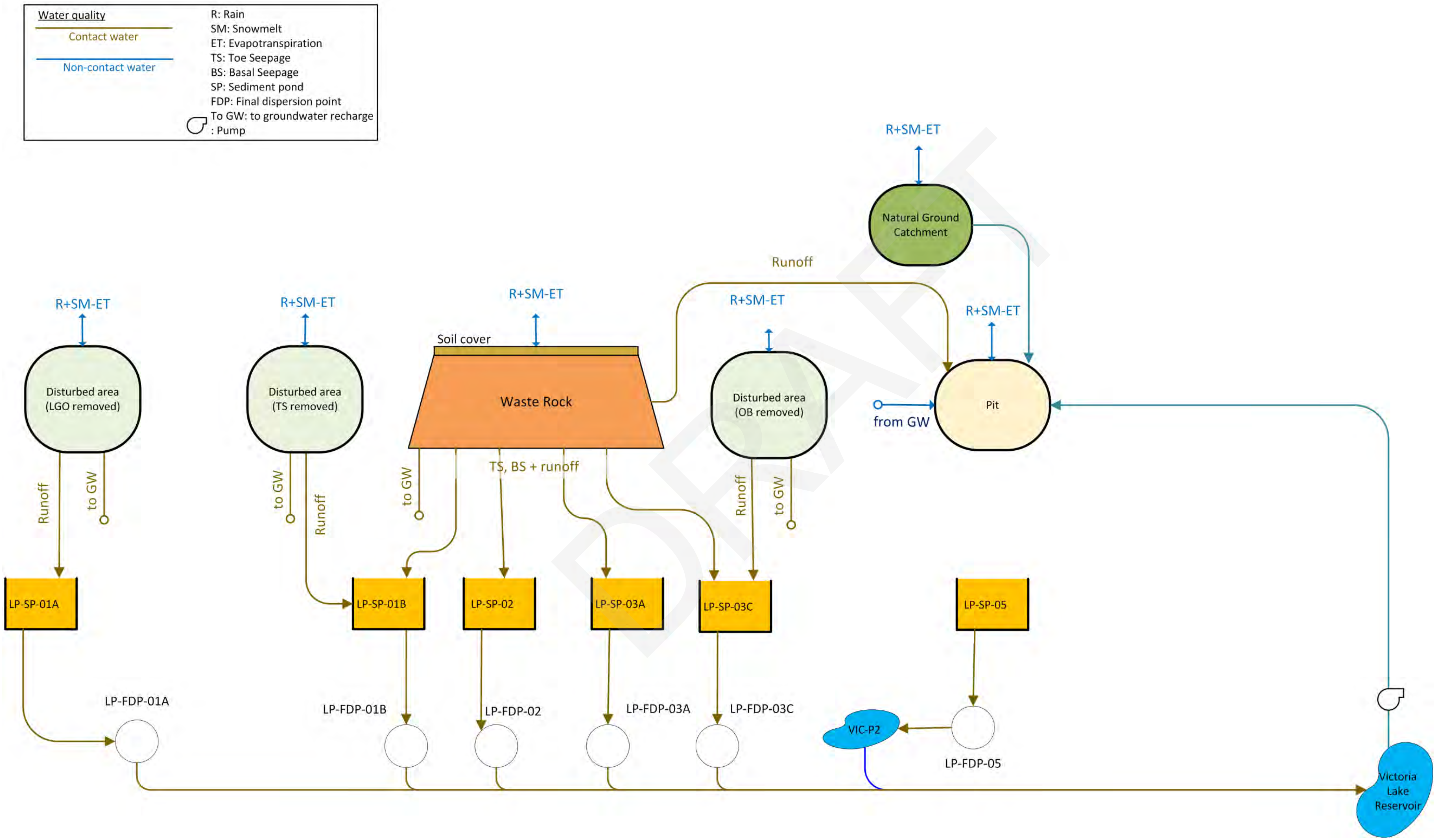


Figure 6.7 Conceptual Model of Mine Water Management – Leprechaun Complex Closure (Year 13 to Pit Full)

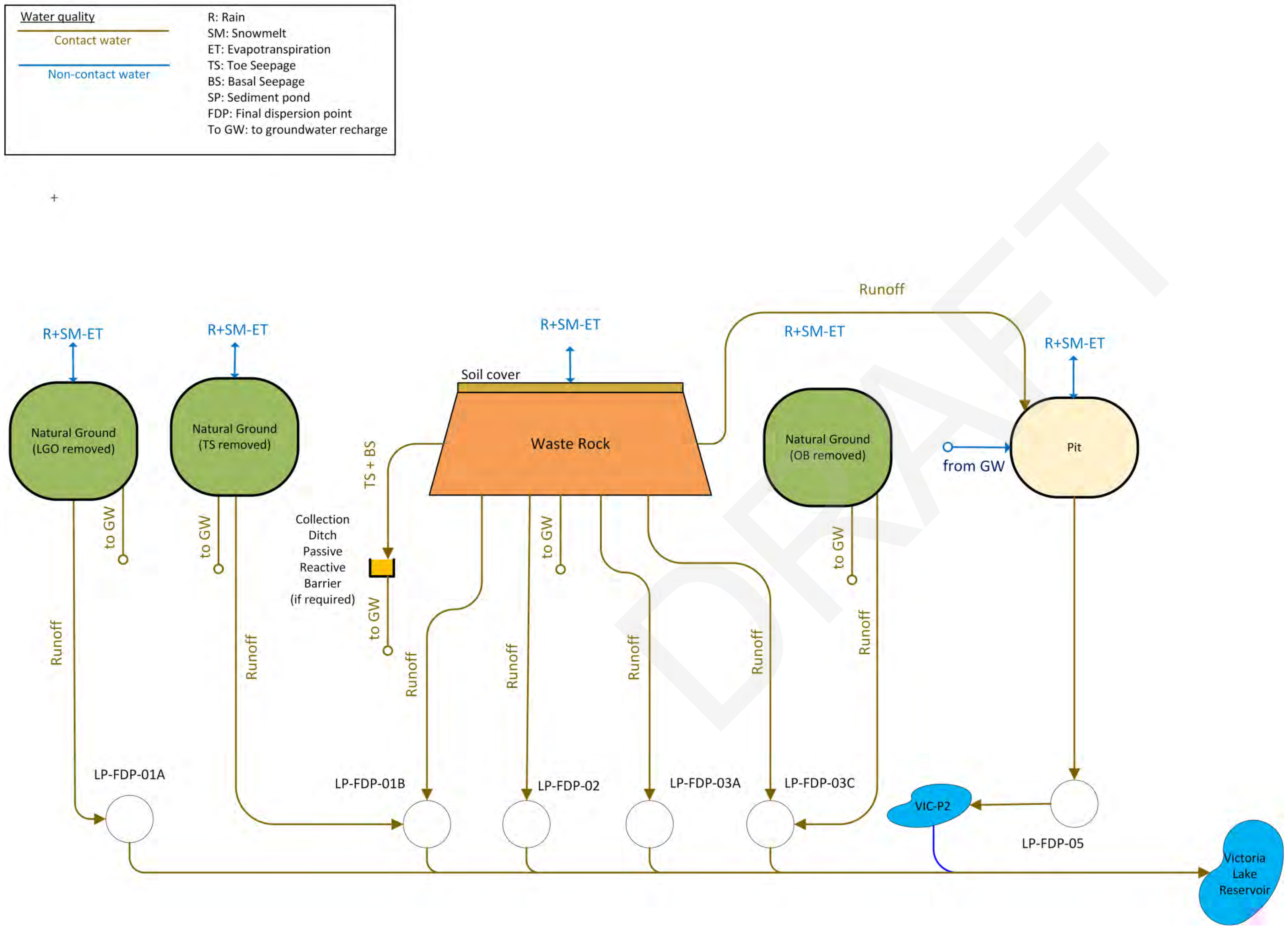


Figure 6.8 Conceptual Model of Mine Water Management – Leprechaun Complex Post-Closure (Pit is full)

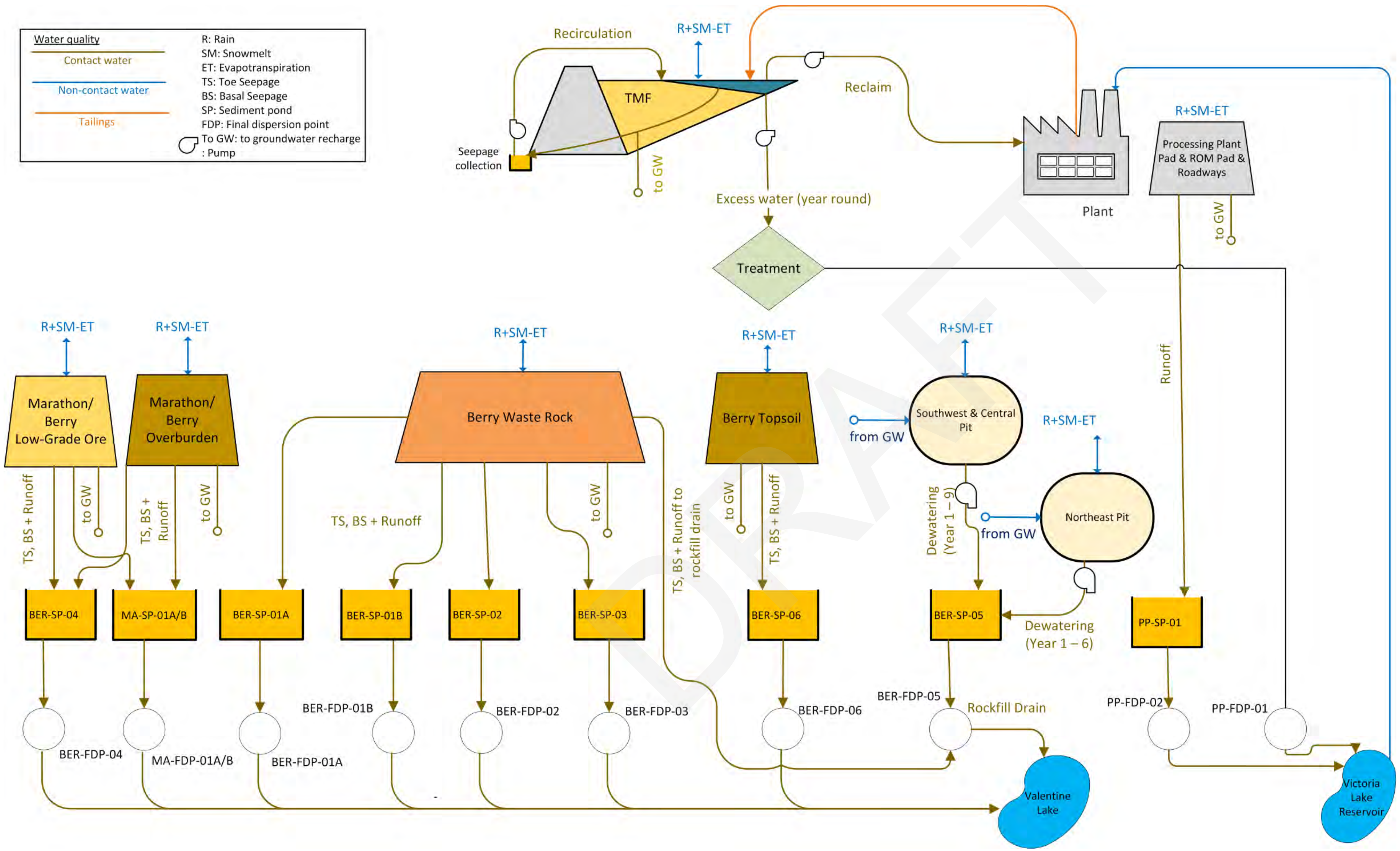


Figure 6.9 Conceptual Model of Mine Water Management – Berry Complex – Construction and Operation Mine Years -2.25 to 6

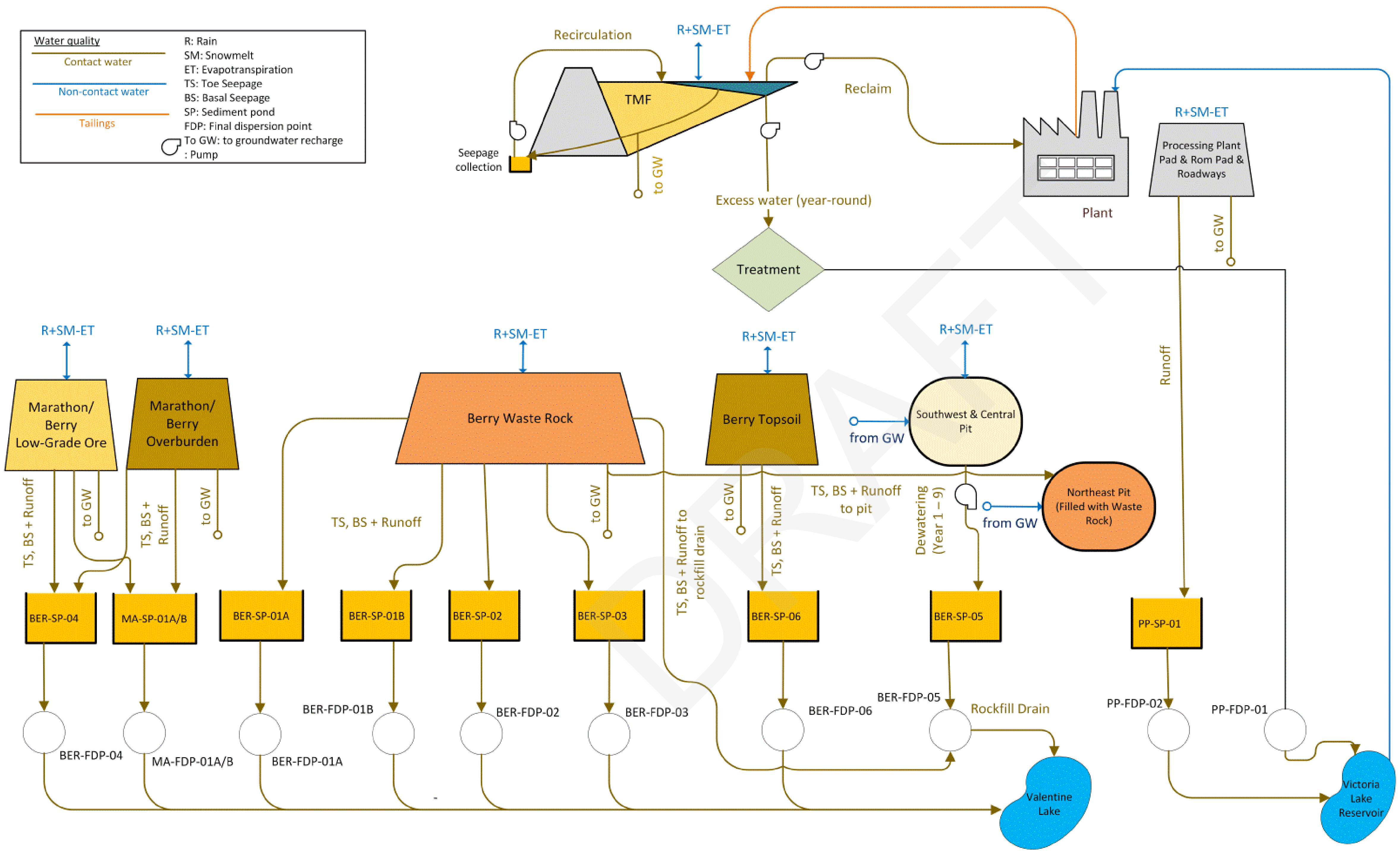


Figure 6.10 Conceptual Model of Mine Water Management – Berry Complex – Operation Mine Years 7 to 9

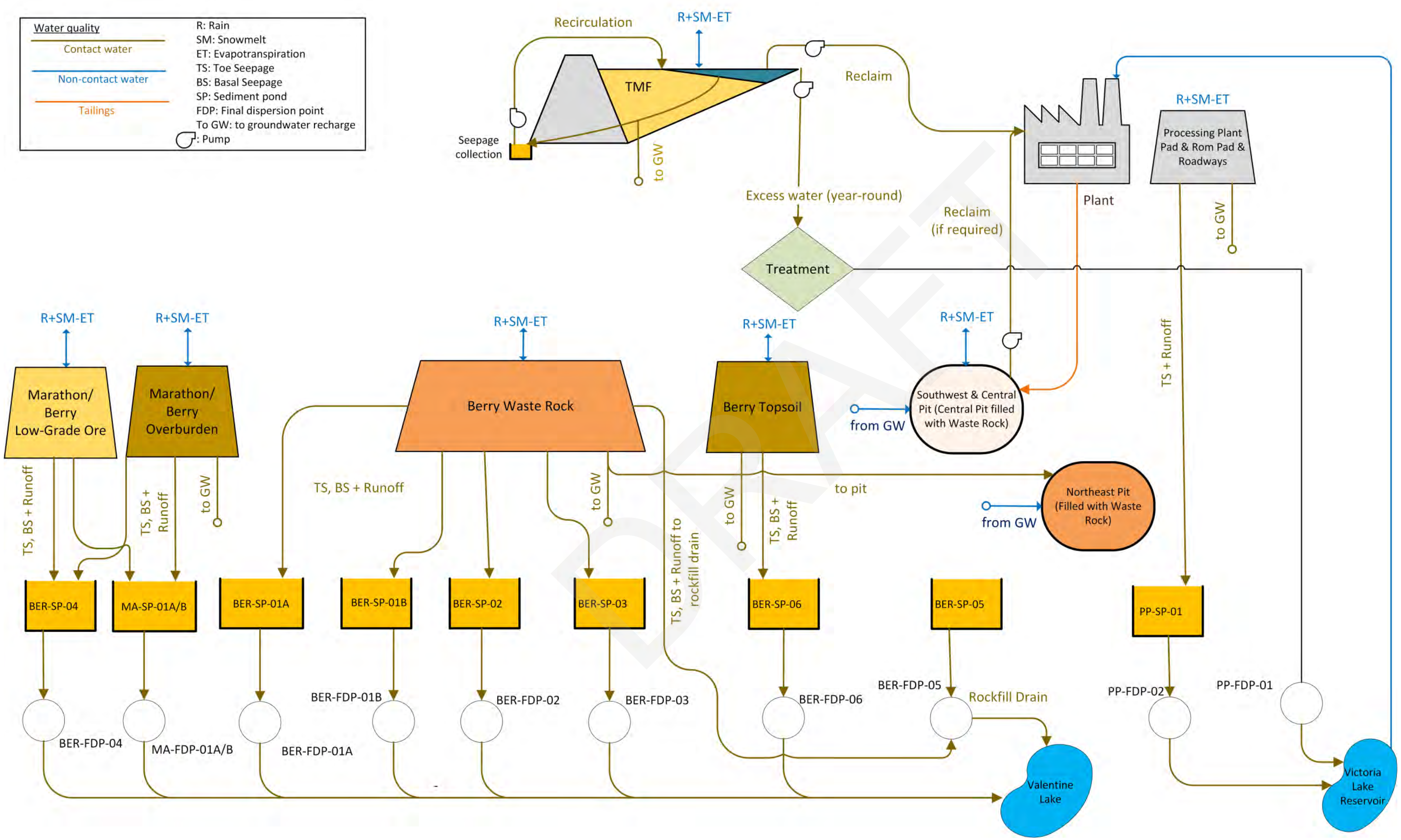


Figure 6.11 Conceptual Model of Mine Water Management – Berry Complex – Operation Mine Years 10 to 12

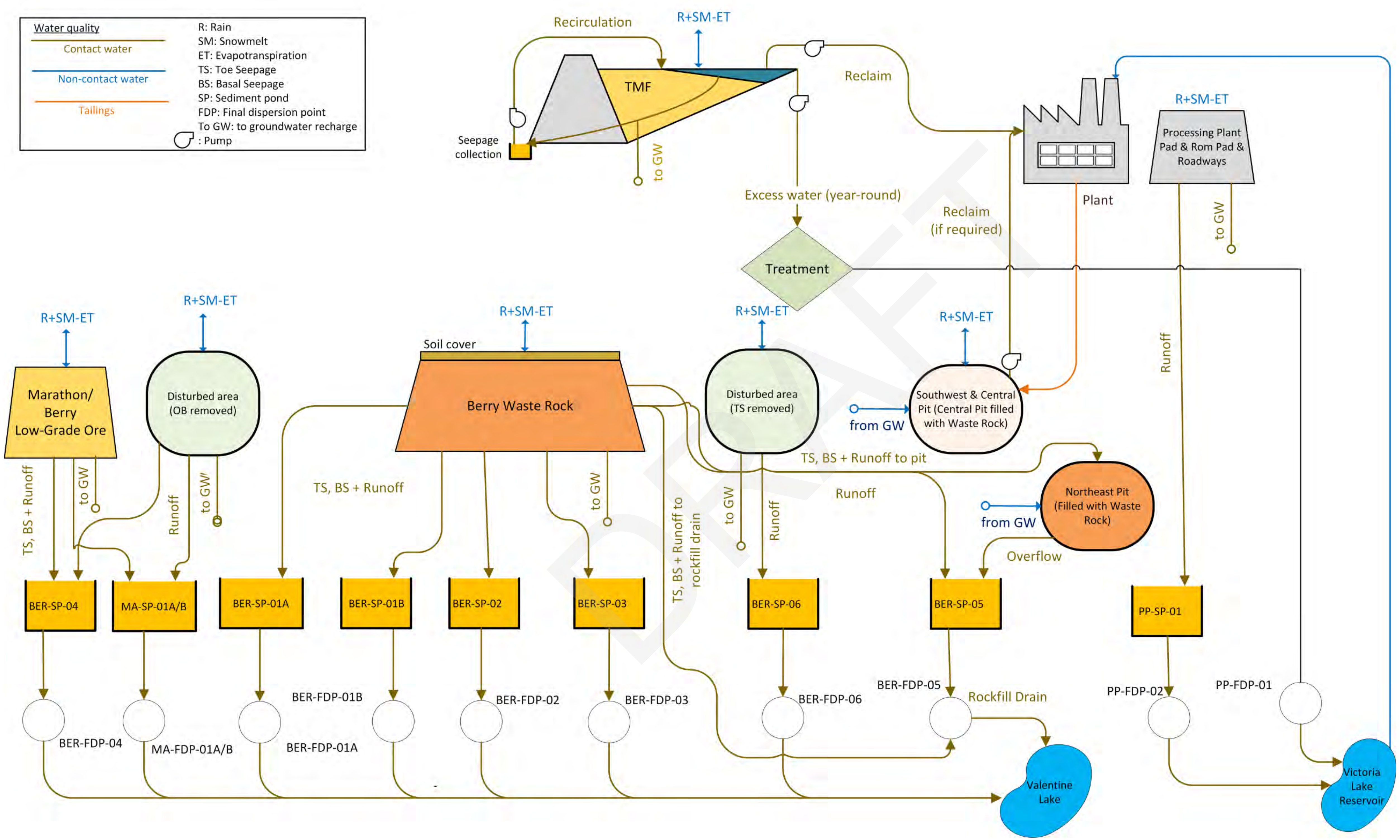


Figure 6.12 Conceptual Model of Mine Water Management – Berry Complex – Operation Mine Years 13 to 15

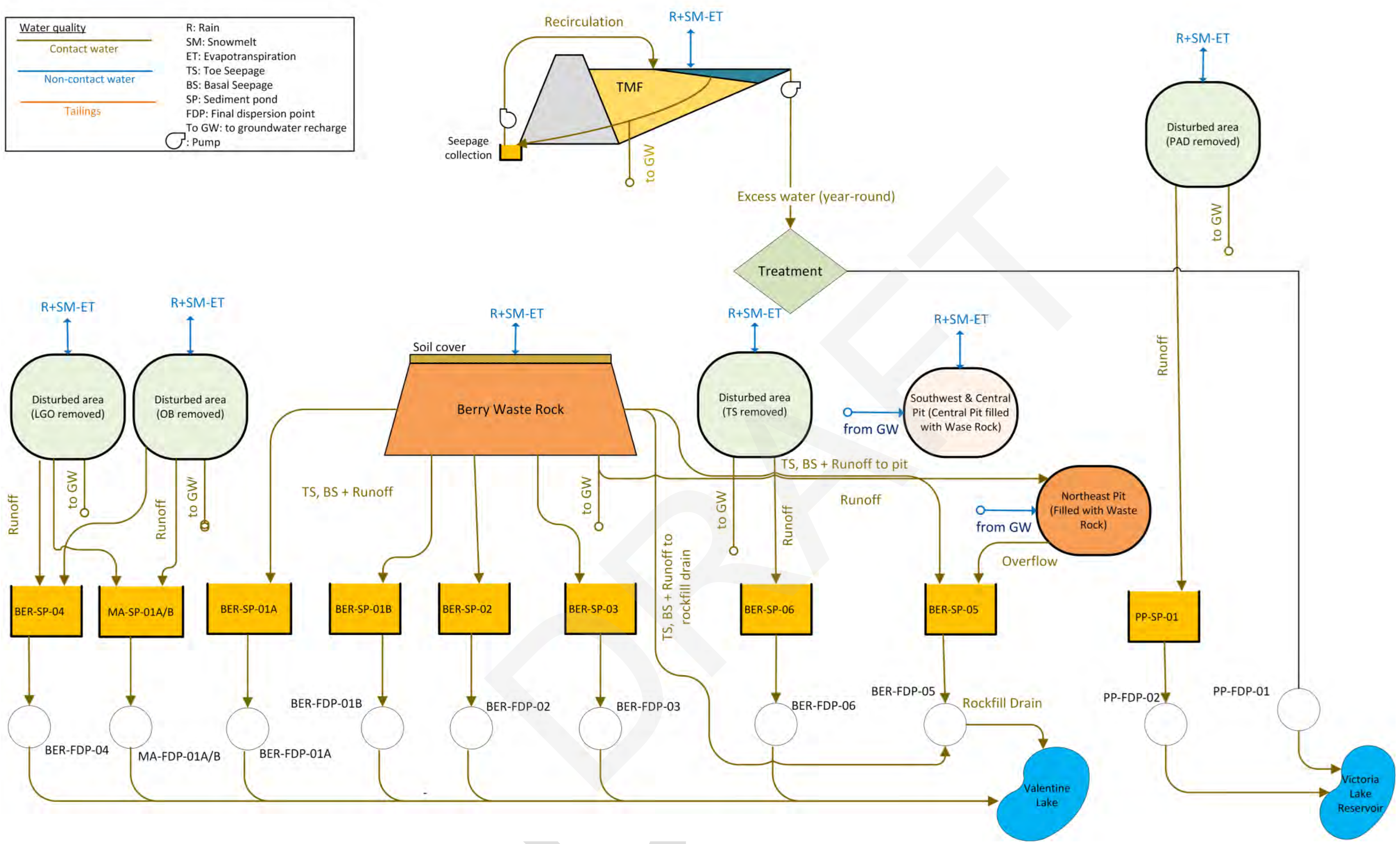


Figure 6.13 Conceptual Model of Mine Water Management – Berry Complex – Closure (Mine Year 16 until Pit is Full)

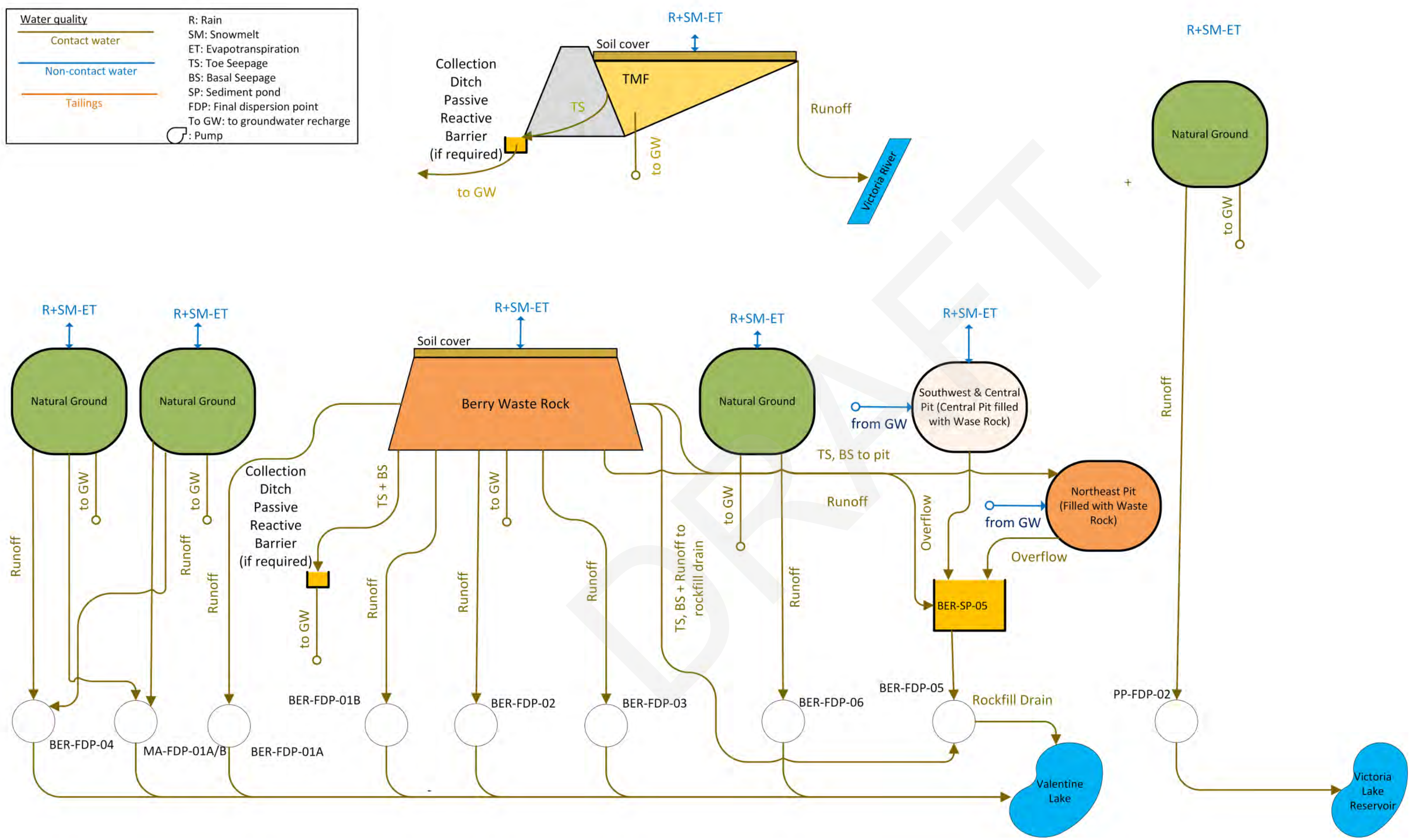


Figure 6.14 Conceptual Model of Mine Water Management – Berry Complex – Post-Closure (Pit is Full)

6.2 WATER BALANCE RESULTS

Outflows and water quantities from water management ponds were predicted in the water balance models, accounting for seepage and surface flow collected in the perimeter ditching of each Project facility and dewatering of the open pit.

During all project phases, the magnitude of the flow from the water management ponds is dictated by outlet configuration, pond volume, level, surface water flow and groundwater infiltration to the ponds.

The water quantity model shows that the ponds become full during freshet of the first year of operation, and overflow to the FDPs thereafter. Table 6.1 presents the water management pond predicted climate normal average annual outflows from the operations (Years 1-9) phase of development for the Marathon complex, Processing Plant and TMF, Leprechaun, and Berry complexes.

Table 6.1 Climate Normal Annual Average Flows/Outflows to/from Sediment Ponds

Sediment Pond	Flow (m^3/s)
PP-SP-01	0.0135
LP-SP-01A	0.0026
LP-SP-01B	0.0043
LP-SP-02A	0.0139
LP-SP-03A	0.0108
LP-SP-03C	0.0064
LP-SP-05	0.0401
MA-SP-01AB	0.0152
MA-SP-01C	0.0025
MA-SP-03	0.0156
MA-SP-04	0.0118
MA-SP-05	0.0458
BER-SP-01A	0.0049
BER-SP-01B	0.0080
BER-SP-02	0.0059
BER-SP-03	0.0069
BER-SP-04	0.0082
BER-SP-05	0.0403
BER-SP-06	0.0059

The Berry pit will be mined for the first nine years of the Project, the Leprechaun Pit will be mined for the first 12 years of the project, and the Marathon pit will be mined for the first 13 years of the Project. In these years, flow components into the open pit include groundwater seepage, precipitation, surface runoff from natural areas, evaporation, and dewatering. The southern basin of the Berry pit will be operated as a tailings storage facility from the end of Mine Year 9 to the end of Mine Year 15. The central and northern basins of the Berry pit will be filled with waste rock beginning in Mine Year 10 and 7, respectively. The Leprechaun, Berry and Marathon pits will be filled with water to form pit lakes during closure.

To accelerate pit filling, the perimeter berms installed during operation to keep natural drainage from entering the pits will be removed and these flows will be directed toward the Marathon and Leprechaun pits. In Mine Year 10, tailings deposition will switch to deposition will switch to deposition in the southern basin of the Berry pit. After in-pit mining ceases at the end of Mine Year 6 in the Berry northern basin, it will be filled with waste rock. Once the waste rock in-filling elevation reaches the existing ground surface, the Berry waste rock pile will be extended over the northern pit basin area. The Berry northern pit basin is predicted to fill and discharge to the spillway (404 m asl) between 7.75 and 9.8 years after stopping in-pit mining. The Berry southern pit basin will be filled with tailings and waste rock will be placed in the Central basin after in-pit mining is stopped at the end of Mine Year 9. The combined SW and Central basins are estimated to discharge via the spillway at 418 m asl elevation between 6.3 and 9.75 years after stopping in-pit mining.

From the end of Mine Year 12, the Leprechaun pit will take 10.6 and 11 years to fill (without placement of tailings in it following stopping of in-pit mining and a freshwater filling rate from the Victoria Lake Reservoir of 4 Mm^3/year). The Marathon pit is estimated to take between 8.8 and 9.3 years for the wet and dry scenarios, respectively, to fill and overflow at the spillway elevation of 330 m asl after stopping in-pit mining at the end of Mine Year 13. Accelerated pit filling will mitigate potential residual effects in that it will act to improve the water quality of the pit lake, reduce long-term liability related to an extended period of natural pit filling, and expedites the submergence of potentially reactive materials possibly exposed on the pit walls.

The source of water for the primary process plant is reclaim water from the TMF, supplemented with a freshwater make-up from Victoria Lake Reservoir. When water storage in the TMF is inadequate to supply normal reclaim flow to the process, additional water will be withdrawn from the Victoria Lake Reservoir. When tailings deposition is transferred to the southern Berry pit basin and the only inflows to the TMF are from precipitation, additional freshwater supplemental flow is estimated to be required in Mine Years 11 to 15. The climate normal maximum flow rate from Victoria Lake Reservoir during Years 1 to 9 is predicted to be approximately 37 L/s and from Year 10 to 15, the maximum flow rate under accelerated pit filling is predicted to be
147 L/s.

The model was run iteratively to analyze the volume of excess water from the TMF requiring treatment prior to discharge to the environment. The tailings pond volume level at which the treatment is activated when the tailings pond level reaches 70% of its volume capacity. Operation of the pond the water treatment plant capacity during operation will not be exceeded for the 95th percentile annual precipitation total corresponding to a 1:25 year return period wet year.

7.0 WATER QUALITY TREATMENT AND PREDICTIONS

7.1 WATER QUALITY TREATMENT

Water quality treatment for the tailings process water effluent involves the following:

1. Cyanide (CN) destruction circuit in the mill circuit, designed to reduce cyanide levels prior to discharging to the TMF
2. Sedimentation of suspended solids and supplemental natural cyanide degradation in the TMF tailings pond, with seasonal discharge to a process water treatment plant
3. Copper and ammonia removal and pH adjustment in the water treatment plant
4. Peak effluent flow equalization and sedimentation in the SAGR® unit

The tailings pond will have sufficient storage to facilitate the sedimentation and precipitation of suspended solids. Water will be stored in the tailings pond during open water conditions to promote natural degradation of residual cyanide, when possible. The cyanide degradation process in the tailings pond is primarily comprised of volatilization and UV light degradation. The tailings pond is predicted to have concentrations of unionized ammonia, total cyanide and copper above MDMER limits.

A water treatment plant will be situated below the tailings pond (Figure 4.2). The treatment process will be designed to remove ammonia, total cyanide, and copper. Additions of coagulant polymer will facilitate the removal of colloidal-sized suspended matter. Effluent from the water treatment plant will be discharged to the SAGR® unit.

The SAGR® unit will further reduce the concentrations of contaminants to below the MDMER effluent limits, via further coagulation and sedimentation of copper and cyanide-metal solids and degradation of ammonia and cyanide. Water will be retained in the SAGR® unit for up to five days, with residence times developed to facilitate settling of coagulated particulate.

The water quality treatment chain including the mill cyanide destruction circuit, tailings pond, water treatment facility, and SAGR® unit, is designed to provide a final effluent that meets the MDMER effluent water quality criteria.

The water management design of other mine contact water treatment is focused on sedimentation. As sedimentation will reduce TSS concentrations and the particulate fraction of metals. Sedimentation for the treatment of Project facilities contact water will be mainly accomplished through the construction of water management ponds located near each FDP. The invert elevation of the water management pond outlet orifice pipe is set to provide an adequate pond volume for settling of the 10-year return period storm event volume, the water quality design event.

Additional erosion and scour protection (e.g., sediment berms, riprap lining of ditches, energy dissipation pools) was designed in the collection ditches and downstream conveyance channel to further reduce TSS concentrations in the effluent.

7.2 WATER QUALITY PREDICTIONS

7.2.1 Sources of Potential Contaminants

As presented in the ARD/ML reports (Stantec 2020c, h, Stantec 2023e), mine water from the open pit areas may contain suspended solids, explosive residuals (mainly ammonia, nitrite, and nitrate), and elevated levels of metals. Most of the pit walls and rubble on pit benches will be represented by waste rock, which has low ARD/ML potential in both deposits. Minimum ARD onset time is about six years after exposure of a small amount of potentially acid generating (PAG) materials based on kinetic testing (Stantec 2020h). These materials will be submerged during pit filling and therefore acidification of pit lakes water is not currently expected. Mine water discharged during operations and pit lake discharges are expected to meet MDMER limits.

Findings presented in the ARD/ML report (Stantec 2020h, Stantec 2023e) are summarized below:

- Less than 0.5% of the approximately 50 Mm^3 of Leprechaun waste rock is classified as PAG. Overall, the waste rock pile is not expected to generate ARD due to the small amount of PAG material and substantial excess of NP. Therefore, specific ARD management of waste rock is not required. For Marathon, approximately 14% of the 60 Mm^3 of waste rock is conservatively estimated to be PAG. Blending PAG and non-PAG rock with excess of neutralization potential and/or encapsulation of PAG waste by non-PAG rock is recommended to neutralize acidity potentially generated in PAG pockets. The final drainage from waste rock is not expected to be acidic. The waste rock pile will be covered by growth medium / overburden during rehabilitation, further reducing the risk of ARD/ML. For Berry, the overall estimated percentage of PAG (1<NPR) and uncertain waste rock (1<NPR<2) is 11%. All waste rock units have some PAG samples and waste rock shows moderate ML potential for Al, Cd, Cu, Fe, Mo, Se, U, and Zn based on currently available (early) data from kinetic tests. There are no exceedances of MDMER limits observed in leachates from the waste rock humidity cells. Where waste rock will be used for site earthworks and grading during construction and operational development, necessary test work will be conducted to prevent PAG materials from being used in construction.
- About 10% of Leprechaun low-grade ore is estimated to be PAG, however overall is not expected to generate ARD. There are no exceedances of MDMER limits observed in these tests. For Marathon, approximately one-half of the low-grade ore is conservatively classified as PAG. The ARD onset time in PAG pockets of low-grade ore is approximately six years based on maximum laboratory leaching rates. There are no exceedances of MDMER limits observed in leachates from low-grade ore under neutral conditions. For Berry, 41% of the samples are classified as PAG material. In the kinetic testing to date, there are exceedances of CWQG-FAL in Al, Cd, Cu, Fe, U and Zn. The MDMER limit is exceeded for Cu in Week 8 of the Berry LGO-PAG-CO3DP humidity cell test (HCT).

- High-grade ore from the Leprechaun and Marathon deposits will be stockpiled together with 30% of the material originating from Leprechaun and the remainder from Marathon, on average. Approximately 13% and 67% of ore samples from Leprechaun and Marathon pits, respectively are conservatively classified as PAG. The overall mixture of Leprechaun and Marathon high-grade ores is non-PAG, and the high-grade ore stockpile is not expected to generate ARD. Drainage from the high-grade ore stockpile flows to the TMF by gravity and any potential acidity will be neutralized in the decant pond or in the mill during pH adjustment required as a part of the gold recovery by cyanide process. For Berry, 58% of high-grade ore is PAG. Concentrations of Al, Cd, Cu, Fe and Zn have exceedances of the respective CWQG-FAL thresholds in the kinetic test results available to date. No exceedances of MDMER are observed in results.
- Approximately 51 Mt of tailings will be produced from both high-grade ore and low-grade ore with about 30% of the material originating from the Leprechaun pit, 19% originating from the Berry pit, and the remainder from the Marathon pit. It is critical that high grade ore destined for processing be processed within the onset period for acid rock drainage potential, of which the shortest onset period is approximately 11 years.
- Composite samples of tailings from both deposits are classified as non-PAG and are not expected to generate ARD. During operation, tailings pond and pore water will likely exceed the MDMER limits for total cyanide (CN_T), un-ionized ammonia ($N\text{-}NH_{3\ UN}$), and copper (Cu) sourced from process water. Seepage from the TMF is conservatively predicted to exceed MDMER limits for CN_T, un-ionized ammonia, and Cu in post-closure. Requirement for treatment is further predicted by the water quality models and assimilative capacity assessments (Stantec 2020h).
- Surface runoff from areas immediately upgradient of the tailings disposal area may contain suspended solids from wind-blown sources (e.g., process plant area, dry tailings beaches, and ROM pad). Process tailings water from the mill will contain suspended solids, be highly alkaline, and contain free and metal-complexed cyanide. Excess water produced by the TMF will be reclaimed to the process plant to offset process water demand and limit volumes of discharge from the tailings pond. TMF excess water not reused in ore processing will be treated via a water treatment plant and directed to a SAGR® unit prior to discharge to the environment.

7.2.2 Predicted Surface Water Quality

The monthly effluent water quality (mean and 95th percentile) at each FDP during operation was simulated during the Project phases of construction, operation, closure and post-closure periods as presented in the water quality and water quality modelling reports (Stantec 2020e, f, Stantec 2023b). Water quality predictions were simulated using a GoldSim model integrating water balance and geochemical inputs. The major objective of the water quality model is to predict concentrations of potential contaminants in mine water collection facilities and at FDPs.

The parameters included in the model have criteria listed in CWQG-FAL and limits in the MDMER. Only the MDMER limits are directly applicable to the discharges. The CWQG-FAL guidelines are not applicable to discharges, as these guidelines are developed for the receiving environment and are used for screening and providing inputs to assimilative capacity assessments.

The predictions for discharge points to the environment are summarized below.

Marathon Complex:

- The water quality model simulated that there are no MDMER exceedances predicted during any mine phase at facilities and discharges in the Marathon Complex (waste rock pile, stockpiles, open pit, ponds and MA-FDP-01 to MA-FDP-04) with a 95th percentile confidence level.
- At baseline conditions, phosphorus (P), chromium (Cr), and zinc (Zn) exceed the respective long-term CWQG-FAL in streams near the Marathon open pit.
- During construction and operation, long-term CWQG-FAL exceedances of copper (Cu), mercury (Hg), fluoride (F), nitrite ($N\text{-}NO_2$), Silver (Ag), un-ionized ammonia ($N\text{-}NH_{3\ UN}$), cadmium (Cd), manganese (Mn), aluminum (Al), arsenic (As), total ammonia ($N\text{-}NH_{3\ T}$), selenium (Se), uranium (U), lead (Pb), iron (Fe), and nitrate ($N\text{-}NO_3$) are predicted to be above the respective long-term CWQG-FAL, in addition to the parameters exceeding at baseline conditions.
- The largest concentrations predicted for water quality during operation are for MA-FDP-02 and associated with seepage from waste rock.
- These parameters decline during closure and stabilize in post-closure with Cu, Hg, F, Ag, Cd, Mn, and Al remaining above CWQG-FAL. Exceedance for F could be a modelling artifact related to high detection limits scaled up to the full-size of the waste rock pile. Zn and Cr stabilize above the background levels in post-closure. The levels and trends for the parameters exceeding CWQG-FAL in MA-FDP-02 and MA-FDP-03 are similar.

Leprechaun Complex:

- The water quality model simulated that there are no MDMER exceedances predicted during any mine phase at facilities and discharges in the Leprechaun Complex (waste rock pile, stockpiles, open pit, ponds and LP-FDP-01 to LP-FDP-05), with a 95th percentile confidence level.
- Long-term CWQG-FAL exceedances of phosphorus (P), chromium (Cr), zinc (Zn), aluminum (Al), manganese (Mn), and iron (Fe) at baseline conditions and during construction.
- In addition to the parameters exceeding at baseline conditions, long-term CWQG-FAL exceedances of Cu, Hg, F, $N\text{-}NO_2$, Ag, $N\text{-}NH_{3\ UN}$, As, $N\text{-}NH_{3\ T}$, Cd, Pb, U, Se, and $N\text{-}NO_3$ are predicted to be above the respective long-term CWQG-FAL for LP-FDP-03.
- These parameters decline during closure and stabilize in post-closure with Cu, Hg, Ag, and F remaining above CWQG-FAL.
- During operation, the greatest number of long-term CWQG-FAL exceedances are predicted for LP-FDP-03 and associated with seepage from waste rock. Seepage from waste rock and low-grade ore also affects LP-FDP-01 and LP-FDP-02, however these discharges have better water quality than LP-FDP-03 resulting in less exceedances of CWQG-FAL.

Berry Complex:

- The water quality model shows that there are no MDMER exceedances predicted at facilities and discharges in the Berry complex except for the following MDMER exceedances:
  - CN_T (95th percentile and mean) in the combined SW and Central pit lake water during the operation and closure phases of the Project Expansion, and below MDMER in post-closure.
  - $N\text{-}NH_{3\ UN}$ (95th percentile and mean) in the combined SW and Central pit lake water during operation phase and N-NH3 UN (mean) during the closure phase.
- Long-term CWQG-FAL are not applicable to discharges, however, were used to screen POPC for receivers. Parameters predicted to exceed the respective long-term CWQG-FAL for FDPs (BER-FDP-01A, BER-FDP-01B, and BER-FDP-02) influenced by the seepage from the Berry waste rock pile are Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, P, Se, Ag, U, Zn, $N\text{-}NO_2$, $N\text{-}NO_3$, $N\text{-}NH_{3\ T}$, $N\text{-}NH_{3\ UN}$, and F during operation. These parameters decrease during closure. Seepage from the Berry waste rock pile also affects BER-FDP-03; however, these discharges have better water quality than the other three FDPs (BER-FDP-01A, BER-FDP-01B, and BER-FDP-02), resulting in less exceedances of CWQG-FAL.
- Seepage from overburden and LGO stockpiles affects the water quality at the BER-FDP-04 and MA-FDP-01AB discharge points. These discharge points have better water quality than other discharge points influenced by the seepage from the Berry waste rock pile. Exceedances of CWQG-FAL during operation are Al, As, Cd, Cr, Cu, Fe, Mn, Hg, P, Se, Zn, $N\text{-}NO_2$, $N\text{-}NH_{3\ UN}$, and F. These parameters decrease during closure with predicted nitrogen species concentrations below CWQG-FAL. This discharge point is assumed to stop discharging to the environment during post-closure.
- Overflow water from the BER-SP-05 sedimentation pond that receives dewatering and overflow from Berry Pit complex affects the water quality at the BER-FDP-05. During operation, As, Cd, Cu, Hg, Se, Ag, U, $N\text{-}NO_2$, $N\text{-}NH_{3\ T}$, $N\text{-}NH_{3\ UN}$, and F are predicted to exceed the respective long-term CWQG-FAL in addition to the parameters elevated under baseline conditions (Al, Cr, Fe, Mn, P, and Zn). Even though the concentrations of these parameters decrease and stabilize during post-closure, the parameters that remain above the long-term CWQG-FAL are Al, Cd, Cr, Cu, Fe, Mn, Hg, P, Zn, $N\text{-}NH_{3\ T}$, $N\text{-}NH_{3\ UN}$, and F. The BER-FDP-06 discharge point has the least number of parameters exceeding the long-term CWQG-FAL than all other FDPs. Exceedances of the long-term CWQG-FAL during operation are As, Cd, Cu, Se, and F in addition to the exceedances (Al, Cr, Fe, Mn, P, and Zn) under baseline conditions and during the construction phase of the Project Expansion.

Processing Plant and TMF Complex:

- During construction, water quality of the SAGR® unit PP-FDP-01 is similar to the chemistry of undisturbed runoff, which shows exceedances of the long-term CWQG-FAL for P, Zn, Cr, Mn, As, Al, Fe, and Cu considering 95^{th} percentile concentrations.
- The model predicts exceedances of MDMER limits for CN_T, Cu, and $N\text{-}NH_{3\ UN}$ in the tailings pond, indicating that these parameters may require treatment in Mine Years 1 to 15. During that time, the SAGR® unit will receive treated effluent.

- During operation, Cu, N-$NH_{3\ UN}$, F, N-$NH_{3\ T}$, CN $_{WAD}$, Hg, N-NO_2, Se and Cd are predicted to be above the respective long-term CWQG-FAL, in addition to baseline exceedances. There is no inflow from the tailings pond to the SAGR® unit starting in mine Year 10 and until end of the closure, and therefore the SAGR® unit can be decommissioned during this period. Post-closure, Cu is predicted to exceed the MDMER limit due to an elevated concentration of this metal in tailings pond toe seepage. Therefore, passive treatment of seepage is proposed. In addition to the MDMER exceedance for Cu and baseline indicated above, CN $_{WAD}$, N-$NH_{3\ UN}$, and N-$NH_{3\ T}$, are predicted to be above long-term CWQG-FAL in post-closure.

Results of the effluent/discharge water quality are further described in the Water Quantity and Quality Modelling Reports (Stantec 2020e, f, Stantec 2023b, c).

7.2.3 Predicted Groundwater Quality

The groundwater table in the Project Area is near surface, which will inhibit inflow by maintaining a low gradient for groundwater flow. At the TMF, in addition to the low gradient, the low permeability of the tailings and the presence of an upstream clay blanket will limit groundwater seepage. The LDPE liner of the tailings dam will also limit the amount of lateral seepage from the TMF to the perimeter ditches. Seepage through the dam will be low relative to average daily discharge rates at the FDP.

Shallow seepage from the south of the tailings pond was assumed to run into the SAGR® unit, and seepage along the remaining perimeter of the dam is collected in ditches and recycled back into the tailings pond. Some groundwater is predicted to seep from the TMF and travel to the Victoria River and tributaries. Elevated concentrations of some metals (i.e., iron and manganese) are predicted to exceed the CWQG-FAL criteria; however, the concentrations of these elements in the baseline conditions exceed the CWQG-FAL criteria. In addition, unionized ammonia is also predicted to exceed the CWQG-FAL criteria, however, mill operations will be optimized to reduce arsenic, cyanide and ammonia.

7.3 PARAMETERS OF POTENTIAL CONCERN

At the TMF, the low permeability of the tailings, and the presence of a synthetic liner on the upstream side of the dam will limit seepage into the groundwater and lateral seepage from the TMF to the perimeter ditches. Seepage through the dam will be low relative to average daily discharge rates at the FDP. The presence of the low permeability synthetic liner will minimize the passage of tailings water through the dam wall. Shallow seepage from the south of the tailings pond was assumed to run into the SAGR® unit, and seepage along the remaining perimeter of the dam is collected in ditches and recycled back into the tailings pond. Some groundwater is predicted to seep from the TMF and travel to the Victoria River and tributaries. Elevated concentrations of some metals (e.g., copper and zinc) are predicted to be below MDMER limits and to exceed the CWQG-FAL criteria, however, these elements exceed the concentrations in the baseline conditions. In addition, unionized ammonia is also predicted to exceed the CWQG-FAL criteria, however it is anticipated that the mill operations can be optimized to reduce arsenic, cyanide and ammonia. The predicted water quality POPC for effluent treatment are listed in Table 3.1.

Both nickel and radium-226 have MDMER effluent discharge limits, however the predicted water quality did not meet the threshold of a POPC for these parameters. Similarly, concentrations of chromium, mercury, selenium, silver, and uranium predicted to exceed the CWQG-FAL at some FDPs also did not meet the threshold of a POPC. Elevated concentrations of sodium at all FDPs were also not considered a POPC, as there is no CWQG-FAL for this parameter.

7.4 ASSIMILATIVE CAPACITY

An Assimilative Capacity (AC) assessment was completed for the operation phase and post-closure conditions of the Project. These phases are anticipated to represent the worst-case conditions with respect to effluent quality. The AC assessment was conducted to estimate the water quality of watercourse and waterbodies receiving discharges directly from FDPs, as well as the ultimate receivers. An assimilative capacity assessment was conducted using the near-field mixing model Cornell Mixing Zone Expert System (CORMIX, Version 11.0) at 100 m and 250 m downstream of the FDPs, and for the three ultimate receivers of Valentine Lake, Victoria Lake Reservoir, and Victoria River. The CORMIX model was used to model mixing zones at the three ultimate receivers under both the regulatory and normal operating conditions.

Water quality was assessed using a mass balance approach under two discharge conditions: regulatory and normal. The regulatory operating conditions are considered worst case and conservative, while normal operating conditions are considered representative of the expected average discharge conditions. Input parameters for these two operating conditions were as follows:

- Regulatory Operating Conditions:
  - MDMER limits for POPC listed parameters for effluent
  - 95th percentile for POPC not listed in MDMER, generated from water quality modelling
  - 75th percentile baseline water quality in the receiving watercourses
  - 7Q10 flow conditions (7-day low flow, 10-year return period)
- Normal Operating Conditions
  - Mean concentrations for POPC generated from water quality modelling
  - Mean concentrations for baseline water quality in the receiving watercourses
  - Mean annual flow (MAF) conditions

The results of the three CORMIX models provide an estimate of the POPCs within the effluent mixing zones under conservative conditions. The conservative conditions are based on maximum effluent concentrations, low flow (7Q10) conditions in the receiving environment and assuming no contaminant decay, sedimentation, and reduction/oxidation kinetics in the mixing zones.

Generally, for both the regulatory and normal operating scenarios, limited assimilative capacity is seen downstream of each FDP until reaching Victoria Lake Reservoir, Valentine Lake or Victoria River, at which point mixing improves in these respective ultimate mixing zones. The FDPs are shown on Figures 5.4 through 5.7 and discussed in detail below.

The mixing zones were determined in terms of assimilation or dilution ratios for the maximum effluent flow rate expected to enter each receiving waterbody. Expected water quality at 100 m downstream of the receiving point of the three ultimate receivers for POPC was determined.

The Marathon Complex for the regulatory scenario has exceedances for zinc at the 100 and 200 m mixing zone for MA-FDP-02 and MA-FDP-03/04. Also, exceedances for aluminum, iron, and manganese were observed downstream from MA-FDP-03 and MA-FDP-04. These exceedances are due to conservative assumptions of the effluent flow and low assimilative capacity of the watercourse. Additionally, the effluent concentrations were assumed at the MDMER limits, which is a very conservative assumption. Based on extrapolated dilution ratios for the regulatory scenario, it is expected that the ultimate mixing zone will extend approximately 300 m into Victoria Lake, Valentine Lake, and the Victoria River, at which point all parameters will meet the CWQG-FAL.

For the Leprechaun Complex and Process Plant and TMF Complex, water quality at the end of the 100 m mixing zone for the regulatory scenario meets the CWQG-FAL for most FDPs, except downstream from LP-FDP-03 and LP-FDP-05, which has potential exceedances for arsenic, copper, lead, zinc and fluoride. These exceedances are due to the conservative assumption of effluent flow and low assimilative capacity of the watercourse. Additionally, the effluent concentrations were assumed at the MDMER levels, which is a very conservative assumption. Based on extrapolated dilution ratios for the regulatory scenario, it is expected that the ultimate mixing zone will extend approximately 300 m into Victoria Lake, at which point all parameters will meet the CWQG-FAL.

For the Berry complex, water quality within the first 100 m of the mixing zone meets the CWQG-FAL at most FDPs. The only exception is the combined effluent from FDP-05, which has potential exceedances at 100 m from the outfall for copper, lead and zinc. The lead concentration meets the CWQG-FAL at 200 m from the outfall, and copper and zinc meet the guideline at ~300 m. These exceedances are due to elevated concentrations in the effluent, conservative assumptions of effluent flow, and the lower assimilative capacity of the nearshore area. The effluent concentrations for these parameters were assumed to be at the MDMER monthly limits, which are higher than the predicted concentrations in the effluent discharge during operation to present a worst-case scenario. Based on extrapolated dilution ratios for the regulatory scenario, the ultimate extent of the mixing zone is expected to extend approximately 300 m from the FDP-05 outfall. At this distance, all parameters will meet the CWQG-FAL. The mixing zone of other FDPs for all parameters is less than 100 m. For average flow conditions at the Berry Expansion Complex, water quality within the first 100 m of the mixing zone meets the CWQG-FAL at all FDPs.

8.0 MONITORING PLAN

The objective of the monitoring program is to confirm compliance with regulatory requirements, support predictions of effects of the Project on water quality, identify changes in drainage patterns and surface water flow, and determine if additional mitigation or emergency response measures are required.

The proposed monitoring programs will include surface and groundwater quality monitoring, surface water flow monitoring of select watercourses and effluent discharge locations, groundwater level monitoring of installed monitoring wells, and visual inspections of facility infrastructure. The proposed monitoring locations are preliminary and will be reviewed and modified as design proceeds in consultation with regulators, and in accordance with permits and approvals.

A Project Environmental Effects Monitoring program will be developed under a separate cover, which should be used in conjunction with the surface water monitoring program to execute the comprehensive monitoring program for the Project to meet federal MDMER requirements.

As per the provincial EIS Guidelines for the Project (NLDMAE 2020), near real-time surface water quality and quantity monitoring station(s) instrumented with telemetry and linked to the provincial real-time monitoring network (in consultation with NLDECC) were established in September 2022. Marathon has engaged with NLDECC regarding the establishment of the real-time water monitoring network site for the Project, which is described further with respect to monitoring parameters and sampling frequency in this Section.

Quality Assurance and Quality Control (QA/QC) is an integral component of proper field and laboratory procedures. As stated in the MDMER (Schedule 5, Section 7(e)), water quality monitoring is to be conducted by *implementing quality assurance and quality control measures that will ensure the accuracy of water quality monitoring data*.

8.1 SURFACE WATER MONITORING

8.1.1 Monitoring Locations

In accordance with the MDMER, Marathon intends to monitor the following locations with respect to surface water quality and quantity:

- Surface water quality and quantity at each of the mine activity water 20 FDPs (Table 8.1)
- Surface water quality at 11 water quality points (WQPs) and two water quality and flow points (WQFPs), which represent the exposure area 100 m downstream/offshore of the point of entry of effluent into water from each FDP (Table 8.2)

- Surface water quantity at two WQFPs (Table 8.2)
  - Surface water quantity is monitored at sites identified as MA-WQFP-45 and LP-WQFP-03 where two FDPs discharge into the same water system on opposite banks (Table 8.2)
- Surface water quantity at nine water flow points (WFPs) (Table 8.3)
- Influent water quality to the sanitary WWTPs at the two inlet points (INPs) (Table 8.4)
- Effluent water quality from the sanitary WWTPs at the two outlet points (OUPs) (Table 8.4)
- Reference surface water quality at two RQPs and RQFP, which represent related reference areas (Table 8.5)
- Reference surface water quantity at one RQFP (Table 8.5)
- As per the EA Decision Letter, establishment during the pre-construction phase of near real-time surface water quality and quantity monitoring station(s) instrumented with telemetry and linked to the provincial real-time monitoring network (in consultation with NLDECC) is required. Seven near real-time surface water quality and quantity monitoring sites are proposed by to be installed. Four of the stations are co-located with MDMER and/or *Fisheries Act* Authorization monitoring locations (Table 8.6).

Table 8.1 Final Discharge Points, Associated Water Management Infrastructure and Discharge Water System

Final Discharge Point	Discharge Location	Sedimentation Pond/ Infrastructure	Mine Facility
Marathon Pit Complex (Figure 8.1)			
MA-FDP-01AB	Stream Val-2; Valentine Lake	MA-SP-01AB	Marathon Low-Grade Ore Stockpile
			Marathon Overburden Stockpile
MA-FDP-01C	Stream VAL-3; Valentine Lake	MA-SP-01C	Marathon Waste Rock Pile
MA-FDP-03	Stream VIC-6; Victoria River	MA-SP-03	Marathon North Waste Rock Pile
MA-FDP-04	Stream VIC-8; Victoria River	MA-SP-04	Marathon North Waste Rock Pile
			Marathon Topsoil Stockpile
MA-FDP-05	Stream VIC-8; Victoria River	MA-SP-05	Marathon Pit
			Marathon South Waste Rock Pile
Leprechaun Pit Complex (Figure 8.3)			
LP-FDP-01A	Stream VIC-26; Victoria Lake Reservoir	LP-SP-01A	Leprechaun Low-Grade Ore Stockpile
LP-FDP-01B	Stream VIC-26; Victoria Lake Reservoir	LP-SP-01B	Leprechaun Topsoil Stockpile
			Leprechaun South Waste Rock Pile
LP-FDP-02	Victoria Lake Reservoir	LP-SP-02	Leprechaun South Waste Rock Pile
LP-FDP-03A	Stream VIC-16; Victoria Lake Reservoir	LP-SP-03A	Leprechaun South Waste Rock Pile

Table 8.1 Final Discharge Points, Associated Water Management Infrastructure and Discharge Water System

Final Discharge Point	Discharge Location	Sedimentation Pond/ Infrastructure	Mine Facility
LP-FDP-03C	Stream VIC-16; Victoria Lake Reservoir	LP-SP-03C	Leprechaun South Waste Rock Pile Leprechaun Overburden Stockpile
LP-FDP-05	Pond VIC-P2; Victoria Lake Reservoir	LP-SP-05	Leprechaun Pit
Process Plant Area (Figure 8.2)			
PP-FDP-01	Victoria Lake Reservoir	SAGR® unit	TMF
PP-FDP-02	Pond L2; Victoria Lake Reservoir	PP-SP-01	Process Plant Pad
Berry Complex (Figure 8.4)			
BER-FDP-01A	Valentine Lake	BER-SP-01A	Berry Waste Rock Pile
BER-FDP-01B	Unnamed Tributary to Valentine Lake	BER-SP-01B	Berry Waste Rock Pile
BER-FDP-02	Valentine Lake	BER-SP-02	Berry Waste Rock Pile
BER-FDP-03	Valentine Lake	BER-SP-03	Berry Waste Rock Pile
BER-FDP-04	ValP3 to Valentine Lake	BER-SP-04	Berry / Marathon Low Grade Ore Stockpile
BER-FDP-05	Valentine Lake	BER-SP-05	Berry Pit
BER-FDP-06	Unnamed Tributary to Valentine Lake	BER-SP-06	Berry Topsoil Stockpile

Table 8.2 Water Quality Points, Water Quality and Flow Points and Associated Final Discharge Points

Water Quality Point (WQP) / Water Quality and Flow Point (WQFP)	Receiver Location	Associated Final Discharge Point(s)
Marathon Pit Complex (Figure 8.1)		
MA-WQP-01AB	Steam VAL-2	MA-FDP-01AB
MA-WQP-01C	Stream VAL-3	MA-FDP-01C
MA-WQP-03	Stream VIC-6	MA-FDP-03
MA-WQFP-45	Stream VIC-8	MA-FDP-04; MA-FDP-05
Leprechaun Pit Complex (Figure 8.3)		
LP-WQP-01	Stream VIC-26	LP-FDP-01A; LP-FDP-01B
LP-WQP-02	Victoria Lake Reservoir	LP-FDP-02
LP-WQFP-03	Stream VIC-16	LP-FDP-03A; LP-FDP-03C

Table 8.2 Water Quality Points, Water Quality and Flow Points and Associated Final Discharge Points

Water Quality Point (WQP) / Water Quality and Flow Point (WQFP)	Receiver Location	Associated Final Discharge Point(s)
LP-WQP-05	Pond VIC-P2	LP-FDP-05
TMF and Process Plant Area (Figure 8.2)		
PP-WQP-01	Victoria Lake Reservoir	PP-FDP-01
PP-WQP-02	Pond L2	PP-FDP-02
Berry Pit Complex (Figure 8.4)		
BER-WQP-01A	Unnamed Tributary	BER-FDP-01A
BER-WQP-04	ValP3	BER-FDP-04
BER-WQP-06	Unnamed Tributary	BER-FDP-06

Table 8.3 Water Flow Points and Water Systems

Water Flow Point (WFP)	Water System
Marathon and Berry Pit Complexes (Figure 8.1)	
WFP-05	Stream VAL-5
WFP-HS8	Stream VIC-9
WFP-HS9	Pond VAL-P3 Outlet
WFP-35	Stream VIC-35
Leprechaun Pit Complex (Figure 8.3)	
WFP-HS4	Stream VIC-17
WFP-HS5	Stream VIC-15
WFP-26	VIC-26
Process Plant Area (Figure 8.2)	
WFP-HS7	VIR-32
WFP-33	VIR-34

Table 8.4 Wastewater Treatment Plant Inlet and Outlet Points

Inlet Point (INP) / Outlet Point (OUP)
Process Plant Area (Figure 8.2)
AC-INP-01
AC-OUP-01
PP-INP-01
PP-OUP-01

Table 8.5 Reference Quality Points, Reference Quality and Flow Points and Water Systems

Reference Quality Point (RQP)/ Reference Quality and Flow Point (RQFP)	Water System
Marathon and Berry Pit Complexes (Figure 8.1 and Figure 8.4)	
RQP-VAL01	Valentine Lake
Leprechaun Pit Complex (Figure 8.3)	
RQP-VIC01	Victoria Lake

RQFP-34	Unnamed tributary to Beothuk Lake

Table 8.6 Provincial Real-Time Water Quality and Quantity Points and Water Systems

Provincial Real-Time Water Quality and Quantity Points	Water System
Marathon Pit Complex (Figure 8.1)	
WFP-HS9 †	Pond VAL-P3 Outlet
WFP-HS8 †	Stream VIC-9
NLECC-VL-Outflow	Valentine Lake Outlet (Stream VIC-35)
NLECC-VR-Pit	Victoria River

RQFP-34 †	Unnamed tributary to Beothuk Lake
NLECC-VR-VRB	Victoria River
Note: † - Stations co-located with Marathon MDMER and/or *Fisheries Act* Authorization monitoring locations	

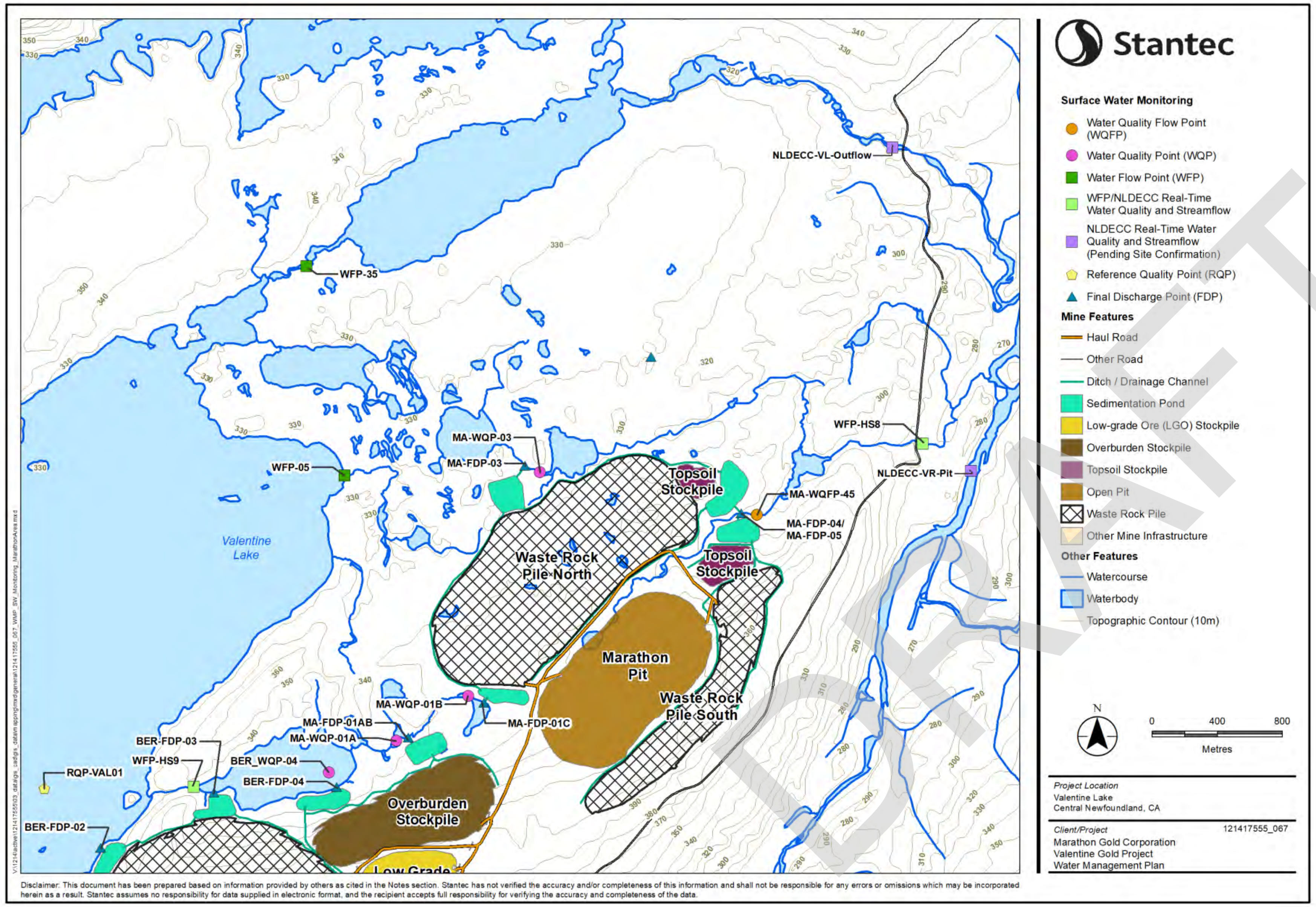


Figure 8.1 Surface Water Monitoring Stations – Marathon Complex

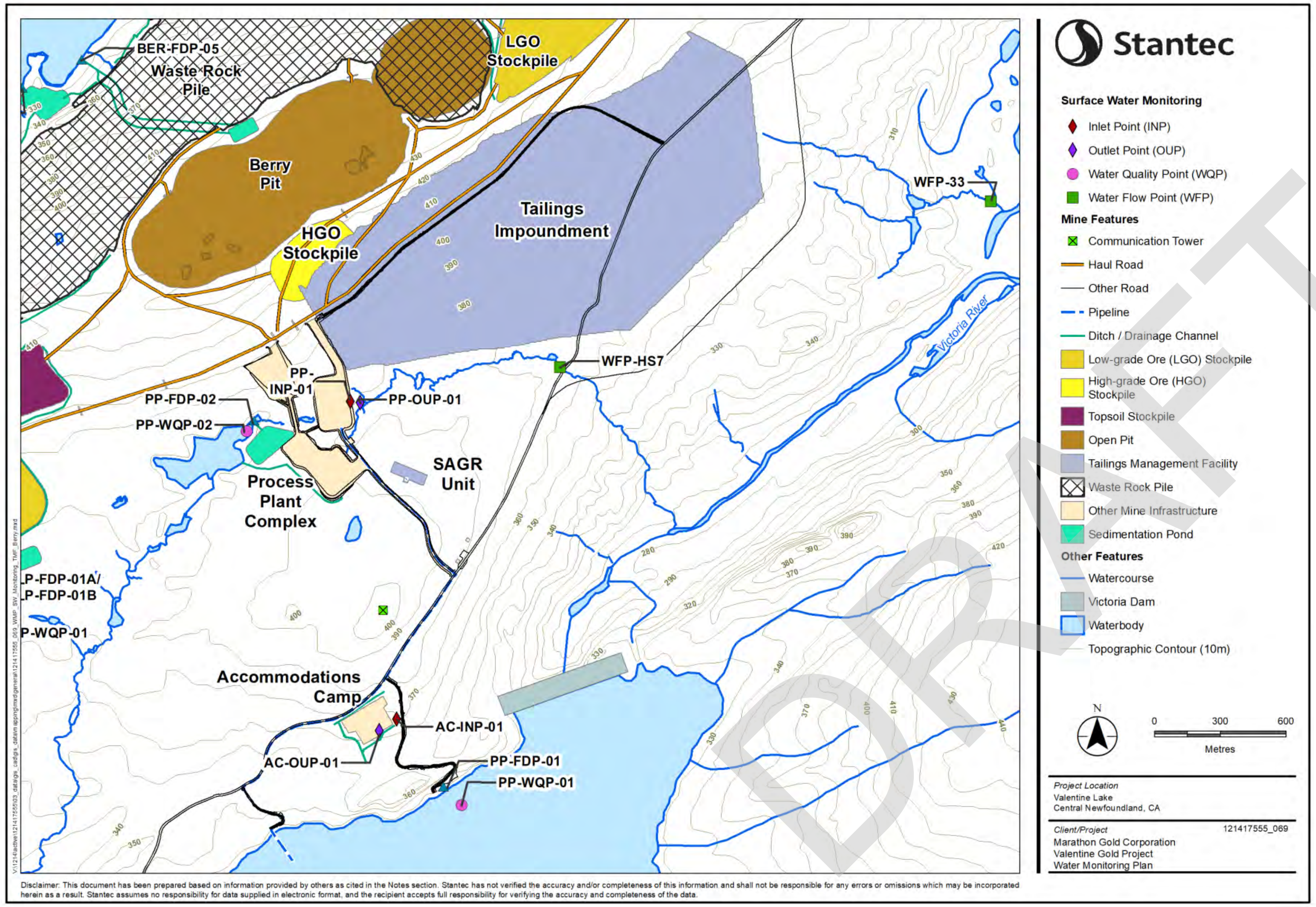


Figure 8.2 Surface Water Monitoring Stations – Processing Plant & TMF Complex

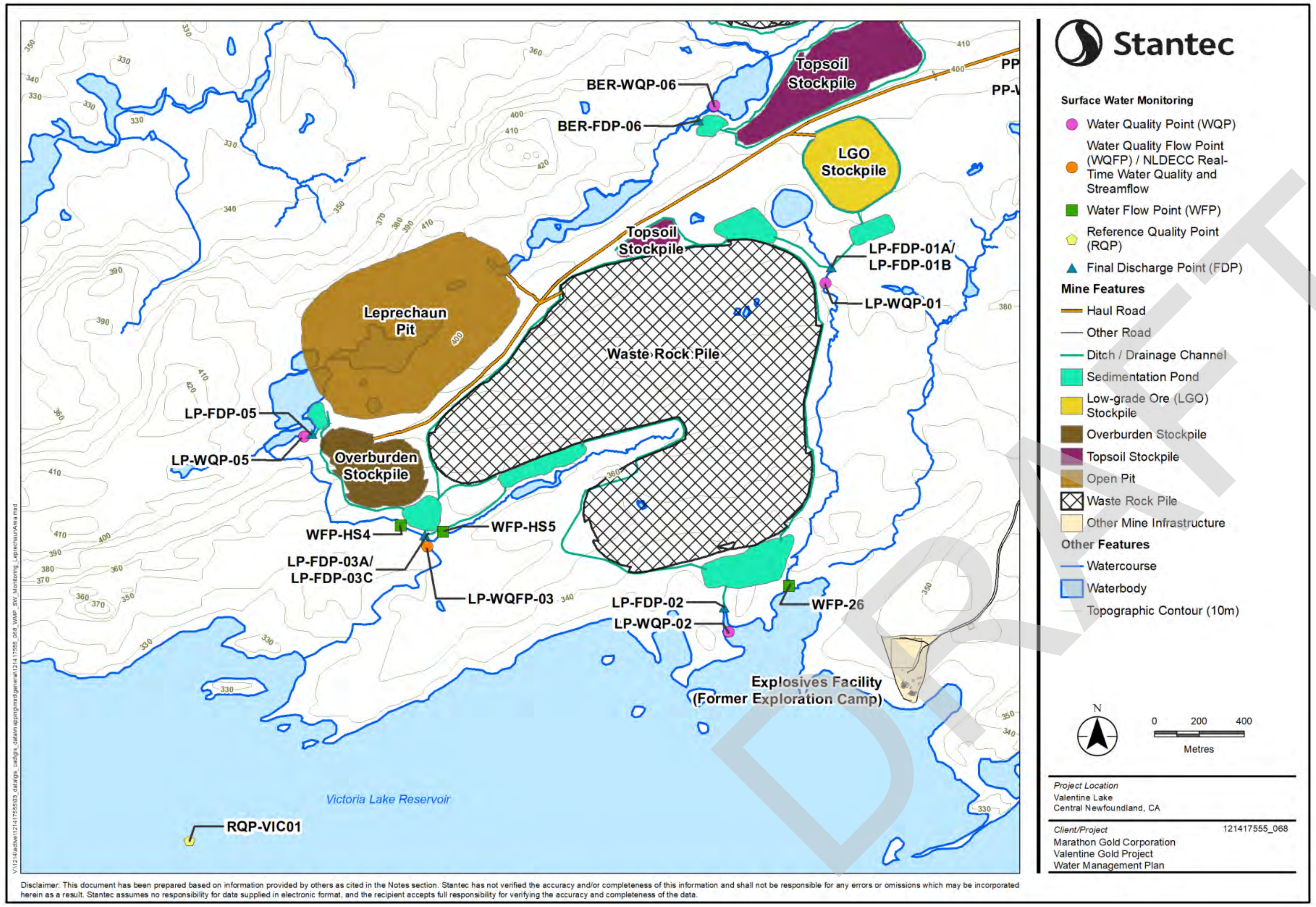


Figure 8.3 Surface Water Monitoring Stations – Leprechaun Complex

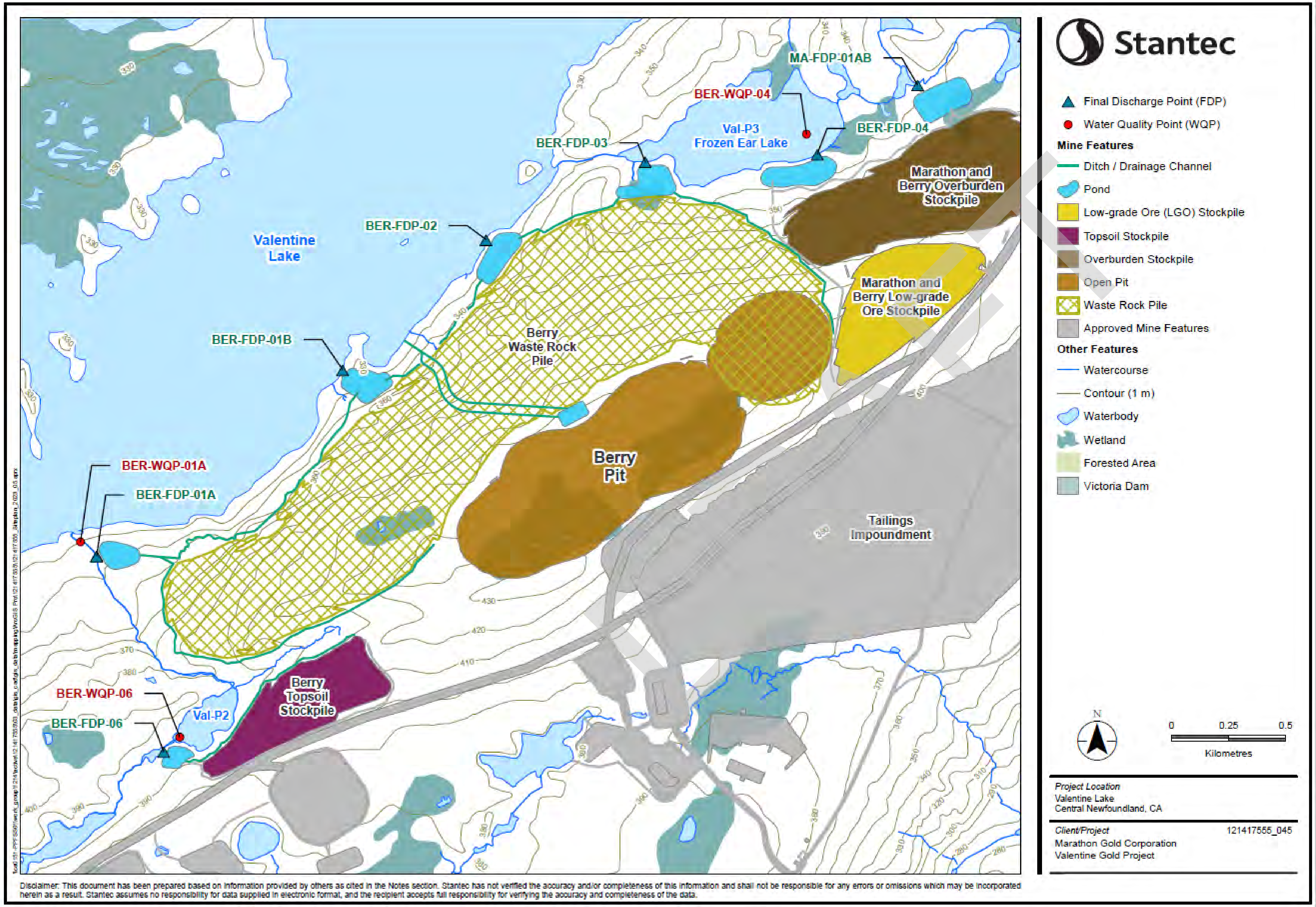


Figure 8.4 Surface Water Monitoring Stations – Berry Complex

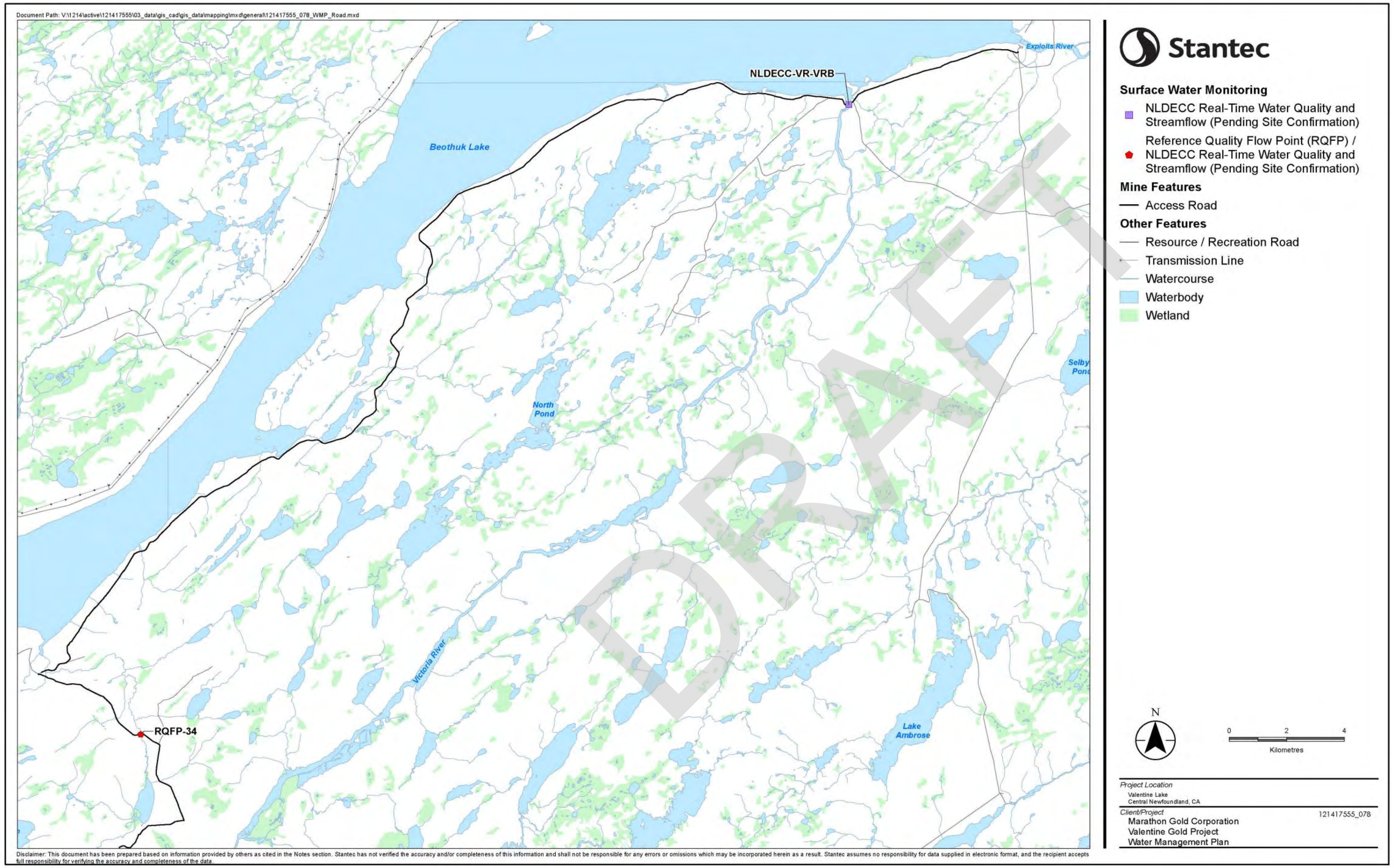


Figure 8.5 Surface Water Monitoring Stations – Victoria River/Beothuk Lake Watershed

8.1.2 Surface Water Quantity

As part of routine operation, effluent discharge, mine water, tailings water reclaim, freshwater makeup, process water, and potable water volumes will be recorded daily. Gauges will be installed in distribution lines for process reclaim water, spigoted tailings, and process water discharge to facilitate the monitoring of flows. Records will include a monthly total and average volumes. Fresh water make-up and potable water withdrawal will be gauged and recorded.

Hydrometric monitoring will be conducted at the FDPs at a minimum accuracy of 15% of the total discharge, according to the flow measurement requirements outlined in the MDMER. Within the sedimentation pond outfall FDPs, water levels are monitored within outlet maintenance holes with flow rates estimated for these sites using open pipe flow equations based on water level, pipe diameter, pipe slope and pipe material roughness. Pond outflows for when stored pond water reaches elevations that enter the spillway channel estimates spillway flow via total water depth in the maintenance hole/pond, spillway dimensions, spillway slope and spillway material roughness. Total outfall flow for the ponds is estimated by summing together outfall pipe and spillway flow estimates.

The flow rates at watercourse stations (WQFPs, WFPs and RQFP-34) are estimated using a combination of periodic *in situ* channel velocity, depth, and flow profiling measurements, supported by continuous water level monitoring. Using datalogging instrumentation (level loggers), water level and water temperature are monitored on a continuous basis by measuring at a 15-minute frequency. A barologger will also be deployed at one of the monitoring stations to collect barometric pressure. Level logger and barologger data is downloaded monthly at the time of the in-situ watercourse measurements or water quality monitoring. Monitored atmospheric pressure and ambient temperature is used to barometrically compensate level logger water level data. Subsequently, this enables conversion of level data to flow using the station rating curves.

Staff gauges are installed at each water level monitoring site and levels recorded at the time of level logger data retrieval.

Flow monitoring of all pumping equipment on site will be conducted using flow totalizing meters, to include the open pit dewatering rates, water withdrawal rates from Victoria Lake Reservoir, water treatment plant rates, wastewater treatment effluent rates, effluent discharge from TMF, reclaim and tailings deposition rates.

8.1.3 Surface Water Quality

During construction and operation, Marathon will collect grab surface water samples at the FDPs, WQPs, WQFPs and RQPs according to the schedule presented in Table 8.6 and associated regulations. The MDMER specify monitoring frequency and parameters with respect to monitoring at FDPs, WQPs and RQPs, which is the basis of the monitoring program. Sublethal toxicity testing is proposed for FDPs that receive mine activity water from waste rock piles, ore piles, pit dewatering, and the TMF SAGR® unit. Additional parameter packages to be monitored include the POPCs identified in the original EIS Chapter 7, Section 7.3.5.2 (Marathon 2020), and Chapter 8 of the EA Update / Environmental Registration, Section 8.2.1.2, and typical monitoring parameters required by NL certificates of approval. The specific parameters monitored in each package are presented in Table 4.6, along with the MDMER threshold criteria for assessing specific parameter results.

When the mine site FDPs are operational, a request can be submitted to ECCC to reduce the sampling frequency for arsenic, copper, cyanide, lead, nickel, zinc and/or un-ionized ammonia, if that parameter's monthly mean concentration at an FDP is less than 10% of the maximum authorized monthly mean concentration (Table 4.6; MDMER Schedule 4, Table 1, Column 2) for 12 consecutive months. For radium 226, if the concentration at the FDP is less than 0.037 Bq/L for 10 consecutive weeks, a request can be made to reduce the sampling frequency. For acute lethality tests, if the result is not acutely lethal for 12 consecutive months, a request can be submitted to reduce the sampling frequency.

If subsequent FDP monitoring results for the above approved parameters on a reduced sampling frequency are equal to or exceed 10% of the maximum authorized monthly mean concentration (or 0.037 Bq/L for radium 226), Marathon will increase the sampling frequency to weekly. If an acute lethality test result is acutely lethal, Marathon will increase the sampling frequency to monthly.

8.1.4 Reporting

A summary of the surface water monitoring reporting deliverables is presented in Table 8.7.

Table 8.7 Monitoring Site Types and Monitoring Frequency

Point Type	Parameter Package [1]	Sampling Frequency	Frequency Limitation	Notes
FDPs	MDMER, Schedule 4, Table 1	Weekly	≥24 hours apart between samples	The analysis shall comply with analytical requirements set out in MDMER Schedule 3, Table 1
	MDMER Acute Lethality Test [2]	Monthly	Sampling date selected and recorded ≥30 days in advance; if cannot sample on that date, must be done as soon as practicable; ≥15 days apart between samples	Collect sufficient sample that an aliquot can be submitted for laboratory analysis for MDMER effluent characterization and MDMER, Schedule 4, Table 1 (if analysis not done on same initial grab sample)
	MDMER Effluent Characterization [3]	Four times per calendar year	≥one month apart between samples	The analysis shall comply with analytical requirements set out in MDMER Schedule 3, Table 2
	NL Certificate of Approval - Typical	Four times per calendar year	≥one month apart between samples	
	EIS Parameters of Potential Concern	Four times per calendar year	≥one month apart between samples	
	MDMER Sublethal Toxicity Test [4]	Semi-Annual (Operation Year 3 and onward – Quarterly; Tests with lowest geometric mean values producing a 25% effect or effective concentration of 25%)		
INPs & OUPs	NL ECWSR Schedule A	One time per calendar year		
	NL Wastewater Characterization	Quarterly		
OUPs	WSER	Monthly	≥10 days apart between samples	Grab or composite; Daily wastewater volume ≤2,500 m^3
WQPs/WQFPs	MDMER, Schedule 4, Table 1	Four times per calendar year	≥one month apart between samples;	The analysis shall comply with analytical requirements set out in MDMER Schedule 3, Table 1
	MDMER Effluent Characterization [3]	Four times per calendar year	≥one month apart between samples	The analysis shall comply with analytical requirements set out in MDMER Schedule 3, Table 2
	NL Certificate of Approval - Typical	Four times per calendar year	≥one month apart between samples	
	EIS Parameters of Potential Concern	Four times per calendar year	≥one month apart between samples	
RQPs/RQFPs	MDMER, Schedule 4, Table 1	Four times per calendar year	≥one month apart between samples	The analysis shall comply with analytical requirements set out in MDMER Schedule 3, Table 1
	MDMER Effluent Characterization [3]	Four times per calendar year	≥one month apart between samples	The analysis shall comply with analytical requirements set out in MDMER Schedule 3, Table 2
	NL Certificate of Approval - Typical	Four times per calendar year	≥one month apart between samples	
	EIS Parameters of Potential Concern	Four times per calendar year	≥one month apart between samples	

Note:
[1] Table 3.1 lists the specific parameters, detection limits and threshold criteria for each parameter package; [2]MDMER, 14(1) & (2); [3]MDMER, 4(1), (2) & (3); [4]MDMER, 5(1) & 5(3), 6(1)

Table 8.8 Surface Water Monitoring Reports

Deliverable	Parameters	Pre-Construction	Construction	Operations
Monthly FDP Water Quality Results	MDMER Schedule 4, Table 1 monthly mean concentrations and monthly loads	NA	Technical memo – submitted to ECCC	Technical memo – submitted to ECCC
Quarterly Water Quality Results (within 45 days of each quarter)	Table 4.6 results; monthly mean concentrations and monthly flow volumes and loads (MDMER Schedule 4, Table 1); Quarterly loads; Sampling type (composite or grab); # of days of discharge	NA	Technical memo with Laboratory Certificates of Analysis and Results Spreadsheet to ECCC and NLDECC	Technical memo with Laboratory Certificates of Analysis and Results Spreadsheet to ECCC and NLDECC
Annual Surface Water Quality and Quantity Report (submit no later than March 31 in each year for previous calendar year)	Table 4.5 and Table 4.6 results; non-compliance results with causes and remedial measures (planned or implemented)	NA	Technical memo – submitted to IAAC, ECCC and NLDECC	Technical memo – submitted to ECCC and NLDECC
Water Quality Exceedances (as defined by the trigger thresholds described in Table 4.6) (without delay)	MDMER, Schedule 4, Table 1 results; Acute Lethality Test results	NA	Reported to IAAC, ECCC inspector and NLDECC upon occurrence.	Reported to IAAC, ECCC and NLDECC upon occurrence.
Water Quality Exceedances Follow-up Report (within 30 days after tests completed)	MDMER, Schedule 4, Table 1 results; Acute Lethality Test results; Other applicable parameter results from Table 4.6	NA	Technical memo – submitted to IAAC, ECCC and NLDECC	Technical memo – submitted to IAAC, ECCC and NLDECC
Quarterly WWTP Water Quality Results (within 45 days after the end of each quarter)	WWTP Permit to Operate; WSER	NA	Technical memo – submitted to NLDECC	Technical memo – submitted to NLDECC

8.2 GROUNDWATER MONITORING

The proposed initial monitoring program will consist of three, monthly events per year for manual water level measurement and water quality sample collection. Based on the typical climate conditions, sampling is proposed for April/May, July/August and October/November annually through the construction and operational phases. Snowpack depth and air temperature could inhibit site access and sampling between November and March. Some flexibility may be warranted based on actual conditions.

Sampling frequency will be revisited after the first six sampling events to determine if it is appropriate. Modifications to the plan may be warranted depending on the development of site infrastructure and if any significant impacts are detected that warrant further investigation.

The first sampling event should be carried out in existing monitoring wells upon initiation of Project construction. Proposed monitoring wells will be installed a minimum of one year (i.e., three sampling events) prior to the beginning of pit dewatering with sampling incorporated into the well development effort following drilling and installation.

The groundwater quantity and quality monitoring well network will be updated with proposed monitoring sites for the Berry complex following detailed design of the Berry pit, waste rock pile, stockpiles, and water management infrastructure, and in support of environmental permitting.

8.2.1 Locations

The proposed groundwater monitoring network is presented in Figures 8.6 to 8.8. A total of 48 monitoring locations are recommended for groundwater quantity and quality monitoring, consisting of existing and proposed monitoring wells. A number of the existing monitoring are located within the boundary of planned site infrastructure and may require decommissioning as site development progresses. Table 8.8 presents the list of monitoring stations differentiated as interim and potential long-term based on location with respect to site infrastructure.

In addition to monitoring wells proposed for water level measurement and water quality sampling as part of the groundwater monitoring plan, NLDECC has requested real time groundwater monitoring stations be established as a condition of EA release. Based on discussions with NLDECC, six real-time groundwater monitoring stations are proposed at five locations (four individual wells and one shallow/deep pair) and are shown in Figures 8.6 to 8.8.

8.2.2 Groundwater Quantity

Groundwater levels will be monitored in monitoring wells to document changes in water levels in response to dewatering of the open pits and changes in recharge due to Project components (e.g., waste rock piles, ore stockpile, overburden storage areas, TMF).

Groundwater is at or close to ground surface over most of the Process Plant and TMF Complex and a layer of glacial till is present over the bedrock. Apart from flow along discrete structural features in the bedrock (e.g., faults, jointing, etc.), it is anticipated that groundwater flow is likely to occur within the overburden, the bedrock/till contact, and within the upper slightly weathered bedrock zone. Monitoring wells will be installed to monitor these potential flow pathways.

Potential groundwater interactions at the open pits include seepage into the pit through water-bearing fractures intersecting the pit walls, and gradual lowering of the static water table in bedrock surrounding the open pit due to progressive mine dewatering. Groundwater monitoring wells will be monitored for static water levels to assess effects to groundwater quantity.

Table 8.9 Groundwater Monitoring Network

Site Location	Monitoring Well ID	Interim Groundwater Monitoring Locations	Long-term Groundwater Monitoring Locations	Water Level Measurement	Water Quality Sampling
Marathon Area	19-MW7		✓	✓	✓
	19-MW8		✓	✓	✓
	20BH-15A	✓		✓	✓
	20BH-15B	✓		✓	✓
	20BH-16		✓	✓	✓
	20BH-20	✓		✓	✓
	Proposed Well Real-time monitoring station		✓	✓	✓
	Proposed Well Real-time monitoring station		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓

Table 8.9 Groundwater Monitoring Network

Site Location	Monitoring Well ID	Interim Groundwater Monitoring Locations	Long-term Groundwater Monitoring Locations	Water Level Measurement	Water Quality Sampling
TMF Area and Process Plant	19-MW2	✓		✓	✓
	19-MW4		✓	✓	✓
	20BH-24	✓		✓	✓
	20BH-25	✓		✓	✓
	20BH-29		✓	✓	✓
	20BH-30		✓	✓	✓
	20BH-31	✓		✓	✓
	21BH-MW-02		✓	✓	✓
	20BH-09	✓		✓	✓
	21BH-GLDR-14	✓		✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Paired Well (Shallow) Real-time monitoring station		✓	✓	✓
	Proposed Paired Well (Deep) Real-time monitoring station		✓	✓	✓
Leprechaun Area	19-MW3		✓	✓	✓
	19-MW5	✓		✓	✓
	19-MW6		✓	✓	✓
	20BH-35A	✓		✓	✓
	20BH-35B	✓		✓	✓
	20BH-37		✓	✓	✓
	Proposed Paired Well (Shallow) Real-time monitoring station		✓	✓	✓
	Proposed Paired Well (Deep) Real-time monitoring station		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓

Note: Proposed interim groundwater monitoring locations are located within the footprint of planned site infrastructure and may be decommissioned during site development

The groundwater levels will identify if the resultant depressed groundwater table is as predicted and if the depression has an influence on stream flows of adjacent waterbodies. Should groundwater monitoring identify impacts to nearby surface water tributary flows, groundwater contingency measures will be implemented to maintain flow. A contingency plan will be developed that outlines emergency response.

The use of dedicated water level loggers is recommended in select monitoring wells along with one barometric pressure logger. This will allow for a better understanding of the temporal variability of aquifer water levels between the manual water level monitoring events. The water level loggers should be hung using braided steel cable, Kevlar cord, or other suitable cable (made from material that doesn't stretch when wet) from the molded plastic loop on the j-plug. The logger should be placed a minimum of 5 m below the static water level, or deeper in areas immediately adjacent to open pit dewatering. The barometric pressure logger should be deployed inside of any one of the well protectors where it is free to the atmosphere. The use of water level loggers should prioritize monitoring wells with the largest expected increases and decreases of water levels (i.e., boundaries of the open pits, waste rock piles, and TMF).

8.2.3 Groundwater Quality

Groundwater in contact with the mine site will have changes in quality. Some seepage through and under the dams at the TMF can be anticipated. It is expected that the majority of the seepage from the dams can be collected in ditches and conveyed to small sumps and, if necessary, pumped back into the TMF. The remainder would be lost to the groundwater flow regime.

The potential for vertical seepage pathways and thrust faults may result in groundwater in contact with the open pit to interact with adjacent surface water bodies. Other potential groundwater effects at the site may include accidental release of petroleum hydrocarbon or mill processing chemicals into groundwater. Therefore, groundwater quality will be monitored to identify changes in water quality in down-gradient wells due to recharge of runoff from the site, identify interactions with surface water bodies, identify areas of seepage and/or to support calibration of the seepage models, identify an accidental release of petroleum hydrocarbon or mill processing chemicals into groundwater, or to identify low grade ARD impacts to groundwater.

A network of groundwater monitoring stations will be located around the perimeter of each Project complex (Marathon, Processing Plant and TMF, and Leprechaun) during the initial construction program. An additional monitoring well will be installed outside the TMF to serve as an indicator of background groundwater quality.

Groundwater monitoring will be conducted during pre-development, construction, operation, and closure stages. Monitoring and maintenance of the reclaimed facilities will be carried out during operations and into closure. It is anticipated that monitoring and maintenance will be carried out during the active closure stage at frequencies similar to those required during operations. Post-closure monitoring and maintenance will be carried out at a reduced frequency depending on the results of the monitoring and the measures of success selected for closure.

Table 8.9 identifies the monitoring wells that are proposed for water quality monitoring, which are all wells in the program.

8.2.4 Reporting

Monitoring data will be compiled after every field event. A formal review of the monitoring data will be conducted after the first three events to establish the ambient conditions prior to significant pit development. The initial data review will be conducted by a qualified hydrogeologist and will be made readily available to regulatory authorities upon their request.

The results of future on-going groundwater monitoring activities will be reviewed, analyzed, and presented in an annual report containing, at a minimum, the following:

- Well hydrographs.
- A map presenting updated groundwater elevation contours from a representative monitoring event.
- Quantification of horizontal and vertical hydraulic gradients.
- Groundwater chemistry presented in table format and screened against a reference regulatory guideline(s).
- A discussion of groundwater chemical conditions and the identification of additional indicator parameters that may be used to identify site-related impacts on groundwater quality.
- Recommendations for on-going monitoring (e.g., changes in parameters, locations, frequency).

In addition to annual provincial and federal reporting, reporting of analytical results to the NLDECC electronic data management system is typically required as part of a Certificate of Approval. The necessity and frequency of formal reporting should be set in consultation with provincial and federal regulatory agencies.

8.3 CLOSURE MONITORING

Surface water and groundwater monitoring will continue into closure and post-closure. The objective of the monitoring will be to determine if the rehabilitation measures were successful, and the Project produces stable runoff and seepage quality compliant with regulatory closure regulations. The monitoring frequency will continue as per operation and will be revisited one year into closure.

The proposed closure monitoring and maintenance activities include visual inspections of reclaimed areas to identify unstable areas, maintain all facilities and equipment to be used during closure until they are no longer required, install instrumentation at selected facilities for monitoring of the reclaimed areas, and test surface and groundwater quality and measure water volumes at select locations to confirm that the closure measurements are performing as predicted and are not adversely affecting the environment as required by the Newfoundland and Labrador Mine Regulation 42/00.

9.0 REFERENCES

Atlantic RBCA. 2021. Atlantic RBCA Environmental Quality Standards and Pathway Specific Standards. https://atlanticrbca.com/document/atlantic-rbca-environmental-quality-standards-and-pathway-specific-standards/.

Ausenco. 2021. N.I. 43-101 Technical Report & Feasibility Study in the Valentine Gold Project. Prepared for Marathon Gold Corporation.

Ausenco. 2022. N.I. 43-101 Technical Report & Feasibility Study in the Valentine Gold Project. Prepared for Marathon Gold Corporation. December 20, 2022. Available at: https://marathon-gold.com/site/uploads/2022/12/FINAL-REPORT-Valentine-Gold-43-101-and-FS-Dec-20.pdf

British Columbia Ministry of Environment, Lands and Parks (BC MELP). 1996. Guidelines for Assessing the Design, Size, and Operation of Sedimentation Ponds Used in Mining. Available at: http://www.bcrock.com/reports/Design_SedimentPonds.pdf

Canadian Council of Ministers of the Environment (CCME). 2010. Canadian water quality guidelines for the protection of aquatic life: Ammonia. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment (CCME). 2019. Canadian water quality guidelines for the protection of aquatic life: Manganese (Dissolved) 2019. In: Canadian environmental quality guidelines, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment (CCME). 2020. Canadian water quality guidelines for the protection of aquatic life: Summary Table. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg, MB. Accessed from http://st-ts.ccme.ca/en/index.html in January 2020.

Doneker, R.L. and Jirka, G.H. 2017. CORMIX User Manual: A Hydrodynamic Mixing Zone Model and Decision Support for Pollutant Discharges into Surface Waters, Report prepared for U.S. Environmental Protection Agency.

ECCC. 2019. Engineering Climate Datasets. Retrieved from Environment and Climate Change Canada: https://climate.weather.gc.ca/prods_servs/engineering_e.html

Environment and Climate Change Canada (ECCC). (2019). Canadian Climate Normals 1981-2010 Buchans. Retrieved from Climate Normals and Averages: https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=6579&autofwd=1

ECCC (Environment and Climate Change Canada). 2020. National Long-term Water Quality Monitoring Data. Retrieved from Environment and Climate Change Canada: https://open.canada.ca/data/en/fgpv_vpgf/67b44816-9764-4609-ace1-68dc1764e9ea

GEMTEC. 2022a. Valentine Gold Project 2022 Feasibility Study Update: Geotechnical and Hydrogeological Investigation Final Report. Submitted to Marathon Gold Corporation. October 19, 2022.

GEMTEC. 2022b. Rehabilitation and Closure Plan. Valentine Gold Project. Prepared for Marathon Gold Corporation. Submitted to Mineral Development Division. November 4, 2022.

Government of Newfoundland and Labrador. 2000. Newfoundland and Labrador regulation 42/00 - Mining Regulations under the *Mining Act.*

Government of NL. 2004 – Typical Silt Fence Installation Detail -1260. Accessed from on March 1, 2022: https://www.gov.nl.ca/ti/files/1260.pdf

Government of NL. 2020. Environmental Impact Statement Guidelines for the Valentine Gold Project. Prepared by the 2015 Environment Assessment Committee for the Minister of the Department of Municipal Affairs and Environment, Government of Newfoundland and Labrador.

Golder Associates Ltd. (Golder). 2020. Marathon Gold Prefeasibility Study for Tailings Disposal at the Valentine Gold Project, Newfoundland. Mississauga, Ontario.Golder Associates Ltd. (Golder) 2022. Valentine Gold Project – Water Balance and Hydraulic Design for Tailings Management Facility. Technical Memorandum. Reference No. 20350991-006-TM-RevB

Health Canada. 2022. Guidelines for Canadian Drinking Water Quality. Available online at: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html

Marathon Gold Incorporated (Marathon). 2020. Valentine Gold Project Environmental Impact Statement. Marathon Gold.

Marathon. 2021. Valentine Gold Project Construction DRAFT Environmental Protection Plan. Version 1.0.

Marathon. 2022. Valentine Gold Project: Project Refinements related to Caribou Mitigation, Supplemental Information.

Marathon & Ausenco. 2020. N.I. 43-101 Technical Report & Pre-Feasibility Study on the Valentine Gold Project, Newfoundland and Labrador, Canada.

McCabe, Gregory J, and Steven L. Markstrom. 2007. A monthly Water-Balance Model Driven By a Graphical User Interface. Open-file report, Reston, Virginia: US Geological Survey.

Meays, C., and R. Nordin. 2013. "Ambient Water Quality Guidelines for Sulphate. Technical Appendix, Water Protection and Sustainability Branch, Environmental Sustainability and Strategic Policy Division." BC Ministry of Environment.

MOE (Ontario Ministry of Environment). 2003. Stormwater Management Planning and Design Manual, Ministry of Environment, Ontario.

Newfoundland and Labrador Department of Municipal Affairs and Environment (NLDMAE). 2014. "Policy for Flood Management." Newfoundland and Labrador Department of Municipal Affairs and Environment. March 19. https://www.mae.gov.nl.ca/waterres/regulations/policies/flood_plain.html.

Oak, T. 2022. “Letter to Brent Keeping, Impact Assessment Agency of Canada.” Marathon Gold.

Read, W.S. & Cole, L.J. 1972. The Bay D'Espoir Hydro Electric Development. Newfoundland and Labrador Power Commission.

Stantec Consulting Ltd. (Stantec). 2017. Valentine Lake Project: Preliminary Baseline Hydrogeology Assessment. Project #: 121415923.

Stantec. 2019. Valentine Lake Project: Preliminary Baseline Hydrogeology Assessment, Water Level Data. Project #: 121415923.

Stantec. 2020a. Valentine Gold Project: 2019 Baseline Hydrology and Surface Water Quality Monitoring Program. Markham, Ontario: Stantec Consulting Ltd.

Stantec. 2020b. Valentine Gold Project: Basis of Design for Pre-Feasibility Level Water Management Design - Final.: Stantec Consulting Ltd.

Stantec. 2020c. Valentine Gold Project: Valentine Gold Project: Acid Rock Drainage/Metal Leaching (ARD/ML) assessment report. September 2020.

Stantec 2020d. Valentine Lake Gold Project – Fish and Fish Habitat Valued Component Chapter.

Stantec 2020e. Valentine Lake Gold Project – Marathon Water Quantity & Water Quality Modelling Report

Stantec 2020f. Valentine Lake Gold Project – Leprechaun Water Quantity & Water Quality Modelling Report

Stantec 2020g. Valentine Lake Gold Project - Assimilative Capacity Assessment

Stantec. 2020h. Valentine Gold Project: Valentine Gold Project: Acid Rock Drainage/Metal Leaching (ARD/ML) assessment report (Phase II). September 2020.

Stantec. 2021a. Valentine Gold Project: Groundwater Monitoring Plan. Draft Report.

Stantec. 2021b. Valentine Gold Project: Surface Water Monitoring Plan. Draft Report.

Stantec. 2021c. Basis of Design for Feasibility Level Water Management Design Input Marathon and Leprechaun Complex's. Draft Report.

Stantec. 2022a. Design Brief - Water Management Infrastructure – Berry Complex Feasibility Level Final Report. November 4, 2022.

Stantec. 2022b. Valentine Gold Project: Application for Paragraph 35(2)(b) Fisheries Act Authorization. Attachment B. May 6, 2022.

Stantec. 2023a. Design Brief - Early Works Water Management Infrastructure - Issued for Construction Design. Final Report. January 31, 2023.

Stantec 2023b. Valentine Gold Project: Updated Water Balance and Water Quality Model Report. July 2023.

Stantec 2023c. Valentine Gold Project: Hydrogeological Model Update. July 2023.

Stantec 2023d. Valentine Gold Project: Assimilative Capacity Assessment Update. July 2023.

Stantec 2023e. Valentine Gold Project: Acid Rock Drainage and Metal Leaching Assessment Report Update (Proposed Revisions to Address the Addition of the Berry Pit Expansion). July 2023.

Simons, Li & Associates Inc. 1982. Design Manual for Sedimentation Control Through Sedimentation Ponds and Other Physical/Chemical Treatments, prepared for U.S. Department of the Interior Office of Surface Mining.

USACE (United States Army Corps of Engineers). 2000. Hydrologic Modeling System HEC-HMS, Technical Reference Manual, US Army Corps of Engineers, Institute of Water Resources, Hydrologic Engineering Center, California, US.

USDA (United States Department of Agriculture). 2004. Chapter 11 Snowmelt. Part 630 Hydrology National Engineering Handbook. Natural Resources Conservation Service.

USACE (United States Army Corps of Engineers). 2010. Hydrologic Modeling System HEC-HMS, User's Manual, US Army Corps of Engineers, Institute of Water Resources, Hydrologic Engineering Center, California, US.