Appendix C.5

Surface Water Resources Assessment

Crawford Nickel Project: Technical Data Report – Surface Water Resources Assessment

September 30, 2024

Prepared for:

Canada Nickel Company

Prepared by:

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Limitations and Sign-off

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Executive Summary

Canada Nickel Company Incorporated (Canada Nickel) proposes to develop, construct, operate, and progressively reclaim a new open pit nickel mine and processing facility, collectively known as the Crawford Nickel Project ('the Project'), approximately 42 km north of Timmins, Ontario. The Project includes the development of an Open Pit, Stockpiles, Tailings Management Facility (TMF), Impoundment Facility and two ore Processing Plants, and other mine-related infrastructure, as well as a new rail spur line and the relocation of Highway 655 and an existing 500 kilovolt (kV) transmission line. Ore will be extracted from a single Open Pit that will be divided into an East Zone and Main Zone. The Project has a mineral reserve estimate of 1,715 million tonnes (Mt) and an expected Project life of 41 years.

The following Technical Data Report (TDR), titled Surface Water Resources Assessment is appended as Appendix C.5 of the Impact Statement, and consolidates the results of the assessment of the effects of each of the Project components and physical activities, in all phases of the Project, based upon a comparison of baseline environmental, health, social and economic conditions and the predicted future conditions with and without the Project for surface water. This assessment will inform the completion of the associated Valued Component (VC) Chapter 15 of the Impact Statement (Assessment of Potential Effects on Surface Water).

This assessment has been prepared pursuant to the *Impact Assessment Act,* 2019 and in consideration of the Tailored Impact Statement (TIS) Guidelines for the Project.

This assessment summarizes and documents existing conditions and analytical assessment techniques used to identify predicted changes in surface water hydrology and surface water quality to determine potential and residual cumulative changes due to the Project. Flows and water levels under pre-development conditions were used as the baseline against which Project-related changes during the construction, operation, decommissioning and closure phases were assessed. Water management infrastructure and its associated mitigation measures have been designed to reduce the potential for Project effects on surface water quantity and quality. The changes in watershed areas are primarily a result of construction of mine infrastructure and the implementation of measures to manage water on site.

Project-related changes in hydrology were assessed at the watershed scale using the following tiered approach:

- A Site-Wide Water Management Plan (Appendix J of the Impact Statement) has been developed to guide the efficient and responsible use and management of water throughout the Project.
- A site-wide water balance model was developed in GoldSim™ to predict the water quantity changes through the Project phases (Appendix I of the Impact Statement [Site-Wide Water Balance Summary Report]).

- A continuous HEC-HMS hydrological model was developed to simulate existing hydrologic conditions for the watersheds containing the Project and to predict and assess changes to watercourse flows through the Project phases:
  - To account for the extended mine life and globally driven changes in climate, climate change effects were integrated into the development of a future climate year which was downscaled to daily meteorological conditions.
  - Expected daily flows for construction, operation, and decommissioning and closure mine phases were compared to pre-development conditions to establish expected changes in surface water quantity within and at the boundary of the hydrologic model.

Pre-development surface water quantity was used as the baseline against which changes in surface water quantity during Project mine life phases were assessed. Baseline hydrology was analyzed using regional and local water quantity assessments conducted to describe water quantity conditions in the Project Area. Regional hydrologic variables addressed by the baseline assessment include annual flows, monthly flows, peak flows, low flows and environmental flows using extensive historic datasets for the region. The baseline hydrological model was validated against local Project hydrometric station data using the developed local site rating curves. Surface water runoff and groundwater discharge associated with the Open Pit, Impoundment Facility, East and West Stockpiles and Tailings Management Facility were evaluated during construction, operations, and decommissioning and closure phases.

Project activities may interact with surface water quantity in the construction, operations, and decommissioning and closure phases of the Project. In general, the interactions can be characterized as being primarily associated with controlled, routine treated mine water discharges from the Project. The water balance results, using climate change adjusted climate normal precipitation and temperature, were calculated at the Final Discharge Point (FDP) discharges into the West Buskegau River and North Driftwood River (Appendix I of the Impact Statement [Crawford Site-Wide Water Balance Summary Report]).

Much research on the development of ecological flows has been conducted over the last several decades, especially in countries such as Australia and South Africa who have experienced severe drought conditions. Many researchers have indicated when daily flow alterations are no greater than 10% a high level of ecological protection will be provided (Richter et. al. 2011; Acreman and Ferguson 2010; Maine DEP 2006; DFO 2013). Thus, a daily flow change of 10% was used in this assessment as a screening threshold. Flow reductions over 10% were further assessed by comparison to environmental flow values, and if flows were lower than baseline condition environmental flows, a local water quantity residual effect was expected. Flow increases over 10% were further assessed by comparing predicted flood flows (100-year return period, 24-hour duration event; Q_{100}) to the baseline condition flood flow to assess potential flooding and erosion.

Table ES.1 summarizes the results of the quantity assessment at the outlet of each watershed model as it relates to the ±10% threshold limit for the modelled year for each mine phase. No flow reductions are predicted above the 10% threshold for the Jocko Creek or the West Buskegau Watersheds for any mine life phase at the downstream extent of the hydrologic model. For the North Driftwood watershed there were 20 days during the operations phase 2 (Mine Year 17) with flow reductions greater than the 10% threshold at the hydrologic model outlet, however none fell below the environmental flow value. No other days above the 10% reduction threshold were predicted for the North Driftwood watershed for subsequent mine life phases. The flow increases above the 10% threshold at the watershed model outlets in the three watersheds and eight modelled scenarios were generally associated with periods of low flow conditions.

Table ES.1 Summary of Instantaneous Flow Changes for the Project in Jocko Creek, West Buskegau River and North Driftwood River at Watershed Model outlets.

Mine Life Phase	Exceedance Threshold	Jocko Creek (JC_DS) No. of Days	West Buskegau River (WB_1) No. of Days	North Driftwood River (ND_1) No. of Days
Construction (Modelled Years -3 to -1 – Year -1)	+10% Reduction Days	NA	0	0
	+10% Reduction & Below Environmental Flow Days	NA	0	0
	+10% Increase Days	NA	106	91
	Q_{100} Flood Flow Increase	NA	**No**	**No**
Operations Phase 1 (Modelled Years 1 to 4 – Year 2)	+10% Reduction Days	NA	0	0
	+10% Reduction & Below Environmental Flow Days	NA	0	0
	+10% Increase Days	NA	88	119
	Q_{100} Flood Flow Increase	NA	**No**	**No**
Operations Phase 1 and 2 (Modelled Years 4 to 18 – Year 17)	+10% Reduction Days	0	0	20
	+10% Reduction & Below Environmental Flow Days	0	0	**0**
	+10% Increase Days	112	151	203
	Q_{100} Flood Flow Increase	**No**	**No**	**No**
Operations Phase 2 (Modelled Years 18 to 30 – Year 23)	+10% Reduction Days	0	0	0
	+10% Reduction & Below Environmental Flow Days	0	0	0
	+10% Increase Days	0	145	136
	Q_{100} Flood Flow Increase	**No**	**No**	**No**

Mine Life Phase	Exceedance Threshold	Jocko Creek (JC_DS) No. of Days	West Buskegau River (WB_1) No. of Days	North Driftwood River (ND_1) No. of Days
Operations Phase 3 (Modelled Years 30 to 41 – Year 35)	+10% Reduction Days	-	0	0
	+10% Reduction & Below Environmental Flow Days	-	0	0
	+10% Increase Days	-	3*	74
	Q_{100} Flood Flow Increase	-	**No**	**No**
End of Operations (Modelled Year 41)	+10% Reduction Days	-	0	0
	+10% Reduction & Below Environmental Flow Days	-	0	0
	+10% Increase Days	-	0	61
	Q_{100} Flood Flow Increase	-	**No**	**No**
Passive Closure (Modelled Year 46 onward – Year 47)	+10% Reduction Days	-	0	0
	+10% Reduction & Below Environmental Flow Days	-	0	0
	+10% Increase Days	-	0	29
	Q_{100} Flood Flow Increase	-	**No**	**No**
Pit Filled	+10% Reduction Days	-	0	0
	+10% Reduction & Below Environmental Flow Days	-	0	0
	+10% Increase Days	-	0	29
	Q_{100} Flood Flow Increase	-	**No**	**No**

Notes:
- Denotes no change in exceedance of the ±10% threshold limit
NA No works planned within the Jocko Creek watershed to impact drainage during the construction phase
* Flow increases are associated with low flow conditions (<1 m^3/s) which would not increase scour and erosion potential

Upstream of the watershed model outlet for the West Buskegau and North Driftwood River watersheds, subwatersheds affected by Project area development have predicted exceedances of the ±10% threshold, including flood flows above the baseline Q_{100} value (less than 1.0 m^3/s outside the North Driftwood River Diversion Channel realignment section) and low flow reductions below the environmental flow values (subwatersheds immediately adjacent to PA with drainage area reductions). The Project is located within headwater subwatersheds within both the North Driftwood River and West Buskegau River causing reductions in drainage areas and/or alterations in drainage patterns during the different mine phases (Figure A.5 to Figure A.10). These changes in drainage areas within headwater subwatersheds have more quantitative impacts than farther downstream of the Project.

The Project is predicted to increase and decrease groundwater discharge by the groundwater model (Groundwater Technical Data Report, Appendix C.5) to the main channels of Jocko Creek, the North Driftwood River and the West Buskegau River and lake waterbodies near the PA during different life of mine phases. Decreases in groundwater discharge and associated changes in waterbody water levels in the three watersheds were considered within the range of natural variability. Changes in flows within the main channels were further assessed using the HEC-HMS hydrologic model and no changes greater than the 10% threshold were predicted at the modelled watershed outlets (JC_DS, ND1 and WB1).

The following surface water quality models were developed to assess potential Project effects on surface water quality:

- Contact water quality for the Project discharging into groundwater and mine water management infrastructure during different mine phases was predicted using a site-wide water quality GoldSim™ model. The model outputs were used to develop treatment discharge effluent criteria for the treatment plants.

- An Assimilative Capacity Study was conducted to develop effluent criteria and estimate the water quality of watercourses and waterbodies receiving discharges directly from the Project final discharge points to the North Driftwood River and West Buskegau River. The near-field mixing model CORMIX (Version 12.0) was used to predict water quality under both regulatory and normal discharge scenarios for the North Driftwood River and West Buskegau River as the receivers for the mine FDPs. Outputs from the GoldSim™ water quality model were used to estimate seepage quality to the assimilative capacity assessment from the Project during different mine phases.

Parameters of Potential Concern (PoPCs) were considered to be parameters in receiving waters and mine effluent that exceeded the Ontario Provincial Water Quality Objectives (PWQOs) and/or the Canadian Council of Ministers of the Environment's Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life (CCME CWQG-FAL). Water quality parameters in the effluent and seepage predictions by the water quality model were used to identify PoPCs, which included receiver and effluent-based PoPCs nitrate, nitrite, fluoride, aluminum, chromium (VI) and (III), arsenic, cobalt, copper, iron, nickel, selenium, uranium, vanadium, zinc, and phosphorus, and seepage-based PoPcs un-ionized ammonia, boron, and chloride. Within the receivers, dissolved aluminum (0.2 µm particle size), total iron and total phosphorus were identified as Policy 2 parameters (MECP Procedure B.1.5).

Effluent discharge from the FDPs and Project associated groundwater seepage quality is predicted to be consistently below maximum authorized monthly mean and maximum authorized parameter concentrations set out in Table 1 of Schedule 4 of the Metal and Diamond Mine Effluent Regulations.

Assimilative capacity assessments related to the PoPCs parameters were conducted considering two life of mine phases, the construction/operations phase and the post closure phase, under two discharge conditions, regulatory (dry, conservative) and normal (average, typical). The near-field mixing CORMIX model (Version 12.0) was used to determine the length to the point of full mixing, which was less than 200 m downstream of the FDPs. Mass balance analyses were used to determine concentrations at the point of full mixing and farther downstream. The extent of the mixing zone was calculated as the distance between the FDP and the point where concentrations decrease below or meet the regulatory objective/guidelines.

The mixing zone was estimated for the two discharge conditions. In the construction/operations phase for regulatory conditions (7-day low flow, 20-year return period low flow in the receiver with maximum FDP discharge), mixing zones are predicted to extend to the Frederick House River confluence for the West Buskegau River and to the Abitibi River confluence for the North Driftwood River (Table ES.2). Nitrite, total iron and total phosphorus were the parameters that controlled the extent of the ultimate mixing zone.

Table ES.2 PoPC Assimilative Capacity Assessment Summary Results in Jocko Creek, the West Buskegau River and the North Driftwood River

Mine Life Phase	Discharge Conditions	Jocko Creek		West Buskegau River (Most Downstream FDP – SP-01)		North Driftwood River (Most Downstream FDP – SP-02)	
		Ultimate Mixing Zone Extent*	Mixing Zone Extent Control Parameter(s) **	Ultimate Mixing Zone Extent	Mixing Zone Extent Control Parameter(s) **	Ultimate Mixing Zone Extent	Mixing Zone Extent Control Parameter(s) **
Operations Phase (Modelled Years 4 to 30)	Regulatory	NA	NA	40.2 km at the Frederick House River Confluence	Nitrite, Total Phosphorus	87 km at the Abitibi River Confluence	Iron, Nitrite, Total Phosphorus
	Normal	NA	NA	0.166 km at the Point of Full Mixing	10 Parameters ***	3.6 km at Sub-watershed ND8 Outlet	Nitrate
Post Closure Phase (Pit is Full) (Year 167)	Regulatory	NA	NA	NA	NA	NA	NA
	Normal	NA	NA	NA	NA	NA	NA

Notes:
NA - Mixing zone assessment due to FDP is not applicable; Concentrations did not exceed the regulatory objective/guidelines
* - Distance between the most downstream FDP in the receiver and the point where concentrations decrease below the regulatory objective/guidelines
** - Parameters with the longest mixing zones
*** - Nitrite, nitrate, arsenic, cobalt, chromium (VI) and (III), copper, selenium, uranium and vanadium

In normal operating conditions (scenario 2), however, the edge of the mixing zones in the operations phase was upstream of or at the point of full mixing in the West Buskegau River and North Driftwood River for all PoPCs, except for nitrate in the North Driftwood River with a mixing zone extending 3.6 km downstream of FDP-SP-02.

The assimilative capacity assessment of PA associated groundwater seepage into the Jocko Creek channel and its waterbodies predicted no increases in PoPC parameters above the regulatory objective/guidelines.

During the pit-full life of mine phase, water quality in the pit lake was predicted to be below regulatory objective/guideline values for the regulatory and normal conditions and therefore there would be no mixing zone in the West Buskegau River and North Driftwood River receiving pit lake outflows.

Other assessed surface water quality parameter changes in receivers due to Project activities had the following results:

- Baseline local surface water asbestos fibre (chrysotile) concentrations were typically below the laboratory RDL and the single result slightly above detection was below US EPA human health water quality criteria (2024). It is not anticipated to be a surface water potential contaminant of concern due to Project activities.
- Water temperatures and dissolved oxygen concentrations in receivers (Jocko Creek, the West Buskegau River and North Driftwood River) are not expected to change due to Project activities with planned water management system mitigation measures (e.g., bottom draw pump intakes from sedimentation ponds, aeration within treatment plants and discharge channels)
- Average Total Phosphorus (TP) concentrations at FDPs are not predicted to increase receiver TP concentrations above the PWQO value, which was developed to prevent excessive plant growth, in the West Buskegau River and North Driftwood River.
- Average Total Inorganic Nitrogen (TIN) (total ammonia + nitrate + nitrite) concentrations in the FDP discharges to the West Buskegau River are not predicted to increase the potential for eutrophication. The average TIN concentration in the FDP discharges to the North Driftwood River would be expected to increase the potential for eutrophication from FDP-TMF-SP to up to 3.6 km downstream of FDP-SP-02.
- An empirical loading assessment for methyl mercury for permanently inundated areas predicted by project activities estimated expected concentration increases due to the North Driftwood Diversion Channel realignment ranging from 0.1 to 0.109 ng/L. The predicted North Driftwood River methyl mercury concentration does not exceed the CCME CWQG-FAL value (4 ng/L).
- Deposition of sulphur and nitrogen compounds on waterbodies was assessed with respect to increase in lake acidity for the construction and operations phases on select waterbodies predicted to receive maximum deposition rates. The Potential Acid Input (PAI) loading rates from the project and low acid sensitivity of the receivers predicts negligible changes to existing acidity in waterbodies outside the PA.

Table of Contents

List of Tables

List of Figures

List of Appendices

Acronyms and Abbreviations

ALS	ALS Global
AP	acid potential
ARD	acid rock drainage
CALA	Canadian Association for Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
CoC	Chain of Custody
CWQG-FAL	Canadian Water Quality guidelines for Protection of Freshwater Aquatic Life
DARM	Drainage-Area Ratio Method
DEM	Digital Elevation Model
DFO	Department of Fisheries and Oceans Canada
DO	Dissolved oxygen
ECCC	Environment and Climate Change Canada
FDP	Final Discharge Point
HEC-HMS	Hydrologic Engineering Centre, Hydrologic Modelling System
HYDAT	Hydrometric Data
IAA	*Impact Assessment Act*, 2019
IK	Indigenous knowledge
IPT	In Process Tailings
kV	kilovolt
LIDAR	Light Detection and Ranging
LSA	Local Study Area

MAF	Mean Annual Flow
masl	meters above sea level
MDMER	Metal and Diamond Mining Effluent Regulations
MECP	Ministry of the Environment, Conservation, and Parks
MEND	Mine Environment Neutral Drainage Program
ML	Metal Leaching
MMF	Mean Monthly Flow
MOEE	Ministry of the Environment and Energy
MSC	Meteorological Service of Canada
NGO	Non-governmental Organization
NP	neutralizing potential
NPAG	Non-potentially acid generating
NSE	Nash-Sutcliffe Efficiency
ORP	Oxidation Reduction Potential
OWIT	Ontario Watershed Information Tool
PA	Project Area
PAG	Potentially acid generating
PoPC	Parameter Of Potential Concern
PWQO	Ontario Provincial Water Quality Objectives
PWQMN	Provincial Water Quality Monitoring Network
PRF	Peak Rate Factor
RDL	Reportable Detection Limit
RMS	Root Means Square
RMSE	Root Mean Square Error

RPD	relative percent difference
RSA	Regional Study Area
Testmark	Testmark Laboratories
'the Minister'	Minister of the Environment and Climate Change
TIS Guidelines	Tailored Impact Statement Guidelines
TMF	Tailings Management Facility
VC	Valued Component
WSC	Water Survey of Canada
7Q20	20-year low flow, 7-day average

1 Introduction

Canada Nickel Company (Canada Nickel) proposes to develop, operate, and progressively reclaim the Crawford Nickel Project ('the Project'), a new open pit nickel mine and processing facility approximately 42 kilometres (km) north of Timmins, Ontario along Highway 655. The Project is being assessed in accordance with the *Impact Assessment Act*, 2019.

Stantec Consulting Ltd. (Stantec) has been retained by Canada Nickel to conduct an assessment of surface water resources for the Project. This report provides a surface water effects assessment based on the proposed Project design and corresponding activities proposed during construction, operation, and decommissioning of the Project.

This Surface Water Resources Assessment has been completed to inform the Impact Statement. It has been prepared pursuant to the *Impact Assessment Act,* 2019 and in consideration of the Tailored Impact Statement Guidelines: Crawford Nickel Project (Appendix A.1 of the Impact Statement).

The information presented in this report is intended to summarize and document the existing conditions of surface water resources and the analytical assessment techniques used to identify changes in surface water hydrology and surface water quality to determine potential and residual cumulative changes due to the Project, to support the preparation of the Impact Statement.

1.1 Study Objectives

The Surface Water Resources Assessment is intended to summarize and document existing conditions and analytical assessment techniques used to identify predicted changes in surface water hydrology and surface water quality to determine potential and residual cumulative changes due to the Project. The specific objectives of this assessment were the:

- Collection and review of available information and data.
- Simulation of predicted construction, operations and decommissioning phases of the Project water quantity conditions using a water balance model (Appendix I of the Impact Statement [Site-Wide Water Balance Summary Report]) and hydrologic computer model.
- Simulation of predicted construction, operations, and decommissioning phases of the Project water quality for parameters of potential concern (PoPCs) using a water quality model and assimilative capacity model and assessment.
- Assessment of predicted changes in surface water quantity and quality.

Table 1.1 presents the studies completed and corresponding sections of the report.

Table 1.1 Concordance Table of Studies Summarized within the Surface Water Resources Assessment

Report Results Section	Report Name	Study Objectives
6.1	Surface Water Resources Baseline Report	• Establish baseline hydrologic conditions for the Project • Establish baseline surface water quality for the Project • Integrate local meteorology, local and regional watersheds, terrain, soils, groundwater, and vegetation conditions into a continuous hydrologic model
6.3	Site-Wide Water Management Plan (Appendix J of the Impact Statement)	• Reduce water inventory through perimeter berms and promote overland flow of non-contact runoff • Reduce the number of Final Discharge Points (FDPs) through grading of ditches and construction of diversion channels to combine discharge points of sedimentation ponds • Maintain flow to fish bearing streams and waterbodies by maintaining pre-development catchments and flows • Reduce water management costs during construction and operations phases through grading and gravitational drainage, thus reducing pumping requirement
6.3.5	Site-Wide Water Balance Summary Report (Appendix I of the Impact Statement)	• Evaluate the quantity of surface water and groundwater taken from and discharged to the open pit during construction, operations, and decommissioning and closure • Evaluate the quantity of groundwater discharge and surface water runoff associated with Project infrastructure, including waste rock storage areas (Impoundment Facility), ore Stockpiles, and overburden Stockpiles during construction, operations, and decommissioning and closure • Evaluate the quantity of groundwater discharge and surface water runoff associated with the Tailings Management Facility (TMF) during construction, operations, and decommissioning and closure phases • Predict the quantity of water that will be discharged to the environment during construction, operations, and decommissioning and closure phases and to allow the assessment of treatment requirements based on the results of the Assimilative Capacity Study (Section 6.3.6.2.1) • Address water management needs to meet water demand with a focus on the reuse of contact water to meet Project demands and to reduce the volume of water under management at the site
6.3.6.1.2	Water Quality Model	• Evaluate the quality of surface water and groundwater discharged to the open pit during construction, operations, and decommissioning and closure phases • Evaluate the quality of groundwater discharge and surface water runoff associated with Project infrastructure, including the Impoundment Facility, ore Stockpiles, and overburden Stockpiles during construction, operations, and decommissioning and closure phases

Report Results Section	Report Name	Study Objectives
		• Evaluate the quality of groundwater discharge and surface water runoff associated with the TMF during construction, operations, and decommissioning and closure phases • Predict the quality of water that will be discharged to the environment during construction, operations, and decommissioning and closure phases and to allow the assessment of treatment requirements based on the results of the Assimilative Capacity Study (Section 6.3.6.2.1)
6.3.6	Flow change assessment	• Evaluate the change in surface water quantity during construction, operations, and decommissioning and closure phases of the Project
6.3.6.2.1	Assimilative Capacity Study	• Identify the treated effluent discharge locations for the Project • Predict changes to water quality in receiving waters for the Project • Determine the length of the mixing zones within the receiving waters • Evaluate the effectiveness of treated effluent discharge design on the dispersion and plume dissipation • Confirm the assimilative capacity of receiving waters and develop effluent discharge criteria which are protective of the receiving environment.

1.2 Project Overview

The Project includes the development of an Open Pit, Stockpiles, two ore processing plants, and other mine related infrastructures, as well as new rail spur line and the relocation of Highway 655 and 500 kilovolt transmission line. Ore will be extracted from a single Open Pit that will be divided into an East Zone and Main Zone. The Project has a mineral reserve estimate of 1,715 million tonnes and an expected project life of 41 years.

The Crawford Project site is located approximately 42 km north of the City of Timmins, Ontario, in the geographic townships of Crawford, Carnegie, Kidd, Lucas, Beck, Nesbitt, Wark and Prosser. A small portion of the Project extent within the geographic townships of Kidd and Wark also lies within the municipal boundary of the City of Timmins.

Based on the current Project design, the maximum rate of ore extraction will be up to 240,000 tonnes per day (tpd) during year 5 of operations and an average rate of 160,000 tpd over the life of mine. The two ore Processing Plants and associated service facilities will process run of mine ore delivered to primary crushers to produce nickel concentrate, iron concentrate, and tailings at a rate of approximately 60,000 tpd at the start of mine life, ramping up to a maximum of 120,000 tpd. In addition to nickel and iron, other metals such as cobalt, chromium, palladium and platinum are expected to be recovered from concentrate streams.

Based on the proposed processing rate and current information regarding the ore body, the current life of the proposed Project is expected to be approximately 41 years. Mining would be completed at a faster pace than milling, thus mining of ore would occur for about 30 years, then milling alone for the last 11 years.

Concentrate from the processing plants will be loaded onto rail cars and shipped via the rail spur line for refinement offsite.

1.3 Key Project Activities

The temporal boundary of the assessment includes all Project phases from the start of construction through to the end of closure. Based on the current Project schedule, the Project phases include:

- Construction (Mine Year -3 to Year -1)
- Operations
  - Operations phase 1 (Year 1 to Year 5); 60 kilotonnes per day (kt/d) milling capacity with ore extraction
  - Operations phase 2 (Year 5 to Year 30); 120 kt/d milling capacity with ore extraction
  - Operations phase 3 (Year 30 to Year 41); 120 kt/d milling capacity with no ore extraction
- Decommissioning and closure
  - Active closure (Year 40 to Year 46)
  - Passive closure (Year 46+)

1.3.1 Construction Phase

The construction phase will include the preparation of the site up to the point at which the first process plant has been commissioned and is ready to commence operations. This phase will include site preparation, physical construction, pre-production, and commissioning activities. Construction is anticipated to begin in the Main Zone and East Zone, and rock extracted at this time may be crushed into aggregate using a mobile aggregate crusher for use during the construction of roads and other infrastructure, as necessary.

It is noted that additional construction will occur through the operations phases of the Project, and that this phase is defined by the start of ore processing.

1.3.2 Operations Phase

The Operations Phase is focused on the active processing of ore and generation of concentrate for delivery to market, specifically operation of the process plant(s). Due to the sequential nature of the mine operations, the operations phase of the Project has been divided into 3 sub-phases based on the Open Pit extraction schedule and sequential operation of the two process plants.

The three sub-phases of the operations phase include:

- Operations phase 1 – This phase includes the operation of the first of two process plants that will be operating at an ore processing capacity of approximately 60 kt/day (or 21.9 Mt/a). In Process Tailings (IPT) carbonation within the process plant may also commence if a CO_2 source is available. Mining operations during this phase will produce more ore than the process plant can process, with surplus material to be stockpiled in the East Stockpile location for future processing. Construction will continue during the phase to expand and construct the second process plant and other supporting mine infrastructure, including the Highway 655 realignment. Material will begin to be stored within the West Stockpile at the end of this phase.
- Operations phase 2 – This phase includes the operation of both process plants that will be operating at an ore processing capacity of approximately 120 kt/d (or 43.8 Mt/a), including IPT carbonation. Mining operations during this phase will produce up to 240 kt/day, which is more ore than the process plants can process. Surplus ore will continue to be stockpiled in the East and/or the West Stockpiles.
- Operations phase 3 – This phase includes continuation of the operation of both process plants at an ore processing capacity of approximately 120 kt/d (or 43.8 Mt/a) following completion of mining operations (e.g., no further extraction of ore from the pits). The process plants, including IPT carbonation, will continue to operate by processing the ore stockpiled during operations phases 1 and 2. As mine operations cease, there will be an opportunity for progressive reclamation of the pits, haul routes, and other infrastructure no longer required.

1.3.3 Decommissioning and Closure Phase

Following the completion of ore processing, all Project operations will cease, and active closure will commence. Active closure includes the removal of buildings, structures, and other infrastructure, as well as reclamation and site stabilization activities. Once complete, the Project will then enter a passive closure phase as the pit lake fills. During this time, closure monitoring and adaptive mitigation will occur. Following pit lake filling, the Project site will be permanently closed.

Activities completed during the decommissioning and closure phase of the Project are focused on reclaiming the environments, establishing physical, chemical, and biological stability at the site, and to meet desired end land functions and uses. The Closure Plan will be updated throughout the life of the Project as necessary to reflect the environmental requirements in place at the time of closure. The Closure Plan will be prepared, refined, and implemented in accordance with the Ontario *Mining Act* and Ontario Regulation 35/24.

Progressive reclamation throughout the course of the mine life will occur, but other closure activities such as plants and building decommissioning will commence at the cessation of mining activities and will be completed five years after ore processing ceases. Ongoing closure monitoring and maintenance activities will be carried out throughout active and passive closure phases until the closure objectives have been satisfied and the Project has been moved to a closed out status.

2 Study Area

The Project comprises approximately 11,785 hectares (ha) (118 square kilometres [km^2]) along Highway 655 approximately 42 km north of the City of Timmins, Ontario. The Project is located mostly within the Geographic Townships of Crawford and Lucas, with elements also in the Townships of Nesbitt, Beck, Carnegie, and Prosser. The proposed Highway 655 realignment and rail spur line extend into the geographic Townships of Kidd and Wark (which are considered to be part of the City of Timmins).

2.1 Project Area

The **Project Area (PA)** encompasses the Project footprint and is the anticipated area of physical disturbance associated with the construction, operations, and decommissioning and closure of the Project. The PA includes the Open Pit, Stockpiles, Impoundment Facility, TMF, two ore Processing Plants, and other mine-related infrastructure, as well as a new rail spur line and the relocation of Highway 655 and an existing 500 kV transmission line. The extent of the PA for the Project is shown on Figure A.1 within Appendix A.

2.2 Local Study Area

The **Local Study Area (LSA)** encompasses the area in which Project-related effects (direct or indirect) were predicted or measured with a level of confidence appropriate for the assessment and in which there is a reasonable expectation that the potential effects in the LSA are of public interest.

The LSA includes the PA and subwatersheds on the west side of the West Buskegau River main channel, several catchments within the Jocko Creek watershed, and headwater and downstream subwatersheds of the North Driftwood River. The LSA continues downstream on the West Buskegau River and North Driftwood River, away from the PA. The LSA is shown on Figure A.1 within Appendix A .

2.3 Regional Study Area

The **Regional Study Area (RSA)** includes the area within which cumulative effects on surface water quality and quantity are likely to occur, depending on the location of other past, present, or reasonably foreseeable future projects or activities.

The RSA for the Surface Water Resources assessment includes the PA and LSA and extends farther downstream than the LSA along the North Driftwood River, West Buskegau River and Jocko Creek. The RSA is shown on Figure A.1 within Appendix A.

3 Regulatory Setting

There are several federal and provincial regulatory requirements that may apply to the Project from a surface water quantity or quality perspective, including environmental assessment and other environmental permitting obligations. These are further discussed in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement) and include, but are not limited to, approvals associated with:

- *Impact Assessment Act*, 2019
- *Fisheries Act,* 1985
- *Canadian Navigable Waters Act*, 2019
- *Mining Act*, 1990
- *Lakes and Rivers Improvement Act,* 1990
- *Ontario Water Resources Act,* 1990
- *Conservation Authorities Act,* 1990

The primary regulatory guidance and criteria applicable to this study include the following:

- Ontario Provincial Water Quality Objectives (PWQOs) (MOEE 1994b)
- Ontario Ministry of the Environment and Energy (MOEE) Procedure B-1-5 (MOEE 1994a)
- Canadian Council of Ministers of the Environment's Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life (CCME CWQG-FAL) (CCME 2024)
- Schedule 4 of Metal and Diamond Mining Effluent Regulations (MDMER) SOR/2002-222 under the *Fisheries Act*
- British Columbia Ministry of Environment and Climate Change Strategy (BC MECCS) for the protection of aquatic life guideline for sulphate

4 Background

The Project is located within three subwatersheds: the North Driftwood River and the West Buskegau River, both of which drain north into the Abitibi River, and Jocko Creek, which drains into Kidd Creek and subsequently the Mattagami River. Several lakes located adjacent to the PA drain into the North Driftwood River.

Baseline surface water quantity and quality conditions were characterized through desktop analysis and field methods. Desktop analysis included watershed delineation, a climate and climate change assessment, regional hydrological assessment (streamflow monitoring stations operated by the Water Survey of Canada), bathymetric assessment, an environmental water balance, and the development of a hydrological model.

Regional and local water quality assessments were conducted to analyze and describe water quality conditions in the PA. Regional water quality data was obtained from seven Provincial Water Quality Monitoring Network stations.

Local general water quality in the watercourses and waterbodies identified slightly acidic conditions, with three parameters of potential concern identified based on 75^{th} percentile exceedances of provincial and/or federal guidelines (phosphorus, aluminum, and iron). Both the regional and local water quality exhibited seasonal trends for various parameters. Concentrations of parameters were typically higher in the late fall and winter months and lower in the spring and summer months. Results were comparable across the various watersheds.

Additional details related to surface water hydrology and water quality are provided in the Surface Water Baseline Report (Appendix B.6 of the Impact Statement) with summaries of the methods (Sections 5.2 and 5.9) and results (Section 6.1) provided in this report.

5 Methods

5.1 Effects Assessment

Surface water resources are an integral part of the hydrological cycle and were selected as a Valued Component (VC) because they can influence and be influenced by activities of the Project.

Specifically, surface water was selected as a VC for the following reasons:

- Importance as an ecosystem (recreation, terrestrial life uses and aquatic life habitat)
- Potential for Project-related effects on both surface water quality and hydrology, including or resulting from:
  - Potential changes to surface water quality associated with effluent releases, surface water runoff, process water management, as well as potential effects on water quality associated with material storage or stockpiling
  - Potential changes to hydrological or hydrometric conditions and effects of lowering the water table on aquatic ecosystems
  - Management of pit water quality during operation and post-closure

The environmental effects analyses for changes in hydrology and surface water quality were carried out using a number of analytical methods and tools including a site-wide water quality and quantity GoldSim^{TM} model, site-wide hydrogeological model, local area hydrological model, and 3-dimensional steady state near-field Cornell Mixing Zone Expert System (CORMIX) model. Development of the models, inputs, and results are described in the following sections.

5.1.1 Hydrology

Flows and water levels under pre-development conditions were used as the baseline against which Project-related changes during the construction, operations, decommissioning and closure phases were assessed. Pre-disturbance (baseline) watershed areas are presented on Figure A.4 within Appendix A and expected changes to these watersheds were delineated for subsequent phases of the mine life, as shown on Figures A.5 to A.10 within Appendix A. Baseline hydrological conditions are summarized in Section 6.1 and presented in greater detail in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement). Placement of infrastructure and mine waste was designed for improved water management, proximity to the Open Pit and Process Plants, and reduced overall footprint and impact to surface water and groundwater systems. The changes in watershed areas are primarily a result of construction of mine infrastructure and the implementation of measures to manage water on site.

Project-related changes in hydrology were assessed at the watershed scale using the following tiered approach:

- A Site-Wide Water Management Plan (Appendix J of the Impact Statement) has been developed to guide the efficient and responsible use and management of water throughout the Project. The Site-Wide Water Management Plan provides an overview of all contact and non-contact water streams managed by the Project and, where applicable, how the stream will be drained or pumped, stored, diverted, and discharged. The Site-Wide Water Management Plan will be updated through the detailed design of the mine and will be finalized prior to the commencement of site preparation.
- A site-wide water balance model (Appendix I of the Impact Statement) was developed in GoldSim™ to predict the water quantity changes through the Project. The water balance model includes the Open Pit, TMF, overburden Stockpiles, impoundment facility (waste rock, sand/till, clay), lower value ore Stockpiles, process plant and ancillary infrastructure, and water management infrastructure.
- The continuous HEC-HMS hydrological model developed as part of the Surface Water Baseline assessment forms the basis from which the change in surface water quality will be evaluated. To assess project changes through life of mine, the subwatersheds in the hydrological model were adjusted to account for mine water management, mine discharges to FDPs, and Project-related changes to groundwater discharge.
- To account for the extended mine life and globally driven changes in climate, climate change effects were integrated into the development of a future climate year which was downscaled to daily meteorological conditions. The HEC-HMS hydrological model setup with climate change adjusted meteorological inputs (air temperature, precipitation) at a daily scale to estimate baseline conditions from which Project change would be assessed. Changes in daily flows from climate change adjusted baseline flows were used as a screening threshold to determine whether further assessment of changes in flow were required. Changes in daily flows were calculated during each phase of mine development for a modelled year of daily flows. Subwatersheds with an expected change in daily flow of greater than 10% were carried forward to subsequent assessment steps. The +/- 10% threshold was selected based on case studies presented by Richter et. al. (2011), Acreman and Ferguson (2010) and DFO (2013)., which indicate that when flow alterations are within 10% of the natural flow a high level of ecological protection is provided.
  - For subwatersheds with an expected daily flow decrease of over 10%, the daily flows were compared with the climate change adjusted baseline predicted environmental flows. If environmental flows were maintained, the residual effect was not substantial. If environmental flows were not maintained, a local residual effects was assigned. Environmental flows have been updated from the baseline assessment to account for climate change. Environmental flows were derived using the Tessman Method (1980), based on mean monthly flow (MMF) and mean annual flow (MAF) taken from the updated HEC-HMS models that incorporate climate change (Section 5.8). If the expected daily flows were lower than the baseline environmental flows, a local surface water quantity residual effect is expected within the LSA.

  - For watersheds with an expected increase in daily flows of over 10%, expected flood flows (100-year return period, 24-hour duration event) were compared with the baseline condition flood flow to assess the potential for flooding, erosion and scour.
- Pre-development watersheds at the extent of the LSA are shown on Figure A.4 within Appendix A and present the watersheds during the construction, operations, and decommissioning and closure mine phases, Figures A.5 to Figure A.10 within Appendix A. Expected daily flows for these phases were compared to pre-development conditions to establish expected changes in surface water quantity at the boundary of the LSA. If a residual effect for surface water is propagated to the boundary of the LSA and beyond, it is considered a residual effect.

5.1.2 Water Quality

Baseline surface water quality was used as the baseline against which changes in surface water quality during Project phases were assessed. Baseline surface water quality was analyzed using regional and local water quality assessments conducted to describe water quality conditions in the PA. The quality of surface water runoff and groundwater discharge associated with the Open Pit, Impoundment Facility, Ore Stockpiles, and TMF was evaluated during construction, operations, and decommissioning and closure phases. PoPCs were parameters in receiving waters and mine effluent that exceeded the PWQOs or the CCME CWQG-FAL. As MECP Policy 5 of Water Management (MOE 1994a) indicates that mixing zones are not to be used as an alternative to reasonable and practical treatment, the effluent mixing zones for each PoPC were determined based on both the assimilative capacity of local receiving waters and reasonable and practical water treatment limits.

The conditions of the assimilative capacity (receiving water) assessment are defined in MECP Procedure B-1-5 (1994a) which require effluent criteria to be developed to be site-specific based on the following:

- Low flow conditions in the receiving water (7Q20 low flows)
- Poorer water quality in the receiver (75^{th} percentile water quality)
- Maximum effluent discharge rates from effluent source (maximum predicted flow to each FDP)
- Maximum predicted effluent water quality (after water treatment)
- Incorporation of receiver mixing zone extent and reasonable and practical treatment

An average condition was also developed for the assimilative capacity assessment based on mean annual flow in the receivers, average discharge rates, average water quality in the receiver and average discharge quality or effluent target objective from the treatment system.

Additionally, effluent limits must comply with maximum authorized monthly mean and maximum authorized concentrations set out in Table 1 of Schedule 4 of MDMER.

5.2 Baseline

5.2.1 Regional Hydrological Assessment

The baseline assessment used the hydrologic data from non-regulated Water Survey of Canada (WSC) stations within 200 km of the Project Site, with watershed area no greater than one order of magnitude difference to the project record, and a period of record greater than 20 years. An additional criterion of the station having a period of record that falls within one climate normal period - preferably the most recent Environment and Climate Change Canada (ECCC) climate normal period currently being estimated for climate stations in Canada (1991 to 2020) (ECCC 2023b) - was included for this assessment.

WSC Stations Blanche River Above Englehart (Station ID 02JC008), Ivanhoe River At Foleyet (Station ID 04LC003), Mattawishkwia River At Hearst (Station ID 04LK001), Kamiskotia River Above Enid Creek (Station ID 04LB002), Tatachikapika River Near Timmins (Station ID 04LA003), Nemegosenda River Near Chapleau (Station ID 04LE002), Porcupine River At Hoyle (Station ID 04MD004), and Mollie River At Highway No. 144 (Station ID 04LA006) were selected to undergo homogeneity testing. Beginning in 2014 until 2022, flow data quality issues were identified at Station ID 04MD004 by WSC due to backwater conditions from the operation of an Ontario Power Generation (OPG) dam downstream on Nighthawk Lake, localized beaver activity, and an upstream control dam at a tailings management facility (ECCC 2024). Impacted data from the 2014 to 2022 period was excluded from the analysis.

Further assessment was applied to confirm hydrologic homogeneity where the landscape is subject to similar climate and physiographic conditions. The tests used to confirm hydrologic homogeneity included mean slope, percent area of waterbodies, average annual precipitation, unit flow, flow duration curve (FDC), and Index Flood Flow. A station was not eliminated because it failed a single test but would be eliminated if it failed multiple tests demonstrating more heterogeneity than homogeneity.

Once the above-described homogeneity tests were applied to the stations listed above, station selection for regional hydrologic assessment were confirmed. The regional hydrology assessment was used to calculate the relationship between flow and catchment area to estimate regional hydrological conditions in the RSA. Hydrological relationships were calculated for the mean annual flow, mean monthly flow, peak flows, environmental flows, and base flow index. Further details are provided in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement).

5.2.2 Baseline Hydrology

As part of the local hydrology baseline assessment, a field hydrometric monitoring program was conducted by WSP Golder, Stantec and Canada Nickel staff. WSP Golder installed the hydrometric stations and monitoring equipment between 2021 and 2022. WSP Golder, Stantec and Canada Nickel staff subsequently conducted equipment downloads and manual *in situ* flow and water level measurements. Solinst Leveloggers® were installed at a total of 10 stations at the Project site to monitor continuous water levels. A Solinst Barologger® is installed on site, located north of SW-9 along Highway 655, to collect atmospheric pressure and air temperature data (see Figure A.13 within Appendix A). Continuous water level and temperature data is recorded at each site at a 30-minute frequency.

Manual measurements of streamflow were conducted using the Mid-Section Area-Velocity Method where the discharge was calculated from multiple velocity measurements and cross-section areas (Botma and Struyk 1971; WMO 2010a). Water velocity measurements under wadable conditions were conducted using either a Marsh-McBirney Flo-Mate 2000 with a topset wading rod or a FlowTracker2 (2021 to 2022). In 2023, all wadable flow measurements were captured with a FlowTracker2. During high flow events, either the Sontek M9 current profiler or the USGS Type AA Current Meter were utilized for data collection (2021 to 2022). In 2023, only the Sontek M9 was used during high flow events.

Each site has a staff gauge installed to allow manual water level measurements and support benchmark surveying for each site. The continuous water levels, water temperature, atmospheric pressure and air temperature data were processed using Aquarius™ hydrometric analysis software. The *in situ* continuous water levels and manual flow measurements are used to develop rating curves in the Aquarius™ software. The rating curve estimates continuous flows based on the relationship between water level and manual flow measurements. The WSC's manual for developing rating curves titled *Hydrometric Manual – Data Computations* (Rainville et al. 2016), World Metrological Organization (WMO) *Manual on Stream Gauging, Vol. I: Fieldwork* (WMO 2010a), WMO *Manual on Stream Gauging, Vol. II: Computation of discharge* (WMO 2010b) are used in this study to support rating curve development.

5.2.3 Hydrological Model

The US Army Corps of Engineers' (USACE) Hydrologic Engineering Centre Hydrologic Modelling System (HEC-HMS) software Version 4.10 was used for the development of the baseline hydrological model. A separate HEC-HMS model was generated for each of the three following watersheds: Jocko Creek, North Driftwood River, and West Buskegau River to improve system stability while performing continuous runoff simulation runs.

The Ontario provincial land cover compilation and soils complex data were used to define subwatershed characteristics, such as the hydrologic Curve Number (CN) (Ministry of Natural Resources and Forestry [MNRF 2023c]; Ontario Ministry of Agriculture, Food, and Rual Affairs [OMAFRA 2023]). The CN for each subwatershed was calculated using the Soil Conservation Service (SCS now referred to as the Natural Resources Conservation Service-NRCS) Runoff CN method as defined by the United States Department of Agriculture (USDA) Technical Release for Urban Hydrology for Small Watersheds (TR-55) (USDA 1986). A weighted average of CN values for each individual subwatershed was used to define the overall CN. In following with the TR-55 Manual, the SCS watershed lag method was used to calculate lag time.

For this model, the SCS unit hydrograph with a peaking factor of 250 was selected. The SCS unit hydrograph is a standard, dimensionless representation of runoff resulting from a uniform rainfall depth of 1 inch (25.4 mm) applied to an entire watershed (USDA NRCS 2007). The selected Peak Rate Factor (PRF) value of 250 is consistent with the topography and physiographic conditions of the site and was determined based on iterative model calibration.

The HEC-HMS model defines reach components that route hydrographs through typical channel cross-sections using the Muskingham-Cunge routing method. Within HEC-HMS, subwatershed elements were linked with channel routing where the main river channel (either Jocko Creek, the North Driftwood River, or the West Buskegau River channel) of each watershed physically exists. Minor creeks and tributaries are not modelled with channel routing. Channel length and slope vary between subwatersheds and were determined from the topographic assessment using LiDAR and the Provincial digital elevation model (DEM). Channel bed width and side slope estimation were determined through field observations of channel geometry at the surface water monitoring stations. Channel geometry was approximated as trapezoidal for all channels and reaches. An input celerity of 5 ft/s (1.524 m/s) was selected for each reach as it is standard and applicable in most modelling scenarios (USACE 2024).

The Temperature Index method was chosen to process snowmelt conditions (USACE 2024). Specific input parameters were chosen based off typical values and through further optimization of the model relative to local flow data. One input for the temperature index method is the ATI-melt rate function. To determine the ATI-melt rate function, station data including snow depth measurements needed to be sourced. In this case, the ECCC Timmins Victor Power Airport Station (6078285) was used.

The chosen loss method was the linear deficient and constant method, appropriate for long-term continuous modelling runs within HEC-HMS (USACE 2024). This method defines an initial deficient capacity for the watershed and accounts for changes in infiltration capacity as the soil becomes saturated. These values were iteratively generated through model calibration. Impervious areas were set to 0 as the watersheds cover naturalized land areas with minimal impervious surface.

The Recession Baseflow Method was used to define baseflow within the HEC-HMS models. The Recession Baseflow method defines initial discharge per area associated with each watershed. The initial discharge value comes from the results of the regional baseflow assessment.

Model calibration for the baseline hydrologic model was based on available data from a nearby regional hydrological station operated by the WSC. The Porcupine River Hydrometric Data (HYDAT) station is the closest WSC regional flow station with a total valid record from 1977-1995 and 2008-2014. In 2007 the station was moved 400 m from its previous 1977 to 1995 monitoring location in a 408 km^2 watershed. Flow was monitored at the station from 2014 to 2022 and the station was discontinued in 2022. Beginning in 2014 until 2022, flow data quality issues were identified at the site by WSC due to backwater conditions from the operation of an Ontario Power Generation (OPG) dam downstream on Nighthawk Lake, localized beaver activity, and an upstream control dam at an upstream tailings facility. Flow data that was impacted by variable backwater conditions was graded as estimated (WSC 2024). The time period 2008 to 2014 was selected for calibration since the recorded flows in this time period covered a range of high flow and low flow events and the dataset was primarily outside the 2014 to 2022 period with the identified data quality issues. The year 2014 had four daily flow measurements in July that were estimated due to the above data quality issues, which is substantially lower than later years in the 2014 to 2022 period. Recorded flows were extrapolated by drainage size to each of the three watersheds, generating a unique streamflow time series for each model. The drainage-area ratio method (DARM) was used to develop daily timesteps of stream flow for three watersheds based on recoded flow in the Porcupine River. The DARM method estimates flow at an ungauged location by multiplying the measured flow at the nearby reference gauge by the area ratio of the ungauged to gauged drainage areas.

The baseline hydrological model was validated against local Project hydrometric station data using the developed local site rating curves. Daily flow outputs from the model are compared against the predicted flows using the rating curve equations presented in the baseline report. Using daily precipitation data from the same time period from which flow monitoring at the surface water monitoring stations were conducted, hydrographs are outputted from the model. The hydrographs are assessed for similarity through statistical parameters such as the root means square (RMS), root mean square error (RMSE), and Nash-Sutcliffe efficiency (NSE). This assessment provides further confidence in the ability of the model to represent project watersheds.

Nearby ECCC climate stations were used to provide daily temperature and precipitation depths for the models for the selected time period (January 1, 2008 until May 31, 2022) used for calibration and validation. A combination of the Timmins Climate station (6078262), Timmins Victor Power Airport station (VPA; 6078285) and Kapuskasing Station (6073975 /6073976 /6073978) were used to provide this data.

5.2.4 Regional Surface Water Quality

Regional surface water quality stations operated by the MECP as part of the Provincial Water Quality Monitoring Network (PWQMN) monitoring a suite of water quality parameters were selected to represent regional surface water quality relationships. This assessment examined water quality data at a regional scale, allowing for many years of water quality data from regional PWQMN sites to be analyzed to capture and assess the average and natural variability of parameters.

The seven regional sites used in the baseline water quality analysis were selected for inclusion in the assessment based on their proximity to the Project site, location upstream of pulp and paper effluent discharge points, location upstream of urban development, and recent data available for more than 10 years. The regional sites are summarized in Table 5.1.

Table 5.1 Regional Surface Water Quality Sampling Locations

Station ID	**Waterbody**	**NAD 83 UTM Zone 17N Coordinates**	**Distance to Site (km)**	**Period of Data Availability**
19006401420	Mattagami River	473895m E, 5369134m N	24.71	1972 – Ongoing
19006404502	Porcupine River	483574m E, 5369945m N	25.26	1991 – Ongoing
19006400302	Porcupine River	487068m E, 5371339m N	25.36	1968 – 2005
19006400402	Porcupine River	495955m E, 5377416m N	26.34	1968 – Ongoing
18771000602	Murdock Creek	570296m E, 5328291m N	115.40	1972 – 2003
18771000402	Blanche River	573257m E, 5316174m N	124.00	1972 – 2005
18013700102	Slate Creek	604928m E, 5251333m N	192.66	1988 – 2005

Surface water quality data for each site and for each sampling event were compared to applicable regulatory guidelines. These include both the PWQO (and Interim PWQOs where applicable) and CWQG-FAL. Summary statistics were calculated for each parameter and include mean, minimum, maximum, standard deviation (std. dev.) and 75^{th} percentile where applicable. Results below the reportable detection limit (RDL) were processed with numerical values as applicable based on guidance in the *Guidelines for Quality Assurance and Quality Control in Surface Water Quality Programs in Alberta* (Mitchell 2006).

Where RDL values were processed with numerical values, parameters were processed with respect to seasonal concentration differences (winter [January to March], spring [April to June], summer [July to September] and fall [October to December]).

5.2.4.1 Baseline Water Quality

Surface water quality monitoring has been conducted by WSP Golder (2021, 2022, 2023) and Canada Nickel staff (2023). The sampling frequency occurred annually, quarterly, bi-monthly, or monthly, with some locations as single sampling events. Sampling conducted in 2021 involved 19 sites. In 2022, 13 additional water quality monitoring sites were added to the program. In 2023, another 13 sites were added to the monitoring program. Water quality monitoring sites included 32 watercourses and 13 waterbodies (7 lakes and 6 ponds) (see Figure A.14 within Appendix A).

For each monitoring event, water samples were collected for submission to a Canadian Association for Laboratory Accreditation (CALA) accredited laboratory following chain of custody protocols for analysis. Throughout the duration of the project, samples have been sent to two companies, ALS Environmental Laboratories (ALS) and Testmark Laboratories (Testmark). From August 2021 to October 2022, primary and duplicate samples were sent to ALS for analysis. In addition, samples for some sampling events in June and July 2023 were sent to ALS for analysis. From February 2023 to present, primary and duplicate samples were sent to Testmark for analysis. In addition, *in situ* surface water quality was monitored using a calibrated YSI DSS multi-parameter probe. The *in situ* parameters included temperature, pH, conductivity, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity (added in 2023). Water samples were collected following standard protocols for grab sampling, sample vial labelling, sample storage and shipping in coolers at approximately four degrees Celsius (°C), and completion of Chain of Custody (CoC) sample submission documentation. Water samples for ALS were submitted to their laboratory in Waterloo, Ontario, and samples for Testmark were sent to their Timmins, Ontario location.

Field meters used to collect *in situ* water quality data were calibrated as per manufacturer maintenance manual guidance with certified standard solutions. Pre cleaned and pre-labelled bottles and nitrile gloves were used for sample collection to reduce cross-contamination. Water samples were preserved on site with preservatives provided by the laboratory and were stored on ice until delivery to the analytical laboratory. Samples submitted to the laboratory that required filtration (e.g., dissolved metals) were field-filtered prior to shipment. Samples that required filtration were submitted to Testmark within recommended hold times to allow for laboratory filtration upon receipt. Field blanks were collected to check for potential cross-contamination during field collections and with sample storage and transport, respectively.

5.3 Geochemistry

The potential for metal leaching and acid rock drainage (ML/ARD) from materials generated, exposed, and stored at the Project was investigated by WSP in the Crawford Geochemistry Characterization (Appendix H of the Impact Statement). The geochemical assessment was based on 299 waste rock samples, 109 ore samples, four tailings samples, and 50 overburden samples. The samples underwent static testing (mineralogical analysis, acid-base counting [ABA], shake flask extraction tests, and solid phase elemental analysis) and kinetic (humidity cell tests [HCTs]) testing to characterize their ML/ARD potential.

The capacity of a sample to generate acidity or neutralize acid is referred to as the acid potential (AP) and the neutralization potential (NP), respectively. Neutralization potential was classified using two analytical methods: carbonate NP (CO_3-NP) and the modified Sobek NP method. The ratio of NP to AP is commonly used to evaluate the potential for a material to generate AP. Based on such a ratio, samples are classified as potentially acid generating (PAG), uncertain, or non-potentially acid generating (NPAG). The ML testing for HCTs included assessing whether parameter mass loadings were associated with first flush or long-term leachate discharge. Shake flask extraction (SFE) was conducted to identify soluble constituents from the test materials (Appendix H of the Impact Statement). The geochemical characterization methodology is outlined in the Crawford Geochemistry Characterization (Appendix H of the Impact Statement) guided by the Prediction Manual for Drainage Chemistry from Sulphidic Geological Materials (MEND 2009), which is a nationally recognized guide for the evaluation of ML/ARD potential.

5.4 Site-Wide Water Management Plan

The Site-Wide Water Management Plan (Appendix J of the Impact Statement) developed for the Project provides additional details on the key site-specific mitigation measures to reduce the potential for Project effects on surface water quality and quantity. The Site-Wide Water Management Plan will be implemented during construction, operations, and decommissioning and closure phases, and provides details on runoff and seepage collection strategies and systems (e.g., local seepage sedimentation ponds, berms, drainage ditches, pumps) to collect and contain surface water runoff, and groundwater discharge from major Project components (Open Pit, TMF, Impoundment Facility, low value ore Stockpiles, process plant, overburden stockpiles) during climate normal and extreme weather conditions.

The primary objectives of the Site-Wide Water Management Plan are to mitigate operational risks and the environmental effects of the Project. These objectives include:

- Reduce water inventory through external runoff diversion and promote overland flow of non-contact runoff
- Reduce the number of FDPs through grading of ditches and construction of discharge channels to combine discharge points of sedimentation ponds
- Maintain flow to fish-bearing streams and wetlands by maintaining pre-development catchments
- Reduce water management costs during operation through grading and gravitational drainage, thus reducing pumping requirements

The water management infrastructure is discussed in greater detail in Section 6.3.

5.5 Water Balance

Water balance modelling was conducted to simulate proposed water management for the Project and support site design and operations (Appendix I of the Impact Statement). The model was developed using the GoldSim™ software package to estimate and predict water balances at different component areas of the mine site, including the Open Pit, Impoundment Facility, TMF, Stockpiles, and water management ponds. GoldSim™ is commonly used in the mining industry to develop water balance models at user-defined modelling nodes. Climate change adjusted precipitation and temperature data using a climate normal for the time period 2071-2100 was generated based on the Shared Socioeconomic Pathway (SSP)2-4.5 emissions scenario. This climate change adjusted climate normal period was chosen to provide conservative model results. A nonparametric Kolmogorv-Smirnov test was conducted to select the typical yearly temperature and precipitation data to adjust for the SSP2-4.5 emissions scenario, which was 1999. A 14% increase based on total annual precipitation changes under SSP2-4.5 was applied to the daily total precipitation in 1999 to adjust for climate change. A +5.3°C, +3.9°C, +3.7°C, +3.6°C seasonal increase, based on SS2-4.5, was added to the daily mean temperature in 1999 for winter, spring, summer, and autumn seasons, respectively. For the mine early works (less than Mine Year 20), climate change would not be expected to have as pronounced of an effect on water management and a separate water balance model run using unadjusted 1999 climate data (temperature and precipitation) was developed.

The model was run for the construction phase (Mine Years -3 to -1), operations phase 1 and 2 (Mine Year 4 to 18), operations phase 2 (Mine Year 18 to 30), operations phase 3 (Mine Year 30 to 41), End of operations phase 3 (Mine Year 41), end of active closure (Mine Year 46+), and passive closure (pit-full) (Appendix I of the Impact Statement). The model simulates on a monthly time step for all phases of mine life, and a daily time step for select years to provide inputs to the effects assessment hydrologic model specific years during each mine phase. The Project phases are related to specific phases of water management. They differ from those presented as general Project phasing in Section 1.3; however, the water management activities occurring in construction, operations, decommissioning and closure aligns with the overall Project schedule. The water balance model was developed by Ausenco (Appendix I of the Impact Statement)

5.6 Water Quality Model

To analyze environmental effects for changes in surface water quality, a site-wide water quality GoldSim™ model was developed, utilizing the contaminant transport module of this model. Contact water quality was predicted by integrating geochemical contact water predictions into the GoldSim™ water quantity model (Appendix I of the Impact Statement). Through modelling in GoldSim™, water movement was refined throughout the Project at a monthly time scale, and a number of factors (i.e., contact runoff and seepage estimates, water management infrastructure storage/sedimentation characteristics, and geochemical results) were used to predict contact water quality at the water management ponds and in seepage to the regional groundwater system from the TMF, Impoundment Facility and ore Stockpiles. The various mine components are represented as individual cells within GoldSim™. The source term development (loading sources) for the water quality model was based on geochemical results (Appendix H of the Impact Statement) and baseline groundwater quality (Appendix B.5 of the Impact Statement). The model generates a time series of a suite of water quality parameters which are used to identify PoPCs when compared with guidelines. The GoldSim™ water quality model, developed by Lorax (Appendix K of the Impact Statement), predicts raw water quality prior to supplemental water treatment and release to receivers (North Driftwood River, West Buskegau River).

The parameters selected for inclusion in the model were based on the geochemical characterization in the WSP Crawford Geochemistry Characterization (Appendix H of the Impact Statement), and the Groundwater Baseline Report (Appendix B.5 of the Impact Statement) and criteria listed in Schedule 4 of the Metal and Diamond Mining Effluent Regulations in the Fisheries Act. The Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement) local water quality parameter results that exceeded the PWQOs and/or CCME CWQG-FAL guidelines and parameters listed in the TIS Guidelines were included in the model. The water quality model was developed by Lorax (Appendix K of the Impact Statement).

Leaching rates from overburden, waste rock and ore were calculated as cumulative average mass loading rates. When parameter concentrations were equal to the detection limit, a value of half the detection limit was used in the mass loading rate calculation. Mass- and surface-leaching rates for overburden, waste rock and ore were based on humidity cell testing data. When concentrations in leachates from testing data were reported below the detection limit loading rates were calculated using half the detection limit value. Humidity cell test results were weighted proportional to the lithologic composition of each mine waste facility as defined by the mine plan. Scaling factors were applied to the average leaching rates to scale up to the full size of the Impoundment Facility, overburden and ore piles (Appendix K of the Impact Statement). Upscaled source terms were screened using the geochemical modelling program PHREEQC, and mineral solubility constraints for select species were applied (Parkerhurst and Appello 1999).

The main sources of chemical mass loading in the Open Pit included in the water quality model were groundwater inflow to the pit, leaching of elements from waste rock or ore exposed on the pit walls, leaching and rubble that remains on benches, dissolution of nitrogen species from undetonated blasting residues on blasted rock and ore while awaiting transfer out of the Open Pit, and leaching of elements from tailings placed in the Open Pit from Mine Year 18 to 41.

The Open Pit as it fills with water during the closure phase was simulated as a completely mixed pit lake.

The TMF and its water management ponds were simulated with the following mass inputs:

- atmospheric precipitation
- discharge from process plant
- leaching of elements from tailings beaches exposed to the atmosphere
- seepage collection system water sent to the TMF ponds during operation
- dewatering from the Open Pit

The mass outputs of the TMF and its ponds include the following:

- recycled water to meet mill demand
- locked-in porewater
- removal due to chemical reactions
- surface runoff
- recharge to groundwater flow that is not connected to the seepage collection system
- seepage through the dams that is captured by the seepage collection system

The Water Quality Assessment (Appendix K of the Impact Statement) describes the water quality model in further detail.

5.7 Assimilative Capacity Assessment

An assimilative capacity assessment was conducted to develop effluent criteria and estimate the water quality of watercourses and waterbodies receiving discharges directly from the Project FDPs in the North Driftwood River and the West Buskegau River. Jocko Creek was also assessed as the watercourse that receives mine-sourced seepage but no surface discharge. The near-field mixing model CORMIX (Version 12.0) was used to determine the length to the point of full mixing when the watercourse receives effluent discharge. Mass balance assessment was conducted to predict water quality under both regulatory and normal discharge scenarios for the North Driftwood River, the West Buskegau River, and Jocko Creek. The regulatory operating conditions are considered worst-case and conservative. Input parameters for this condition are as follows:

- Regulatory Construction/Operation Conditions:
  - Identification of PoPCs being receiving water parameters that exceed the PWQO or CWQG-FAL when measured at their 75th percentile and maximum concentrations for raw water parameters in the GoldSim^{TM} water quality model that exceed the same regulatory criteria (Appendix B.6 of the Impact Statement and the Assimilative Capacity Study in Appendix C of this report). Parameters that exceeded the regulatory objective/guidelines in seepage, when maximum concentrations were considered, were also identified as PoPCs.
  - Maximum daily concentrations at FDPs after treatment during the Project lifetime. Effluent daily concentration limits were developed iteratively between the assimilative capacity of the local receivers and effluent treatment technology limits recommended by treatment technology suppliers.
  - Maximum mine effluent flow rate: assigned as the nameplate flow rate of water treatment plants
  - 75th percentile baseline water quality in the receiving watercourses (Appendix B.6 of the Impact Statement)
  - 7Q20 flow (7-day low flow, 20-year return period) receiver conditions in the receiving watercourses based on regression analysis and adjusted for climate change (Appendix B.6 of the Impact Statement)
  - Seepage (basal) flow out of the mine contributing directly to local receiver flow from project infrastructure (i.e., TMF, Impoundment Facility, ore Stockpiles) (Appendix C.4 of the Impact Statement)
  - Maximum predicted seepage quality concentrations for the operations phase from project infrastructure (i.e., TMF, Impoundment Facility, ore Stockpiles) (Appendix K of the Impact Statement)

Assimilative capacity assessments were also conducted for the Post closure phase when the pit lake is full and overflows to the North Driftwood and West Buskegau Rivers (Mine Year 167), in which case the regulatory conditions included the water balance model predicted 7 day average low flow for the pit lake discharge and the receivers (because the pit lake will respond to the same climatic conditions as the local receiving waters), maximum pit lake quality, 75th percentile receiver quality and seepage in the post closure phase.

Input parameters for the normal operating conditions are as follows:

- Normal Construction/Operation Conditions:
  - Mean Annual Flow (MAF) in the receiving watercourses derived based on regression analysis adjusted for anticipated climate change
  - Mean concentrations for baseline water quality in the receiving watercourses
  - Average effluent flow rate during the operations phase and average annual discharge from the pit lake when it is full in the case of the post closure phase
  - Target effluent objective at FDPs after treatment as effluent quality in the operations phase, and mean concentrations in the discharge from the pit lake when it is full in the case of the post closure phase
  - Seepage (basal) flow out of the mine contributing directly to local receiver flow from project infrastructure (TMF, Impoundment Facility, ore Stockpiles)

CORMIX is a 3D effluent mixing model with limitations to its ability to predict mixing zones beyond 200 m. As Project effluent mixing zones are expected to extend beyond the CORMIX model boundary, CORMIX has been used to estimate the point in the mixing zone where full mixing of effluent and receiver is achieved. Beyond the CORMIX boundary, a mass balance assessment is used to determine the mixing zone extent that is the distance between FDPs and the point where concentration decrease to values below the regulatory objective/guidelines. Procedure 5 of Water Management (MOEE, 1994a) indicates that mixing zones are not to be used as an alternative to reasonable and practical water treatment. Thus, the mixing zone is developed based on reasonable and practical water treatment limits and receiving water assimilative capacity.

5.8 Water Quantity Assessment

HEC-HMS models for each mine life phase were developed based on the baseline model. The baseline model has been updated to match the expected future conditions of each phase of mine life. Figures A.5 to A.10 within Appendix A present predicted changes to PA watersheds and subwatersheds through each mine life phase. Seven phases are modelled:

- Scenario 1: Year -3 to -1 - Construction (Mine Year -1)
- Scenario 2: Year 1 to 5 – Phase I Operations (Mine Year 2)
- Scenario 3: Year 5 to 18 – Phase II Full-scale Operations (Mine Year 17)
- Scenario 4: Year 18 to 30 - TMF Rehabilitated (Mine Year 23)
- Scenario 5: Year 30 to 41 – Impoundment Facility Rehabilitated (Mine Year 35)
- Scenario 6: Year 41 – End of Operations (Mine Year 41)

- Scenario 7: Year 46+ – End of Active Closure (Mine Year 47)
- Scenario 8: Pit-Full – Post-Closure when pit lake is formed

Each of these time periods represents a change in the mine footprint or water management from the Project. At each mine life phase, subbasin areas, topography, and channel lengths are updated. Therefore, CN and lag time estimates are updated as well. During certain phases, the mine footprint may cover the majority of a subwatershed, leaving small fractions of the subwatershed orphaned from its subbasin, or nearly negligible. In these cases, the orphaned watershed fragment may be added to an adjacent subwatershed.

For each phase of mine life, changes in subbasins included catchment area reductions and catchment area merges. Model parameters were updated with each change to subbasins throughout the future mine life cycle. Table B.1.1 to Table B.1.3 in Appendix B outline the predicted changes to HEC-HMS model parameters for each watershed reach through the mine life cycle.

The Groundwater Assessment (Appendix C.4 of the Impact Statement) developed a three-dimensional numerical groundwater flow model of the baseline hydrogeological system and Project at different life of mine phases. The groundwater flow model was setup using regional average baseflow of 0.035 $m^3/s/km^2$ based on the regional hydrology assessment at selected WSC stations (2024c). Changes in predicted groundwater discharges to surface water features from baseline were predicted for Construction Year -1 (Scenario 1), Year 15 (Scenario 3), Year 30 (Scenario 5) and Pit-Full (Scenario 8) and assessed as relative percent increases and decreases from baseline. The HEC-HMS model setup for each life of mine phase includes project associated seepage to surface water receivers based on the project infrastructure seepage rates predicted by the groundwater flow model (Appendix C.4 of the Impact Statement). From Mine Year 4 and onwards, the North Driftwood River Diversion Channel replaces a portion of the North Driftwood River main channel. The channel reach parameters are updated to reflect the new channel. Table 5.2 summarizes the diversion bypass channel parameters.

Table 5.2 North Driftwood River Diversion Channel Parameters

Subwatershed ID	Channel slope (m/m)	Channel length (m)	Manning's n	Channel Shape	Side slope (xH:1V)	Bottom width (m)	Bankfull Width (m)	Bankfull depth (m
ND20	0.0008	1300	0.035	Trapezoid	3:1	3.5	13.5	1.65
ND15		1900						
ND11		3600						
ND8		1500						

Similarly, during operations phase 2 and 3 from Year 5 to Year 30, inclusive, outflows from the mine are included as point source FDPs. These flow sources come from Collection Pond 1 (FDP-SP-01), Collection Pond 2 (FDP-SP-02), Collection Pond 3 (FDP-SP-03), and TMF seepage and runoff collection ponds (TMF NE and NW Ponds; FDP-TMF-SP). Two collection ponds discharge to the West Buskegau River after receiving treatment (Collection Ponds 1 and 3). The third collection pond discharges to the

North Driftwood River (Collection Pond 2). The TMF ponds outflow in series to the North Driftwood River. Changes to each watershed are tabulated in AppendixB.1.

For the modelling of these future years through mine life the hydrometric model was updated to incorporate climate change for all phases of mine life. A climate normal for the time period 2071-2100 was generated based on the SSP2-4.5 emissions scenario for input daily temperature and precipitation data. The climate change adjusted precipitation and temperature dataset is described in Section 5.5. The HEC-HMS models were run for three consecutive years. The first two years serve as a model warm up period, with the third year providing representative results for the Project phase being assessed.

Once results are gathered from the HEC-HMS models, they are compared to the baseline model to quantify and assess change in flow over time. Models of the Jocko Creek, North Driftwood River, and West Buskegau River are compared to their respective baseline HEC-HMS model at key subbasin junctions or pourpoints. These would include comparing the subwatershed model results directly downstream of the Project impacted area, and the overall study watershed pourpoint to baseline model flow results. The resulting outputs from the model are also compared against environmental flows to support the low flow assessment.

5.9 Water Quality Assessment

The water quality assessment used the following assessment sequence:

- Geochemical testing and assessment to determine water quality source terms and aging predictions
- Water quantity and water quality modelling in GoldSim™ to predict contact water quality at the FDPs and groundwater seepage quality
- An assimilative capacity assessment to predict water quality of receivers, including extent of full mixing and mixing zone extents.
- Supplemental water quality assessments for individual PoPCs based on literature review, professional judgement, water quality and air quality model outputs and empirical loading model results

5.9.1.1 Water Quality Model and Assimilative Capacity Assessment

The water quality assessment focused on the receiving water assimilative capacity assessment for PoPCs in effluent as well as other parameters such as mercury and methyl mercury that are not specifically identified as effluent PoPCs but are important water quality parameters.

The receiving water assimilative capacity assessment is a site-specific assessment of a local receiving water's capacity to assimilate effluent in a mixing zone made as small as possible considering reasonable and practical effluent treatment. The assessment focusses on the parameter(s) requiring the greatest assimilative capacity and, thus, the largest mixing zone to achieve the regulatory objectives/guidelines or recover to baseline conditions. This process in conjunction with an effluent treatment assessment of the limits of reasonable and practical treatment, is used to propose effluent criteria or limits for each PoPC. The effluent criteria typically take the form of a daily limit not to be exceeded and a monthly mean limit. The effluent criteria for PoPCs are used to define the mixing zone needed to assimilate each PoPC and are used to define the largest or maximum extent of the mixing zone. The effluent criteria represent the result of a series of Project mitigations to eliminate or reduce Project effects on local surface water quality. Project water quality mitigations include non-contact water diversion, contact water collection, conveyance, storage in sedimentation ponds, flood control and attenuation with sedimentation pond spillways to the Open Pit, and water treatment to effluent criteria assigned to maintain effluent mixing zones within the boundaries of the mixing zone developed in the receiving water assimilative capacity assessment.

Chrysotile is present within the orebody are assessed qualitatively based on existing conditions and Project activities.

Changes in water temperature and ice formation are assessed qualitatively based on water management at the Project.

Changes in nutrient concentrations (phosphorus, nitrogen species) in receivers are assessed with respect to changes in eutrophication rates. Eutrophication in surface water is the increase in nutrient concentrations, particularly phosphorus in freshwater systems that results in changes to the aquatic ecosystem via higher productivity. Reduced dissolved oxygen, changes in aquatic community structure, increased presence or growth of algae and cyanobacteria and taste/odour impacts are potential effects of eutrophication.

5.9.1.2 Mercury

Other parameters are important because Project activities may cause them to increase in the receiving environment or due to specific concerns raised during consultation, such as mercury methylation as a result of flooding of wetlands. Mercury and methyl mercury are important parameters to discuss in the context of the Project because mercury biomagnifies through the food chain. Flooding of wetlands and organic soil riparian areas releases mercury which can be up taken in primary producer microorganisms and then biomagnified in the food chain through each trophic level to fish which are consumed by people and wildlife. The water quality assessment assesses mercury and methyl mercury from baseline conditions and applies mercury release rates from studies in the Experimental Lakes (Hall and St. Louis 2004; Hall et al. 2005) to assess potential concentration increases. It was reported by St Louis et al. that the net yield of methyl mercury in the wetland complex increased from 1.7 mg/ha/yr under pre-flooding conditions to approximately 70 mg/ha/yr in the first year of loading. The net yield of methyl mercury in the wetland complex declined (10 to 50 mg/ha/yr) during the subsequent flooding periods.

The Flooded Upland Dynamics Experiment - FLUDEX (Hall and St. Louis 2004; Hall et al. 2005) studied the various effects of reservoir construction, including methyl mercury circulation, over boreal forest surfaces varying in stored organic carbon. FLUDEX found that yields of methyl mercury were found to be highest in the reservoir with medium quantities of initial organic carbon at 131 mg/ha/yr, which was nearly two times higher than the 70 mg/ha/yr peak found in the Experimental Lakes Project.

The Project is not anticipated to flood upland areas or raise lake levels, except for the North Driftwood River channel realignment which will potentially flood organic soils within the main channel excavation. The Project will dewater and infill watercourses and waterbodies within the PA. As such, a potential source of mercury that could be introduced to the North Driftwood River or West Buskegau Rivers is from mercury in the topsoil, overburden, or waste rock that will be stored within the PA and managed via the site wide water management system. Although mercury may be present in the tailings, tailings will be permanently stored in the Open Pit or TMF and not released to the receiving environment.

5.9.1.3 Acid Deposition

Deposition of sulphur and nitrogen compounds could increase lake acidity. Lake potential acid input (PAI) was calculated for base case, construction, and operations. Lake concentrations of nitrate and sulphate were used as baseline acid input rates to calculate lake PAI.

Equation 5-1 was used to calculate baseline nitrogen or sulphur inputs (I, measured in keq/ha/a).

$$\boldsymbol{I = \frac{(C\ x\ f\ x\ Q)}{A}}$$ **Equation 5-1**

Where:

C = concentration of nitrogen or sulphate in the lake (mg/L) (Appendix B.6 of the Impact Statement)
f = conversion factor to convert mg/L to keq/L
Q = average annual outflow from the lake (L/ha/a)
A = gross catchment area of the lake (ha)

Adjusted lake PAI (acid deposition above baseline deposition) was calculated using estimates of PAI deposition rates for construction and operation phases. These estimates are from the air dispersion model results (Appendix C.1 of the Impact Statement).

The surface water receptors acid-neutralizing capacity (ANC) was calculated. The surface water receptors ANC, alkalinity and pH were used to characterize the acid sensitivity of the receptor. Saffran and Trew (1996) applied acid sensitivity classifications based on alkalinity and pH to 1,156 lakes throughout Alberta. According to this classification system, lakes with an alkalinity or ANC higher than 40 mg/L (as CaCO3) and pH greater than 7.5 are least sensitive to acidification, see Table 5.3.

Table 5.3 Lake Sensitivity to Acidification

Acid Sensitivity	Alkalinity (mg/L as $CaCO_3$)	ANC (µeq/L)	pH
High	0-10	0-200	<6.5
Moderate	10-20	200-400	6.6-7.0
Low	20-40	400-800	7.1-7.5
Least	40	800	>7.5
SOURCE: Modified from Saffran and Trew 1996			

Average annual outflow (Q) was used to calculate critical loads and lake PAI. For sites with a pourpoint located within either the North Driftwood River, West Buskegau River or Jocko Creek watershed HEC_HMS models lake outflow was taken from the model. For sites with a pourpoint not located in the HEC_HMS models, annual lake outflow was calculated as the sum of runoff volume and annual precipitation.

The gross catchment areas were delineated for each surface water receptor identified for this analysis. A total annual precipitation of 914.54 mm was used as determined for the climate change adjusted climate normal year in the baseline assessment.

Critical loads were calculated for the identified surface water receptors. The critical loads were compared to acidifying inputs (lake PAI) to determine the potential for acidification.

Equation 5-2 was used to calculate critical load (Henriksen and Posch 2001):

$$CL = ([BC^*]_0 - [ANC_{lim}]) \ x \ Q \qquad \textbf{Equation 5-2}$$

Where:

CL = critical load keq/ha/year

$[BC^*]_0$ = Baseline ANC value (keq/L)

$[ANC_{lim}]$ = critical value of ANC (160 µeq/L = 16 x 10^{-8} keq/L)

Q = lake outflow (L/ha/year)

The ANC_{lim} value was determined based on Cheng et al. 2022 who assed the critical load for Bonner Lake (80 km northwest of the PA) and calculated a value of 0.74 keq/ha/yr, which equates to 160 µeq/L.

6 Results

6.1 Baseline

6.1.1 Climate and Physiographic Setting

Local climate affects runoff characteristics and stream flows that define surface water conditions in the PA. The Project site is located within the Lake Abitibi Ecoregion of Ontario (Ecoregion 3E), a part of the Ontario Shield. This ecoregion is identified as a Humid Mid-Boreal Ecoclimatic Region, characterized by long, cold, and snowy winters, with short and mild summers (Ecoregions Working Group 1989). As the Meteorological Service of Canada (MSC) had not updated local climate station climate normals at the time of writing the Surface Water Baseline Report (Appendix B.6 of the Impact Statement), the 1991-2020 climate normal precipitation and temperature data was developed using Timmins VPA observations. The Timmins VPA observations were used from 1991 through 2009 for precipitation and 1991 through 2012 for temperature. The Timmins Climate station data supplemented the Timmins VPA data from 2009 to 2020 for precipitation and from 2012 to 2020 for temperature to compute the updated climate normals. The climate normal monthly mean temperature ranges from -16.4ºC in January to 17.6ºC in July. The annual climate normal precipitation was found to be 801.8 mm.

The three Project study watersheds (Jocko Creek, and North Driftwood River and West Buskegau Rivers) are relatively flat, with an overall topographic average slope of 1.7% for the entire Project study area. Pre-disturbance (baseline) watershed areas are presented on Figure A.4 in Appendix A. Elevations within the Jocko Creek watershed range from a minimum of 258.9 metres above sea level (masl) at subwatershed JC_DS to a maximum of 322.3 masl within JC2, with an overall average slope of 1.8%. The North Driftwood River watershed ranges from a minimum of 248.2 masl at the outlet of the watersheds within subbasins ND1 and ND2, and a maximum of 303.1 masl within ND23 with a total average slope of 1.8%. The West Buskegau River watershed has a minimum elevation of 260.9 masl at the watershed outlet within WB1, and a maximum elevation of 356.1 masl within the subbasin WB27, with a total average slope of 1.6%. The average topographic elevation for all three watersheds is 276.7 masl. Channel slopes of the watershed vary from 0.05% within the West Buskegau River, 0.08% within North Driftwood River, and 0.11% at Jocko Creek according to OWIT (MNRF 2023a).

The Vegetation, Riparian and Wetland Environments Supplemental Baseline Report (Appendix B.7.1 of the Impact Statement) identified that land cover within the PA is composed of upland treed habitat (approximately 19.1%), wetland (approximately 77.1%), water (0.1%), and sparsely vegetated or anthropogenic areas (approximately 3.7%). Typical boreal vegetation found in this region includes black spruce, tamarack, jack pine, trembling aspen and white birch (Rowe 1972).

Impacts from climate change in the general area of the Project are necessary to consider, as warming of 1.3°C of Canada's climate between 1948 and 2016 has been observed (Bush and Lemmen 2019). Northeastern Ontario has observed an increase of 2.4°C between 1970 and 2020, with a greater ratio of winter precipitation falling as rain (MNRF 2021). Modelled climate change projection results came from the ensemble CMIP6 models, distributed through Climatedata.ca, using 1971 – 2000 as a reference period for comparison. Changes in temperature and precipitation are described in the ensuing sections using the moderation emissions scenario, defined as SSP2-4.5, as recommended by Canadian Standards Association (CSA) (2019). The results of the ensembled models show that, for the general area of the Project, temperatures are expected to increase seasonally, on average, by 3.7ºC through the spring, summer, and autumn months for the local area. Winter months can expect substantially greater warming by 5.3ºC. Relative to the present period climate normal value of 801.8 mm, the projected total annual precipitation for the 2071-2100 under the SSP2-4.5 scenario is a relative percent increase of 14%.

6.1.2 Surface Water Quantity

Regional flow relationships between watershed area and hydrologic statistics (mean annual flow [MAF], mean monthly flow [MMF], flood flows, and low and environmental flows) were used to predict flows in watersheds within the PA. These relationships were based on five WSC hydrometric stations which passed homogeneity evaluation using criteria including vegetation and land cover, percent area of waterbodies, annual precipitation, unit flow, flow duration curve, and index flood. These relationships are explored in greater detail in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement). The MAF for the five selected WSC stations were plotted against watershed areas to establish regression relationships (Figure 6.1). Similarly, relationships were developed between peak flows and watershed areas for various return periods (2, 5, 10, 25, 50, and 100-year); Figure 6.2.

Figure 6.1 Regional Station Relationship Between Mean Annual Flow and Catchment Area

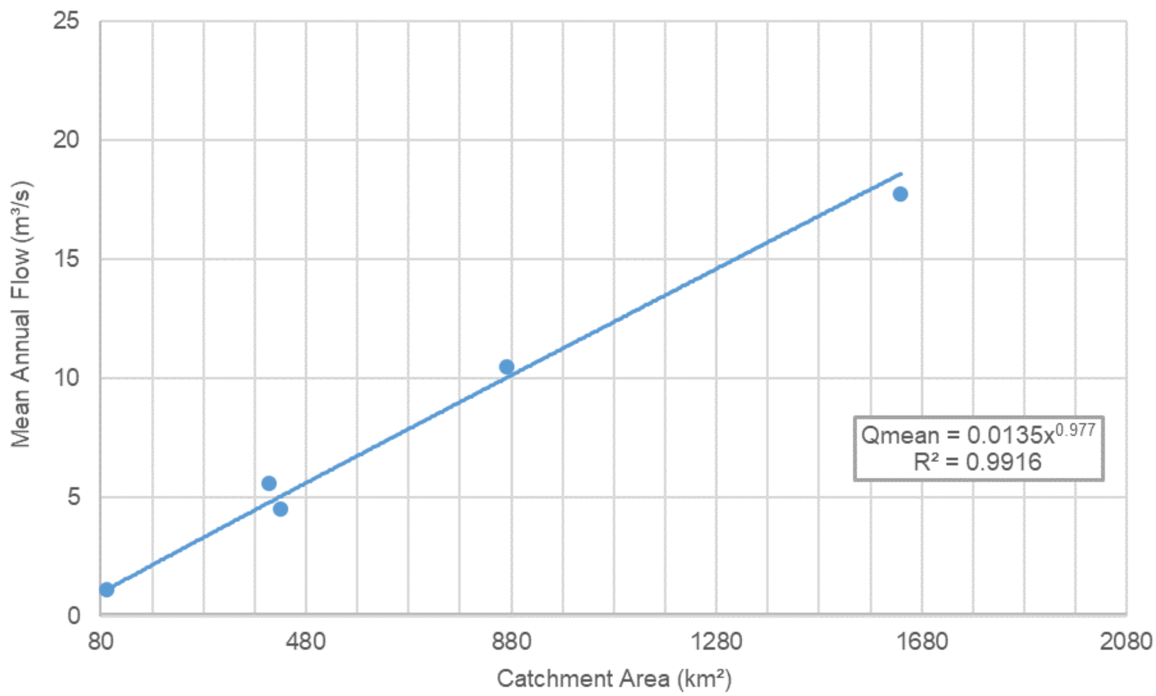
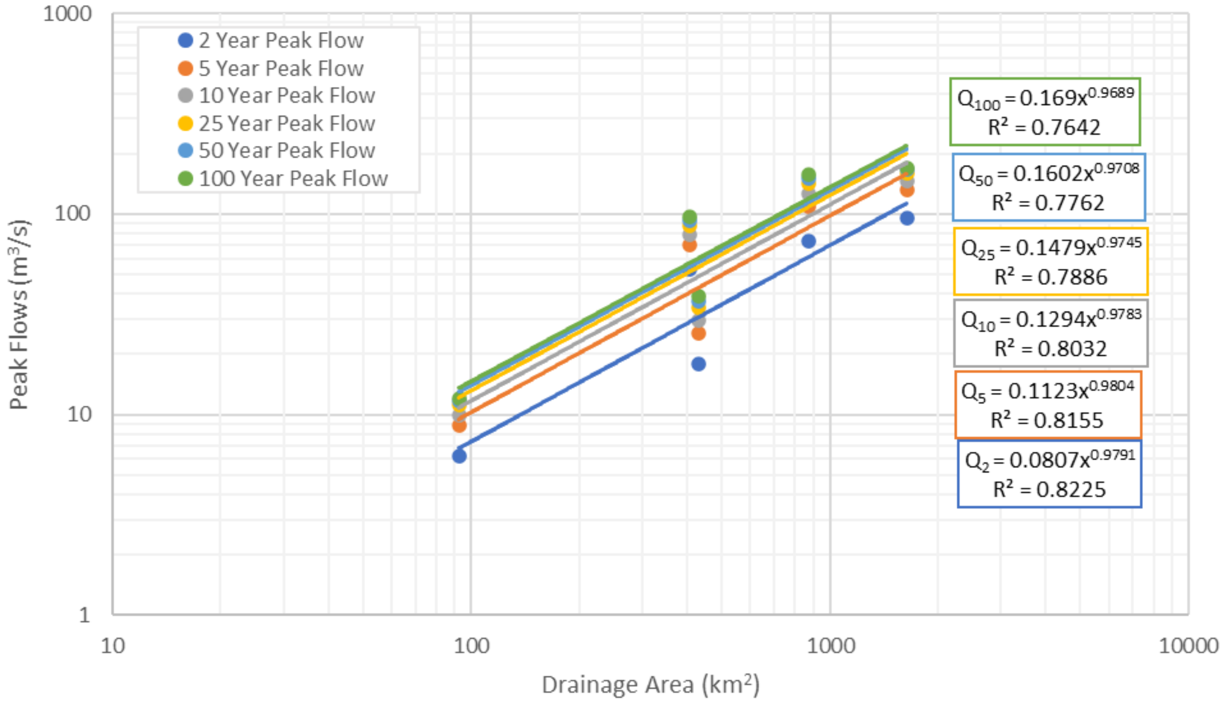
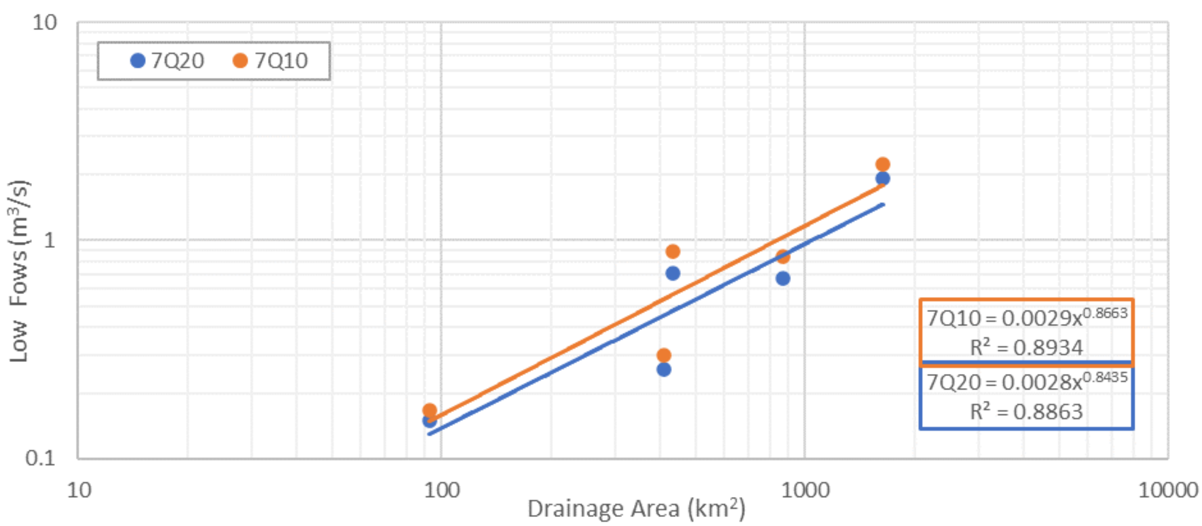


Figure 6.2 Regional Assessment Peak Flood Flows Regression



The 7Q10 (7-day average low flow with a 10-year return period) and 7Q20 (7-day average low flow with a 20-year return period) are indicators of extended low water conditions. The 7Q10 and 7Q20 low flows are plotted against catchment area, presented on Figure 6.3.

Figure 6.3 Regional Low Flows and Catchment Area Regression



Environmental flows were determined at the selected WSC stations using the Tessman Method. Another important environmental flow threshold includes 10% of instantaneous or daily flows and 30% of the mean annual discharge (DFO 2013). The 30% of mean annual discharge is derived from the regression equation for mean annual flow shown on Figure 6.1 and is presented in Table 6.1.

Table 6.1 Summary of Project Site Mean Annual Flows and 30% of Mean Annual Flows

Watershed	Station	Drainage Area (km^2)	MAF (m^3/s)	30% MAF (m^3/s)
Jocko Creek	SW-8	92.5	1.13	0.338
North Driftwood River	SW-2b	105.5	1.28	0.384
West Buskegau River	SW-6b	199.0	2.38	0.714

An environmental water balance was created using the Thornthwaite Monthly Water Balance model developed by the USGS (2007) to assess the balance of evapotranspiration, infiltration, and streamflow. The model was run for three input data scenarios: climate normal (1991-2020), driest year (2012), and wettest year (1961). Under the 1991 – 2020 climate normal period, actual evapotranspiration is modelled to account for 473.4 mm based on the monthly temperature and precipitation, soil storage, and land cover type. The 1991-2020 climate normal total stream flow estimate of 328.2 mm represents a streamflow (runoff) coefficient of 41%. The average regional gauging station value for the runoff coefficient is 44% (ranges from 38% to 51%). The 1991-2020 climate normal total groundwater recharge (infiltration) estimated for the project site is 114.9 mm/year, which is 35% of the total streamflow amount.

Data collected by the local hydrometric monitoring program was utilized for the generation of station-specific rating curves and hydrographs. These results provide a quantitative measure of the hydrological nature of the LSA. Table 6.2 summarizes the results of the final rating curves developed for each station.

Table 6.2 Rating Curve Results Summary

Watershed	Station	Equation[1,3]	R^2	Data Points
Jocko Creek	SW-7	$X = 0.6227\,(Y)^{3.723}$	0.96	7
	SW-8	$X = 0.4051(Y)^{3.2593}$	0.90	7
North Driftwood River	SW-1	N/A[2]	N/A	9
	SW-2b	$X = 1.7922\,(Y)^{2.428}$	0.99	7
	SW-3	N/A[2]	N/A	8
	SW-9	$X = 9.740\,(Y)^{8.201}$	0.92	4
West Buskegau River	SW-4	$X = 0.420\,(Y)^{2.307}$	0.50	5
	SW-5	$X = 6.259\,(Y - 0.5)^{1.343}$	0.99	8
	SW-6b	$X = 5.937\,(Y - 0.6)^{1.110}$	0.98	7

Notes:
1. X = Discharge (m^3/s) and Y = Thalweg Depth (m)
2. SW-1 and SW-3 have no presented rating curve equation due to reduced data quality - no relationship found.
3. The Rating Curve equations are applicable to ice-free periods.

In general, ice thickness varies throughout the Project site study surface water quality stations. Stations recorded ice thicknesses ranging from 0.33 m to 0.56 m in February 2022 and 2023, and March 2023.

A bathymetric assessment of specific site lakes was performed; the results are presented in Table 6.3.

Table 6.3 Bathymetry Results of Select Study Area Lakes

Watershed	Name	0 m Elevation (masl)	Mean Depth (m)	Maximum Depth (m)	Surface Area (ha)
North Driftwood River	Unnamed Lake (near the West Stockpile)	270.19	2.5	11.0	5.02
	Martin Lake	268.29	3.4	11.0	19.98
	Gerry Lake	268.28	6.2	21.0	14.29
	Jack Lake	274.07	4.5	18.0	5.34
	Sutherland Lake	274.68	4.1	22.0	7.95
	Mel Lake	274.86	7.3	21.0	2.73
Jocko Creek	Zed Lake	282.53	4.0	13.0	4.56
	Unnamed Lake – South of Zed Lake	278.58	7.9	13.0	4.10

Local site subwatersheds are defined by the hydrometric monitoring station locations within each major watershed. Application of the equations determined through the regional assessment is executed to quantify annual flows, low flows and flood flows. These results are presented in Table 6.4.

Table 6.4 Application of Regional Regression Relationships for Annual Flows, Low Flows, and Flood Flows to Local Sites

Watershed	Station	Drainage Area (km^2)	Mean Annual Flow (m^3/s)	Minimum Observed Flow (m^3/s)	Maximum Observed Flow (m^3/s)	Low Flow (m^3/s)		Flood Flows (m^3/s)	
						7Q10	7Q20	25-year	100-year
Jocko Creek	SW-7	72.3	0.88	0.46	1.28	0.12	0.10	9.59	10.70
	SW-8	92.5	1.13	0.58	1.63	0.15	0.13	12.19	13.58
North Driftwood River	SW-1	7.2	0.09	0.06	0.14	0.02	0.01	1.01	1.14
	SW-2b	105.5	1.28	0.65	1.85	0.16	0.14	13.86	15.42
	SW-3	14.3	0.18	0.10	0.26	0.03	0.03	1.98	2.22
	SW-9	12.3	0.16	0.09	0.23	0.03	0.02	1.71	1.92
West Buskegau River	SW-4	13.6	0.17	0.10	0.25	0.03	0.03	1.88	2.12
	SW-5	154.5	1.86	0.92	2.68	0.23	0.20	20.09	22.32
	SW-6b	199.0	2.38	1.17	3.43	0.28	0.24	25.72	28.53
Note: SW-8, SW-2b, and SW-6b are the most downstream stations of their respective watersheds									

As described in Section 5.2.3, three HEC-HMS models were developed, one for each watershed. For the baseline assessment, model calibration was performed to match historical recorded flows from nearby WSC Station Porcupine River at Hoyle. Figure A.2 and A.3 (Appendix A) present flow network figures of the subwatershed outflows for the North Driftwood River and West Buskegau Rivers, respectively.

Calibration results indicate good calibration based on several metrics of correlation and goodness of fit presented in Table B.1.5 of Appendix B.1. Hydrographs from each of the three hydrological models are shown on Figure 6.4 to Figure 6.6.

Figure 6.4 Jocko Creek Model Calibration - January 1, 2008 to December 31, 2014

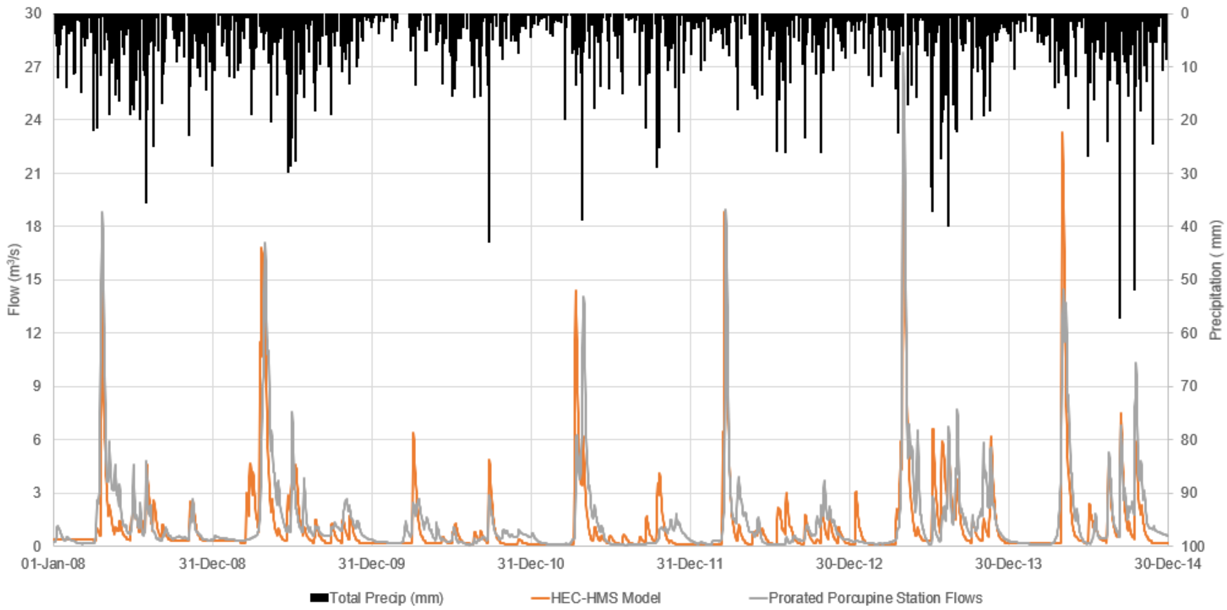


Figure 6.5 North Driftwood River Model Calibration - January 1, 2008 to December 31, 2014

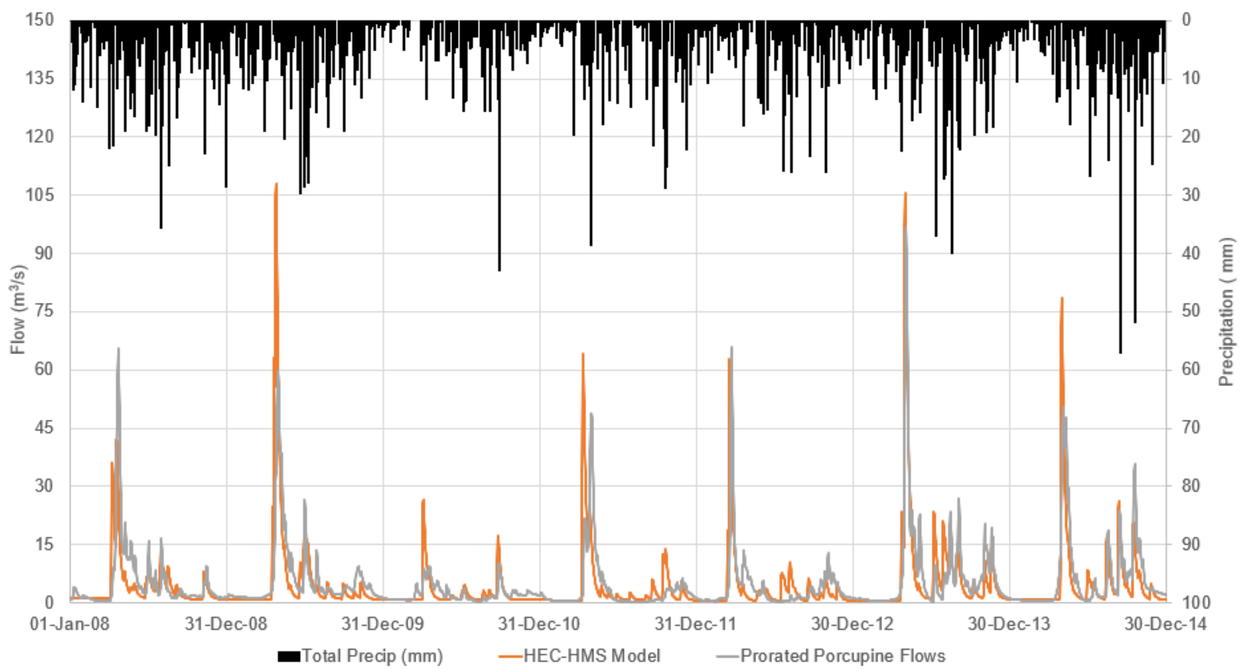
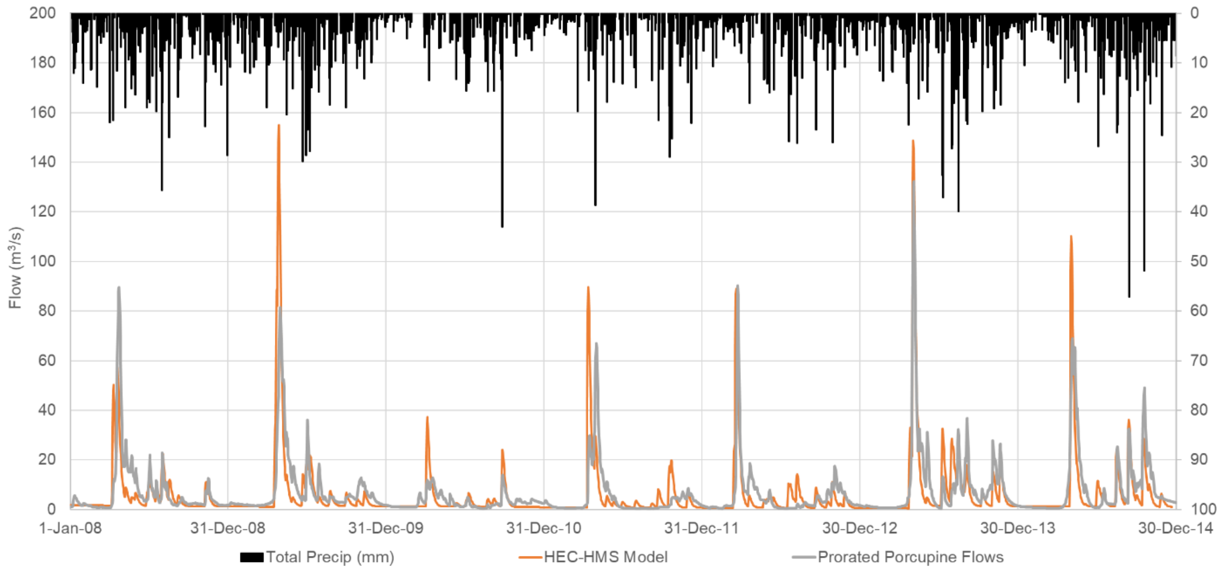


Figure 6.6 West Buskegau River Model Calibration - January 1, 2008 to December 31, 2014



The existing baseline model was validated against the developed local site rating curves using the methodology outlined in Section 5.2.3. The baseline HEC-HMS model was run with precipitation and temperature data (using Timmins Climate daily data gap filled with Timmins A daily data) from September 1, 2022, until November 30, 2022.

6.1.3 Surface Water Quality

Regional water quality data was obtained from seven monitoring stations in the PWQMN. The seven watercourse monitoring stations were located within a 200 km radius of the Project Site, ranging from approximately 25 km to 193 km and located south and southeast of the Project Site. From 2021 to 2023, a total of 33 watercourse locations and 13 waterbody locations were sampled to support local water quality data across three main watersheds: Jocko Creek (9 sites), North Driftwood River (22 sites), and West Buskegau River watersheds (15 sites). By considering both the regional and local surface water quality data, existing water quality conditions in the PA were established.

6.1.3.1 Regional Water Quality

Regional watercourse water quality identified a circumneutral environment. The field pH results ranged from 5.54 to 10.94 with a 75th percentile value of 7.49 and a 25th percentile value of 7.13. Alkalinity was found to be relatively low. For the regional data set, hardness (as $CaCO_3$) values ranged from 26 mg/L to 1,500 mg/L with a 75th percentile of 308 mg/L. Hardness greater than 180 mg/L is considered very hard water (Health Canada 1979). Hardness was observed to be slightly higher in the summer months than during the rest of the year. PoPCs identified in the regional water quality data were total aluminum, total arsenic, total cadmium, total cobalt, total copper, total iron, total lead, total phosphorus, total silver and total zinc. Of the Regional water quality PoPCs, aluminum, total iron and total phosphorus were identified in the local data as PoPCs and are applied to the Project Area.

6.1.3.2 Local Water Quality

Local general water quality in the watercourses and waterbodies identified slightly acidic conditions with 25th percentile values below the CWQG-FAL and PWQO lower limit (6.5). Alkalinity was relatively low with limited acid buffering potential. Waters within the Project Area are typically classified as medium hard with soft waters in the Jocko Creek and West Buskegau River watersheds. Four parameters were identified as Project Area PoPCs where 75th percentile values exceeded the corresponding PWQO and/or CWQG-FAL guideline. Total phosphorus (TP), total aluminum, dissolved aluminum (0.2 µm), and total iron are identified as PoPCs. Other metals and metalloids that reported at least one exceedance of the applicable guideline values as part of the local watercourse and waterbody monitoring program included: total cadmium, total cobalt, total copper, total lead, dissolved manganese, mercury, total selenium, total silver, total zinc, and total zirconium (Table 6.6).

There were no substantial and consistent differences between the three watersheds, Jocko Creek, North Driftwood River, and West Buskegau River. In terms of water feature type, concentrations of the analyzed nutrients, metals and metalloids were observed to be lower in waterbodies than watercourses, with fewer exceedances of the respective guidelines.

6.1.3.2.1 Total Phosphorus

Within the local dataset, TP had a 75th percentile value of 0.033 mg/L for watercourses and 0.020 mg/L for waterbodies, exceeding the respective PWQO criterion of 0.030 mg/L for watercourses and equaling the 0.020 mg/L criteria value for waterbodies. Exceedances of the PWQO were more frequent in the winter and early spring months, with TP concentrations decreasing throughout the spring before increasingly slightly in the summer and fall months.

6.1.3.2.2 Total and Dissolved Aluminum (0.2 µm)

For the assessment of aluminum, CWQG-FAL criteria was used to evaluate total aluminum and PWQO criteria (clay-free samples) used to evaluate dissolved aluminum. Within the local dataset, total aluminum concentrations in watercourses ranged from 26 µg/L to 3,210 µg/L with a 75th percentile of 424 µg/L and a mean value of 361 µg/L. In waterbodies, total aluminum ranged from 3.4 µg/L to 378 µg/L with a 75th percentile of 148 µg/L and a mean value of 91.4 µg/L. The total aluminum concentrations were reported to exceed the CWQG-FAL value in 250 of 317 sampling events. A similar seasonal pattern was observed with total aluminum peaking in March, then decreasing in the spring and increasing slightly during the summer and fall months.

The 75th percentile value for dissolved aluminum exceeded the PWQO criteria of 75 µg/L for the 0.2 µm filtered samples with 75th percentile value of 107 µg/L in watercourses. In waterbodies, dissolved aluminum concentrations had a 75th percentile of 43 µg/L (0.2 µm filter).

6.1.3.2.3 Total Iron

Within the local dataset, total iron concentrations in watercourses ranged from a minimum of 130 µg/L to a maximum of 3,640 µg/L with a 75th percentile of 800 µg/L and a mean value of 695 µg/L. In waterbodies, total iron ranged from below the RDL (10 µg/L) to a maximum of 6,900 µg/L with a 75th percentile of 503 µg/L and a mean value of 381 µg/L. Out of the 317 samples collected, there were 241 exceedances of the CWQG-FAL (300 µg/L) and PWQO (300 µg/L), 212 in the watercourses and 29 in the waterbodies. The 75th percentile values for both the watercourses and waterbodies exceeded the CWQG-FAL and PWQO values; total iron is identified as a PoPC and is anticipated to be a Policy 2 parameter (MOEE 1994). A similar seasonal pattern was observed with total iron peaking in March, then decreasing in the spring and increasing slightly during the summer and fall months.

6.1.3.3 Local and Regional Water Quality Comparison

A comparison of the regional and local water quality shows similarities for seasonal patterns as well as a number of PoPCs. Concentrations of select parameters (total ammonium/total ammonia (as N), TP, aluminum, iron, lead, and zinc) would often be higher in the late fall and winter months and lower in the spring and summer months. TP, dissolved (0.2 µm filter) and total aluminum, and total iron, are considered PoPCs in both the local and regional water quality datasets as they exceeded PWQO and/or CCME CWQG-FAL when compared against their 75th percentile concentration. Additional PoPCs were identified in the regional dataset; however, they were not considered PoPCs in the local data, including total arsenic, total cadmium, total cobalt, total copper, total lead, total silver, and total zinc. A summary of the baseline water quality results for the PA is provided in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement). A summary of PoPCs is provided in Table 6.5 and Table 6.6.

To understand the range of natural variability of water quality, a 95th percentile value was calculated for both the local and regional datasets, and a 5th percentile value for pH and dissolved oxygen which have upper and lower limit guidelines. Greater variability was typically present in the regional dataset for general chemistry, nutrient, and metal and metalloid parameters, potentially due to the longer monitoring period. Total aluminum, Total Suspended Solids (TSS), and DOC had higher 95th percentile local watercourse values than the regional dataset but were within the same order of magnitude. The natural variability of the regional water quality data captured the observed results of the local water quality data.

Table 6.5 Summary of Parameters of Potential Concern in Regional Water Quality Monitoring Stations

Surface Water Feature Type	Parameters	Units	CCME		PWQO	Minimum	Maximum	Mean	75th Percentile	95th Percentile	Std. Dev.	# of Samples	# of non-detects	# of Observed Exceedances
			Short-term	Long-term										
Watercourses	Phosphorus, Total	mg/L	-	Guidance Framework [a]	Guidance [b]	<0.002	13,281	10.898	0.11	0.643	377.914	1,235	29	872
	Phosphorus, Total (without Station 18771000602)					<0.002	5.25	0.07	0.07	0.22	0.187	1,067	29	706
	Total Aluminum	µg/L	-	Narrative [c]	-	0.6	6,100.00	222.9	269.5	684.5	418.9	423	5	210
	Total Arsenic	µg/L	-	5	5	<0.2	1,180	15	9	35	78	396	79	158
	Total Cadmium	µg/L	Equation [d]	Equation [e]	Table [h]	<0.2	8	0.58	0.75	2.12	0.86	406	208	192
	Total Cobalt	µg/L	-	-	0.9	<0.5	176	10.5	4.9	62.4	26.6	404	145	192
	Total Copper	µg/L	-	Equation [f]	Table [i]	<1	350	14.8	19.3	45.3	25.3	921	106	624
	Total Iron	µg/L	-	300	300	<1	7500	541	690	1,500	692	998	9	511
	Total Lead	µg/L	-	Equation [g]	Narrative [j]	-	220	-	-	-	-	778	587	152
	Total Silver	µg/L	-	0.25	0.1	-	6.4	-	-	-	-	134	96	36
	Total Zinc	µg/L	-	-	20	<1	73000	110.5	30	100	2380.1	747	113	283

Notes:

NA - not applicable, T – total, D - dissolved

a. 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.

b. Phosphorus, total (TP): To avoid nuisance concentrations of algae in lakes, average TP concentrations for the ice-free period should not exceed 0.02 mg/L, A high level of protection against aesthetic deterioration will be provided by a TP concentration for the ice-free period of 0.01 mg/L or less. This should apply to all lakes naturally below this value, and excessive plant growth in rivers and streams should be eliminated at a TP concentration below 0.03 mg/L

c. Al CWQG = 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5

d. Cd short-term: 0.11 µg/L if hardness 0 to <5.3 mg CaCO3·L-1, $10^{\{1.016(\log[\text{hardness}]) - 1.71\}}$ 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

e. Cd long-term: 0.04 µg/L if hardness 0 to <17 mg CaCO3·L-1, $10^{\{0.83(\log[\text{hardness}]) - 2.46\}}$ if hardness ≥17 to ≤280 mg CaCO3·L-1, 0.37 µg/L if hardness >280 mg CaCO3·L-1

f. Cu long-term: 2 µg/L if hardness 0 to <82 mg CaCO3·L-1, $0.2*e^{\{0.8545[\ln(\text{hardness})]-1.465\}}$ if hardness ≥82 to ≤180 mg CaCO3·L-1, 4 µg/L if hardness >180 mg CaCO3·L-1

g. Pb long-term: 1 µg/L if hardness 0 to <60 mg CaCO3·L-1, $e^{\{1.273[\ln(\text{hardness})]-4.705\}}$ if hardness ≥60 to ≤180 mg CaCO3·L-1, 7 µg/L if hardness >180 mg CaCO3·L-1

h. Cadmium: 0.0001 mg/L if hardness is 0 to 100 mg CaCO3 L^{-1}, 0.0005 if hardness is >100 mg CaCO3 L^{-1}

i Copper: 0.001 mg/L if hardness is 0 to 20 mg CaCO3 L^{-1}, 0.005 mg/L if hardness is .20 mg CaCO3 L^{-1}

j. Lead: 0.001 mg/L if hardness is <30 mg CaCO3 L^{-1}, 0.003 mg/L if hardness is 30 to 80 mg CaCO3 L^{-1}, 0.005 mg/L if hardness is > 80 mg CaCO3 L^{-1}

Table 6.6 Summary of Parameter Results at Local Water Quality Monitoring Stations

Surface Water Feature Type	Parameters	Units	RDL	CCME		PWQO	Minimum	Maximum	Mean	75th Percentile	95th Percentile	Std. Dev.	# of Samples	# of non-detects	# of Observed Exceedances	PoPC
				Short-term	Long-term											(Y/N)
Watercourses	Total Phosphorus	mg/L	0.002	-	Guidance Framework [b]	Guidance [c]	<0.002	0.119	0.025	0.033	0.052	0.016	241	3	66	Y
	Dissolved Aluminum (0.2 µm)	µg/L	1	-	-	Narrative [l]	14	202	82	107	168	45	72	0	34	Y
	Total Aluminum	µg/L	1	-	Narrative [d]	-	26	3210	361	424	904	372	242	0	229	Y
	Total Arsenic	µg/L	0.1	-	5	5	0.3	2	0.8	1	1.4	0.3	242	51	0	N
	Total Cadmium	µg/L	0.005	Equation [e]	Equation [f]	Table [i]	<0.005	0.33	0.037	0.042	0.069	0.036	242	11	21	N
	Total Cobalt	µg/L	0.1	-	-	0.9	<0.1	1.8	0.3	0.3	0.7	0.2	242	35	6	N

Surface Water Feature Type	Parameters	Units	RDL	CCME		PWQO	Minimum	Maximum	Mean	75th Percentile	95th Percentile	Std. Dev.	# of Samples	# of non-detects	# of Observed Exceedances	PoPC
				Short-term	Long-term											(Y/N)
	Total Copper	µg/L	0.2	-	Equation [g]	Table [j]	<0.5	52	1.9	2	3	3.9	242	28	62	N
	Total Iron	µg/L	10	-	300	300	130	3,640	695	800	1,500	463	242	0	212	Y
	Total Lead	µg/L	0.05	-	Equation [h]	Narrative [k]	<0.10	5.56	0.43	0.54	0.88	0.47	242	2	8	N
	Total Silver	µg/L	0.01	-	0.25	0.1	-	0.17	-	-	-	-	242	213	3	N
	Total Zinc	µg/L	1	-	-	20	2	54	7	8	14	5	241	4	5	N
Waterbodies	Total Phosphorus	mg/L	0.002	-	Guidance Framework [b]	Guidance [c]	<0.002	0.233	0.022	0.02	0.053	0.037	75	3	17	Y
	Dissolved Aluminum (0.2 µm)	µg/L	1	-		Narrative [l]	2	141	37	43	110	41	12	0	2	Y
	Total Aluminum	µg/L	1	-	Narrative [d]	-	3.4	378	91.4	148	315.9	105.3	75	1	22	Y
	Total Arsenic	µg/L	0.1	-	5	5	0.15	1.33	0.47	0.59	1.17	0.31	75	12	0	N
	Total Cadmium	µg/L	0.005	Equation [e]	Equation [f]	Table [i]	-	0.08	-	-	-	-	75	38	3	N
	Total Cobalt	µg/L	0.1	-	-	0.9	-	0.5	-	-	-	-	75	49	0	N
	Total Copper	µg/L	0.2	-	Equation [g]	Table [j]	-	4.1	-	-	-	-	75	40	3	N
	Total Iron	µg/L	10	-	300	300	<10	6900	381	503	790	805	75	4	29	Y
	Total Lead	µg/L	0.05	-	Equation [h]	Narrative [k]	<0.050	0.742	0.162	0.22	0.551	0.174	75	28	0	N
	Total Silver	µg/L	0.01	-	0.25	0.1	-	0.16	-	-	-	-	75	72	1	N
	Total Zinc	µg/L	1	-	-	20	<1.0	33.7	5.3	7	13.4	5.5	75	30	2	N

Notes:
NA - not applicable, T – total, D - dissolved

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. 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.
c. Phosphorus, total (TP): To avoid nuisance concentrations of algae in lakes, average TP concentrations for the ice-free period should not exceed 0.02 mg/L, A high level of protection against aesthetic deterioration will be provided by a TP concentration for the ice-free period of 0.01 mg/L or less. This should apply to all lakes naturally below this value, and excessive plant growth in rivers and streams should be eliminated at a TP concentration below 0.03 mg/L
d. Al CWQG = 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5
e. Cd short-term: 0.11 µg/L if hardness 0 to <5.3 mg CaCO3·L-1, $10^{\{1.016(\log[\text{hardness}]) - 1.71\}}$ 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
f. Cd long-term: 0.04 µg/L if hardness 0 to <17 mg CaCO3·L-1, $10^{\{0.83(\log[\text{hardness}]) - 2.46\}}$ if hardness ≥17 to ≤280 mg CaCO3·L-1, 0.37 µg/L if hardness >280 mg CaCO3·L-1
g. Cu long-term: 2 µg/L if hardness 0 to <82 mg CaCO3·L-1, $0.2 * e^{\{0.8545[\ln(\text{hardness})]-1.465\}}$ if hardness ≥82 to ≤180 mg CaCO3·L-1, 4 µg/L if hardness >180 mg CaCO3·L-1
h. Pb long-term: 1 µg/L if hardness 0 to <60 mg CaCO3·L-1, $e^{\{1.273[\ln(\text{hardness})]-4.705\}}$ if hardness ≥60 to ≤180 mg CaCO3·L-1, 7 µg/L if hardness >180 mg CaCO3·L-1
i. Cadmium: 0.0001 mg/L if hardness is 0 to 100 mg CaCO3 L^{-1}, 0.0005 if hardness is >100 mg CaCO3 L^{-1}
j. Copper: 0.001 mg/L if hardness is 0 to 20 mg CaCO3 L^{-1}, 0.005 mg/L if hardness is .20 mg CaCO3 L^{-1}
k. Lead: 0.001 mg/L if hardness is <30 mg CaCO3 L^{-1}, 0.003 mg/L if hardness is 30 to 80 mg CaCO3 L^{-1}, 0.005 mg/L if hardness is > 80 mg CaCO3 L^{-1}
l. At pH 4.5 to 5.5 the Interim PWQO is 15 µg/L based on inorganic monomeric aluminum measured in clay-free samples, at pH >5.5 to 6.5, no condition should be permitted which would increase the acid soluble inorganic aluminum concentration in clay-free samples to more than 10% above natural background concentrations for waters representative of that geological area of the Province that are unaffected by man-made inputs and at pH >6.5 to 9.0, the Interim PWQO is 75 µg/L based on total aluminum measured in clay-free samples

6.2 Geochemistry

The ML/ARD assessment completed by WSP is provided in the Crawford Geochemistry Characterization (Appendix H of the Impact Statement) and included static and kinetic testing of waste rock, ore, tailings, and overburden samples. ABA testing was completed using the CO_3-NP and modified Sobek NP analytical methods. Overburden was classified as NPAG. The waste rock CO_3-NP and modified Sobek NP results had a larger difference in the classification of ARD potential than the other materials. Using the CO_3-NP, 22% of waste rock was classified as PAG and 7% uncertain whereas for modified Sobek NP, only 1% was classified as PAG. Ore sample CO_3-NP results suggest 5% PAG and 6% uncertain acid generating potential, whereas the modified Sobek NP method results in a classification of 100% of samples as NPAG. Based on the CO_3-NP, tailings samples were classified as having an uncertain acid generating potential (3 of 4 tailings samples had CO_3-NP<2 but >1); however, based on the modified Sobek NP method, the four samples were classified as NPAG. WSP's Crawford Geochemistry Characterization (Appendix H of the Impact Statement) hypothesized that the difference in NP results for the two methods was due to low concentrations of sulphides and carbonates in the waste rock, ore, and tailings, and a prevalence of silicate minerals.

Kinetic HCTs were conducted on five samples of ore and waste rock, representing the site lithologies. The HCTs were run for 99 weeks when ML stabilized. Additional HCTs were started for two ore, eight waste rock, and four tailings samples, and were ongoing when the WSP Crawford Geochemistry Characterization (Appendix H of the Impact Statement) was published in April 2024 with the shortest duration being 25 weeks. The HCT CO_3-NP and modified Sobek NP results also observed a difference in PAG and uncertain acid generating potential results with CO_3-NP results being higher, which was attributed to the low concentrations of sulphides and carbonates in the waste rock, ore, and tailings, and higher concentrations of silicates. Monitoring of pH in the HCT leachate for ore, waste rock, and tailings observed a minimum pH of 6.7, which is within the circumneutral range and above the lower PWQO and CCME CWQG criteria range value. For tailings, one of the dunite HCTs the CO_3-NP was depleted in week 41, but still produced circumneutral discharge (>6.7) for another 58 weeks of monitoring. Long-term monitoring of the ore, waste rock and tailings HCTs was recommended to assess ML/ARD characteristics (Appendix H of the Impact Statement).

Paste pH was measured as part of the ABA test work and the organics samples within the overburden were identified to be below the CCME CWQG pH guideline range value in 26 of 26 organics samples and 2 of 24 mineral samples. The SFE testing as part of the ML analysis had pH values greater than 7 and within the circumneutral range for test results. Runoff from overburden Stockpiles was recommended to be monitored to assess ML/ARD characteristics (Appendix H of the Impact Statement).

The above geochemical assessment to evaluate ARD potential for overburden identified potential acidity issues for the organics components of the material, but overall classified as NPAG using ABA testing. The waste rock, ore and tailings, had static test results identifying presence of PAG or uncertain acid generating potential for the CO_3-NP test results with lower percentages of PAG materials or classified as NPAG based on the modified Sobek NP results. The kinetic HCT results for ore, waste rock and tailings had a minimum pH of 6.7, which is classified as circumneutral and within PWQO and CCME CWQG criteria range with tests extending up to 99 weeks in length. One of the tailings HCT tests (dunite) had CO_3-NP results indicating the carbonate NP of the tailings had been exhausted within 41 weeks of the test starting, but still produced neutral discharges (>6.7) to the end of the 99 week test.

Overburden organics SFE ML results identified dissolved and total aluminum, total fluoride, total boron, total chromium VI, total copper, and total zinc as PoPCs. WSP's Crawford Geochemistry Characterization (Appendix H of the Impact Statement) noted that SFE results for the waste rock, ore and tailings ML results were typically higher than first-flush HCT concentrations (Appendix H of the Impact Statement).

The waste rock SFE ML results identified chloride, fluoride, aluminum (dissolved and total), total arsenic, total antimony, total boron, total chromium (VI), total copper, total iron, total selenium, total thallium, total uranium, total vanadium, and dissolved zinc as PoPCs. The waste rock HCT ML results for the dunite and metavolcanic lithologies that represent 5% and 48% of the waste rock, respectively, had several metalloid and metal parameters that exceeded PWQO and/or CCME CWQG-FAL values. For dunite, this was total chromium (VI) (long-term) and total boron (first flush), and for metavolcanics these parameters were dissolved aluminum, total aluminum, and total arsenic (Appendix H of the Impact Statement).

The ore SFE ML results identified chloride, aluminum (dissolved and total), total arsenic, total antimony, total boron, total cadmium, total chromium (VI), total copper, total iron, total selenium, total thallium, total uranium, and total vanadium as PoPCs. Dunite ore HCT ML testing also identified total chromium (VI) (long-term) and total boron (first flush) as PoPCs; other ore lithologies did not identify ML results exceedances ([Appendix H of the Impact Statement).

The tailings SFE ML results for one sample of peridotite lithology identified total boron, total cadmium, and total chromium (VI) as above the PWQO and/or CCME CWQG-FAL values. The tailings HCT ML results identified chromium (VI) as consistently above PWQO and/or CCME CWQG-FAL values for two lithologies (dunite and peridotite). Dunite tailings also had long-term ML results with exceedances of PWQO and/or CCME CWQG-FAL values for total uranium.

Nitrate (as N) and nitrite (as N) were monitored as part of the HCT and SFE analysis results, including tailings, with values typically below the RDL values of 0.06 mg/L and 0.03 mg/L, respectively, and consistently below PWQO and/or CCME CWQG-FAL values (Appendix H of the Impact Statement).

The ML assessment did not observe metal and metalloid parameter results that exceeded MDMER Schedule 4, Table 1 discharge criteria for overburden, waste rock, ore and tailings. Chloride, fluoride and a number of metals and metalloids parameters that exceeded PWQO and/or CCME CWQG-FAL values will be used to develop source terms for the water quality model and evaluated further as PoPCs for the Project (Section 6.3.6.2).

6.3 Water Management Plan

The Site-Wide Water Management Plan (Appendix J of the Impact Statement) provides details on site-specific mitigation measures to reduce the potential for Project effects on surface water quantity and quality. The Site-Wide Water Management Plan, developed by Ausenco, will be implemented during construction, operations, and decommissioning and closure phases, and provides details on runoff and seepage collection strategies and systems (e.g., sedimentation ponds, non-contact water diversions, drainage ditches, treatment systems) to collect and contain surface water runoff, and groundwater discharge from major mine components (Open Pit, Impoundment Facility, TMF, processing plants, ore Stockpiles and overburden Stockpiles) during climate change adjusted climate normal and extreme weather conditions (Appendix J of the Impact Statement).

The primary objectives of the Site-Wide Water Management Plan (Appendix J of the Impact Statement) are:

- Reduce potential flood effects to local receivers by controlling flooding on site and attenuating effluent discharge
- Reduce water quality impacts on receivers by providing mine water sedimentation control and treatment
- Reduce erosion and sedimentation with appropriate erosion and sedimentation controls
- Maintain existing flows to the receivers to the extent feasible
- Reduce site contact water as much as possible by incorporating surface water/overland flow diversion
- Provide water for mining operations (milling/processing, dust suppressant), including reuse of collected water to the extent feasible

6.3.1 Water Management Design

Design criteria used in the Site-Wide Water Management Plan (Appendix J of the Impact Statement) were developed to mitigate potential effects of the Project on surface water resources and are based on the Project-specific guidance, industry best practices, and Canada Nickel corporate direction. Design criteria related to surface water quality are summarized below and include:

1) Quantity Controls

    a) The system overall has been sized to convey and storge up to the 100-year return period, 24-hour duration storm event without any untreated water being discharged to the environment

    b) Collection ditches have been sized to convey the 100-year return period, 24-hour duration storm event with freeboard

    c) Sedimentation ponds and the Open Pit are used in conjunction and the system has been sized to manage and store up to the 100-year return period, 24-hour duration storm event

i) Sedimentation ponds have been sized to store up to the 10-year return period, 24-hour duration storm event with freeboard

ii) Flows above 10-year return period, 24-hour duration storm event and less than the 100-year return period, 24-hour duration storm event will be managed by controlled release to the Open Pit

iii) In the event of a flood event in excess of 100-year return period parameters, a secondary emergency overflow spillway directing controlled flow to the receiving environment has been designed. Spillways have been sized for a 200-year event.

d) Gravity collection/conveyance ditches will be employed, where possible, inclusive of overflows from sedimentation ponds to the Open Pit

e) Erosion control measures such as vegetation controls and/or stabilization with stone resistant to erosive forces will be employed in erosion-susceptible zones in drainage ditching, pond inlets, outlets, and spillway discharge ditches

f) Balancing water discharges to the North Driftwood River and West Buskegau River to the extent feasible to maintain watercourse flows

2) Quality Controls

a) Use accepted industry best practice geochemistry methods to predict mine contact runoff and seepage quality.

b) Manage water quality through collection ditches, collection (sedimentation) ponds and treatment plants, collecting water from the Project components and discharging locally.

c) Soil sampling at the site of proposed mineworks indicated that 20 to 30% of sampled material is composed of clay (<5 µm diameter). Jar test analysis of a synthetic groundwater sample indicated material is highly settleable; subsequent laboratory analysis will be conducted to confirm settleability, verify retention time of the ponds, and identify requirements for additional water treatment.

d) Sedimentation ponds will be sized a 10-year return period, 24-hour duration storm event with storage capacity to retain the entirety of the design storm event without release.

e) Treatment plants will treat contact water for constituents of concern at each pond prior to discharge to the environment. Treatment requirements will be developed based on the assimilative capacity of the receiving waters, reasonable and practical treatment technologies, and defining the mixing zone boundary as the point downstream in the receiving waters where ambient water quality meets PWQO values or returns to baseline concentrations (Section 6.3.6.2.1).

f) Erosion control measures such as silt fencing, check dams, and scarfing will be considered during construction, operations, and decommissioning and closure phases.

6.3.2 Water Management Infrastructure

The general schematics of the Site-Wide Water Management Plan sequencing for construction, operations, and decommissioning and closure phases (Mine years -3 to 46+) are presented on Figure 6.7 to Figure 6.11, which are adapted from the Site-Wide Water Management Plan (Appendix J of the Impact Statement). Contact water from the Impoundment Facility (waste rock, sand/till, clay), Stockpiles (east/west, overburden, reclaim Stockpiles), TMF, and the Process Plant Area will be collected in ditches and conveyed to one of five sedimentation ponds. Depending on local topography, perimeter ditching may require excavated sumps from which water will be collected and pumped to the sedimentation pond. Treatment plants at each pond will provide additional treatment to meet discharge criteria, as required. Select sedimentation ponds during different Project phases will receive pit groundwater and surface runoff from haul roads and the pits via a pumping system.

Non-contact water is proposed to be diverted using an excavated channel as a new outlet for Martin Lake to divert flow under and then along the re-aligned highway and tie back into North Driftwood River farther downstream (Section 6.3.3). Additionally, a diversion dam or other type of earth works will allow cutting off the existing outlet of Martin Lake to prevent flows from entering into the PA. At the north end of the Impoundment Facility, a combination of perimeter berming and ditching will redirect non-contact water into the West Buskegau River watershed. At the southern extent of the TMF, a diversion ditch will intercept and redirect non-contact water from the east side of the TMF to the North Driftwood River watershed (Figure A.6 within Appendix A).

The Project will have up to four final discharge points (FDPs) during the construction and operations phases to provide zonal water management, with two discharging to the North Driftwood River (TMF NE and NW ponds and Pond 2) and two discharging to the West Buskegau River (Ponds 1 and 3), as presented in Figure 6.7 through to Figure 6.11. During the construction phase and the first few years of the operations phase 1 (up to Year 2) prior to the TMF being constructed to its full footprint size and the realignment of the North Driftwood River, a temporary sedimentation pond will be constructed adjacent to the Process Plant Area to receive plant area surface water runoff and pit dewatering discharge that will be treated and discharged to the North Driftwood River. Discharge criteria will be met at the FDPs prior to release via treatment in sedimentation ponds and treatment plants, as required.

The treatment process for treating effluent from the sedimentation ponds prior to discharge to the environment will be adapted to the predicted changes in water quality. Although no final selection of treatment technologies has been made, it is expected that water treatment will consist of a multi-step treatment train to meet regulatory requirements, (Section 53 of the Ontario Water Resources Act), including an Environmental Compliance Approval issued by the MECP. Nitrogen species (such as ammonia and nitrate) removal would potentially be via a biological treatment system, such as a moving bed biofilm reactor (MBBR). Depending on water quality model predicted formation of nitrogen species during the operations phase in water received by the sedimentation ponds, a biological treatment system is not expected to be required during the first years of construction and operation. A threshold concentration below effluent criteria for nitrogen species will be applied to initiate construction of a biological treatment system. Reoxygenation of the water may be required following the initial biological treatment step.

Metals removal (dissolved and total), when required, would be via chemical precipitation within a reactor tank or tanks that may include pH adjustment, aeration and deaeration. Chemical dosing for the precipitation reactions may be required in more than one tank to remove multiple metal parameters and adjust required aerobic or anaerobic, and pH conditions. Following the chemical precipitation treatment steps, clarifiers (settling tank) and possibly filtration would be required to remove precipitated metals and suspended solids prior to discharge to the receiver. Settling tanks would require sludge management with disposal either in the TMF or Open Pit (depending on mine life phase). Then aeration and/or pH adjustment may be required prior to discharge to meet regulatory criteria.

During the construction phase, water management infrastructure will be progressively built and commissioned, as required based on water flows and quality to manage. Temporary dewatering, pumping and conveying systems will be installed along with industry standard best management practices. As the site development progresses, the Process Plant Area will have surface water runoff collected by perimeter ditches and conveyed to a temporary sedimentation pond prior to additional required treatment, that is expected to consist of a multi-step treatment train to meet regulatory requirements and discharge to the North Driftwood River at FDP-SP-TEMP_01 (Figure 6.7). Upon completion of Pond 2, the Process Plant Area will be graded so that runoff is directed towards Pond 2 and will be conveyed via the west stockpile perimeter ditching. Sedimentation ponds will be constructed below grade to the extent feasible to limit pumps and pumping requirements and to have permanent pools.

The Impoundment Facility will store rock, clay, sand, and till material excavated during construction and operations. Surface water runoff and toe seepage from the Impoundment Facility will be conveyed to Collection Pond 1 and Pond 2. Pond 1 is an early works sedimentation pond that will begin operation during the construction phase.

Runoff from the West Stockpile will be directed to Pond 2 via excavated perimeter ditches. Runoff from the East Stockpile will be directed to Pond 3 via excavated perimeter ditches, which also includes an excavated sump from which water will be pumped to the pond. Pond 3 is an early works sedimentation pond that will begin operation during the construction phase.

Mine contact water from the TMF for the operations phase 1 and 2 (surface runoff, decanted process/tailings water and toe seepage) will be conveyed through the TMF via seepage collection ditches to the adjacent external TMF water management ponds (TMF northwest (NW) pond and TMF northeast (NE) pond). The TMF NE pond will be constructed first, before operations start, and receive drainage from the initial TMF, which will be pumped to the temporary sedimentation pond at the Process Plant prior to treatment and discharge to the environment. The TMF NW Pond will receive approximately half of the collected TMF contact water along with dewatered flows from pit operations. The other half of the collected contact water from the TMF will be conveyed to the TMF NE pond. Process water for mill operations will be pumped from the TMF NW and NE Ponds to the Process Plant as reclaim water, or from pit dewatering. Excess water not required for process demands will be treated via treatment plants prior to discharge to the environment for the two TMF ponds, which will discharge to the North Driftwood River. The water in the TMF NE Pond will be pumped to the TMF NW Pond prior to discharge via the treatment plant to the environment.

A sewage treatment system is proposed to treat domestic sewage for the Project that will discharge to the North Driftwood River at the same location as the FDP for the TMF NE and NW Ponds. There will be no permanent accommodations complex on-site. The plant will be designed to meet regulatory requirements (Authorized under Section 53 of the Ontario Water Resources Act and completed in accordance with MECP Procedure B.1.5), including an Environmental Compliance Approval issued by the MECP. Further details on the treatment system will be provided as part of the permit applications.

6.3.3 North Driftwood River Channel Realignment

The North Driftwood River Diversion Channel is one of the non-contact water diversions that are part of the water management system for the Project. The objectives of the North Driftwood River diversion are:

1) Re-direct flow in the North Driftwood River from Martin Lake westward then northward along the realigned Highway 655 corridor and to convey this flow back to the North Driftwood River downstream of the Project site.
2) Provide appropriate opportunities for fish habitat offsetting, in consideration of the environmental effects of the North Driftwood River Diversion Channel.

This section summarizes the North Driftwood channel diversion. The diversion channel type proposed is a realignment of the North Driftwood River around the mine site. The design will apply the following design criteria:

- Channel corridor geometry will convey the Timmins Storm flow
- Diversion channel slope to follow existing terrain to the extent practical to reduce cut/fill requirements
- Aquatic habitat to be provided to the extent practical
- Navigability to be considered to the extent practical
- Flood flow depths through diversion should be reduced to lower potential effects on upstream infrastructure
- Diversion corridor must be able to convey flow from external drainage catchments and treated mine water discharges

The following design constraints will be accommodated by the North Driftwood River Diversion Channel:

- Upstream diversion channel tie-in point is at the northwestern end of Martin Lake
- Downstream diversion channel tie-in point is the North Driftwood River downstream of the mine footprint

- Water level elevation in Martin Lake will be maintained (i.e., not raised or lowered to divert flow into the new diversion channel), unless it becomes part of the fish offsetting strategy to do so.

6.3.4 Water Management Strategy

The Project phases presented in the following subsections are related to specific phases of water management. They specifically target water management activities occurring in construction, operations, and decommissioning and closure phases.

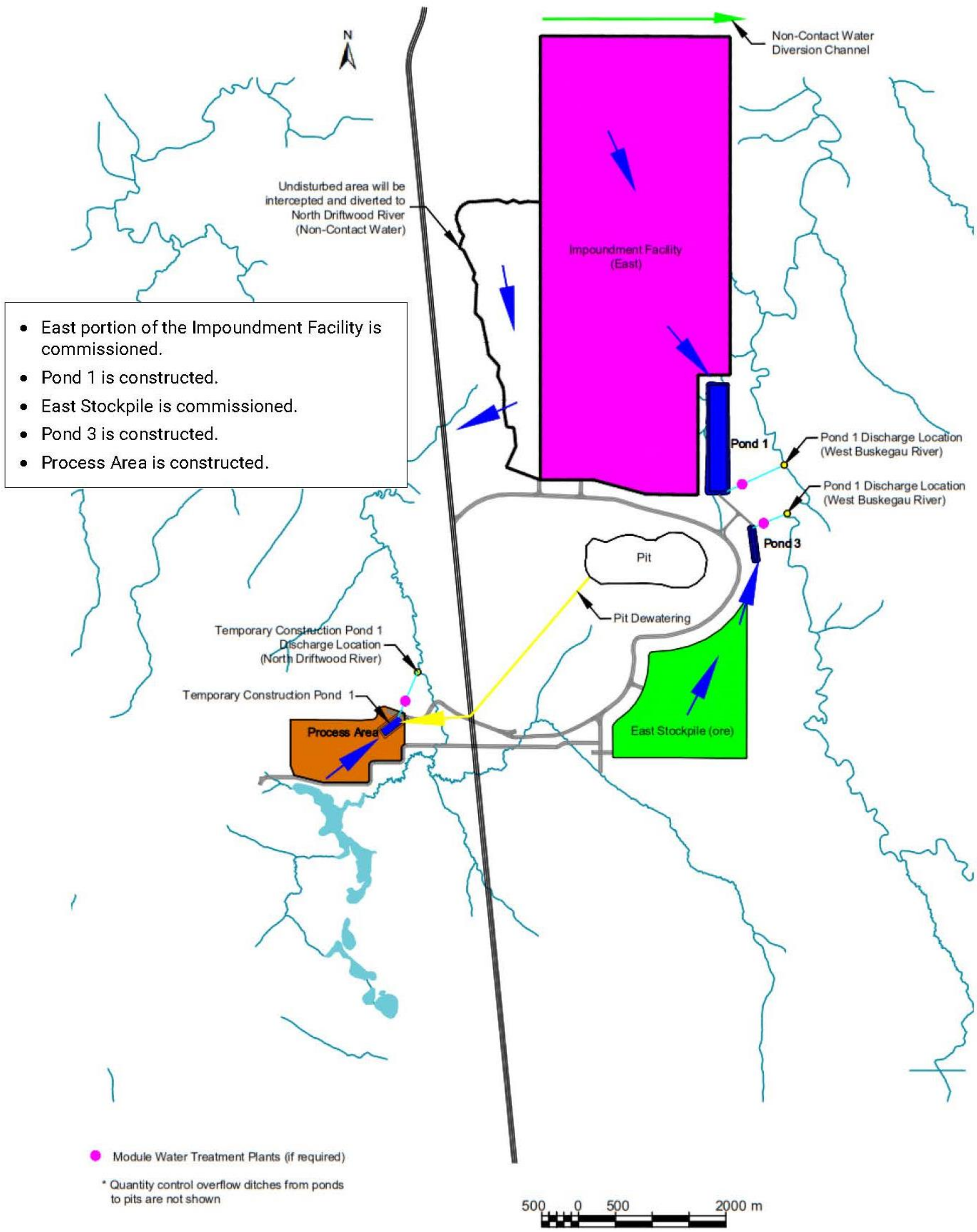
6.3.4.1 Construction (Year -3 to -1)

Water management activities during the construction phase will include erosion and sediment control measures and pit dewatering. Erosion and sediment control measures will be required for various earthwork and construction activities, including clearing, stripping, and grubbing of vegetation; excavation, and storage of overburden; blasting and removal of mine rock and ore; preparation of surfaces in the Process Plant Area and other smaller key infrastructure areas; ditch construction; haul road construction; and dewatering of excavations to reduce environmental effects. Once constructed, collection ditches will be hydroseeded or vegetated with native species to resist erosion. Additional erosion and sediment control practices, inclusive of deploying rock or straw check dams and silt fencing (during construction), will be employed as required. The inlet and outlet locations of collection ponds, in areas where higher velocity is anticipated, will be lined with stone. The sidewalls of the collection ponds will be stabilized with coir matting cover until vegetation establishes, if needed.

Non-contact water is proposed to be diverted using perimeter berms and ditching for orphaned West Buskegau River watersheds on the west side of the Impoundment Facility, which will redirected into the North Driftwood River. Flows along the north boundary of the Impoundment Facility will be directed into the West Buskegau River catchment where the existing condition naturally drains (Figure 6.7).

The general schematic of the Site-Wide Water Management Plan for construction (Years -3 to -1) is shown on Figure 6.7. During construction, collection ditches, the temporary sedimentation pond, Collection Pond 1, and Collection Pond 3 are to be constructed. A temporary sedimentation pond is to be constructed to manage the construction phase Process Plant Area and pit dewatering. During construction, pit dewatering could also be temporarily pumped to Pond 1 or 3 to be built closer to the pit, until later in the construction phase. A package sewage treatment system will be set up that will discharge to the North Driftwood River at the discharge location of the temporary sedimentation pond.

Figure 6.7 Construction (Year -3 to -1) Water Management Schematic



Source: Site-Wide Water Management Plan (Appendix J of the Impact Statement)

6.3.4.2 Operations Phase 1 (Year 1 to 3)

Water management activities during a portion of operations phase 1 (for Years 1 to 3 only) include construction of the TMF NE Pond and a seepage collection ditch along a constructed TMF internal finger dyke to manage surface runoff and toe seepage from the TMF. Collected water from the TMF NE Pond will be reclaimed by the Process Plant, which will start operation during this phase. Excess water from the TMF NE Pond will be pumped to the temporary sedimentation pond prior to discharge to the environment via the treatment plant. A non-contact water diversion will be constructed to convey flows from the future TMF footprint to the North Driftwood River watershed upstream of Martin and Gerry Lakes. The Impoundment Facility will be expanded with surface runoff and toe seepage directed to Collection Pond 1 (Appendix J of the Impact Statement).

6.3.4.3 Operations Phase 1 and 2 (Year 4 to 18)

Water management activities for a portion of Project operations phase 1 (Years 4-5) and a portion of Project operations phase 2 (Years 5-18) include construction of the North Driftwood River Diversion Channel following the realignment of Highway 655. The TMF will be constructed to its full footprint along seepage collection ditches and the TMF NW Pond will replace the temporary sedimentation pond. With continued deposition to the TMF during this operations phase, seepage collection ditches will be constructed to convey seepage to the TMF ponds, inclusive of the newly constructed TMF Northwest Pond. Due to expansion of the Impoundment Facility, collection ditches and Pond 2 will be constructed. Runoff from the Process Plant Area will be connected to the West Stockpile collection ditch and conveyed to Pond 2. The four FDPs will be operating during Years 4 to 18. The general schematic of the Site-Wide Water Management Plan sequencing for portions of operations phase 1 and 2 (Years 4 to 18) is shown on Figure 6.8.

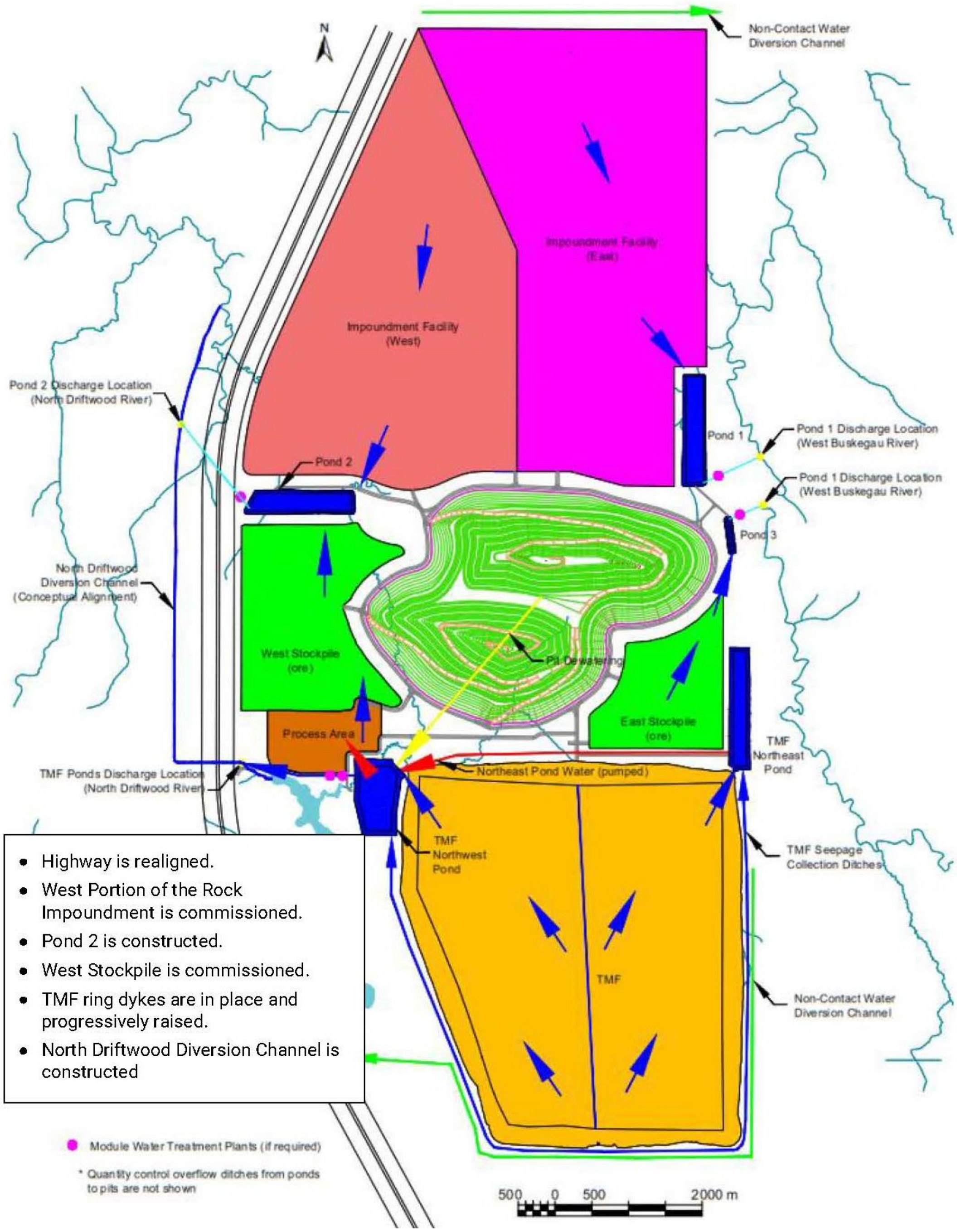
6.3.4.4 Operations Phase 2 (Year 18 to 30)

During the portion of operations phase 2 for Years 18 to 30, placement of tailings in the TMF ceases; progressive reclamation begins on the TMF in Year 18. Tailings will be placed in the Open Pit with decanted water from tailings deposition used to meet Process Plant water needs. Ditches within the reclaimed area of the TMF will be constructed to direct runoff from the eastern portion of the TMF to the western portion and, ultimately, to the North Driftwood River following establishment of vegetation on the rehabilitated TMF after approximately five years (Year 23). Naturalization of the TMF NE Pond is planned for this operations phase following rehabilitation of the TMF and vegetation establishment. The TMF NE Pond naturalization will include vegetation plantings and construction of a spillway overflow. Water obtained from dewatering of the Open Pit will be pumped to the TMF NW Pond. The general schematic of the Site-Wide Water Management Plan sequencing for a portion of operations phase 2 (Years 18 to 30) is shown on Figure 6.9.

6.3.4.5 Operations Phase 3 (Year 30 to 41)

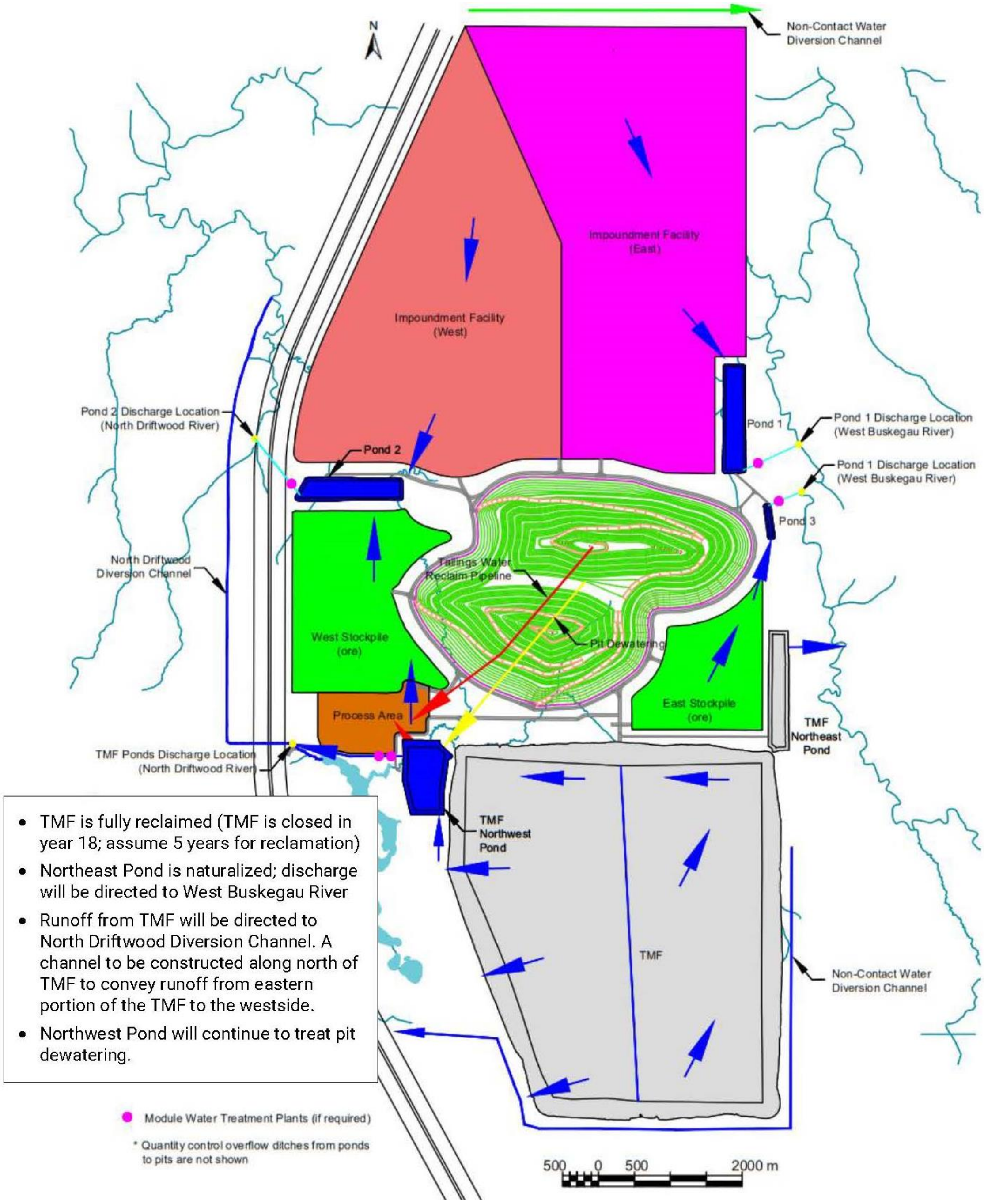
The excavation of the Open Pit and dewatering ceases in mine Year 30. Tailings from the processing of the ore stored in the two East and West Stockpiles will be deposited in the Open Pit. Reclaim water for the Process Plant will be taken from the WZ and EZ of the Open Pit. With no dewatering going to the TMF NW Pond, it will be naturalized, and an overflow spillway constructed. Progressive reclamation will begin on the Impoundment Facility including contouring, placement of growth media, and seeding. It is estimated to take approximately five years for vegetation to establish, at which point the seepage collection ditches will be infilled, Collection Pond 1 will be naturalized, and an overflow spillway constructed. The general schematic of the Site-Wide Water Management Plan sequencing for operations phase 3 (Years 30 to 41) is shown on Figure 6.10.

Figure 6.8 Operations Phase 1 and 2 (Year 4 to 23) Water Management Schematic



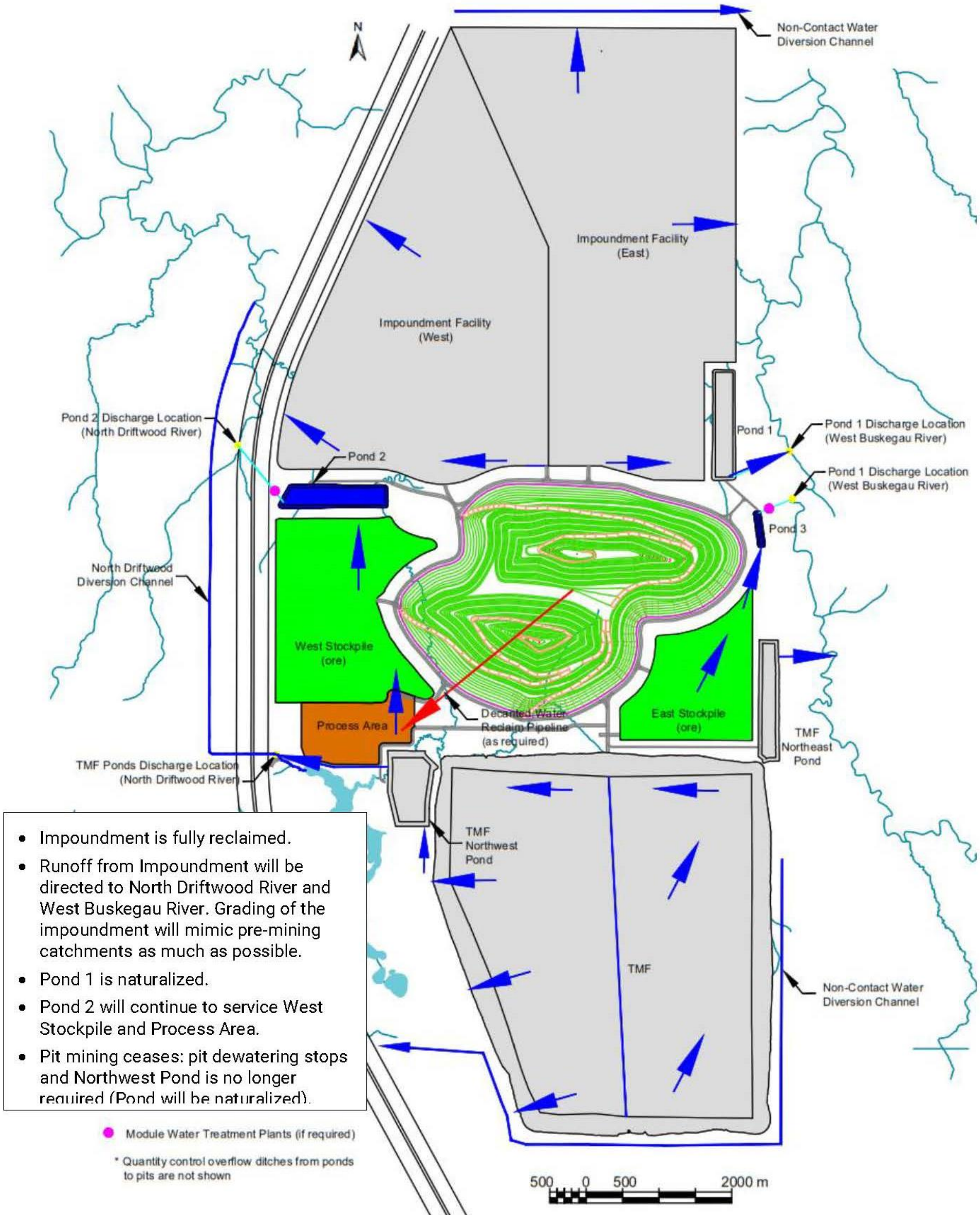
Source: Site-Wide Water Management Plan (Appendix J of the Impact Statement)

Figure 6.9 Operations Phase 2 (Year 23 to 30) Water Management Schematic



Source: Site-Wide Water Management Plan (Appendix J of the Impact Statement)

Figure 6.10 Operations Phase 3 (Year 30 to 41) Water Management Schematic

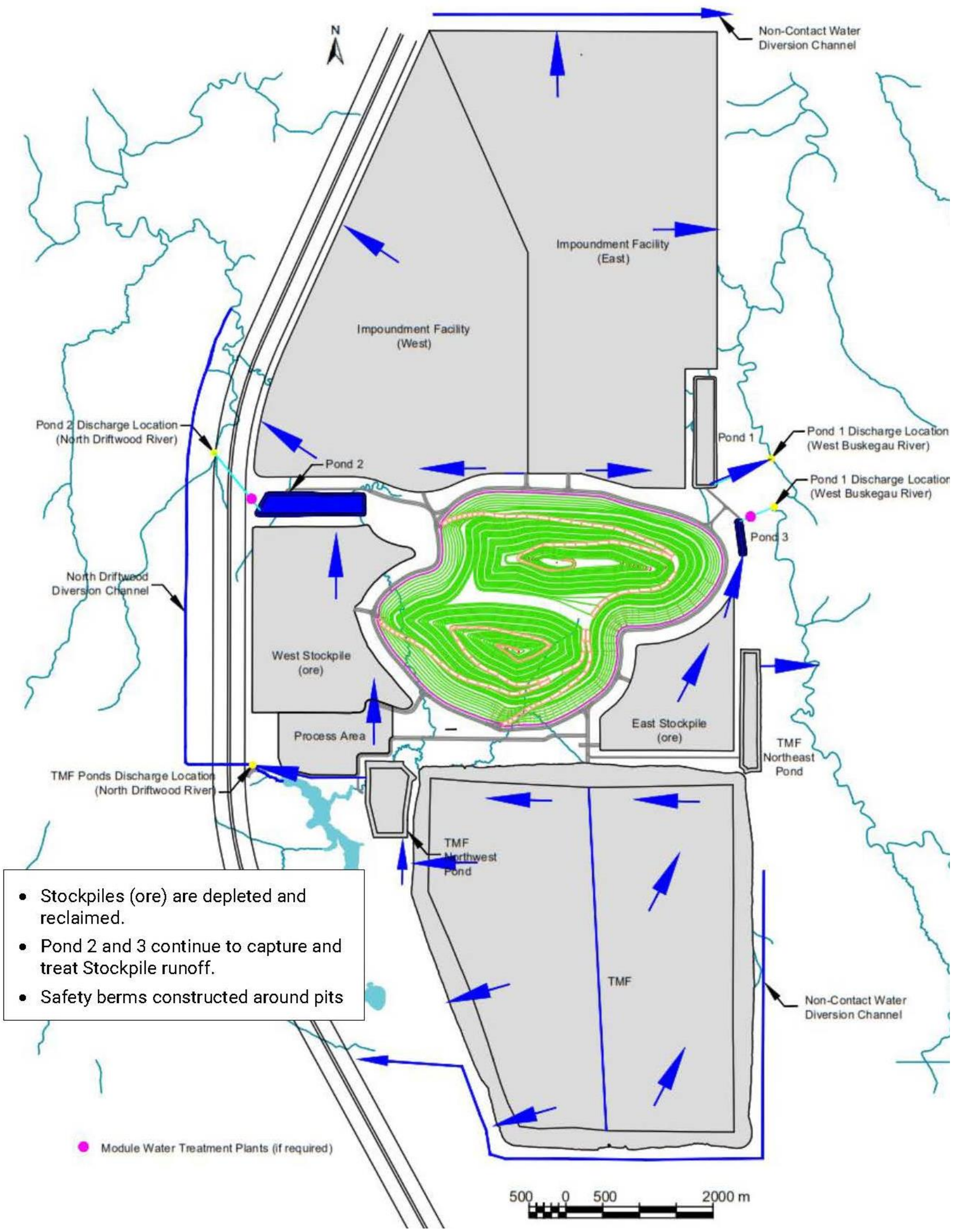


Source: Site-Wide Water Management Plan (Appendix J of the Impact Statement)

6.3.4.6 Active Closure (Year 41 to Year 46)

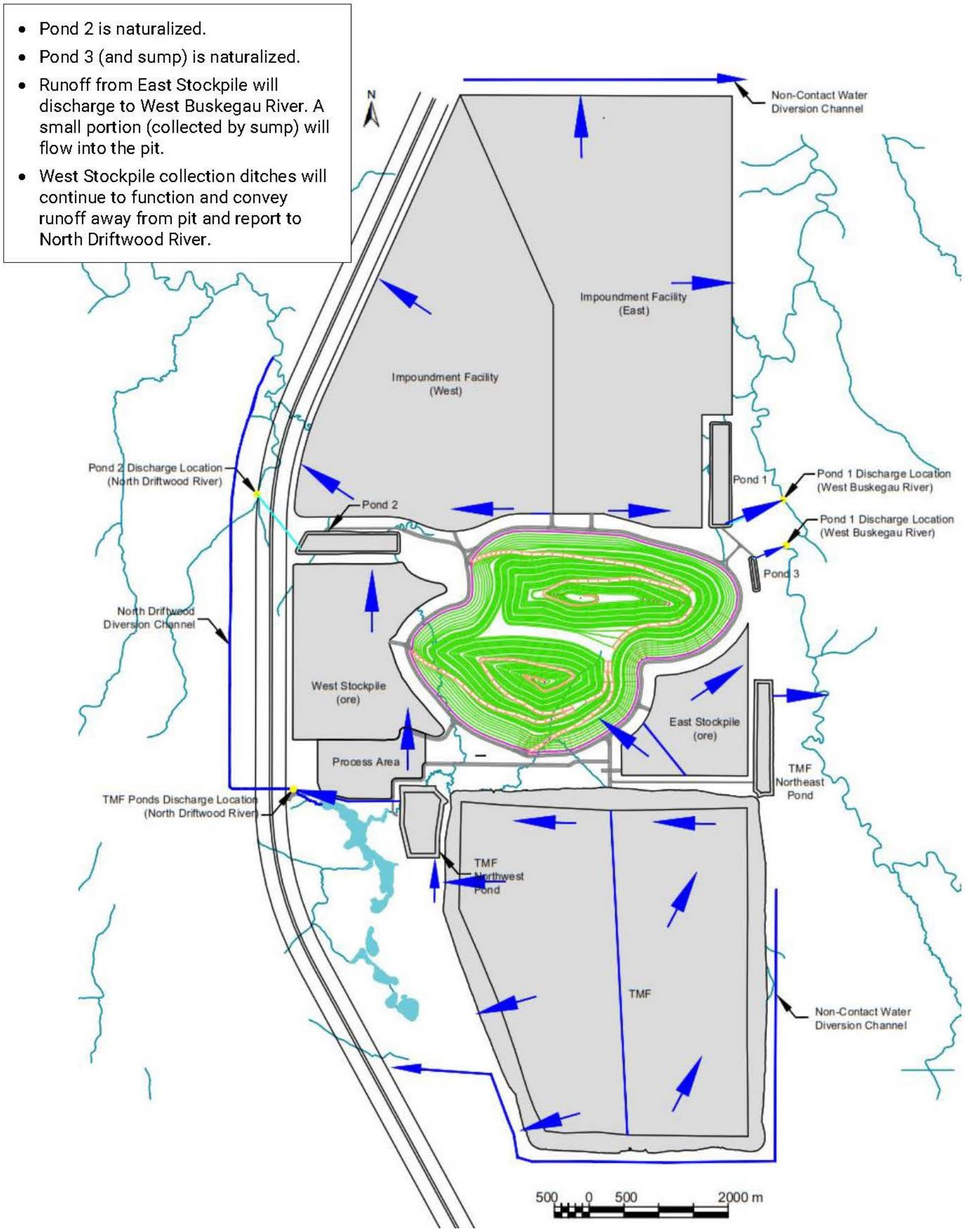
The objective of water management in this portion of the active closure Project phase is to restore the PA to the extent feasible, to re-establish the flow regime to pre-mining conditions, eliminate the need for active treatment of sediment and constituents of concern, and to stabilize landforms. The areas where the West and East Stockpiles were located will be scarified and revegetated. Following establishment of vegetation, in approximately five years, Collection Ponds 2 and 3 will be naturalized and overflow spillways constructed. Seepage collection ditches will be infilled and natural drainage patterns restored, to the extent feasible. Slopes will be contoured, as required, to reduce erosion and increase stability. The general schematic of the Site-Wide Water Management Plan during and following the end of active closure in Year 47 is shown on Figure 6.11 and Figure 6.12, respectively.

Figure 6.11 Active Closure (Mine Year 41 to 46) Water Management Schematic



Source: Site-Wide Water Management Plan (Appendix J of the Impact Statement)

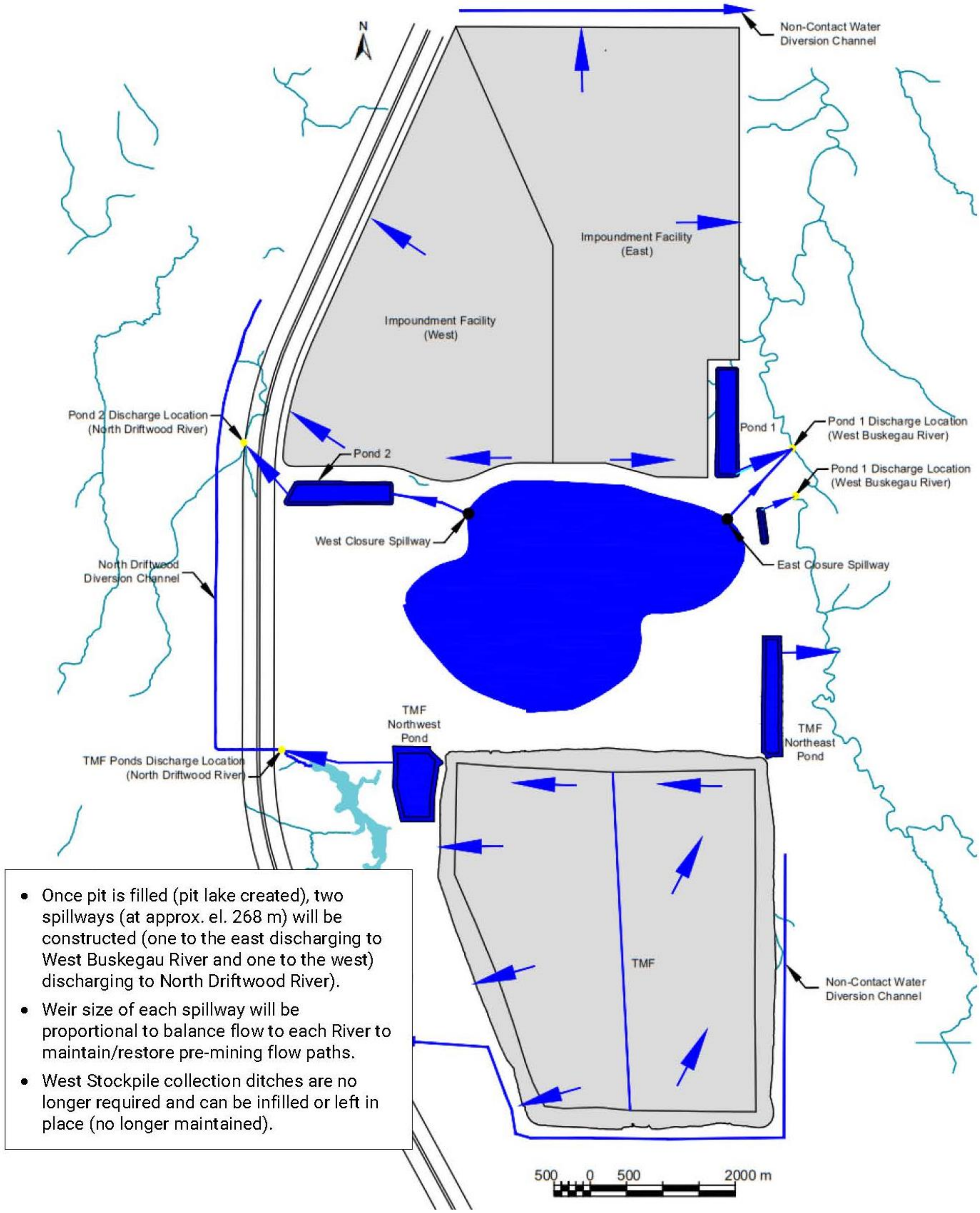
Figure 6.12 Post-Closure Water Management Schematic



Source: Site-Wide Water Management Plan (Appendix J of the Impact Statement)

6.3.4.7 Pit Lake Development and Post-Closure

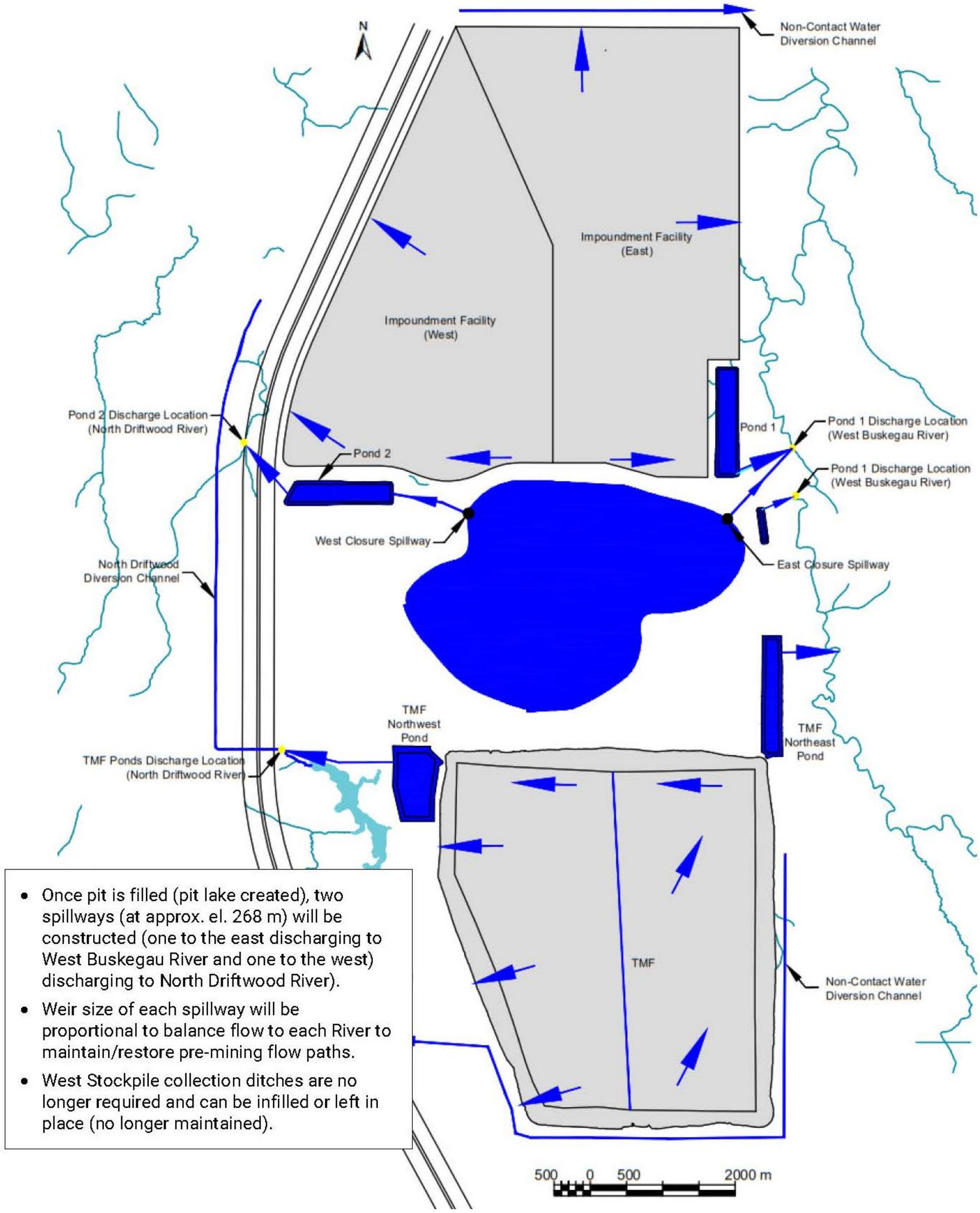
The general schematic of the Site-Wide Water Management Plan (Appendix J of the Impact Statement) for long-term closure is presented on Figure 6.13.



Source: Site-Wide Water Management Plan (Appendix J of the Impact Statement)

A single pit lake will form naturally over time with groundwater and precipitation. Two spillways will be constructed from the pits to divert flow to the North Driftwood and the West Buskegau Rivers. The spillways will be designed to mimic pre-mining flow to each watercourse, to the extent feasible. The water balance model (Appendix I of the Impact Statement [Site-Wide Water Balance Summary Report]) estimates it will take 118 years from the end of mine operations in Mine Year 41 for the pit to fill (Appendix J of the Impact Statement [Site-Wide Water Management Plan]).

Figure 6.13 Long-Term Closure Water Management Schematic



Source: Site-Wide Water Management Plan (Appendix J of the Impact Statement)

6.3.5 Water Balance

Project activities may interact with surface water quantity in the construction, operations, and closure phases of the Project. In general, the interactions can be characterized as being primarily associated with controlled, routine treated mine water discharges from the Project. The water balance results, using existing climate (year 1999) and climate change adjusted climate normal precipitation and temperature, were calculated at the FDP discharges into the West Buskegau River and North Driftwood River (Appendix I of the Impact Statement). Daily discharges from the ponds and associated treatment plants to the receivers are set either to zero or the maximum discharge capacity. The deviation of daily average of the ponds discharges from the maximum discharge capacity is indication of the days with zero discharge. Figure A.15 and A.16 in Appendix A) present the time series of simulated treated discharge from the sedimentation (also referred to as settling) ponds for three and seven different mine phase conditions under existing climate (year 1999) and climate change adjusted, respectively. Table 6.7 provides average and maximum daily flow predicted from the water balance model for select years during different mine phases.

Table 6.7 Water Balance Model Predicted Average and Maximum Daily Flow Rates (1999 and Climate Change Adjusted) for Different Mine Life Phases

Climate Data		Under Existing Condition (1999)			Climate Change Adjusted							
Mine Year		-1	2	17	-1	2	17	23	35	41	46+	159
Phase		Construction	Operations Phase 1	Operations Phase 2	Construction	Operations Phase 1	Operations Phase 2	Operations Phase 2	Operations Phase 3	Operations Phase 3	Passive Closure	Pit Lake Full
Maximum Daily Flow (m^3/d)	Pond 1	28,000	28,000	28,000	28,000	28,000	28,000	28,000	-	-	-	-
	Pond 2	-	-	28,000	-	-	28,000	28,000	28,000	28,000	-	-
	Pond 3	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	-	-
	NE TMF	-	28,000	28,000	-	28000	28,000	-	-	-	-	-
	NW TMF	-	-	28,000	-	-	28,000	28,000	-	-	-	-
	Temporary Process Plant Pond	28,000	19,148	-	28,000	21,820	-	-	-	-	-	-
	Pit Lake – North Driftwood River	-	-	-	-	-	-	-	-	-	-	324,438
	Pit Lake – West Buskegau River	-	-	-	-	-	-	-	-	-	-	191,149
Average Daily Flow (m^3/d)	Pond 1	22,170	24,241	27,616	25,008	25,929	28,000	28,000	-	-	-	-
	Pond 2	-	-	19,408	-	-	21,863	22,170	10,893	6,904	-	-
	Pond 3	1,753	3,260	3,315	1,918	3,699	3,671	3,671	3,699	1,233	-	-
	NE TMF	-	15,573	19,408	-	17,030	21,786	-	-	-	-	-
	NW TMF	-	-	19,638	-	-	21,556	5,600	-	-	-	-
	Temporary Process Plant Pond	13,212	1,150	-	13,419	1,293	-	-	-	-	-	-
	Pit Lake – North Driftwood River	-	-	-	-	-	-	-	-	-	-	20,733
	Pit Lake – West Buskegau River	-	-	-	-	-	-	-	-	-	-	14,930

Note: "-" denotes that no flow is expected
Source: Crawford Site-Wide Water Balance Summary Report (Appendix I of the Impact Statement)

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6.3.5.1 Construction (Year -3 to -1; Year -1)

During site preparation and construction, three FDPs will be operating, which are associated with Sedimentation Pond 1 (FDP-SP-01) and Sedimentation Pond 3 (FDP-SP-03) discharging to the West Buskegau River and a temporary sedimentation pond (FDP-SP-TEMP_01) discharging to the North Driftwood River.

The existing climate condition Year -1 water balance model outputs observe larger average discharge from FDP-SP-01 (22,170 m^3/d) compared with the FDP- SP-TEMP_01 and FDP-SP-03 average flows of 13,212 m^3/d and 1,753 m^3/d, respectively. The highest flows for the three FDPs occurs repeatedly throughout the year (Figure A.15a). Similar to existing climate condition, the climate change adjusted Year -1 water balance model outputs from Pond 1 (25,008 m^3/d) is larger compared with the FDP- SP-TEMP_01 and FDP-SP-03 average flows of 13,419 m^3/d and 1,918 m^3/d, respectively. The highest flows for the three FDPs occurs repeatedly throughout the year (Figure A.16a, Appendix A).

6.3.5.2 Operations Phase 1 (Year 1 to 4; Modelled Mine Year 2)

In operations phase 1, there will be three discharge points associated with FDP-SP-01, FDP-SP-03, FDP-SP-TEMP_01. The NE TMF pond ultimately discharges to the FDP-SP-TEMP_01. Discharge rates from the ponds in Year 2, as a sample year in this operations phase, are shown in Figure A.15b for existing climate and Figure A.16b for climate change adjusted conditions in Appendix A. The discharges from FDP- SP-TEMP_01, include the temporary sedimentation pond (24,241 m^3/d) and NE TMF Pond (15,573 m^3/d), are larger on average compared with the FDP-SP-01 and FDP-SP-03 average flows of 13,212 m^3/d and 1,753 m^3/d, respectively, under existing climate conditions. Higher discharge rates of 25,934 m^3/d in FDP-SP-01 and 3,716 m^3/d in FDP-SP-03 and lower discharge rates of 1,291 m^3/d for the FDP-SP_TEMP_01 were observed in operations phase 1 compared to Construction Phase Year -1.

6.3.5.3 Operations Phase 2 (Year 5 to 30; Modelled Year 17 and Year 23)

In Year 17, there are four FDPs associated with the five ponds (FDP-SP-01, Sedimentation Pond (FDP-SP-02), FDP-SP-03, NE TMF Pond, and NW TMF Pond both of which discharge to FDP-TMF-SP) (Table 6.7); Figure A.15c and Figure A.16c within Appendix).

When the TMF reaches its design capacity at the end of Year 17, it will be progressively reclaimed, and tailings will be deposited into MZ of the Open Pit. Once the NE TMF Pond is naturalized (Year 23), discharge from this pond to the associated FDP will stop. In Year 23, there will be four FDPs (FDP-SP-01, FDP-SP-02, FDP-SP-03, and FDP-TMF-SP with only the NW TMF Pond contributing flow) (Figure A.16d within Appendix A). In Year 17, FDP-SP-01 releases the largest amount of discharge with maximum daily discharge of 28,000 m^3/d based on the treatment plant capacity rate, followed by FDP-SP-02 (20,170 m^3/d), FDP-TMF-SP (5,600 m^3/d) and FDP-SP-03 (3,671 m^3/d). FDP-SP-01 also has the highest average daily flows of the FDPs in Year 23 (Table 6.7).

6.3.5.4 Operations Phase 3 (Year 30 to 41: Modelled Mine Years 35 and 41)

During operations phase 3, the Impoundment Facility will close and be reclaimed, and active Open Pit mining will cease. FDP-SP-01 will be naturalized with no further discharges to watercourses. FDP-SP-02 will remain active and will receive water from the West Stockpile and the Process Plant Area. FDP-SP-03 will continue to manage surface runoff and toe seepage from the East Stockpile. Figure A.16e and f within Appendix A present discharges in Years 35 and 41, respectively. Discharge from FDP-SP-02 will decrease between Years 35 and 41, from an average daily flow rate of 10,893 m^3/d to 6,904 m^3/d. FDP-SP-03 will experience a decrease in flow between Years 35 and 41 as well, from an average daily flow rate of 3,699 m^3/d to 1 m^3/d (Table 6.7). In Year 41, discharges from FDP-SP-02 and FDP-SP-03 will be the lowest in comparison to those occurring in the earlier construction and operations phases.

6.3.5.5 Passive Closure and Pit-Full Phase (Mine Year 46+)

Following the cessation of Process Plant operations, the East and West Stockpiles and Process Plant Area will be reclaimed, along with Collection Pond 2 and Collection Pond 3, resulting in no direct discharge to watercourses from sedimentation ponds and treatment plants via FDPs. Spillways constructed for Pond 2 and Pond 3 will divert excess water to receiving environments.

6.3.5.6 Pit-Full Scenario

The pit drainage area includes a boundary area around the edge of the Open Pit and an area to the southeast (Figure A.16g, Appendix A). The pit is predicted to fill to the spillway elevation in 118 years (Mine Year 159) from the end of operation (Mine Year 41). Although not part of the base case, if beginning in Year 42 the TMF drainage area was diverted to drain into the pit to accelerate pit filling, the pit is predicted to be filled in 65 years.

Total discharge from the Pit to the West Buskegau River and North Driftwood River are presented in Figure A.16g (Appendix). The pit lake overflow spillways to the North Driftwood and West Buskegau Rivers will be sized proportionally to the catchment area of each River through the pit lake meaning pit lake discharges will be proportional to each receiver. Mean discharge to the West Buskegau River and North Driftwood River are 14,930 m^3/d and 20,733 m^3/d, respectively, as approximately 43% and 57% of the pit lake catchment is within the West Buskegau and North Driftwood River watersheds. Maximum discharge to the North Driftwood River (324,438 m^3/d) is larger than that to West Buskegau River (191,149 m^3/d). Whereas discharge time series associated to the two rivers differ in magnitude throughout the year, they follow the same pattern as demonstrated in Figure A.16g (Appendix A).

6.3.6 Effects Assessment

6.3.6.1 Water Quantity Assessment

6.3.6.1.1 Flow Change Assessment

The Project phases presented in the following subsections are related to specific phases of water management. They differ from those presented as general Project phasing in Section 1.3; however, the water management activities occurring in construction, operations and closure align with the overall Project schedule.

The watershed baseline condition and Project scenario HEC-HMS model daily hydrologic flow results were compared to quantify and assess change in flow during different mine phases for Jocko Creek, West Buskegau River and North Driftwood River. Figure A.11 and A.12 (Appendix A) present flow network figures of the subwatershed outflows of the North Driftwood River and West Buskegau Rivers, respectively, in the passive closure phase. As indicated in Section 5.8, the baseline and project scenario model input precipitation and temperature data has been adjusted for climate change.

Much research on the development of ecological flows has been conducted over the last several decades, especially in countries such as Australia and South Africa who have experienced severe drought conditions. Many researchers have indicated when daily flow alterations are no greater than 10% a high level of ecological protection will be provided (Richter et. al. 2011; Acreman and Ferguson 2010; Maine DEP 2006; DFO 2013). Thus, a daily flow change of 10% was used in this assessment as a screening threshold. Flow reductions greater than 10% from baseline were compared to climate change adjusted environmental flows estimated using the baseline HEC-HMS model results. When environmental flows were maintained, the effect was considered moderate, however a residual effect was assigned when environmental flows were not maintained. Additionally, another limit is applied for when flow fall to below 30% of the Mean Annual Discharge (MAD; or MAF). To make this comparison for potential future impacts associated with the Project in local receiving waters, 30% MAF values are determined at each of the Project watersheds.

Flow increases greater than 10% had PA predicted 100-year return period, 24-hour duration (Q_{100}) flow compared to the baseline condition 100-year return period, 24-hour duration flood flow for the study subwatershed to assess potential for flooding, erosion and scour (Section 5.1.1).

Jocko Creek

Results were gathered from the Jocko Creek Watershed HEC-HMS models to quantify and assess change in flow over time and are presented in the following sections. As described in Section 5.8, the hydrometric model was updated to incorporate climate change for all phases of mine life. The analysis of HEC-HMS results includes a comparison against baseline conditions and environmental flows to support the low flow assessment for the climate change adjusted 1999 climate dataset.

Daily baseline and operations year (Year 17) flows for the most downstream subwatershed outlet of the Jocko Creek watershed (subwatershed JC_DS) are presented on Figure 6.14. Construction phase (Years -1) and operations phase I (Year 2) HEC-HMS models were not developed for the Jocko Creek watershed as no Project activities are proposed within the drainage area during these life of mine phases (Figure A.7 within Appendix A). Daily flow summaries for the JC_DS watershed pourpoint are presented in Table B.2.15 within Appendix B.2 in.

For operations mine life phases, changes in subbasins including catchment area reductions and catchment area merges are tabulated in Appendix B.2.

Operations Phase 2 (Year 4 to 18 – Year 17)

A portion of the TMF will be within the Jocko Creek watershed during the operations phase s 1, 2 and 3, and closure phases (Year 4 onward) (Figure A.5 to Figure A.10 within Appendix A). The Jocko Creek HEC-HMS model subwatershed JC1 will be reduced following construction of the TMF and its surrounding water management infrastructure.

Under operations conditions in Year 17 for JC_DS at the downstream extent of Jocko Creek there were no days of flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.8).

The Year 17 HEC-HMS model results for subwatershed JC_DS simulated 112 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset, respectively (Table 6.8). The days when flow is higher than the 10% threshold are typically low flow days that are at or below the environmental flow threshold, see Figure 6.14. The maximum predicted flow rate of the 112 days is 0.54 m^3/s using the climate change adjusted climate dataset. The predicted Q_{100} for Year 17 does not exceed the baseline condition Q_{100} value (Table B.2.16).

Operations Phase 2, 3 and Passive Closure Phases (Year 18 to Year 46+ - Year 23)

In the Year 23 the TMF cover is assumed to be fully rehabilitated with a vegetated cover and the seepage collection ditches in-filled as required, which represents Jocko Creek into the passive closure phase.

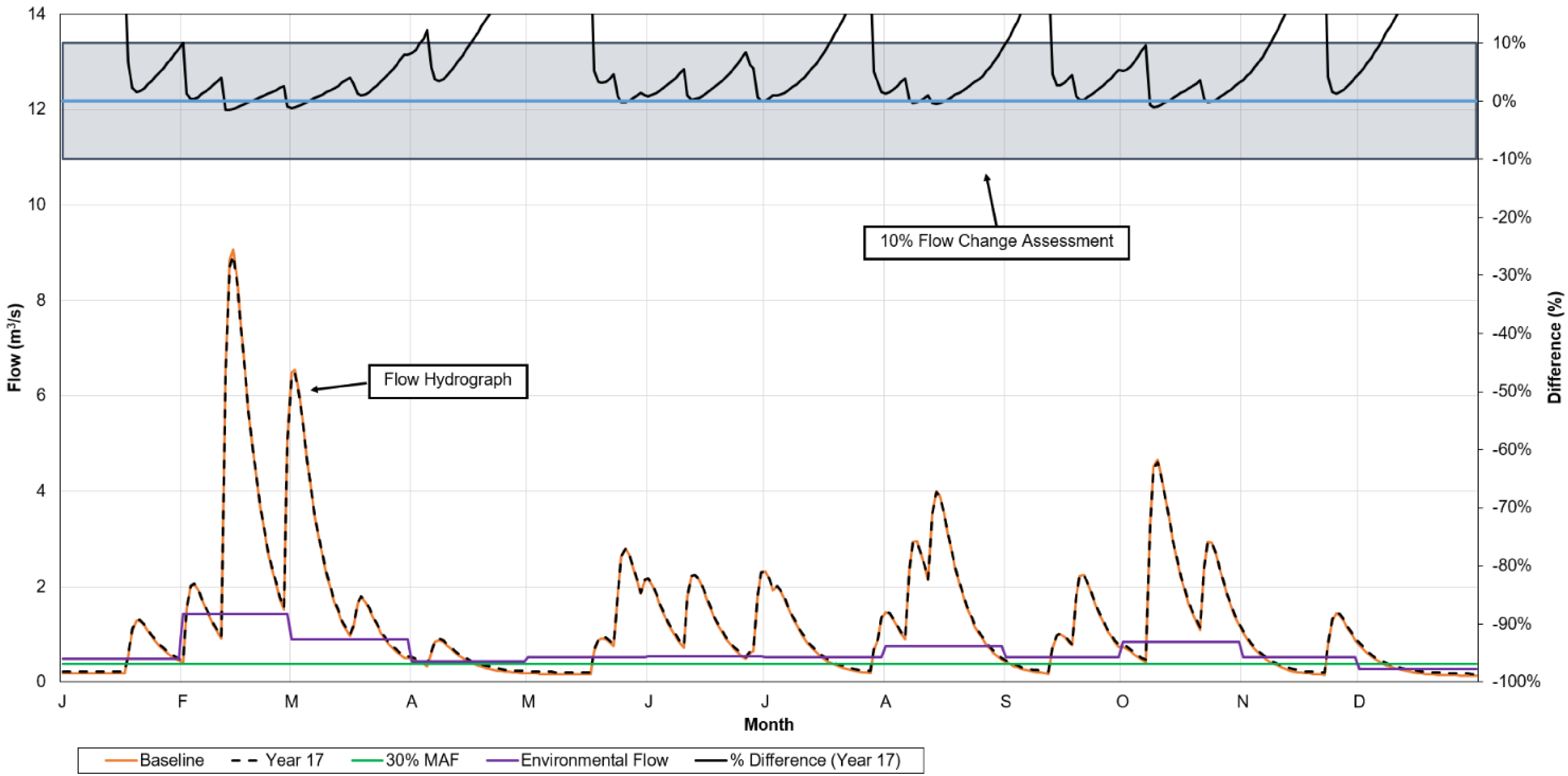
In Year 23 with the rehabilitated TMF reducing seepage rates into the Jocko Creek watershed at JC_DS there were no days of flow reduction predicted to be greater than 10% for the climate adjusted dataset in comparison to the baseline condition model results (Table 6.8)

For the Year 23 model, there were no days predicted to have an exceedance of the 10% increase in flow from baseline conditions for the climate adjusted dataset.

Table 6.8 Jocko Creek Flow Changes - JC_DS Subwatershed

Subwatershed	Operations Phase 2 (Modelled Years 4 to 18 – Year 17)				Operations Phase 2 (Modelled Years 18 to 30 – Year 23+)			
	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase
JC_DS	0	0	112	No	0	0	0	No

Figure 6.14 Climate Change Adjusted Baseline and Year 17 Mine Life Phase Flows for the Jocko Creek Watershed – JC_DS Subwatershed



West Buskegau River

Results were gathered from the West Buskegau River Watershed HEC-HMS models to quantify and assess change in flow over time and are presented in the following sections. As described in Section 5.8, the hydrometric model was updated to incorporate climate change for all phases of mine life. The analysis of HEC-HMS results includes a comparison against baseline conditions and environmental flows to support the low flow assessment for the climate change adjusted 1999 climate dataset.

Daily baseline and Year 17 of operations phase 1 flows for the most downstream pourpoint of the West Buskegau River HEC-HMS Model, subwatershed WB1, are presented in Figure 6.15. WB1 is located 17.5 km downstream of the upstream subwatershed (WB14) that is first impacted with respect to drainage by the PA. Table 6.9 to Table 6.10 present a summary of modelled daily flows for the WB1 outlet in comparison to modelled baseline and baseline model estimated environmental flow conditions. Daily flows were assessed in select upstream subwatersheds impacted by the project, which included WB14, which is the first subwatershed to have impacts to its drainage area by the PA. WB9 is the subwatershed that contains the FDP-SP-01 and FDP-SP-3 for Collection Ponds 1 and 3, respectively. WB5 is the most downstream subwatershed that contains the PA, which impacts its drainage area. Daily flow summaries for the pourpoints of subwatersheds WB5, WB9 and WB14 are presented in Appendix B.2.

For each phase of mine life, changes in subbasins including catchment area reductions and catchment area merges are tabulated in AppendixB.2.

Construction Phase (Years -3 to -1 – Year -1)

For assessment of the construction phase (Year -1) subwatersheds were altered to reflect construction of the east portion of the Impoundment Facility, Collection Pond 1, Collection Pond 3, and East Stockpile (Figure A.5). Two point sources were introduced to the HEC-HMS model for assessment of the construction phase: Collection Pond 1, and Collection Pond 3. Collection Pond 1 and Collection Pond 3 and their associated treatment plants discharge to subbasin WB9 in the HEC-HMS model. The water management system is designed to provide flood control for the Project and mine water treatment, including sedimentation, while balancing flows to the West Buskegau River and North Driftwood River to the extent feasible.

Under construction conditions in Year -1 for WB1 at the downstream extent of the West Buskegau River HEC-HMS model there were no days of a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.9).

The Year -1 HEC-HMS model results for WB1 simulated 106 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset. The days when flows are higher than the 10% threshold are typically low flow days that are at or below the environmental flow threshold, see Figure A.18 within Appendix A. The maximum predicted flow rate of the 106 days is 3.34 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for WB1 with reduction of the upstream catchment area and introduction of Collection Pond 1 and Collection Pond 3 (Table B.2.16 in Appendix B.2).

Operations Phase 1 (Years 1 to 4 – Year 2)

Overall, the West Buskegau River watershed catchment was reduced in the Year 2 HEC-HMS model due to expansion of mine facilities (Figure A.6).

Under operations phase 1 conditions (Year 2) for WB1, there were no days of a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.9).

The Year 2 HEC-HMS model for WB1 simulated 88 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset (Table 6.9). The days with flows higher than the 10% threshold are typically low flow days that are at or below the environmental flow threshold, see Figure A.19 within Appendix A. The maximum predicted flow rate of the 88 days is 3.28 m^3/s using the climate adjusted dataset. An increase to the Q_{100} flow value from baseline conditions was not predicted for WB1 during this operations phase 1 scenario (Table B.2.16).

Operations Phase 2 (Years 5 to 18 – Year 17)

For assessment of operations phase 2 (Year 17), West Buskegau River subwatersheds were further reduced by the construction of the west portion of the Impoundment Facility, TMF NE Pond, and tailings deposition in the TMF (Appendix J of the Impact), see Figure A.7. This scenario represents the full extents of the PA and its associated water management infrastructure.

Under operations phase 2 conditions (Year 17) for WB1, there no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.9).

The Year 17 HEC-HMS model for WB1 simulated 151 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset (Table 6.9 and Table 6.10). The days with flows higher than the 10% threshold are typically low flow days that are at or below the environmental flow threshold, see Figure 6.15. The maximum predicted flow rate of the 151 days is 3.75 m^3/s using the climate adjusted dataset. An increase to the Q_{100} flow value from baseline conditions was not predicted for WB1 during this operations phase 2 scenario (Table B.2.16).

Operations Phase 2 (Years 18 to 30 – Year 23)

For assessment of operations phase 2 (Year 23), the HEC-HMS model was updated to include the rehabilitated TMF (Figure A.8 within Appendix A).

For the Mine Year 23 scenario in WB1, there were no days of a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.9).

The Year 23 model simulated 145 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset (Table 6.10). The days with flows higher than the 10% threshold are typically low flow days that are at or below the environmental flow threshold, see Figure A.20 within Appendix A. The maximum predicted flow rate of the 145 days is 3.72 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for WB1.

Operations Phase 3 (Year 30 to 41 – Year 35)

For assessment of operations phase (Year 35), the HEC-HMS model was updated with a fully rehabilitated impoundment facility and removal of the Collection Pond 1 outflows as it is also rehabilitated. With the reclamation of the Impoundment Facility, surface water runoff was directed to the West Buskegau River for the new subwatersheds WRSA_2, WRSA_3, WRSA_4, and WRSA_5 (Figure A.9 within Appendix A).

For the Year 35 scenario at WB1, there were no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.10).

The Year 35 model simulated 3 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset (Table 6.10). The days with flows higher than the 10% threshold are typically low flow days that are at or below the environmental flow threshold, see Figure A.21 within Appendix A. The maximum predicted flow rate of the 3 days is 0.93 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for WB1.

End of Operational Phase (Year 41)

For assessment of end of operations (Year 41), outflows from Collection Pond 3 and its associated treatment plant to FDP-SP-03 were updated based on the results of the Ausenco Site-Wide Water Balance Summary Report (Appendix I of the Impact Statement).

For the Year 41 scenario at WB1, there were no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.10 and Figure A.22 within Appendix A).

The Year 41 model simulated no days with a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset (Table 6.10 and Figure A.22).

Passive Closure Phase (Mine Year 46 onward – Mine Year 47)

For assessment of the start of the passive closure phase in Year 47, Collection Pond 3 was removed as a point source in the HEC-HMS model due to the naturalization of Pond 3 (Figure A.10 within Appendix A). With the reclamation of the East Stockpile, the HEC-HMS model incorporated runoff from the reclaimed stockpile to the West Buskegau River. Sub-catchment LGEast was included in the West Buskegau HEC-

HMS model for the passive closure phase (Figure A.10 within Appendix A). Figure A.11 within Appendix A presents the flow network connections for the West Buskegau River HEC-HMS model with the rehabilitated PA.

For the Year 47 scenario at WB1, there were no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.10 and Figure A.23).

The Year 47 model simulated no days with a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset (Table 6.10 and Figure A.23).

Pit-Full

For the assessment of this phase, the West Buskegau River watershed HEC-HMS model was updated based on the results of the Ausenco Site-Wide Water Balance Summary Report (Appendix I of the Impact Statement).

For the Pit-Full scenario at WB1, there were no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.10 and Figure A.24).

The Pit-Full model simulated no days with a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset (Table 6.10 and Figure A.24).

Table 6.9 Climate Change Adjusted West Buskegau River Flows and Changes

	Construction (Modelled Years -3 to -1 – Year -1)				Operations Phase 1 (Modelled Years 1 to 4 – Year 2)				Operations Phase 2 (Modelled Years 4 to 18 – Year 17)				Operations Phase 2 (Modelled Years 18 to 30 – Year 23)			
	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase
WB1	0	0	106	No	0	0	88	No	0	0	151	No	0	0	145	No
WB5	40	35	160	No	36	26	169	No	19	0	219	No	24	0	213	No
WB9	18	15	205	No	27	21	223	No	8	0	249	No	9	0	245	No
WB14	0	0	0	No	0	0	0	No	0	0	37	No	0	0	0	No

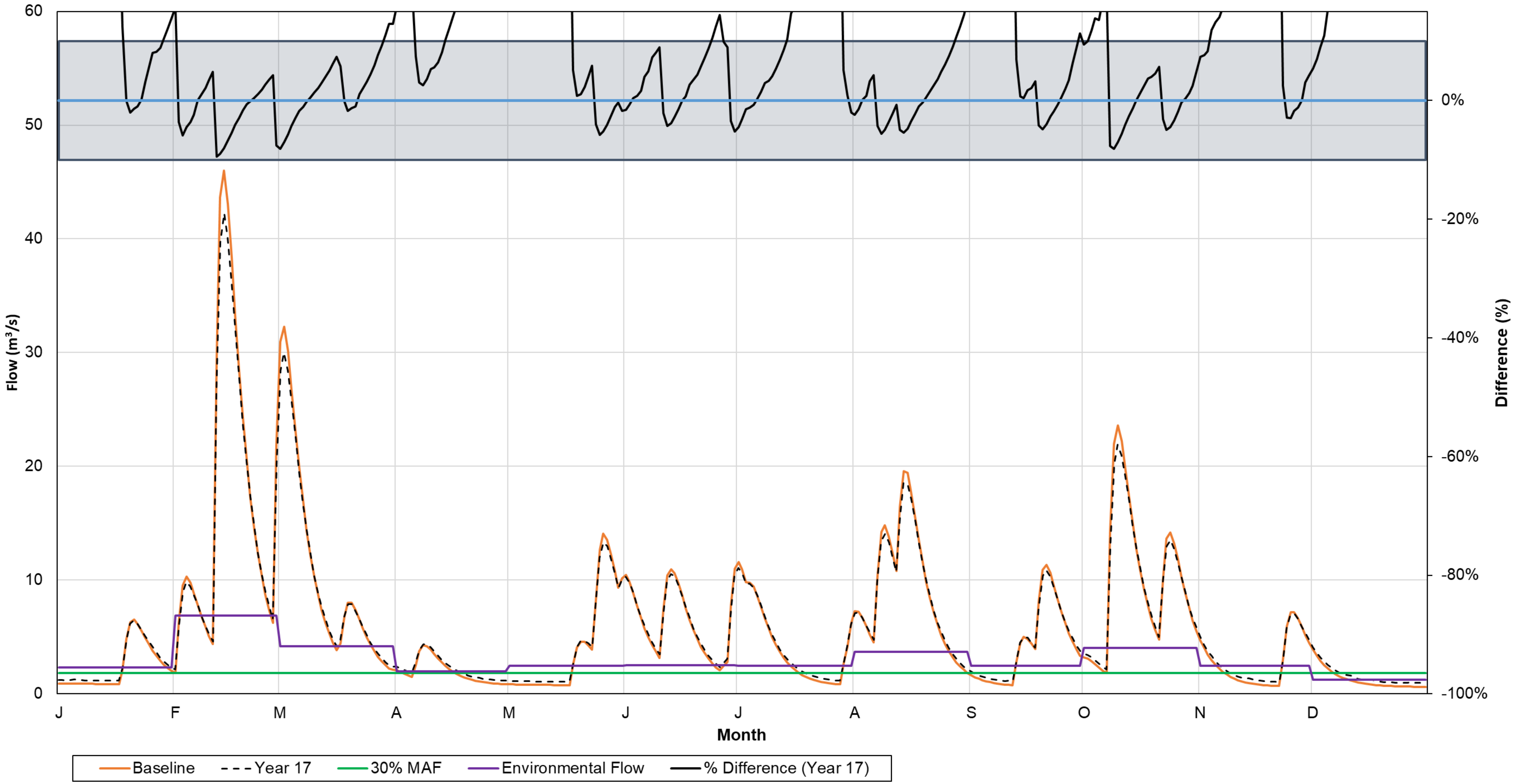
← Moving Upstream

Table 6.10 Climate Change Adjusted West Buskegau River Flows and Changes – Continued

	Operations Phase 3 (Modelled Years 30 to 41 – Year 35)				End of Operations (Modelled Year 41)				Passive Closure (Modelled Year 46 onward – Year 47)				Pit Filled			
	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase
WB1	0	0	3	No	0	0	0	No	0	0	0	No	0	0	0	No
WB5	2	0	30	No	3	0	13	No	0	0	12	No	0	0	12	No
WB9	0	0	57	No	0	0	31	No	0	0	22	No	0	0	22	No
WB14	0	0	157	No	0	0	157	No	0	0	187	No	0	0	187	No

← Moving Upstream

Figure 6.15 Climate Change Adjusted Baseline and Year 17 (Operations Phase 2) Flows and Flow Changes for the West Buskegau River Watershed – WB1



North Driftwood River

Results were gathered from the North Driftwood River Watershed HEC-HMS models. This section presents results compared to the baseline model to quantify and assess change in flow over time. As indicated in Section 5.8, the hydrometric model was updated to incorporate climate change for all phases of mine life. The analysis of HEC-HMS results includes a comparison against baseline conditions and environmental flows to support the low flow assessment for the climate change adjusted 1999 climate dataset.

Daily baseline and Year 17 of operations phase 1 flows for the most downstream outlet of the North Driftwood River watershed, subwatershed ND1, are presented on Figure 6.16. Table 6.11 to Table 6.12 present a summary of daily flows at the outlet for ND1 in comparison to baseline and environmental conditions. The ND1 watershed outlet is approximately ~48.5 km downstream of Martin Lake including the channel realignment, and ~24.1 km downstream of the subwatershed with the downstream impacts to drainage area (ND5). ND18 is located immediately upstream of the channel realignment and ND8 is the subwatershed where the realignment rejoins the existing North Driftwood River main channel. ND5 is the most downstream subwatershed with changes to drainage patterns from the PA, and ND3 is the most downstream subwatershed with the PA boundary within it. Daily flow summaries for the pourpoints of subwatersheds ND3, ND5, ND8 and ND18 are presented in Appendix B.2.

For each phase of mine life, changes in subbasins including catchment area reductions and catchment area merges are tabulated in Appendix B.2.

Construction Phase (Years -3 to -1 – Year -1)

For the assessment of the construction phase (Year -3 to -1) subwatersheds, watersheds WB11 and WB8 are located on the west side of the Impoundment Facility and are not able to be connected back to the West Buskegau River watershed via a non-contact water diversion ditch. Flows from WB11 and WB8 were incorporated into the North Driftwood River watershed via non-contact water diversions (Figure A.5 within Appendix A). No diversion channel is constructed during this period for the North Driftwood River, and a temporary settling pond and its associated treatment plant discharge into the North Driftwood River in subwatershed ND14. The temporary settling pond (FDP-SP_TEMP_01) will receive pit dewatering for this life of mine phase.

Under construction conditions in Year -1 for ND1 at the downstream extent of the North Driftwood River HEC-HMS model there were no days of a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.11).

The Year -1 HEC-HMS model results for ND1 simulated 91 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset. The maximum predicted flow rate of the 91 days is 3.63 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for ND1 with the addition of subwatersheds of WB8 and WB11 (Table B.2.16 in Appendix B.2).

Operations Phase 1 (Years 1 to 4 – Year 2)

For the assessment of the operations phase 1 (Years 1 to 4) subwatersheds, orphaned watersheds WB11 and WB8 are reduced by expansion of the Impoundment Facility. Flows from the temporary settling pond and its associated treatment plant discharge into the North Driftwood River in subwatershed ND14 were updated for this phase. Tailings deposition commences in the TMF, further reducing the North Driftwood River watershed (Figure A.6).

Under construction conditions in Year 2 for ND1 at the downstream extent of the North Driftwood River HEC-HMS model there were no days of a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.11).

The Year 2 HEC-HMS model results for ND1 simulated 151 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset. The maximum predicted flow rate of the 151 days is 13.76 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for ND1 for this project phase (Table B.2.16 in Appendix B.2).

Operations Phase 2 (Years 4 to 18 – Year 17)

For the assessment of operations phase s 1 and 2 in the North Driftwood River watershed model, subwatersheds ND10, ND13, ND14, ND21, ND17, and ND22 were removed from the HEC-HMS model due to construction of the west portion of the Impoundment Facility, West Stockpile, Collection Pond 2, water management infrastructure and tailings discharge to the TMF. Seepage water was routed through the TMF NE and NW ponds and into the North Driftwood River (Figure A.7 within Appendix A). The non-contact water North Driftwood River diversion bypass channel was modelled to run through ND20, ND15, ND11 and ND8. This scenario represents the full extents of the PA and its associated water management infrastructure. Additionally, Collection Pond 2 (FDP-SP-02) and both the TMF NW and NE ponds (FDP-TMF-SP) are included as point sources in this operations phase. Pit dewatering flows are pumped to the TMF NW pond. The TMF ponds discharge next to the ND18 outlet and represent an increased drainage area entering into the outflow of Martin Lake, with the North Driftwood River channel realignment being adequately sized to manage these treated mine water discharges.

Under operations phase 2 conditions (Year 17) for ND1, there were 20 days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset, respectively (Table 6.11). Of the 20 days with a flow reduction greater than 10% from baseline for the climate change adjusted 1999 climate data set, none were below the predicted environmental flow values.

The Year 17 HEC-HMS model results for ND1 simulated 203 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset. The maximum predicted flow rate of the 203 days is 6.10 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for ND1 for this project phase (Table B.2.16 within Appendix B.2).

Operations Phase 2 (Years 18 to 30 – Year 23)

For the assessment of operations phase 2, two subbasins, TMF_1 and TMF_2, were included in the North Driftwood River HEC-HMS model to represent the TMF being fully reclaimed with a vegetated cover (Figure A.8 within Appendix A). In the HEC-HMS model, runoff from the TMF was directed to the North Driftwood River Diversion Channel and ultimately, the North Driftwood River.

Under Year 23 conditions for ND1, there were no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the 1999 climate dataset (Table 6.11).

The Year 23 HEC-HMS model results for ND1 simulated 136 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset. The maximum predicted flow rate of the 136 days is 6.41 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for ND1 for this project phase (Table B.2.16 within Appendix B.2).

Operations Phase 3 (Years 30 to 41 – Year 35)

For the assessment of operations phase 3 conditions, further progressive reclamation facilities are incorporated into the HEC-HMS model. The Impoundment Facility is progressively reclaimed and, following vegetation establishment, the seepage collection ditches are infilled and no longer drain to Collection Pond 2. Collection Pond 2 continues to receive surface runoff and toe seepage from the west stockpile. The subwatersheds WRSA_1 and WRSA_6 within the Impoundment Facility were added to the North Driftwood River HEC-HMS model. The TMF NW Pond stops receiving dewatering discharge in Mine Year 30 and is naturalized with an overflow spillway installed and added as a subwatershed to the model (Figure A.9 within Appendix A).

Under Year 35 conditions for ND1, there were no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.12).

The Year 35 HEC-HMS model results for ND1 simulated 74 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset. The maximum predicted flow rate of the 74 days is 31.72 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for ND1 for this project phase (Table B.2.16 within Appendix B.2).

End of Operational Phase (Year 41)

For the assessment of the end of operations phase, outflows from Collection Pond 2 were updated based on the results of the Ausenco Site-Wide Water Balance Summary Report (Appendix I of the Impact Statement).

Under Year 41 conditions for ND1, there were no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.12).

The Year 41 HEC-HMS model results for ND1 simulated 61 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset. The maximum predicted flow rate of the 61 days is 31.72 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for ND1 for this Project phase (Table B.2.16 within Appendix B.2).

Passive Closure Phase (Year 46 onward – Mine Year 47)

For the assessment of the closure phase, Collection Pond 2 was removed as a point source in the HEC-HMS model due to Pond 2 naturalization and installation of an overflow spillway following reclamation of the West Stockpile (Figure A.10 within Appendix A). The reclaimed West Stockpile area is added as a subwatershed to the North Driftwood River HEC-HMS model. Figure A.3 (Appendix A) presents the flow network connections for the North Driftwood River HEC-HMS model with the rehabilitated PA.

Under Year 47 conditions for ND1, there were no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.12).

The Year 47 HEC-HMS model results for ND1 simulated 29 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset. The maximum predicted flow rate of the 29 days is 43.98 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for ND1 for this project phase (Table B.2.16 within Appendix B.2).

Pit-Full

For the assessment of this phase, the North Driftwood River watershed HEC-HMS model was updated based on the results of the Ausenco Site-Wide Water Balance Summary Report (Appendix I of the Impact Statement).

Under Pit-Full conditions for ND1, there were no days with a flow reduction predicted to be greater than 10% in comparison to the baseline condition model results for the climate change adjusted 1999 climate dataset (Table 6.12).

The Pit-Full HEC-HMS model results for ND1 simulated 29 days of a flow increase greater than 10% from baseline conditions at the daily time step for the climate change adjusted 1999 climate dataset. The maximum predicted flow rate of the 29 days is 43.98 m^3/s using the climate adjusted dataset. An increase to the Q_{100} from baseline conditions was not predicted for ND1 for this Project phase (Table B.2.16 within Appendix B.2).

Table 6.11 Climate Change Adjusted North Driftwood River Flows and Changes

	Construction (Modelled Years -3 to -1 – Year -1)				Operations Phase 1 (Modelled Years 1 to 4 – Year 2)				Operations Phase 2 (Modelled Years 4 to 18 – Year 17)				Operations Phase 2 (Modelled Years 18 to 30 – Year 23)			
	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase
ND1	0	0	91	No	0	0	119	No	20	0	203	No	0	0	136	No
ND3	0	0	118	No	0	0	151	No	30	0	209	No	13	0	158	No
ND5	15	3	205	No	21	17	215	No	105	61	224	No	103	65	200	No
ND8	34	10	238	No	38	27	224	No	109	63	229	No	103	68	208	No
ND18	123	76	17	No	132	76	17	No	0	0	365	Yes	0	0	365	Yes

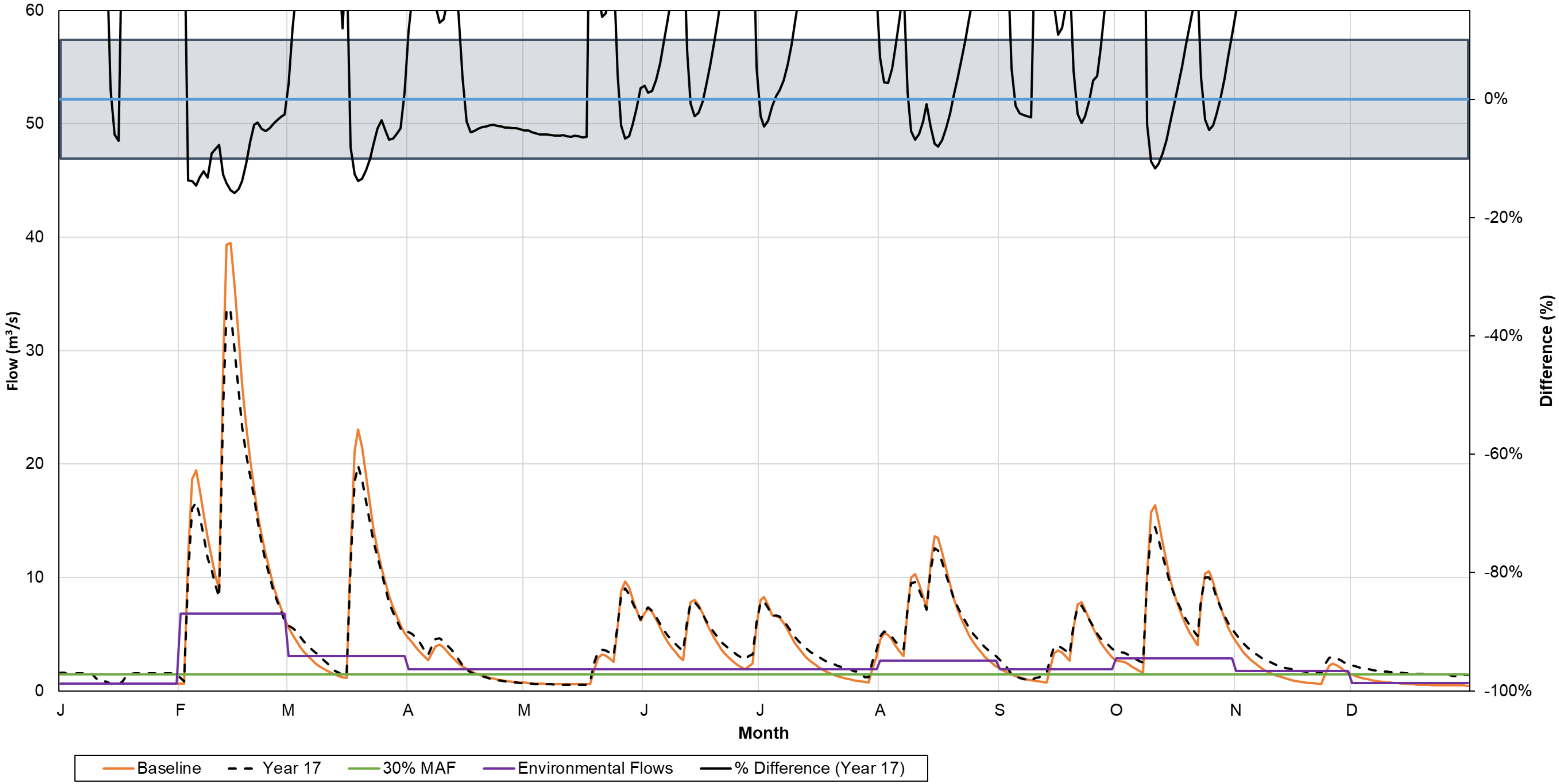
← Moving Upstream

Table 6.12 Climate Change Adjusted North Driftwood River Flows and Changes - Continued

	Operations Phase 3 (Modelled Years 30 to 41 – Year 35)				End of Operations (Modelled Year 41)				Passive Closure (Modelled Year 46 onward – Year 47)				Pit Filled			
	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase	+10% Reduction Days	+10% Reduction & Below Environmental Flow	+10% Increase Days	Q100 Flood Flow Increase
ND1	0	0	74	No	0	0	61	No	0	0	29	No	0	0	29	No
ND3	16	0	86	No	22	0	69	No	23	1	32	No	23	1	32	No
ND5	115	73	112	No	130	76	90	No	139	87	35	No	139	87	35	No
ND8	108	66	113	No	127	75	83	No	126	77	57	No	126	77	57	No
ND18	0	0	365	Yes	0	0	365	Yes	0	0	365	Yes	0	0	365	Yes

← Moving Upstream

Figure 6.16 Climate Change Adjusted Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND1



6.3.6.1.2 Surface Water-Groundwater Change Assessment

Stantec (2024f) assessed the predicted changes to groundwater discharge to surface water features for the construction phase (Year -1), operations phase 2 (Year 15), operations phase 3 (Year 30) and Pit-Full (Table 6.13). The HEC-HMS model setup for each life of mine phase includes project associated seepage to receivers (watercourses, waterbodies) based on the project infrastructure seepage rates predicted by the groundwater flow model (Appendix C.4 of the Impact Statement) and is presented in Table B.1.4 within Appendix B. The changes in groundwater flow at the receivers assessed for each life of mine phase are conservatively assumed to occur within the life of mine phases. Groundwater seepage from the PA during the different life of mine phases for the HEC-HMS model, except for the Project infrastructure seepage rates identified in Table B.1.4 is assumed to be 0 m^3/d.

Jocko Creek and two waterbodies within its watershed during the construction phase are predicted to have small reductions in groundwater seepage rates (≤5%), which equate to absolute seepage rate reductions of 0.001 m^3/s or less for the lakes and 0.003 m^3/s for Jocko Creek (Table 6.13). No changes in watershed area are planned due to the Project in the construction phase and the seepage reductions are not expected to have substantial changes to waterbody water levels/watercourse flow rates in the Jocko Creek watershed. During the operations phase 2 groundwater discharge to Jocko Creek, Zed Lake and an Unnamed Lake (South of Zed Lake) is predicted to increase by up to 100% due to seepage from the TMF, which is discussed in the HEC-HMS model results (Section 1494444688.485.1317956704.43.1317952208). Following installation of a vegetated cover on the TMF in Year 18, seepage rates from the TMF will be reduced as indicated in the Year 30 groundwater model results with changes within ±3% from baseline seepage rates and be within the range of natural variability. When the pit is full the seepage rates to Jocko Creek and waterbodies in the watershed are predicted to increase up to 10% from baseline.

There are no lake waterbodies near the PA in the West Buskegau River watershed. The Year -1 groundwater discharge is predicted to decrease for the West Buskegau River reach adjacent to the project to become a surface water recharge feature (Table 6.13). FDP-SP-01 discharges to the West Buskegau River in construction (Year -1) and operations phase 1 (Year 2) and there is no expected groundwater seepage from the PA discharging to the river. The climate change adjusted climate data set at the downstream WB1 subwatershed do not predict reductions in flows greater than the 10% threshold in Year -1 and Year 2 (Table 6.9 and Table 6.10). Operations phase 2 (Year 15) groundwater discharge to the West Buskegau River is predicted to increase to become a groundwater recharge feature. During operations phase 3 (Year 30 to Year 41) and the passive closure phase there is a predicted decrease in groundwater recharge to the West Buskegau River and the HEC-HMS model results for the climate change adjusted climate normal, do not predict any days with flow reductions below the 10% threshold at the WB1 subwatershed outlet (Table 6.10). When the pit is full there is a predicted increase in groundwater discharge to the West Buskegau River and the HEC-HMS model does not predict days with flow reductions or increases at the WB1 subwatershed outlet that exceed the ±10% threshold (Table 6.10).

Table 6.13 Predicted Groundwater Discharge to Surface Water Features

Watershed	Surface Water Feature	Baseline	Construction (Year -1)		Operations Phase 2 (Year 15)		Operations Phase 3 (Year 30 and Passive Closure)		Pit-Full (~Year 159)	
		Groundwater Discharge Rate (m^3/d) [1]	Groundwater Discharge Rate (m^3/d) [1]	Percent Increase (Decrease)	Groundwater Discharge Rate (m^3/d) [1]	Percent Increase (Decrease)	Groundwater Discharge Rate (m^3/d) [1]	Percent Increase (Decrease)	Groundwater Discharge Rate (m^3/d) [1]	Percent Increase (Decrease)
Jocko Creek	Jocko Creek	6,104	5,846	(4)	7,797	28	6,115	0.2	6,230	2
	Zed Lake	-1,620	-1,705	(5)	-842	48	-1,653	(2)	-1,584	2
	Unnamed Lake (South of Zed Lake)	1,054	1,011	(4)	2,158	105	1,087	3	1,157	10
West Buskegau River	West Buskegau River	1,234	-202	(116)	2,243	82	-2,000	(262)	1,788	45
North Driftwood River	North Driftwood River	6,334	9,085	43	848	(87)	569	(91)	2,160	(66)
	Mel Lake	1,211	1,147	(5)	1,818	50	1,192	(2)	1,272	5
	Sutherland Lake	-2,858	-3,161	(11)	-2,235	22	-2,717	5	-2,627	8
	Jack Lake	350	-304	(187)	543	55	240	(31)	332	(5)
	Gerry Lake	6,444	4,731	(27)	7,180	11	5,966	(7)	6,748	5
	Martin Lake	1,577	25	(98)	2,340	48	2,029	29	2,809	78
	Total North Driftwood Main Stem Lakes	6,724	2,438	(64)	9,646	43	6,710	0	8,534	27
	Unnamed Lake (near the West Stockpile)	58	62	7	-255	(540)	-254	(538)	301	419

Note:
1. A negative number indicates that surface water is recharging groundwater at that reach/lake.
Source: Groundwater Assessment (Appendix C.4 of the Impact Statement)

The North Driftwood River contains six waterbodies that are adjacent to the PA and upstream of the proposed channel realignment. The five lakes in order from upstream to downstream are Mel Lake, Sutherland Lake, Jack Lake, Gerry Lake and Martin Lake, which are located within a glaciofluvial loe (esker) formation (Groundwater Assessment Appendix C.4 of the Impact Statement). The Unnamed Lake (near the West Stockpile) is the only waterbody that is not part of the chain of lakes on the main stem of the North Driftwood River. The North Driftwood River for Year -1 is predicted to have an increase in groundwater discharge from baseline in the main stem and decreases within the five headwater lakes (Table 6.13). With temporary sediment pond flows from the PA (FDP-SP-TEMP_01) discharging to the North Driftwood River, the Year -1 and Year 2 HEC-HMS model predicts no flow reductions at the ND1 subwatershed downstream from the Project for the climate change adjusted climate dataset scenarios (Table 6.12 and Table 6.14). The groundwater seepage decrease in the chain of five headwater lakes is estimated to be 64% from baseline (0.050 m^3/s decrease). The 0.05 m^3/s flow reduction would equate to a 0.05 m decrease in water level within the downstream North Driftwood River and within the upstream waterbodies, which would be within the expected natural water level variability.

The operations phase 2 (Year 15) modelled groundwater discharges to the chain of lakes on the North Driftwood River main channel are predicted to increase with a reduction in groundwater recharge from baseline to the North Driftwood River channel reach (Table 6.13). The operations phase 2 HEC-HMS model flow at ND1 is predicted to have 20 days or more with flow reductions greater than the 10% threshold from baseline, but above environmental flows (Table 6.11). The ND1 pourpoint includes PA seepage discharges and FDP-TMF-SP and FDP-SP-02 discharges for the climate change adjusted normal climate scenario. The Unnamed Lake (near the West Stockpile) is predicted to have a substantial decrease (540%; 0.004 m^3/s) in groundwater recharge from baseline changing it to a surface water to groundwater recharge feature, which could see water level reductions during the operations phase 2 (Table 6.13). The 0.004 m^3/s flow reduction would equate to a 0.02 m decrease in water level within the unnamed lake outflow watercourse and waterbody itself, which would be within the expected natural water level variability.

The operations phase 3 (Year 30) and Passive Closure (Year 47 to Pit-Full) modelled groundwater discharges with the TMF having a vegetated cover installed causing seepage rates predicted to the chain of lakes on the North Driftwood River main channel approximately the same as baseline (Table 6.13). The North Driftwood River main channel is also predicted have a reduction in groundwater discharge from baseline and be a surface water to groundwater recharge feature. The ND1 subwatershed from the HEC-HMS model for the climate change adjusted climate dataset is predicted to have no reductions in flow at the downstream ND1 subwatershed outlet (Table 6.11). The Unnamed Lake (near the West Stockpile) is predicted to have a substantial decrease (538%; 0.004 m^3/s) in groundwater to surface water recharge from baseline changing it to surface water to groundwater recharge feature, which could see water level reductions during the operations phase 3 (Table 6.13). The 0.004 m^3/s flow reduction would equate to a 0.02 m decrease in water level within the downstream unnamed watercourse and within the waterbody itself, which would be within the expected natural water level variability.

The Pit-Full groundwater flow model predicted discharge to the North Driftwood main channel is less than baseline and is predicted to be above baseline for the five headwater lakes on the main channel. The Unnamed Lake (near the West Stockpile) is predicted to become a groundwater to surface water recharge feature with a rate above the baseline condition (Table 6.13). The HEC-HMS model for the pit filled scenario at the ND1 subwatershed outlet for the climate change adjusted climate dataset is predicted to not have flow reductions greater than the 10% threshold value (Table 6.14).

6.3.6.2 Water Quality Assessment

6.3.6.2.1 Assimilative Capacity Assessment

Construction/Operations Phase

An assimilative capacity assessment was conducted to estimate water quality in watercourses receiving discharges from FDPs and groundwater seepage (Appendix C). The West Buskegau River has two FDPs (FDP-SP-03 and FDP-SP-01) and two FDPs in the North Driftwood River (FDP-TMF-SP and FDP-SP-02) (Table 6.14). Jocko Creek receives groundwater seepage from the PA. The cumulative effects of the two FDPs in each receiver were assessed with respect to downstream concentrations for PoPCs. The assessments were conducted using the near-field mixing CORMIX model (Version 12.0) in conjunction with mass balance analyses to determine PoPC concentrations at the point of full mixing and at the pourpoint (outlet) of subwatersheds downstream of the FDPs. A mass balance analysis was conducted for Jocko Creek to determine PoPC concentrations at the outlet of subwatersheds downstream of the PA.

Two water quality scenarios were modelled, regulatory (MECP Procedure B-1-5 (MOEE 1994a; worst-case and conservative)) and normal (average) conditions for the construction/operation and post-closure (Pit-Full) life of mine phases. The construction/operations regulatory and normal condition assessment input flow parameters for the FDPs and receivers for the Assimilative Capacity Study are presented in Table 6.14. Groundwater seepage flows from the PA to local receivers, including lakes within watersheds, are estimated for the construction/operations phase with the maximum rate between Year 18 and Year 30 scenario groundwater model seepage flow outputs being used for the regulatory condition and a weighted average for the Year 18 and 30 seepage depending on the time period the Project activity operates in a given condition (e.g., Impoundment Facility before and after capping) (Appendix C).

Table 6.14 Final Discharge Point (FDP) and Receiver Hydrology and Flows for Construction/Operations Regulatory and Normal Conditions

Flow Condition	Parameter	FDP-SP-03	FDP-SP-01	FDP-TMF-SP	FDP-SP-02
General	Contributing Sedimentation Ponds	Pond 3	Pond 1	TMF NE Pond and TMF NW Pond	Pond 2
	Receiver	West Buskegau River		North Driftwood River	
	Upstream Drainage Area (km^2)	150	158	20.4	29.4
Regulatory	Maximum Effluent Discharge (m^3/d)	10,000	28,000	56,000	28,000
	Receiver 7Q20 * and Groundwater Seepage (m^3/d)	20,650	21,514	6,912	8,640
Normal	Average Effluent Discharge (m^3/d)	3,110	27,313	36,403	16,456
	Mean Annual Flow (MAF) and Groundwater Seepage (m^3/d)	175,910	184,896	26,611	40,694
Note: * 7Q20 – 7-day low flow, 20-year return period					

The water quality input parameters for the Assimilative Capacity Study assessment for the FDPs for the regulatory and normal conditions are based on treatment limits/objectives for PoPCs and site-wide water quality model results (Appendix K of the Impact Statement) for non-PoPCs (Section 5.7). The water quality model predicted different total parameter concentrations for various TSS concentrations (30, 15 and 10 mg/L) and also dissolved forms. PoPCs were identified based on receiver water quality (Appendix B.6) and water quality model untreated effluent maximum concentration results at each FDP and PA groundwater seepage maximum concentration results during operations (Appendix K of the Impact Statement) and comparison to PWQO values. When there was no PWQO objective for a water quality parameter, guidelines in CWQG-FAL were used in the comparative assessment. There were 18 PoPCs identified based on receiver and FDP effluent predictions, which included nitrate, nitrite, fluoride, total and dissolved aluminum, total chromium (III and IV), total arsenic, total cobalt, total copper, total iron, total nickel, total selenium, total uranium, total vanadium, total and dissolved zinc, and total phosphorus. Boron, un-ionized ammonia and chloride were also identified as PoPCs based on PA groundwater seepage, resulting in 21 PoPCs included in the Assimilative Capacity Study. The predicted PA seepage quality maximum PoPC concentrations for the regulatory condition do not exceed the Metal and Diamond Mining Effluent Regulations (MDMER).

Water treatment plants will be used to treat water collected in the sedimentation ponds prior to discharge via the FDPs. A list of PoPC maximum concentrations at the FDPs from the water quality model that exceeded PWQO or CWQG-FAL values were shared with water treatment experts and treatment technology suppliers to develop reasonable and practical treatment limits. The limits developed included the daily maximum (regulatory condition), maximum average monthly treatment limit and a target objective (normal condition). The target objective represents the discharge concentration that the treatment plant should be able to meet on a consistent basis. For the normal condition, if the average water quality model result for a given PoPC was lower than the target objective, the average water quality model result was applied (Appendix K of the Impact Statement).

Groundwater seepage quality from the Project infrastructure was predicted by the water quality model (Appendix K of the Impact Statement). Regulatory conditions used the maximum seepage concentrations during operations for each Project infrastructure source (TMF, Impoundment Facility, ore Stockpiles). The average seepage concentration for each Project infrastructure source was used for the normal condition.

Near-Field Modelling

The CORMIX model was used for the receivers at the locations of FDP discharge to estimate the distance until full mixing across the width of the receiver. Limitations associated with using CORMIX included (i) CORMIX predictions beyond a near-field length of 200 m were not reliable, and (ii) CORMIX was not applicable when effluent discharge was larger than the receiver flow. A mass balance assessment was used to determine approximate extent of full mixing when the effluent discharge was larger than receiver flow. Beyond the extent of the point of full mixing a mass balance assessment was applied. The CORMIX model and mass balance assessment estimated extents of the distance to full mixing are presented in Table 6.15, with the distances to full mixing being below the 200 m boundary length.

Table 6.15 Mixing Zone Characteristics at Points of Full Mixing

FDP		FDP-03 (Upstream)	FDP-01 (Downstream)	FDP-TMF (Upstream)	FDP-02 (Downstream)
Receiver		**West Buskegau River**		**North Driftwood River**	
Regulatory Conditions	Receiver Flow (7Q20+Seepage) (L/s)	239	249	80	100
	Distance to Full Mixing (m)	23	30•	30	30
	Dilution Ratio	2.99	n/a•	n/a	n/a
Normal Conditions	Receiver Flow (MAF+Seepage) (L/s)	2,036	2,140	308	471
	Distance to Full Mixing (m)	199	166	30	185
	Dilution Ratio	51.9	7.8	n/a	3.5

Notes:
30 m was assumed as a conservative estimate for the length to the point of full mixing when CORMIX was not applicable
n/a: Not applicable because when the effluent flow is larger than the receiver flow, CORMIX is not applicable

Mass Balance Assessment

Mass balance analysis, as detailed in the attached assimilative capacity report, continued downstream to a point where concentrations decrease below regulatory objectives/guidelines. The distance between the location of each FDP and the point where regulatory objectives/guideline concentrations are achieved is presented as the extent of the mixing zone for a given water quality parameter. The ultimate mixing zone is defined by the PoPC which requires the greatest mixing zone. Preliminary assessment indicated that the extent of the mixing zone was beyond the watershed limits that were considered in the HEC-HMS hydrological models in the Surface Water baseline report. Accordingly, further watershed delineation was conducted downstream of model limits to the Frederick House River on the West Buskegau River and to the Abitibi River on the North Driftwood River. The downstream watershed delineation extension was not required in Jocko Creek as concentrations were below regulatory objective/guideline at the outlet of the hydrologic model subwatersheds.

The Assimilative Capacity Study in Appendix C details mass balance results for each FDP and construction/operations regulatory and normal condition. For the construction/operations regulatory discharge condition, the assessed phase for the FDPs was when the maximum number of FDPs discharged concurrently to receivers in operations phase 2 (Mine Year 5 to 23). For the regulatory condition, the Frederick House River confluence with the Buskegau River was identified as the edge of the largest mixing zone on the West Buskegau River at 40.2 km downstream of the most downstream FDP (SP-01) on the West Buskegau River. Nitrite and total phosphorus were the determinant parameters of the ultimate mixing zone length as their concentrations converged to the objective/guidelines farther downstream then other parameters. Transformation of nitrite to other nitrogen species, e.g., to nitrate due to nitrification, was not considered in mass balance assessment. Nitrite is rapidly oxidized to nitrate through nitrification when oxygen is available (Kendall 1998). Nitrite would be expected to be rapidly oxidized to nitrate in the turbulent and oxygenated environment in the receivers, and the corresponding mixing zone would be shorter. Total phosphorus, which is a Policy 2 parameter with a PWQO value of 0.03 mg/L, was used to identify the ultimate extent of the mixing zone. Because the effluent criteria are based on receiving water and reasonable and practical treatment, technology limits for total phosphorus define the effluent criteria despite water quality modeling predictions of highest total phosphorus concentrations in mine water being lower than technology limits. As a result, the mixing zone for total phosphorus is also expected to be much smaller than modeled under the regulatory condition case. Concentrations of total iron and total aluminum with total iron a Policy 2 parameter were below baseline concentrations within the mixing zone and converged to the baseline concentration at the Frederick House River confluence. The regulatory condition effluent quality assimilates the receiver water quality and improves total iron and total aluminum quality in the West Buskegau River.

Construction/operations regulatory condition assimilative capacity assessment results for the North Driftwood River estimated the mixing zone extended to the confluence Abitibi River, 87 km downstream of the most downstream FDP (SP-02). Except for nitrite, concentrations of other Policy 1 parameters fell below the regulatory objective/guidelines at the Abitibi River confluence. The extent of the nitrite mixing zone is expected to be smaller due to the effects of nitrification processes. The total aluminum concentration at each FDP is below baseline within the watercourse and converges to the baseline concentration downstream of the confluence with the Abitibi River. For Policy 2 parameters, concentrations of total phosphorus and total iron, as Policy 2 parameters, were above guidelines at the Abitibi confluence implying that they are the determinants of the ultimate mixing zones, which would be at the point of full mixing of the North Driftwood River with the Abitibi River.

The extents of the regulatory condition mixing zones were determined assuming the conservative worst case receiver quality and low flow conditions occur at the same time as when the effluent quality and discharge are at their peak values, representing the worst case scenario for the effluent. This is a particularly conservative and an improbable condition for the Project because the mine water management system is driven by climatic conditions. Therefore when extended drought conditions are driving low flows in the receiver, those same dry conditions are controlling effluent flow rates. During drought conditions the FDPs would have substantially lower flows than the maximum discharge rates. Results of assimilative capacity assessments under climate change adjusted climate normal conditions predicted that, except for nitrate, in the North Driftwood River, the downstream edge of mixing zones for other parameters were either prior to or at the point of full mixing of the downstream FDP in either receivers. The downstream FDPs on the West Buskegau River and the North Driftwood River are FDP-SP-01 and FDP-SP-02, respectively. The mixing zone nitrate concentration decreased below the CWQG-FAL guideline values on the West Buskegau River at the point of full mixing of FDP-SP-01 (0.166 km downstream), and on the North Driftwood River at the pourpoint of subwatershed ND8, 3.6 km downstream of the FDP-SP-02.

For the construction/operations case, normal condition among Policy 2 parameters, total phosphorus did not exceed the PWQO objective in the two receivers. Dissolved aluminum did not exceed the regulatory objective/guidelines in the North Driftwood River and was above guidelines but below the baseline concentration in the West Buskegau River. Total iron and total aluminum were above guidelines but below baseline concentrations within the two receivers. These trends indicate the assimilation effects of the effluent, which improve water quality in the receiver for these Policy 2 parameters. The construction/operations normal condition extent of the ultimate mixing zone on the West Buskegau River is at the point of full mixing of FDP-SP-01 (0.166 km downstream), whereas the regulatory condition mixing zone extent was at the Frederick House River confluence, 40.2 km downstream of FDP-SP-01. On the North Driftwood River, the mixing zone extent decreased from 87 km downstream of FDP-SP-02 for the regulatory condition at the Abitibi River confluence to 3.6 km downstream for the parameter nitrate. For the North Driftwood River normal condition the remaining PoPC parameters were at or below regulatory objective/guideline values at the end of pipe or the point of full mixing for an individual FDP.

The assimilative capacity assessment of PoPCs in Jocko Creek with PA associated groundwater seepage did not predict exceedances above guidelines for Policy 1 parameters for the regulatory and normal conditions in any of the three subwatersheds. Concentrations of Policy 2 parameters were also below baseline concentrations. Therefore, mixing zones due PA groundwater seepage are not predicted to occur in Jocko Creek. Non-PoPCs concentrations were predicted to not exceed objective/guideline values in the subwatersheds for the regulatory and normal conditions. Therefore, mixing zones were not applicable in Jocko Creek for non-PoPCs.

Mass balance analyses were also conducted for non-PoPC values for the regulatory and normal conditions, which are presented in Appendix B.2 of the Assimilative Capacity Study (Appendix C of the Surface Water Resources Assessment).

Passive Closure (Pit-Full) Phase

The pit lake will outlet to the West Buskegau and North Driftwood River in flow proportioned spillways discharging approximately 37% and 63% of the pit lake catchment to the West Buskegau and North Driftwood River watersheds, respectively. When the pit lake is full, water balance predictions show that the low water conditions discharge from the pit to the West Buskegau River and the North Driftwood River will be 500 m^3/d and 900 m^3/d, respectively, which is from groundwater seepage. For the normal condition, the average pit lake discharge rates to the West Buskegau River and North Driftwood River increase to 2,523 m^3/d and 3,266 m^3/d, respectively. For the post-closure phase when the pit lake is full, seepage quality related to the reclaimed Impoundment Facility, reclaimed TMF, and tailings in the pit was considered from the water quality model results (Appendix K of the Impact Statement).

When the pit lake fills and commences discharge to the North Driftwood and West Buskegau Rivers, the pit lake quality is expected to meet regulatory objectives/guidelines. Therefore, mixing zones due to FDPs were not created in the post closure phase when the pit is full and discharging.

Effluent Criteria

Based on the assimilative capacity assessments in the study, the recommended effluent criteria is presented in Table 6.16, which includes effluent limits/objectives for PoPCs as well as maximum monthly discharge from FDPs in the Project Area.

Table 6.16 Recommended Effluent Criteria

Parameter	Metal and Diamond Mining Effluent Regulations (MDMER)		Regulator Guidelines (mg/L) •	Target Effluent Objective (mg/L)	Monthly Mean Limit	Target Daily Maximum (mg/L)
	Maximum Authorized Monthly Mean Concentration (mg/L)	Maximum Authorized Concentration in a Grab Sample (mg/L)				
Nitrite (as N)	-	-	0.06*	0.5	0.75	1
Nitrate (as N)	-	-	3*	6	10	12
Un-ionized Ammonia (as N)	0.5	1	0.0165*	-[B]	- [B]	- [B]
Fluoride	-	-	0.12*	0.18	0.24	0.36
Aluminum (Total)	-	-	0.1*	0.12	0.15	0.225
Aluminum (Dissolved)	-	-	0.075	0.018	0.023	0.034
Arsenic (Total)	0.1	0.2	0.005	0.0075	0.01	0.015

Parameter	Metal and Diamond Mining Effluent Regulations (MDMER) Maximum Authorized Monthly Mean Concentration (mg/L)	Metal and Diamond Mining Effluent Regulations (MDMER) Maximum Authorized Concentration in a Grab Sample (mg/L)	Regulator Guidelines (mg/L) •	Target Effluent Objective (mg/L)	Monthly Mean Limit	Target Daily Maximum (mg/L)
Boron (Total)	-	-	0.2	0.3	0.4	0.6
Cobalt (Total)	-	-	0.0009	0.0018	0.0027	0.0036
Chromium III	-	-	0.0089	0.013	0.018	0.027
Chromium VI	-	-	0.001	0.0015	0.002	0.003
Copper (Total)	0.1	0.2	0.005	0.0075	0.01	0.015
Iron (Total)	-	-	0.3	0.5	0.6	0.9
Nickel (Total)	0.25	0.5	0.025	0.0375	0.05	0.075
Selenium (Total)	-	-	0.001*	0.001	0.002	0.003
Uranium (Total)	-	-	0.005	0.0075	0.01	0.015
Vanadium (Total)	-	-	0.006	0.01	0.012	0.018
Zinc (Total)	0.4	0.8	0.02	0.03	0.04	0.06
Zinc (Dissolved)	-	-	0.075-0.079*,A	0.03	0.04	0.06
Phosphorus	-	-	0.03	0.05	0.06	0.09
Suspended Solids	15	30	Note*,C	-	15	30

Maximum Discharge from Management Ponds:

FDP	Maximum Discharge (m^3/d)	Receiving Water
FDP-SP-03	10,000	West Buskegau River
FDP-SP-01	28,000	West Buskegau River
FDP-TMF-SP	56,000	North Driftwood River
FDP-SP02	28,000	North Driftwood River

Notes:

PWQO or CWQG-FAL when PWQO is not available (the latter is shown with *)

A. Varies across receivers based on pH, hardness, and dissolved organic carbon concentration

B. Not a PoPC in the effluent. It is included in the list of PoPCs because it is a PoPC based on seepage quality, but untreated FDP discharge quality is not expected to exceed PWQO and/or CWQG-FAL values.

C. 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).

6.3.6.2.2 Asbestos Fibres

Due to the presence of chrysotile in the orebody an assessment of baseline asbestos fibre concentrations was conducted. Health Canada does not have a quantitative water quality guideline for asbestos fibres, and there is no PWQO or CCME CWQG-FAL for asbestos fibres. The United States Environmental Protection Agency (US EPA) water quality criteria for human health for the consumption of Water is 7 million fibres/L (MFL) (US EPA 2024). Local water quality baseline results reported chrysotile asbestos samples were collected in December 2023 at 12 watercourse monitoring locations and one waterbody location. The water samples were analyzed for determination of asbestos structures of lengths ≥0.5 µm and >10 µm. The samples analyzed were below the RDL of 0.20 MFL (million fibres per litre) at the 12 watercourse locations. The waterbody location sampled, Martin Lake (MARLK) had a detected fibre ≥0.5 µm with a concentration of 0.51 MFL which falls below the US EPA standard of 7 MFL. Asbestos fibres are not anticipated to be a surface water PoPC due to Project activities.

6.3.6.2.3 Water Temperature & Dissolved Oxygen

Surface water runoff from the PA is directed via collection ditches to the sedimentation ponds prior to discharge via treatment plants and armoured discharge channels in into the North Driftwood River or West Buskegau River. Toe seepage from the base of waste rock, overburden and ore piles and the TMF, along with shallow lateral groundwater flows will be intercepted by the collection ditches and conveyed to the sedimentation ponds. The temporary sedimentation pond and TMF NW pond will receive pit dewatering flows to support the process plant. The surface water management processes for the Project are controlled by environmental ambient air temperatures and climatic processes. There are no thermal sources planned to substantially increase discharge water temperatures to receivers.

There will be expected temperature increases to the surface runoff to sedimentation ponds from the existing condition as the soil and rock piles will have increased impervious surfaces to the existing wooded land cover. The ponds will have a bottom draw pump intake that optimally draws from 1 m to 3 m below the pond surface that conveys water to the treatment plant. The MOE (2003) manual indicates this can reduce discharge temperatures by several degrees Celsius. Bottom draw pump intakes are located below the permanent pool elevation (approximately 1 m) and collect water from cooler depths (SWAMP 2005). A literature review conducted by Toronto and Region Conservation Authority (TRCA) (2013) identified that, within Ontario, bottom draw outlet structures would reduce outflow temperatures by 1°C to 5°C. In addition, the sedimentation ponds and treatment plants are designed to release storm events over multiple days to the receivers (Ausenco 2024). With a multi-day release approach, the ponds are expected to discharge overnight via treatment plants, as well as during the day. A portion of the release would benefit from cooler discharge temperatures in the nighttime and decreases from day to night discharge temperature of up to 5°C (MOE 2003). The treatment plants associated processes are not expected to substantially change water temperatures from the pond outlet temperatures. Based on these stormwater management mitigation measures, the FDP discharge temperatures are expected to be approximately the same as the water temperatures in the receivers (North Driftwood River, West Buskegau River).

The FDP dissolved oxygen concentrations are expected to be within the PWQO and CWQG-FAL value ranges and not substantially change the dissolved oxygen concentrations in the receivers due to the following:

- Surface water runoff from the PA that is directed via collection ditches to the sedimentation ponds will be aerated as it flows over the relatively large surface areas on the TMF, IF and ore piles
- The treatment plant following the sedimentation pond will aerate the treated mine water prior to discharge via the FDP
- FDP discharge temperatures are expected be the same as water temperatures in the receivers. Similar water temperatures have the same dissolved oxygen carrying capacity
- The treated mine water discharge at the FDPs is not expected to be a substantial source of organic compounds and would have a low biochemical oxygen demand where aerobic bacteria would consume dissolved oxygen
- Discharge at the FDPs from the treatment plants is conveyed in a rock lined ditch to the receiver that through turbulent flow further aerate the treated mine water prior to discharge into the receiver

Snow cover has a high reflectivity that controls the snowmelt process, and is impacted by location, cloud cover, snow age, snow depth, snow density and dust content (Wiscombe and Warren 1980). Dark-coloured particles, such as dust, can absorb sunlight and shorten the duration of snow cover, which would impact local hydrologic conditions and ice formation within adjacent watercourses and water bodies. The provincial MECP criteria for particle matter deposition (dustfall) for the Project is 7 g/m^2/30-days. The existing condition peak particulate matter deposition amount observed during a 30-day period was 1.82 g/m^2/30-days from December 2021 to May 2023, which is 26% of the MECP criterion (Appendix H of the Impact Statement). The maximum predicted 30-day average total particle deposition amount for the construction and operations phases of the Project are 0.78 g/m^2/30-days and 2.57 g/m^2/30-days, respectively (Appendix C.1 of the Impact Statement). The construction and operations predicted maximum particulate matter are 11% and 37% of the MECP particle matter deposition criterion, which is related to the soiling of land cover and its aesthetic effects. These additional maximum particular matter rates when added to the existing condition have values of 2.6 g/m^2/30-days and 4.39 g/m^2/30-days for construction and operation, respectively, which are below the MECP criterion and would not cause a substantial and measurable change in the melting of ice or snow around the PA.

6.3.6.2.4 Eutrophication

Phosphorus is typically the limiting nutrient in freshwater environments with respect to productivity in aquatic ecosystems. The average TP concentrations in the West Buskegau River and North Driftwood Rivers are below the PWQO of 30 µg/L as presented in Table 6.17 (Appendix B.6 of the Impact Statement). The Project is predicted to discharge phosphorus to the environment via the FDPs, and no atmospheric phosphorus deposition is estimated (Appendix C.1 of the Impact Statement). The maximum average FDP TP discharge concentration and maximum average TP concentration at the point of complete mixing in the receiver in both the West Buskegau River and North Driftwood River are predicted to be below the PWQO value (Table 6.17). The PWQO of 30 µg/L was developed as a criteria value to prevent excessive plant growth in rivers and streams (MOEE 1994b).

Table 6.17 Average Condition Total Phosphorus Concentrations in Receiver, FDPs and Point of Complete Mixing

Watercourse	Watercourse Average Total Phosphorus Concentration (µg/L)	Final Discharge Point	Maximum Average FDP Total Phosphorus Concentration (µg/L) *	Maximum Point of Complete Mixing Total Phosphorus Concentration in Receiver (µg/L)
North Driftwood River	23	TMF-SP	29	26
		SP-02		
West Buskegau River	28	SP-03		28
		SP-01		
Note: * FDP discharge quality predicted maximum average raw water concentration in sedimentation ponds as it is lower than the treatment plant target objective				

Nitrogen is transported from the Project to surface waterbodies and watercourses by two pathways: 1. Atmospheric particulate deposition, and 2. Discharge via FDPs. The maximum predicted Project associated total nitrogen deposition rates for construction and operations to specific receptors outside the PA are 0.3 kg/ha/yr (W2 – Unnamed Pond 142) and 0.59 kg/ha/yr (W4 – Unnamed Lake (near the West Stockpile), respectively, which is assumed to be in the form of nitrate (as N) (Appendix C.1 of the Impact Statement). Figure A.17 (Appendix) presents the locations of the specific receptors W2 and W4. Cheng et al. (2022) for Bonner Lake near Moonbeam, ON (approx. 80 km northwest from the PA) measured a total dry and wet nitrate (as N) deposition rate of 1.2 to 1.8 kg/ha/yr for the 2014 to 2018 monitoring period. Assuming a total nitrate as N deposition rate of 1.2 kg/ha/yr for the baseline condition, the construction and operations depositional loads represent an increase in atmospheric nitrogen deposition of 25% and 49%, respectively. Nitrogen deposition within the watershed was assumed to be retained within the land cover and only direct deposition on the lake surface would contribute to nitrogen loading (Sulivan 2000). Calculating the baseline atmospheric deposition concentration within the waterbody using waterbody area and annual flow (Section 5.9.1.3) estimates a nitrate (as N) concentration of 0.22 mg/L. The baseline average nitrate (as N) concentrations for local waterbodies could not be calculated as 71 of 75 samples were below the reportable detection limit (Appendix B.6 of the Impact Statement). A nitrate (as N) concentration of 0.02 mg/L for the receiver waterbodies was assumed and associated with atmospheric deposition, internal nitrogen cycling within the waterbody and surface water runoff and groundwater flows. Conservatively assuming that 100% of the baseline nitrate (as N) concentration of 0.020 mg/L is associated with an atmospheric deposition load of 1.2 kg/ha/yr, the calculated Unnamed Pond 142 construction nitrate (as N) concentration is 0.025 mg/L. The Unnamed Lake (near the West Stockpile) operations predicted nitrate (as N) concentration is 0.030 mg/L. These predicted nitrate (as N) concentrations are less than the CCME CWQG-FAL value of 3 mg/L, and Project associated atmospheric nitrogen deposition would not be expected to cause a substantial increase in eutrophication within the receiving waterbodies and watercourses.

The average baseline total inorganic nitrogen (TIN) concentrations (total ammonia + nitrate + nitrite) in watercourses and waterbodies from the local water quality monitoring program are 83 µg/L and 63 µg/L, respectively, assuming nitrate and nitrite concentrations are equal to the reportable detection limit (Appendix B.6 of the Impact Statement). The TIN to TP ratio in local watercourses and waterbodies is 3.3 and 2.8, respectively. Lower ratios (less than 10) indicate nitrogen as the limiting nutrient (CCME 2016).

The FDP discharges to the North Driftwood River and West Buskegau River at the point of complete mixing, TIN concentrations in the receiver for the average condition have TIN:TP ratios of 41.2 and 10.2, respectively (Table 6.18). Nitrate (as N) is the nitrogen parameter with the highest concentration with a treatment target objective of 6,000 µg/L. Ratios greater than 20 indicate a phosphorus limiting environment (CCME 2016). There are substantial increases in the TIN concentration within the receiver with nitrate (as N) as the main driver and returning below the CCME CWQG-FAL value between the ND11 and ND8 subwatersheds (between 1 km to 3.6 km downstream of FDP-SP-02) in the North Driftwood River and 0.03 km downstream of FDP-SP-01 in the West Buskegau River (see Assimilative Capacity Study in Appendix C). CCME (2016) list TIN with concentrations greater than 1,370 µg/L and total nitrogen concentrations greater than 3,000 mg/L as having negative effects on aquatic biota. The CCME (2016) guidance manual also identified total nitrogen concentrations between 580 and 1,670 µg/L as being associated with high quality biological communities.

Table 6.18 Average Condition Total Inorganic Nitrogen Concentrations in Receiver, FDPs and Point of Complete Mixing

Watercourse	Average Total Inorganic Nitrogen Concentration (µg/L) *	Final Discharge Point (FDP)	Maximum Average FDP Total Inorganic Nitrogen Concentration (µg/L) *, **	Maximum Average Point of Complete Mixing Total Inorganic Nitrogen Concentration in Receiver (µg/L)
North Driftwood River	90	TMF-SP	6,594	3,710
		SP-02		
West Buskegau River	90	SP-03		917.8
		SP-01		

Notes:
* Total inorganic nitrogen calculated as sum of total ammonia, nitrate and nitrite
** FDP discharge quality for nitrate, nitrite and total ammonia either predicted maximum average raw water concentration in sedimentation ponds or treatment plant target objective, whichever is lower in value

The West Buskegau River average TIN discharge via the FDPs is not expected to cause a substantial increase in eutrophication within the watercourse. The North Driftwood River average TIN discharge via FDPs would be expected to increase the potential for eutrophication in the watercourse segment from FDP-TMF-SP to up to 3.6 km downstream of FDP-SP-02.

6.3.6.2.5 Mercury

As part of the baseline local watercourse and waterbody monitoring program methyl mercury reported no exceedances in watercourses or waterbodies of the CCME CWQG-FAL guidelines value of 4 ng/L. The baseline local hydrology program reported a North Driftwood River average methyl mercury concentration of 0.10 ng/L.

For the North Driftwood channel realignment, the methyl mercury net yield of 70 mg/ha/yr and 131 mg/ha/yr was applied to the proposed main channel sections that intersect organic soils extending deeper than 140 cm below surface. The proposed channel has a length of 7,700 m with a channel width 0f 6.52 m and intersected approximately 4,750 m^2 (0.475 ha) of organic Larder and Harley soils. The estimated methyl mercury yield for the North Driftwood channel realignment is approximately 217 mg/yr and 405 mg/yr, respectively. The conservatively estimated increase in methyl mercury concentration in the North Driftwood channel realignment is 0.005 ng/L for a methyl mercury net yield of 70 mg/ha/yr and 0.009 ng/L) for a net yield of 131 mg/ha/yr during the first year of inundation. The expected methyl mercury concentrations in the channel realignment accounting for the watercourse baseline concentration would be 0.105 ng/L and 0.109 ng/L for the net yield rates of 70 mg/ha/yr and 131 mg/ha/yr, respectively, which represents up to a 9% increase in concentration. This increase from the maximum baseline methyl mercury concentration would not represent an exceedance of the CCME CWQG-FAL value, which is 37 times higher than the average predicted methyl mercury concentration. The net yield of methyl mercury would be expected to decline in subsequent years as observed in the Experimental Lakes studies (Hall and St. Louis 2004; Hall et al. 2005).

Predicted total mercury concentrations at the FDPs for the normal condition are approximately equal to the half detection limit value of 5 ng/L, which was applied to below detection limited source terms in the water quality model (Appendix K of the Impact Statement; Tables C-11 and C-12, Assimilative Capacity Study, Appendix C). The below detection source term mercury concentration values would be expected to be similar to total mercury average concentrations in the receivers, which range from 2.47 to 4.77 ng/L in the North Driftwood River and West Buskegau Rivers, respectively. The total mercury concentrations in the North Driftwood River and West Buskegau Rivers downstream of the FDPs would be assumed to not increase due to Project discharges.

6.3.6.2.6 Acid Deposition

Deposition of sulphur and nitrogen compounds on waterbodies and their potential to increase lake acidity was assessed by calculating the change in PAI from baseline for the construction and operations life of mine conditions. The waterbodies selected for the assessment were the waterbodies that were predicted to have the highest construction and operation PAI values (Martin Lake and Unnamed Lake (near the West Stockpile), respectively) and select waterbodies east and northeast of the PA (Table 6.19; Figure A.17 (Appendix A).

Lake PAI values were below critical loads calculated for three surface water receptors assed, see Table 6.19. The surface water receptors were classified as least sensitive to acidification under the alkalinity- and pH based systems of Saffran and Trew (1996), outlined in Section 5.9.1.3. In the absence of water quality data at the specific receptor the “all waterbodies’ concentration from the baseline assessment was used.

Table 6.19 Predicted PAI for Select Surface Water Receptors

Receptor # & Name	Gross Catchment Area – Baseline (ha)	Water Body Surface Area (ha)	PAI Deposition Rate - Construction (keq/ha/year) *	PAI Deposition Rate -Operation (keq/ha/year) *	Surface Water Receptor PAI (keq/ha/yr)		
					Baseline	Construction	Operations
W4 ND-P-045 (Unnamed Lake [near the West Stockpile])	11.5	5	3.15E-03	2.11E-02	17.74 **	17.74	17.75
W1 Martin Lake (including Gerry Lake, Jack Lake, Sutherland Lake, Mel Lake and Davis Lake)	1393	76.3	5.30E-03	1.70E-02	2.92E-02	2.95E-02	3.01E-02
W2 WB-P-142 (unnamed pond on West Buskegau River tributary)	46.8	0.7	1.07E-02	1.72E-02	2.75	2.75	2.75
W3 Deception Lake (closest named lake northeast of PA)	1224.5	184.2	8.82E-04	2.62E-03	1.25E-01	1.25E-01	1.26E-01

Notes:
* Source: Air Quality Assessment (Appendix C.1 of the Impact Statement)
** local water quality from lakes used to calculate baseline nitrate and sulphate concentrations; Otherwise, calculated using average local monitored waterbodies concentrations

The watershed adjusted total construction and operations PAI loading rates for the four selected waterbodies in comparison to the baseline watershed PAI calculated using local nitrate and sulphate water quality results (Appendix B.6 of the Impact Statement) were increased above 0.1% for W1 (Martin Lake) and W3 (Deception Lake) due to the larger waterbody surface areas as a percentage of the total waterbody drainage area. Martin Lake (including Gerry Lake, Jack Lake, Sutherland Lake, Mel Lake and Davis Lake) had PAI increases for the construction and operations phase of 1.0% and 3.1%, respectively, in comparison to baseline. Deception Lake had PAI increases in comparison to baseline of 0.1% and 0.3% for the construction and operations phases, respectively.

To assess the PAI values with respect to whether they would substantially alter acidity, critical acidity loads were calculated which represent the acid deposition load where no harmful effects to the aquatic ecosystem would be expected (Sullivan 2000). In addition, baseline pH, alkalinity and ANC were assessed for each lake to classify the acid sensitivity of the waterbody with the four selected waterbodies being defined as least sensitive to acid deposition due to their circumneutral pH values, and relatively high alkalinity concentrations (Table 6.20). The Martin Lake, WB-P-142 and Deception Lake critical load values were substantially higher than the baseline PAI, and construction and operations mine phase PAI loading rates and would have negligible changes to acidity from acid deposition. The Unnamed Lake (near the West Stockpile) has a relatively small watershed area (11.5 ha) for the size of the waterbody (5 ha). The baseline PAI is calculated using average local waterbody nitrate and sulphate and was calculated to have a PAI of 17.74, which exceeds the critical load, and the operations phase is estimated to increase the PAI by 0.05%, which would have a negligible change to existing acidity in the waterbody.

Table 6.20 Calculated Acid Sensitivity and Critical Loads for Select Surface Water Receptors

Receptor Name	Baseline pH	Alkalinity (mg/L)	ANC Baseline (µeq/L)	Acid Sensitivity (Saffran and Trew 1996)	Critical Load (keq/ha/yr)	Mine Phase PAI Above Critical Load
ND-P-045 - Unnamed Lake (near the West Stockpile)	7.3	118	2,255.8	Least	12.76	Yes *
Martin Lake (including Gerry Lake, Jack Lake, Sutherland Lake, Mel Lake and Davis Lake)	7.1 **	82 **	1,125.0 **	Least	3.80	No
WB-P-142	7.3	118	2,255.8	Least	8.03	No
Deception Lake	7.3	118	2,255.8	Least	9.56	No

Notes:
* Baseline PAI exceeds critical load and construction and mine phase PAI values are estimated to increase by 0.05%
** local water quality from lakes used to calculate baseline nitrate and sulphate concentrations; Otherwise, calculated using average local monitored waterbodies concentrations

Other waterbodies outside the PA were estimated to have lower construction and operations PAI values than Martin Lake and Unnamed Lake (near the West Stockpile) and would be expected to have negligible changes to acidity to the waterbodies from acid deposition (Appendix C.1 of the Impact Statement).

7 Summary and Conclusions

This assessment was comprised of a surface water hydrology and surface water quality analytical assessment to identify potential and residual cumulative changes due to the proposed Crawford Nickel Project.

7.1 Hydrology

Predicted changes to the watershed areas for the Jocko Creek, West Buskegau River, and North Driftwood River watersheds (Figure A.4 within Appendix A were determined for construction, operations, and decommissioning and closure phases of mine life (Figure A.5 to Figure A.10 within Appendix). Flows under pre-development conditions were adjusted for climate change (SSP2-4.5 for 2071 to 2100) and used as the baseline against which Project-related changes were assessed given the extended mine life (41 years of operation and ~118 years for pit filling from end of operations) and daily flows for different mine phases. A continuous HEC-HMS hydrological model was used to predict baseline flows and subsequent project changes through mine life with simulated FDP flows from the site-wide water balance model (Appendix I of the Impact Statement).

The *Framework for Assessing the Ecological flow Requirements to Support Fisheries in Canada* (DFO 2013) provides guidance on the application of a ±10% threshold limit to changes in flow relative to the natural flow regime. These threshold limits were used to assess changes within watersheds. Flow reductions over 10% were further assessed by comparison to environmental flow values, and if flows were lower than baseline condition environmental flows, a local water quantity residual effect was expected. Flow increases over 10% were further assessed by comparing predicted flood flows (100-year return period, 24-hour duration event) to the baseline condition flood flow to assess potential flooding and erosion.

7.1.1 Flow Reductions

Days with a flow reduction greater than 10% were not predicted in the Jocko Creek watershed for subwatershed JC_DS, the outlet of the watershed model and limit of the LSA, for the different mine phases (construction, operations, active closure and post-closure) (Table 7.1). Groundwater seepage reductions to Jocko Creek and two waterbodies within the watershed (Zed Lake and South of Zed Lake) are predicted to be relatively small (<5%) during the construction and operations phase 3 life of mine phases and not measurable changes.

Days with a flow reduction greater than 10% were not predicted in the West Buskegau River watershed model outlet, WB1, which is 17.5 km downstream of the first subwatershed that has its drainage area impacted by the PA (WB14), for the different mine life phases. Subwatersheds upstream of WB1 are predicted to have localized flow reductions greater than 10% and below environmental flows for up to 35 days per year (March to May) for the construction and operations (Phase 1) life of mine periods.

Days with flow reductions greater than 10% were predicted at the North Driftwood River watershed model outlet (ND1) for the operations phase 2 (Year 17), where the outlet is located ~24.1 km downstream of the most downstream subwatershed with impacts to its drainage area (ND5). Of the days predicted in Year 17 below the 10% threshold for reductions at ND1, none were below the environmental flow values (Table 7.1). Groundwater seepage decreases are predicted for the chain of five lakes in the headwaters of the North Driftwood River during the construction phase that could impact lake water levels.

Table 7.1 Summary of Instantaneous Flow Changes for the Project in Jocko Creek, West Buskegau River and North Driftwood River at Watershed Model outlets.

Mine Life Phase	Exceedance Threshold	Jocko Creek (JC_DS) No. of Days	West Buskegau River (WB_1) No. of Days	North Driftwood River (ND_1) No. of Days
Construction (Modelled Years -3 to -1 – Year -1)	+10% Reduction Days	NA	0	0
	+10% Reduction & Below Environmental Flow Days	NA	0	0
	+10% Increase Days	NA	106	91
	Q_{100} Flood Flow Increase	NA	**No**	**No**
Operations Phase 1 (Modelled Years 1 to 4 – Year 2)	+10% Reduction Days	NA	0	0
	+10% Reduction & Below Environmental Flow Days	NA	0	0
	+10% Increase Days	NA	88	119
	Q_{100} Flood Flow Increase	NA	**No**	**No**
Operations Phase 1 and 2 (Modelled Years 4 to 18 – Year 17)	+10% Reduction Days	0	0	20
	+10% Reduction & Below Environmental Flow Days	0	0	**0**
	+10% Increase Days	112	151	203
	Q_{100} Flood Flow Increase	**No**	**No**	**No**
Operations Phase 2 (Modelled Years 18 to 30 – Year 23)	+10% Reduction Days	0	0	0
	+10% Reduction & Below Environmental Flow Days	0	0	0
	+10% Increase Days	0	145	136
	Q_{100} Flood Flow Increase	**No**	**No**	**No**
Operations Phase 3 (Modelled Years 30 to 41 – Year 35)	+10% Reduction Days	-	0	0
	+10% Reduction & Below Environmental Flow Days	-	0	0
	+10% Increase Days	-	3*	74
	Q_{100} Flood Flow Increase	-	**No**	**No**

Mine Life Phase	Exceedance Threshold	Jocko Creek (JC_DS) No. of Days	West Buskegau River (WB_1) No. of Days	North Driftwood River (ND_1) No. of Days
End of Operations (Modelled Year 41)	+10% Reduction Days	-	0	0
	+10% Reduction & Below Environmental Flow Days	-	0	0
	+10% Increase Days	-	0	61
	Q_{100} Flood Flow Increase	-	**No**	**No**
Passive Closure (Modelled Year 46 onward – Year 47)	+10% Reduction Days	-	0	0
	+10% Reduction & Below Environmental Flow Days	-	0	0
	+10% Increase Days	-	0	29
	Q_{100} Flood Flow Increase	-	**No**	**No**
Pit Filled	+10% Reduction Days	-	0	0
	+10% Reduction & Below Environmental Flow Days	-	0	0
	+10% Increase Days	-	0	29
	Q_{100} Flood Flow Increase	-	**No**	**No**

7.1.2 Flow Increases

Days with a flow increase greater than 10% were predicted in the Jocko Creek watershed for subwatershed JC_DS, the outlet of the watershed model, for operations phase 2, which was assessed at Year 17. The flow increases were not associated with an increased Q_{100} flood flow rate and are due to increased groundwater seepage from the TMF. The predicted increases were associated with a maximum flow rate of less than 0.9 m^3/s, which is considered a low flow condition and not associated with increased scour or erosion in the channel. The other seven mine life phases assessed did not have predicted flow increases greater than 10% from the baseline values (Table 7.1).

At the West Buskegau River watershed model outlet, WB1, daily flow increases greater than 10% were predicted for the construction phase and operations phases 1, 2, and 3 (Year -1, Year 2, Year 17 , Year 23, and Year 35, respectively). The maximum predicted flows associated with a daily flow increases greater than 10% for the five model scenarios were associated with low flow conditions and would not increase scour and erosion potential to the channel. Subwatersheds upstream of WB1 (e.g., WB5 and WB9) were predicted to have flow increases greater than 10% and were associated with low flow conditions from construction to the Pit-Full condition for up to 249 days per year (WB9 - operations phase 2) down to 12 days per year (WB5 – Passive Closure).

For the North Driftwood River at the watershed model outlet, ND1, daily flow increases greater than 10% from baseline condition flows were predicted for the eight modelled life of mine scenarios (Construction to Pit-Full phase). The estimated Q_{100} flood flows at ND1 are not predicted to exceed the baseline condition flood flow and there would be no increase to scour and erosion potential in the channel. Subwatersheds upstream of ND1 (e.g., ND3, ND5 and ND8) are predicted to have flow increases greater than 10% and were typically associated with low flow conditions from construction to the Pit-Full condition for up to 229 days per year (ND8 – operations phase 2) reducing to 57 days per year (ND8 – Passive Closure/Pit-Full). ND18, which includes the chain of five lakes (Mel Lake to Martin Lake) is predicted to have flow increases due to changes in watershed drainage area and groundwater seepage from the TMF. The North Driftwood River channel realignment will be designed to accommodate the increased flows from the ND18 and ND19 subwatershed changes and increased groundwater seepage rates from the TMF.

7.1.3 Surface Water-Groundwater Changes

The Groundwater Assessment (Appendix C.4 of the Impact Statement) assessed changes to groundwater discharge to surface water features for a single year steady-state case during four life of mine phases (construction, operations phase 2, operations phase 3, passive closure and Pit-Full) (Appendix C.4 of the Impact Statement). Increases in groundwater seepage rates from the PA were incorporated into the HEC-HMS hydrologic model. Within the Jocko Creek watershed, the watercourse and two waterbodies are predicted to have small reductions in groundwater seepage rates (≤5%) from baseline during the construction phase and increases up to 100% during operations phase 2, changes of ±3% in operations phase 3 and increases of up to 10% during the Pit-Full case. The small reductions in the construction and operations phase 3 phases are considered within the range of natural variability.

Within the West Buskegau River watershed, groundwater seepage changes were assessed in the main channel as no lake waterbodies were identified near the PA. There is a predicted decrease in groundwater seepage rates during the construction and operations phase 3 phases with the hydrologic model not predicting flow reductions less than 10% at the downstream WB1 subwatershed. The groundwater model predicted increases in groundwater seepage to the West Buskegau River during the operations phase 2 and pit-full phases with the hydrology model with the hydrologic model results not predicting increases in flow greater than the 10% threshold.

Within the North Driftwood River main channel, a series of five headwater lakes (Mel Lake, Sutherland Lake, Jack Lake, Gerry Lake and Martin Lake) and Unnamed Lake (near the West Stockpile) were assessed with respect to surface water-groundwater flow changes. The five headwater lakes were predicted to have a decrease in groundwater seepage during the construction phase case (Year -1), which was estimated to equate to a 0.05 m decrease in lake water levels, which is considered within expected range of natural variability. The other modeled life of mine phases did not predict water level reductions in the North Driftwood River headwater lakes. The Unnamed Lake (near the West Stockpile) is predicted to have water level reductions of up to 0.02 m for the operations phase 2, operations phase 3 and passive closure, which is expected to be within the natural variability of the waterbody. The North Driftwood River main channel is predicted to have increases in groundwater discharge rates during the construction and pit-full life of mine phases, and reductions during operations phase 2 and phase 3, and passive closure. The hydrologic model for the operations phase 2 and phase 3, and passive closure modeled years is not predicted to have flow reductions downstream of the project at subwatershed ND1 that are greater than the 10% threshold.

7.2 Surface Water Quality

The water quality assessment used the following assessment sequence:

- Baseline water quality monitoring (regional and local) to identify PoPCs
- Geochemical testing and assessment to determine water quality source terms and aging predictions
- Water quantity and water quality modelling in GoldSim™ refined water movement throughout the Project at a monthly time scale and used contact runoff and seepage estimates, water management infrastructure storage/sedimentation characteristics, and geochemical results to predict contact water quality at the FDPs and groundwater seepage quality
- An assimilative capacity assessment at FDPs using near-field mixing model (CORMIX) to determine extent to the point of full mixing within the receiver in conjunction with a mass balance assessment to predict water quality for the North Driftwood River, the West Buskegau River, and Jocko Creek
- Supplemental water quality assessments for individual PoPCs based on literature review, professional judgement, water quality and air quality model outputs and empirical loading model results

The baseline local water quality monitoring program identified three PoPCs, (total phosphorus, dissolved aluminum (0.2 µm particle size) and total iron), based on comparison to CWQG-FAL and PWQO values in Jocko Creek, the North Driftwood River and the West Buskegau River watersheds. The geochemical assessment of overburden, waste rock, ore and tailings identified chloride, fluoride and a number of metals and metalloids (dissolved and total aluminum, total arsenic, total antimony, total boron, total cadmium, total chromium (VI), total copper, total iron, total selenium, total thallium, total uranium, total vanadium and total and dissolved zinc) to develop source terms for in the water quality model. The water quality model identified nitrite (as N), nitrate (as N), fluoride, total chromium (III), total chromium (VI), total aluminum, total arsenic, total cobalt, total copper, total iron, total nickel, total selenium, total uranium, total vanadium, total zinc and total phosphorus at the four FDPs (SP-01, SP-02, SP-03, TMF-SP). Groundwater seepage quality from the Project predicted by the water quality model identified chloride, nitrite (as N), nitrate (as N), un-ionized ammonia (as N), fluoride, chromium (VI), arsenic, boron, cobalt, copper, selenium, uranium, vanadium, zinc and phosphorus as PoPCs.

Discharge quality from the FDPs and seepage quality from the PA is substantially below MDMER criteria values. Assimilative capacity assessments were conducted for Jocko Creek, the West Buskegau River and the North Driftwood River for the regulatory and normal condition with FDP and PA groundwater seepage discharges for the operations and Pit-Full life of mine phases. The conservative regulatory condition represents high effluent concentrations (maximum water quality model results or daily maximum treatment limit), maximum FDP discharge rates, climate change adjusted low flow rate in receiver (7Q20) and poor water quality (75^{th} percentile local baseline).The normal condition represents average effluent concentrations (average water quality model results or target treatment objective), average FDP discharge rates, climate change adjusted mean annual flow rate in receiver and average water quality (local baseline).

The assimilative capacity assessment of PA associated groundwater seepage into the Jocko Creek channel and its waterbodies predicted no increases in PoPC parameters above the regulatory objective/guidelines (PWQO or CCME CWQG-FAL value and no increase in Policy 2 parameter receiver concentration) for the regulatory and normal conditions.

The near-field mixing assessment for the West Buskegau River FDPs (SP-03 and SP-01) and North Driftwood River FDPs (TMF-SP and SP-02) accounting for PA associated groundwater seepage to the receiver predicted the point of full mixing was achieved within 200 m downstream of each FDP for both the regulatory and normal conditions. For the regulatory condition, the full extent of the mixing zone on the West Buskegau River was predicted to be downstream of the confluence with the Frederick House River (40.2 km downstream of the most downstream FDP (SP-01)) for the parameter nitrite and the Policy 2 parameters (total iron and total phosphorus). For the West Buskegau River normal condition, the full extent of the mixing zone was predicted to be 0.166 km downstream of FDP-SP-01.

The North Driftwood River regulatory condition assimilative capacity assessment predicted the full extent of the mixing zone to be downstream of the confluence with the Abitibi River (87 km downstream of the most downstream FDP (SP-02)) for the parameter nitrite and the Policy 2 parameters (total iron and total phosphorus). The full extent of the mixing zone in the North Driftwood River for the normal condition was predicted to be 3.6 km downstream of FDP-SP-02 for the parameter nitrate with other PoPCs being below regulatory objective/guideline values closer to or at the FDP.

During the Pit-Full case, water quality in the pit lake was predicted to be below regulatory objective/guideline values for the regulatory and normal conditions and therefore there would be no mixing zone in the West Buskegau River and North Driftwood River receiving pit lake outflows.

Other assessed surface water quality parameter changes in receivers due to Project activities had the following results:

- Baseline local surface water asbestos fibre (chrysotile) concentrations were typically below the laboratory RDL and the single result slightly above detection was below US EPA human health water quality criteria (2024). Project activities are not expected to make chrysotile a surface water PoPC.

- Water temperatures and dissolved oxygen concentrations in receivers (Jocko Creek, the West Buskegau River and North Driftwood River) are not expected to change due to Project activities with planned water management system mitigation measures (e.g., bottom draw pump intakes from sedimentation ponds, aeration within treatment plants and discharge channels)
- Average TP concentrations at FDPs are not predicted to increase receiver TP concentrations above the PWQO value, which was developed to prevent excessive plant growth, in the West Buskegau River and North Driftwood River.
- Average TIN (total ammonia + nitrate + nitrite) concentrations in the FDP discharges to the West Buskegau River are not predicted to increase the potential for eutrophication. The average TIN concentration in the FDP discharges to the North Driftwood River would be expected to increase the potential for eutrophication from FDP-TMF-SP to up to 3.6 km downstream of FDP-SP-02.
- An empirical loading assessment for methyl mercury for permanently inundated areas predicted by project activities estimated expected concentration increases due to the North Driftwood Channel realignment ranging from 0.1 to 0.109 ng/L. The predicted North Driftwood River methyl mercury concentration is not predicted to exceed the CCME CWQG-FAL value (4 ng/L).
- Deposition of sulphur and nitrogen compounds on waterbodies was assessed with respect to increase in lake acidity for the construction and operations phases on select waterbodies predicted to receive maximum deposition rates. The PAI loading rates from the project and low acid sensitivity of the receivers predicts negligible changes to existing acidity in waterbodies outside the PA.

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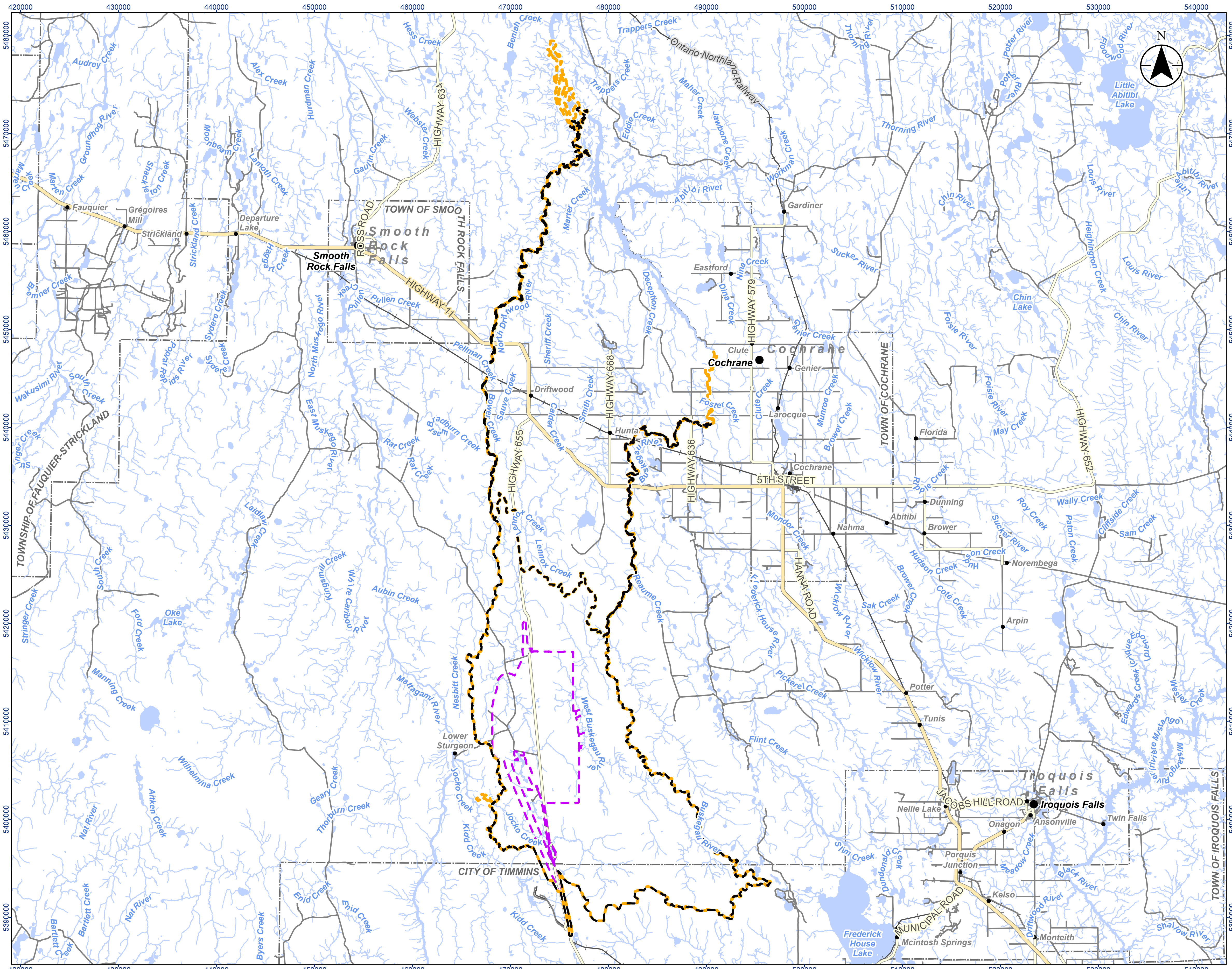
Appendices

Appendix A Figures



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Regional Study Area

Base Features

- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody

0 5 10 km

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Notes

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Timmins, Ontario Prepared by tcoghlan on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.1

Title
Project Area

\\cd1004-f01\01609\active\160930456\gis_cad\gis\mxds\IS\TDR\160930456_IS-TDR_SfcWater.aprx\160930456_IS-TDR_SW_FigA.01_ProjArea Revised: 2024-09-11 By: tcoghlan

Figure A.2 Baseline West Buskegau River Subwatershed Flow Network

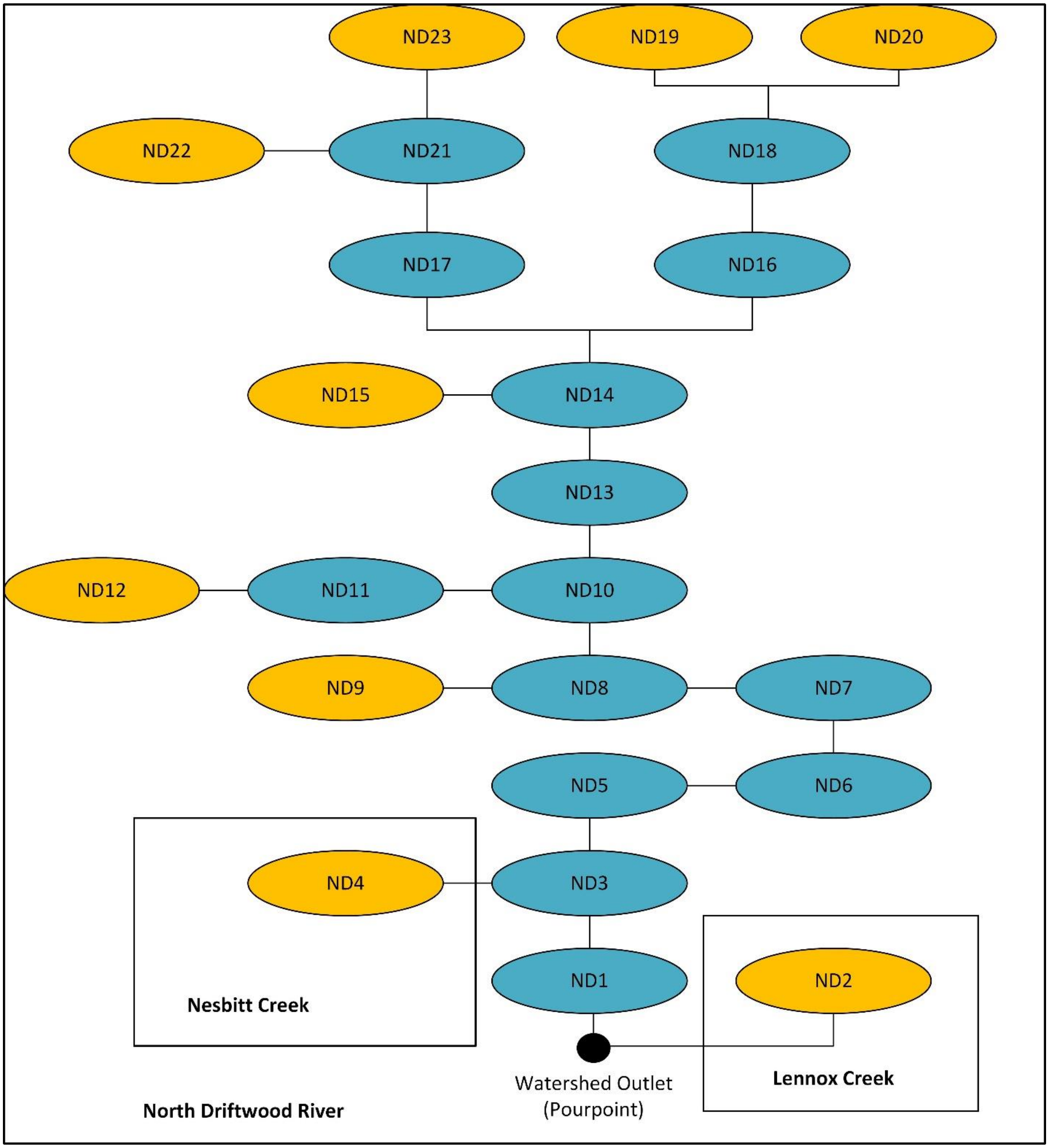
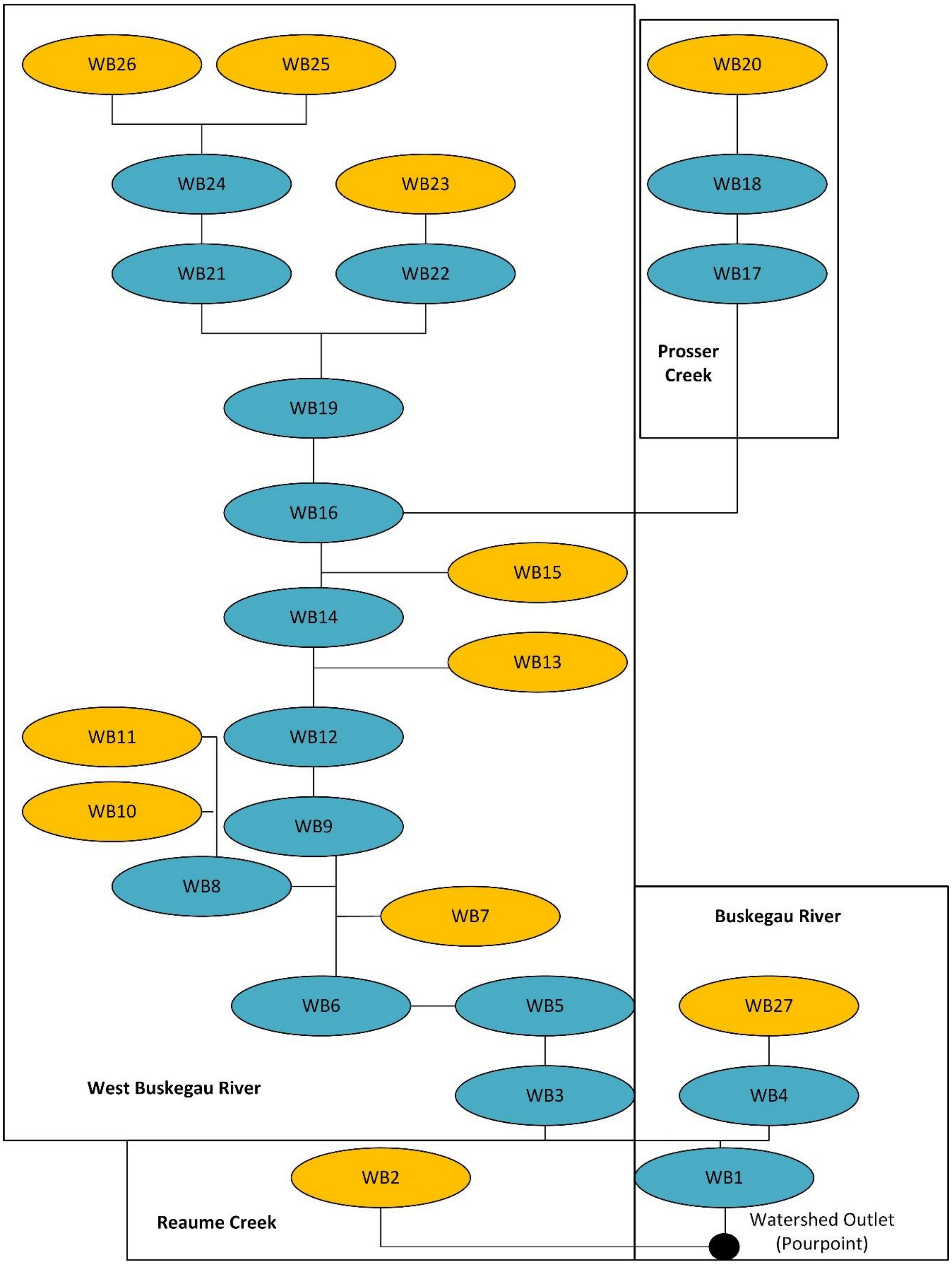


Figure A.3 Baseline North Driftwood River Subwatershed Flow Network



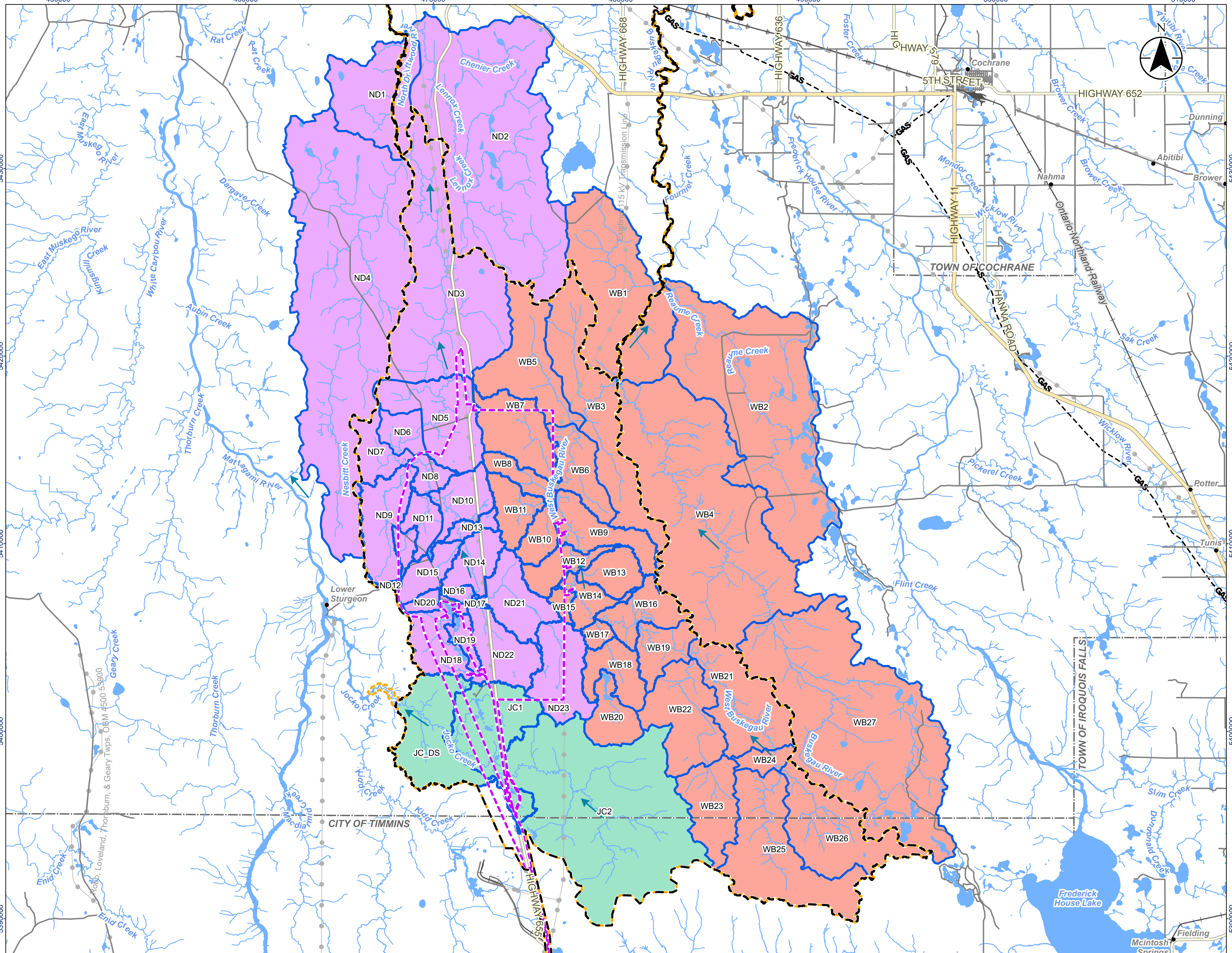


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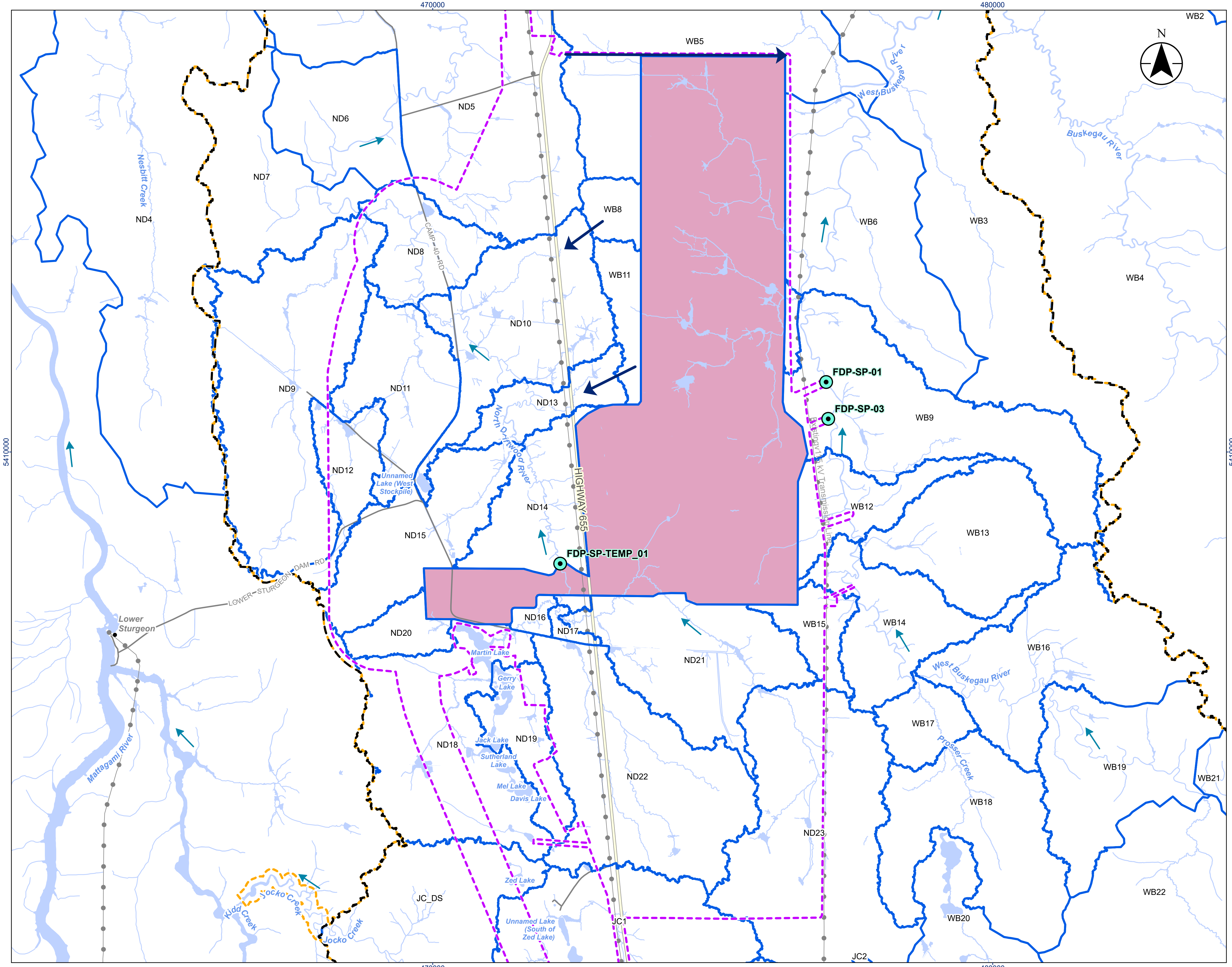
Figure No.
A.4

Title
Baseline Watershed Areas



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Regional Study Area

Base Features

- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Existing Condition Subwatershed
- Subwatershed Reports to Mine Water Management System
- Non-Contact Flow Diversion Direction
- Watercourse Flow Direction
- Discharge Location

0 1 2 km

1:70,000 (At original document size of 11x17)

Notes

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Canada Nickel Company (CNC)
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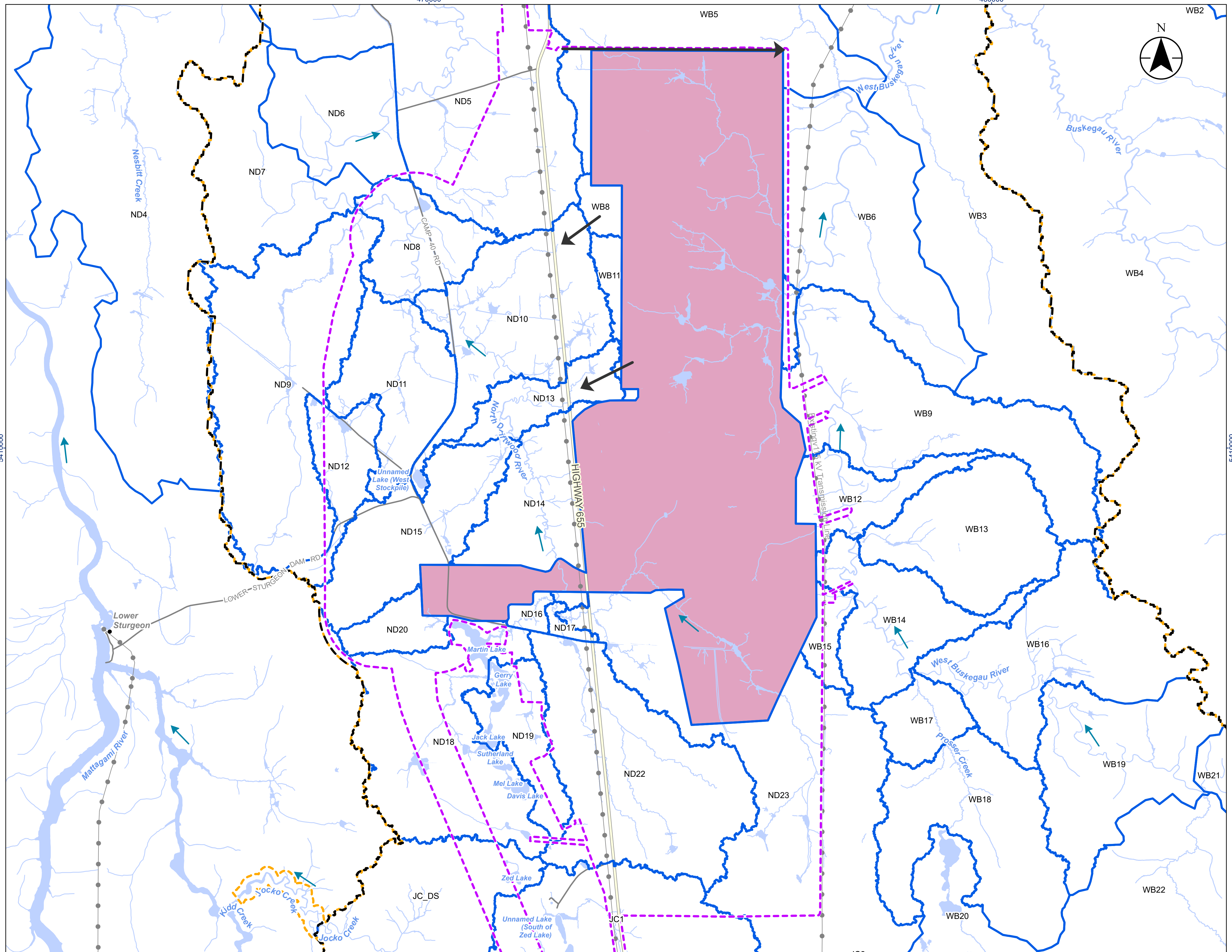
Figure No.
A.5

Title
Project Area Watersheds and Subwatersheds - Construction Phase: Year -3 to -1



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CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Regional Study Area

Base Features

- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Existing Condition Subwatershed
- Subwatershed Reports to Mine Water Management System
- Non-Contact Flow Diversion Direction
- Watercourse Flow Direction

0 1 2 km

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Client/Project
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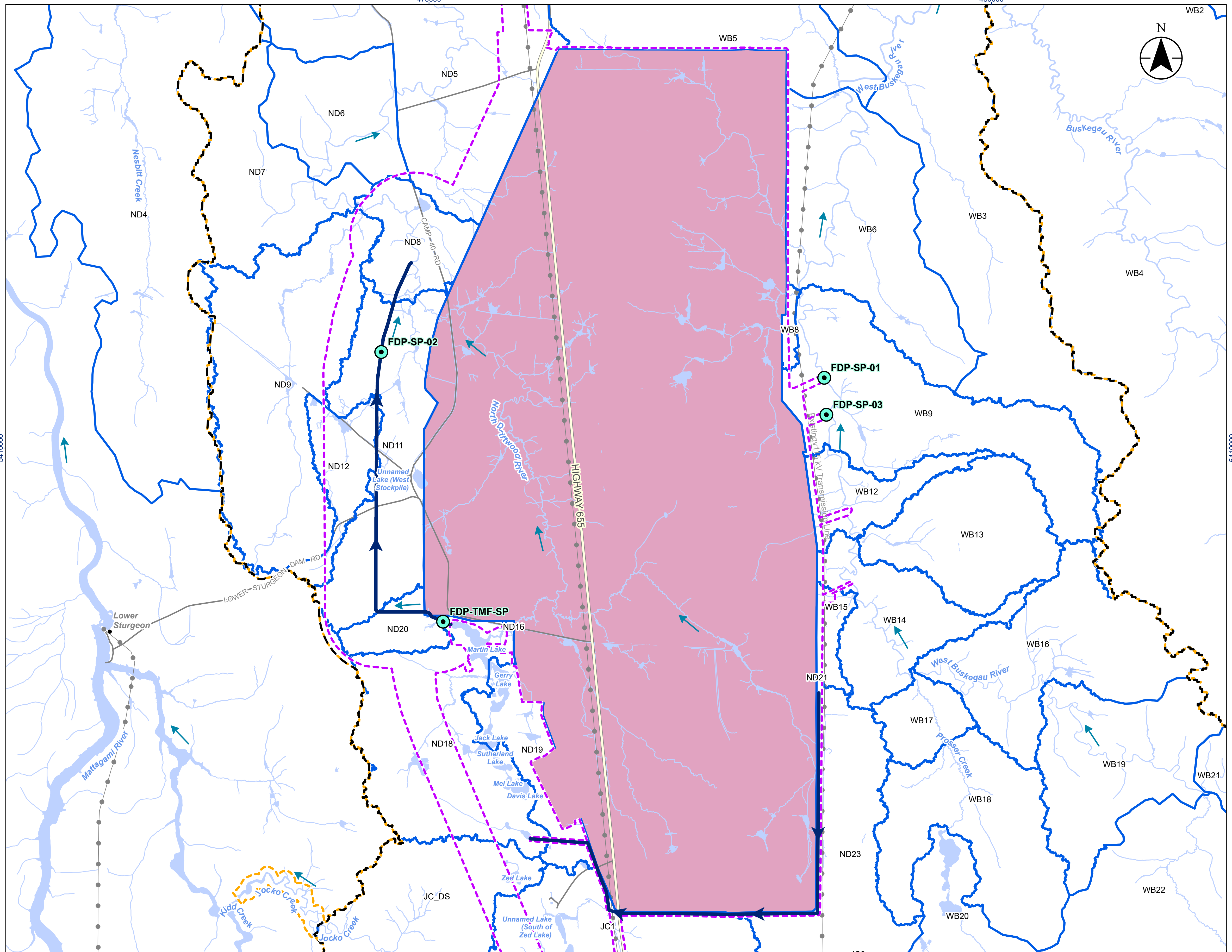
Figure No.
A.6

Title
Project Area Watersheds and Subwatersheds - Operations Phase 1: Year 1 to 4

Revised: 2024-09-11 By: tcoghlan



Legend

- Project Area
- Local Study Area
- Regional Study Area

Base Features

- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Existing Condition Subwatershed
- Subwatershed Reports to Mine Water Management System
- Non-Contact Diversion Channel
- Watercourse Flow Direction
- Discharge Location

0 1 2 km
1:70,000 (At original document size of 11x17)

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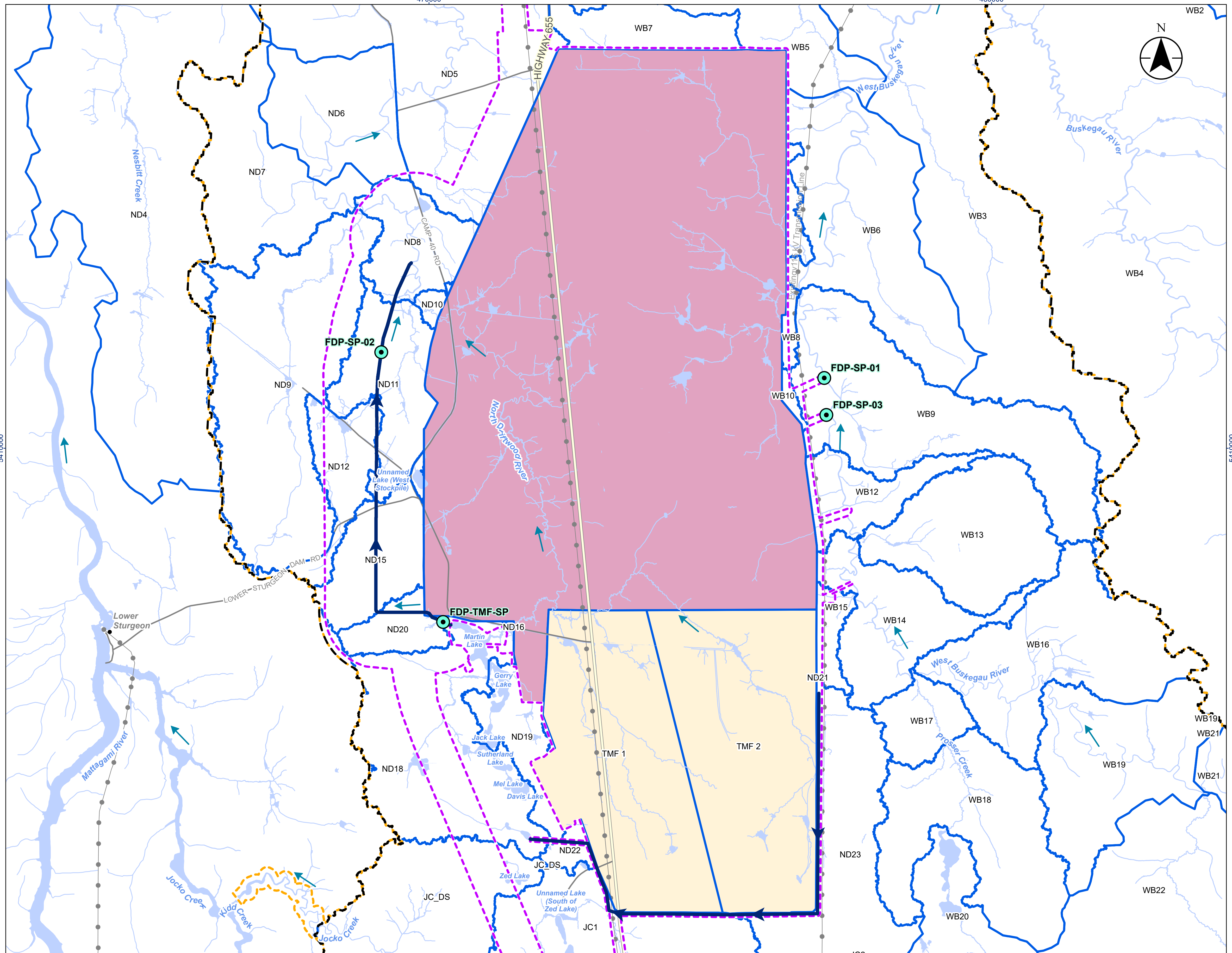
Figure No.
A.7

Title
Project Area Watersheds and Subwatersheds - Operations Phase 1 and 2: Year 4 to 18



Legend

- Project Area
- Local Study Area
- Regional Study Area
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Existing Condition Subwatershed
- Subwatershed Reports to Mine Water Management System
- Project Area Rehabilitated Subwatershed
- Non-Contact Diversion Channel
- Watercourse Flow Direction
- Discharge Location

0 1 2 km
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Ontario
Québec
Project Location
Thunder Bay
Timmins
Lake Superior
Sault Ste. Marie
North Bay
Sudbury
Ottawa
Wisconsin
Michigan

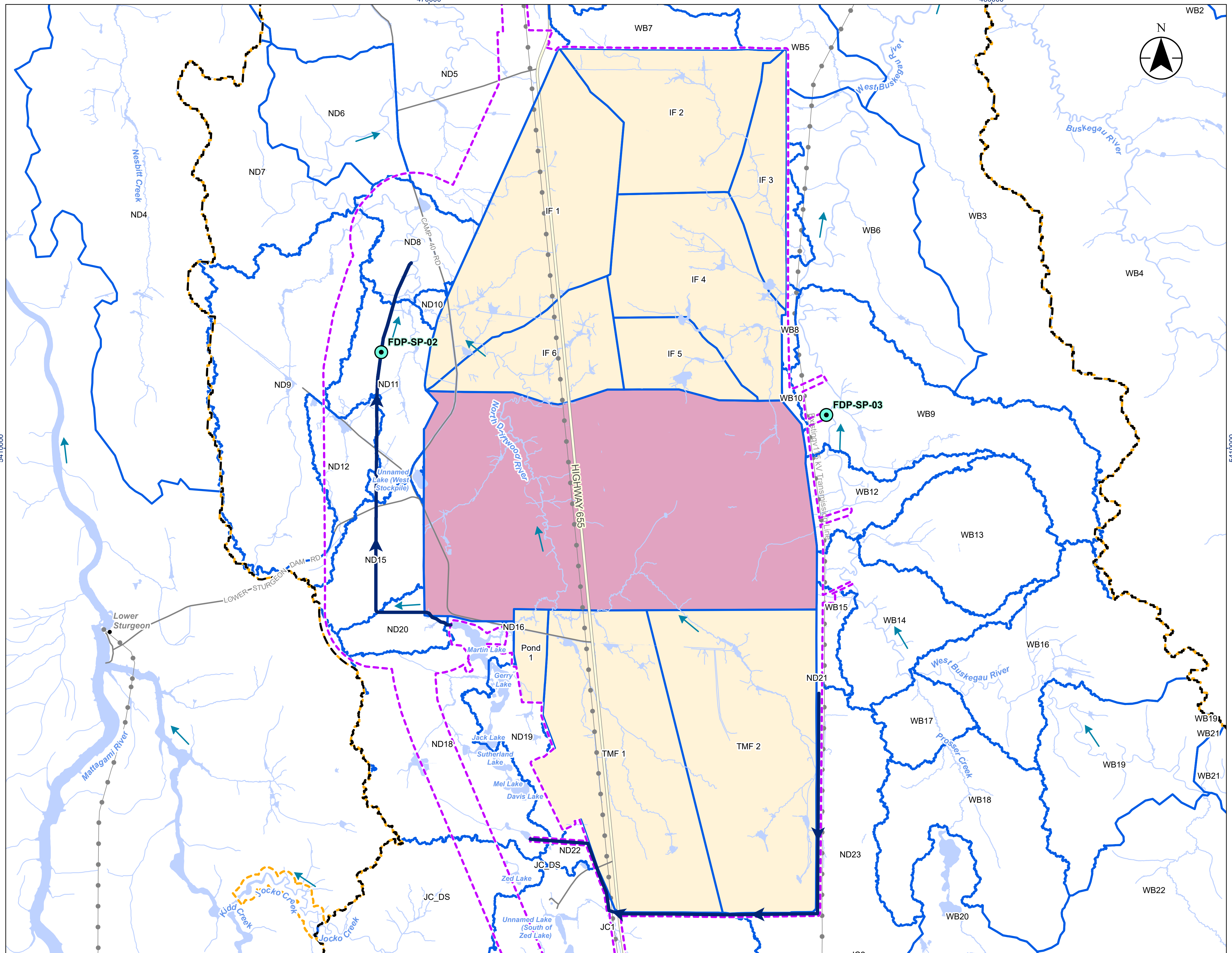
Project Location
Timmins, Ontario

160930456 REVA
Prepared by tcoghlan on 2024-09-11

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8

Title
Project Area Watersheds and Subwatersheds - Operations Phase 2: Year 23



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CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Regional Study Area
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Existing Condition Subwatershed
- Subwatershed Reports to Mine Water Management System
- Project Area Rehabilitated Subwatershed
- Non-Contact Diversion Channel
- Watercourse Flow Direction
- Discharge Location

0 1 2 km

1:70,000 (At original document size of 11x17)

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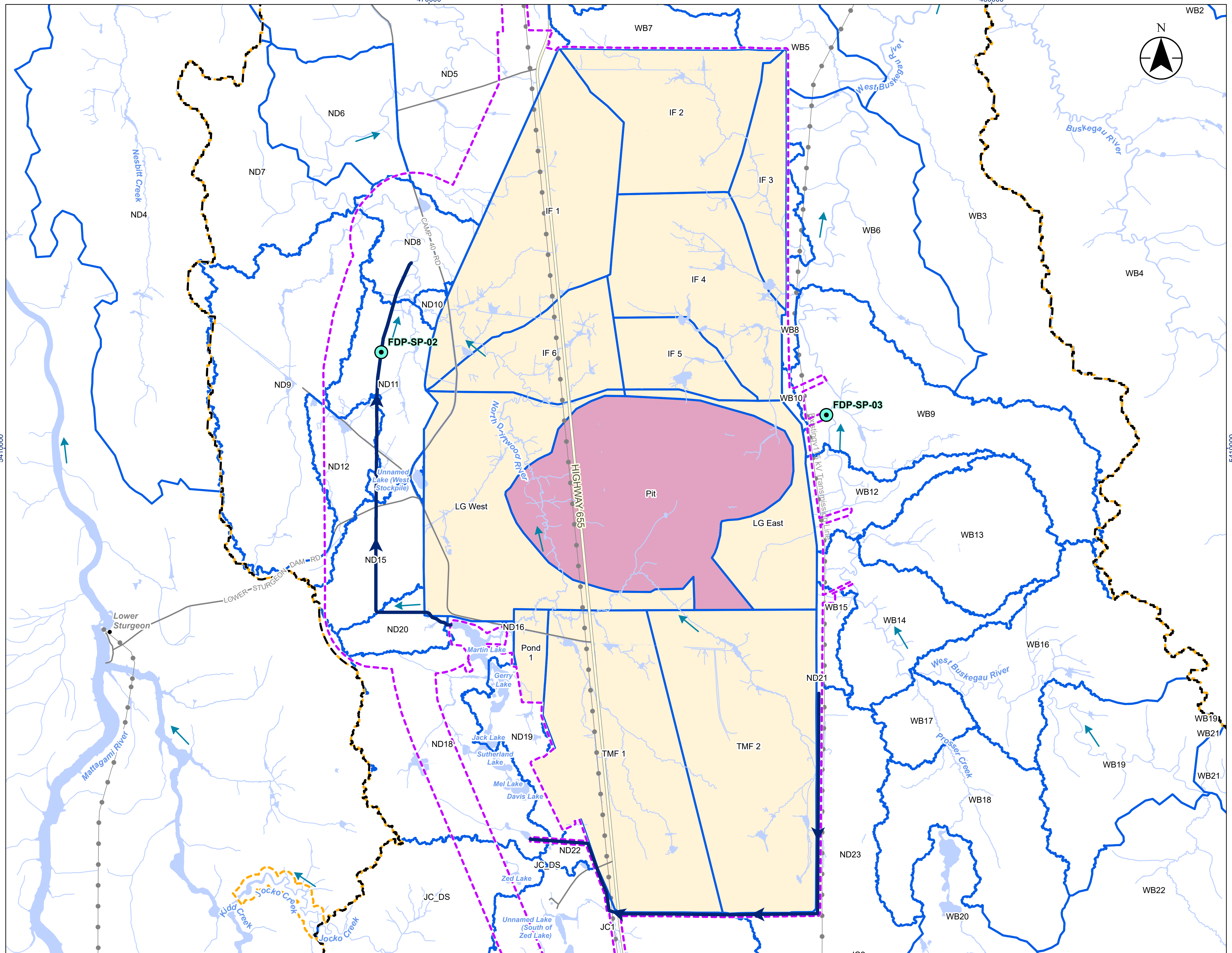
Crawford Nickel Project

Figure No.
A.9

Title
Project Area Watersheds and Subwatersheds - Operations Phase 3 Year 35 and 41



Legend

- Project Area
- Local Study Area
- Regional Study Area
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Existing Condition Subwatershed
- Subwatershed Reports to Mine Water Management System
- Project Area Rehabilitated Subwatershed
- Non-Contact Diversion Channel
- Watercourse Flow Direction
- Discharge Location

0 1 2 km
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Figure No.
A.10

Title
Project Area Watersheds and Subwatersheds - Passive Closure: Year 46+

Figure A.11 Passive Closure West Buskegau River Subwatershed Flow Network

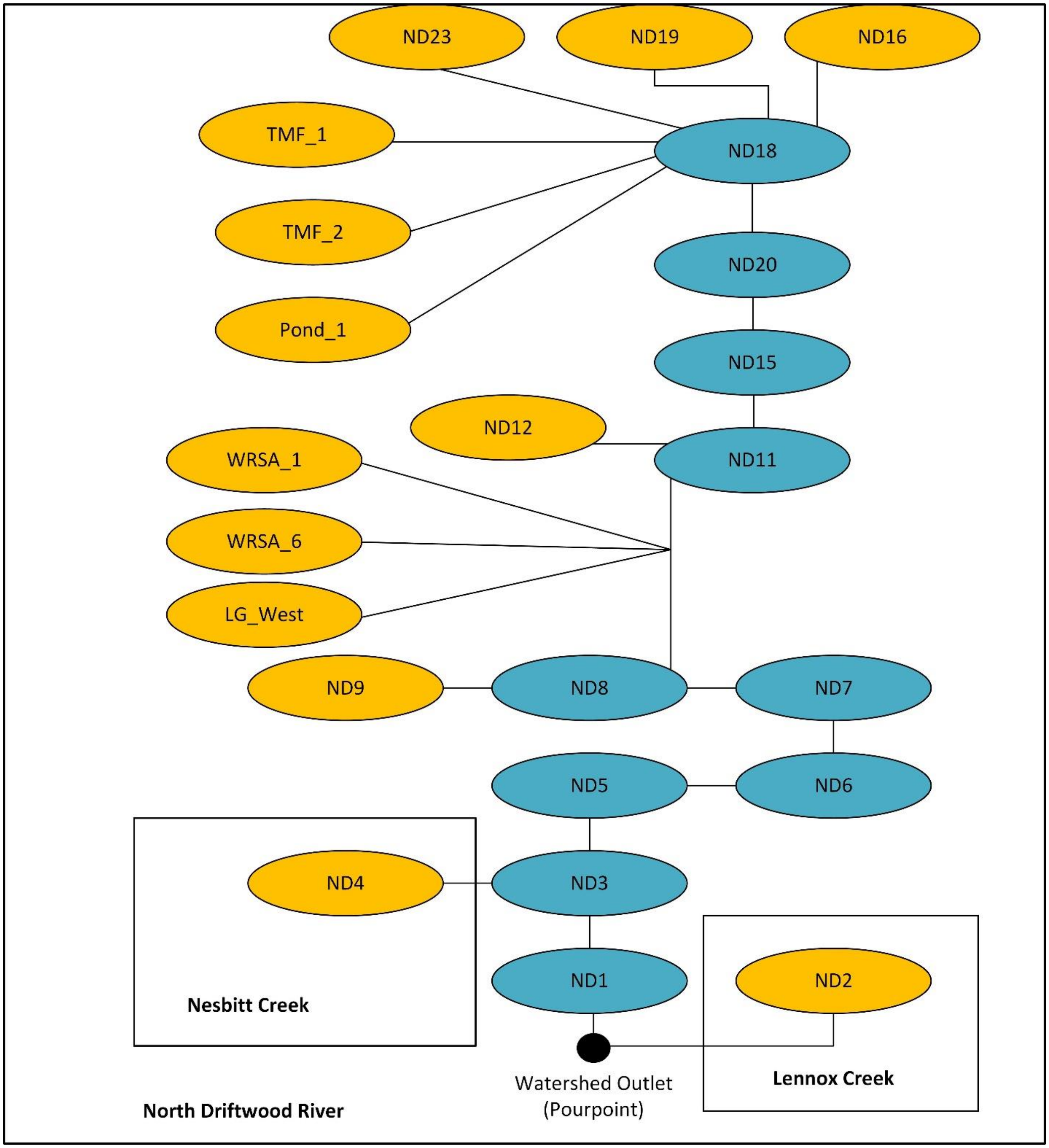
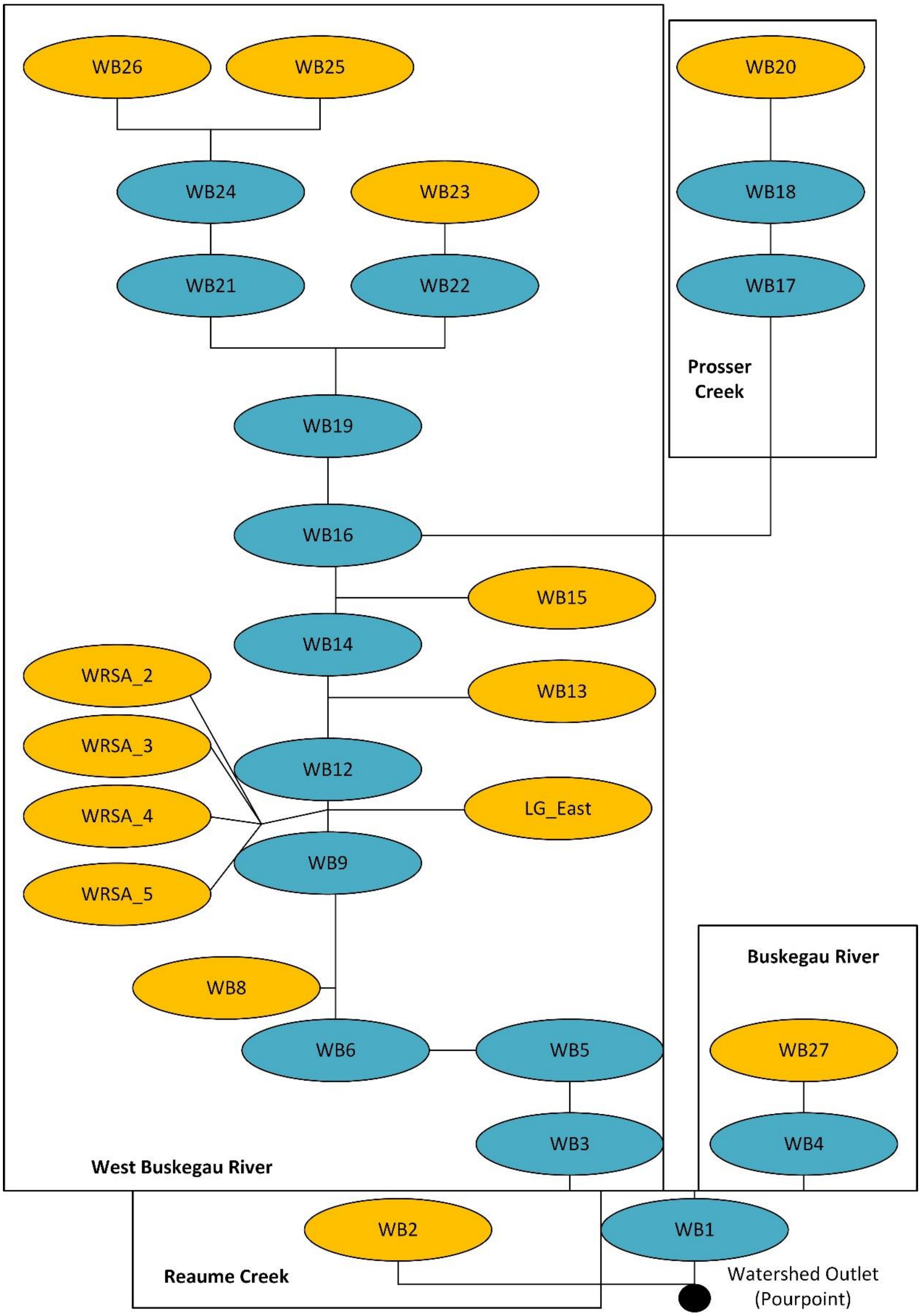
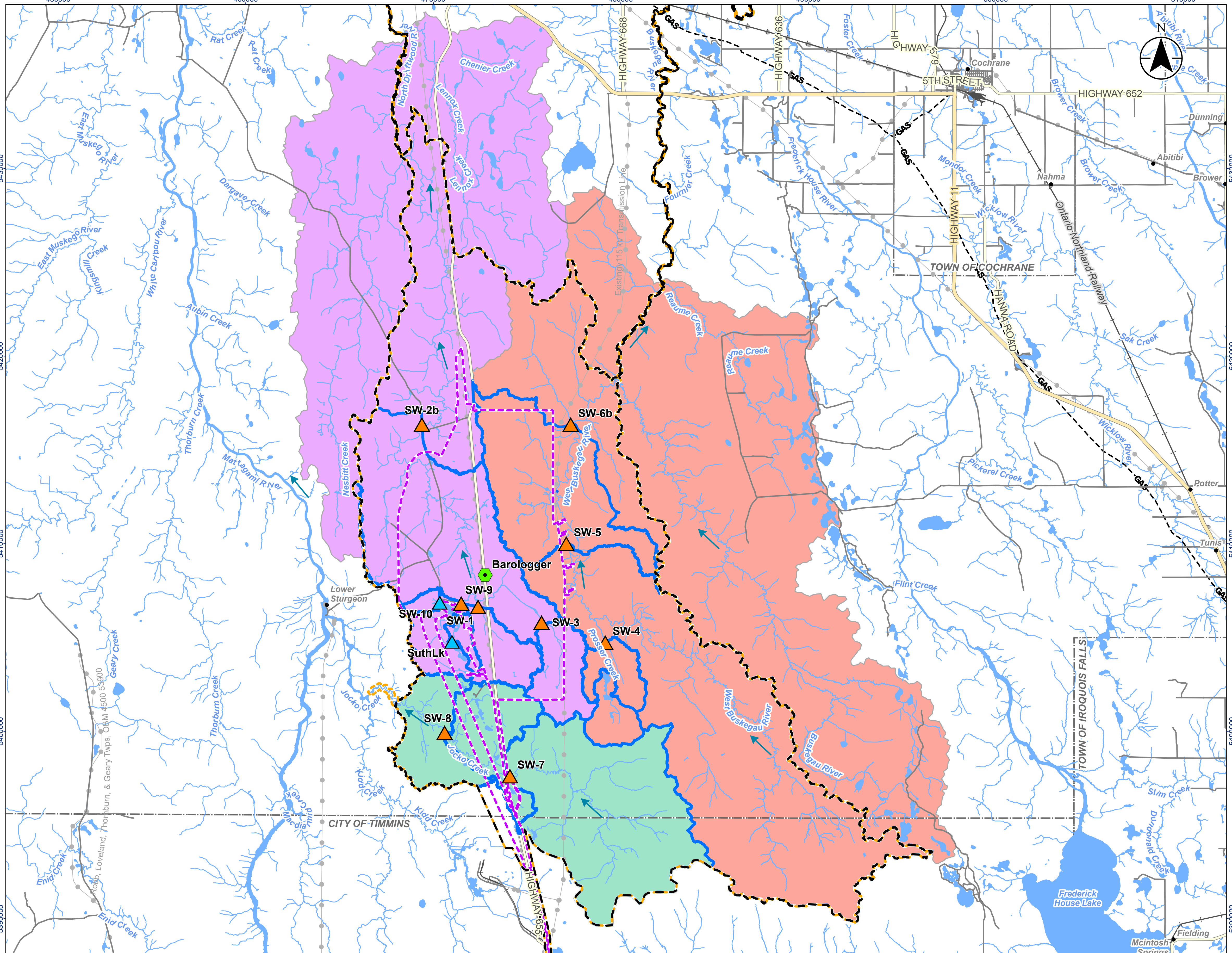


Figure A.12 Passive Closure North Driftwood River Subwatershed Flow Network





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CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Regional Study Area

Base Features

- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- GAS Natural Gas Pipeline
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier
- Barologger
- Hydrometric Staion
- Lake Level Monitoring Station
- Hydrometric Station Subwatershed
- Jocko Creek Watershed
- North Driftwood River Watershed
- West Buskegau River Watershed
- Watercourse Flow Direction

0 5 10 km

1:210,000 (At original document size of 11x17)

Notes

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Client/Project
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Crawford Nickel Project

Figure No.
A.13

Title
Hydrometric Monitoring Stations

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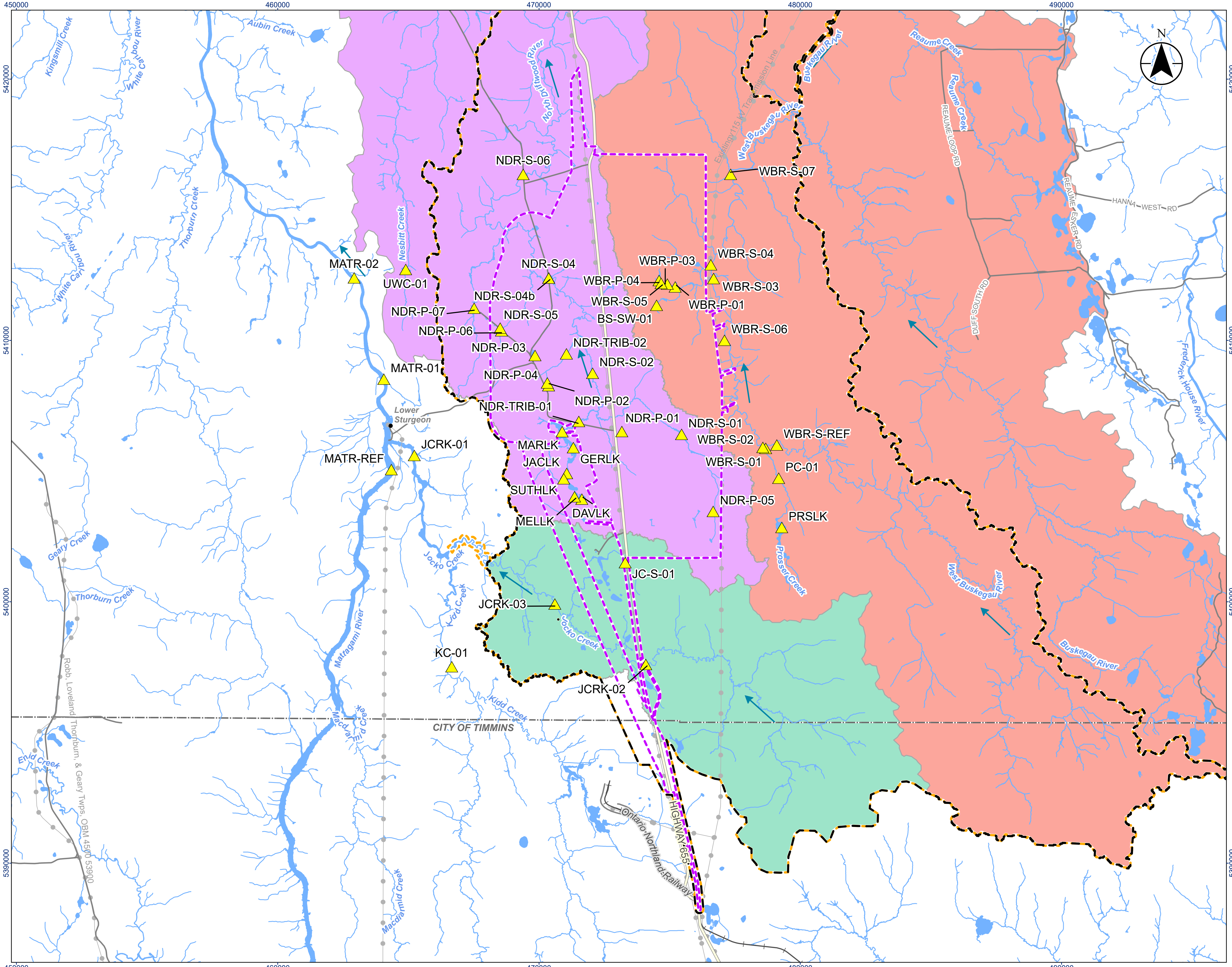

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Regional Study Area

Base Features

- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier
- Local Water Quality Monitoring Stations
- Jocko Creek Watershed
- North Driftwood River Watershed
- West Buskegau River Watershed
- Watercourse Flow Direction

0 5 10 km

1:150,000 (At original document size of 11x17)

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Crawford Nickel Project

Figure No.
A.14

Title
Local Surface Water Quality Stations

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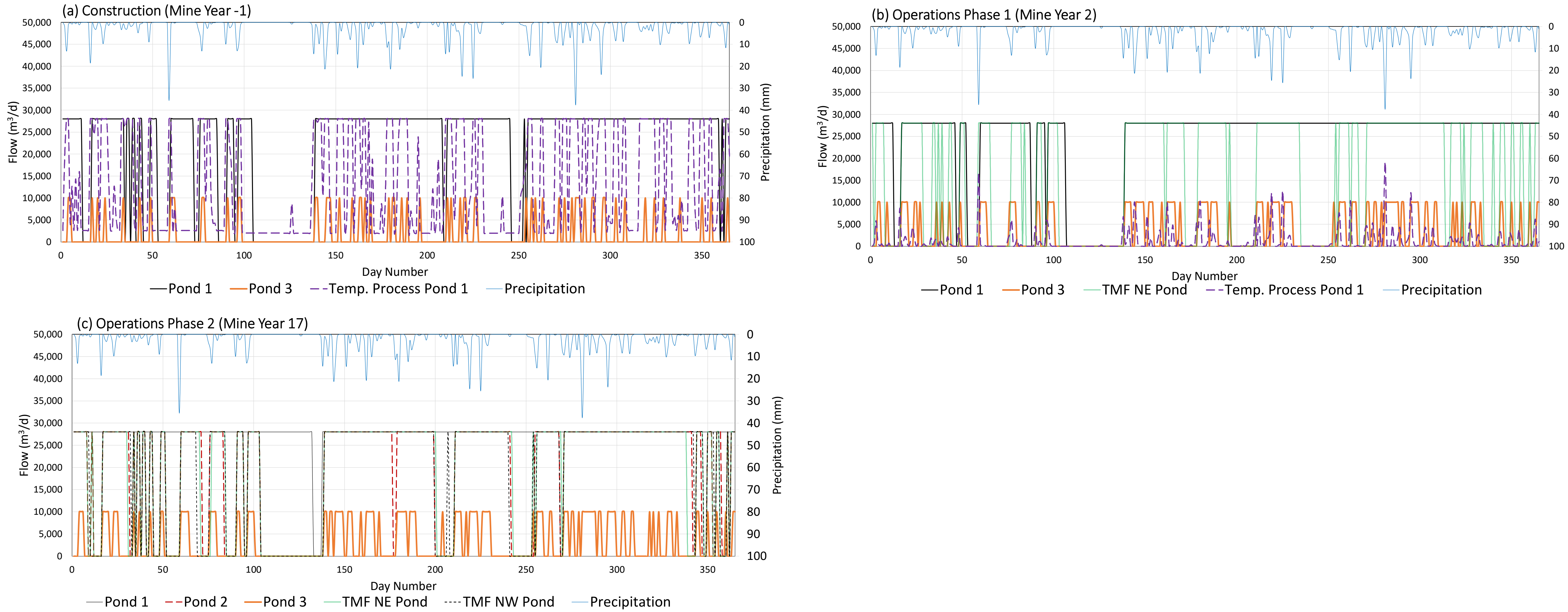
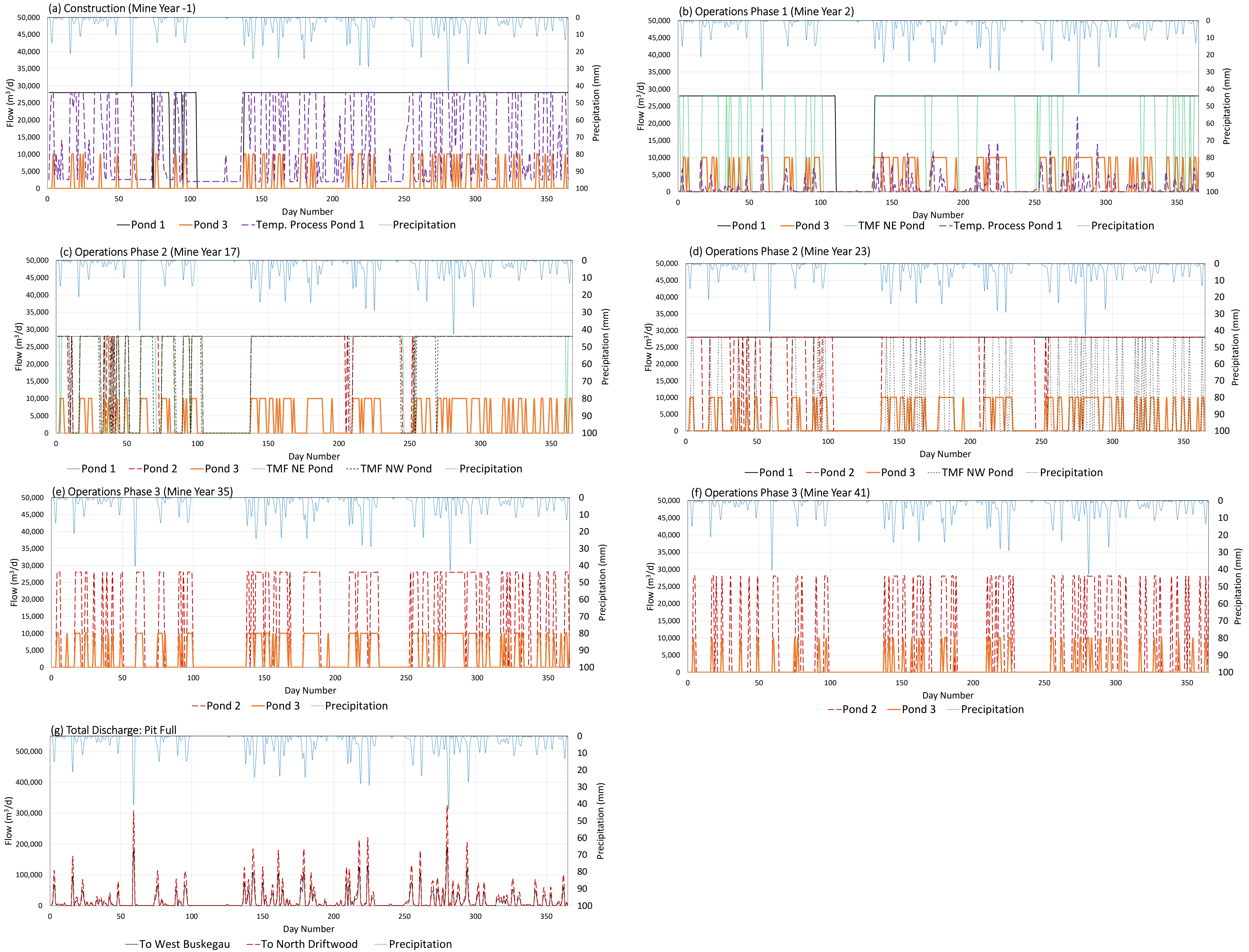
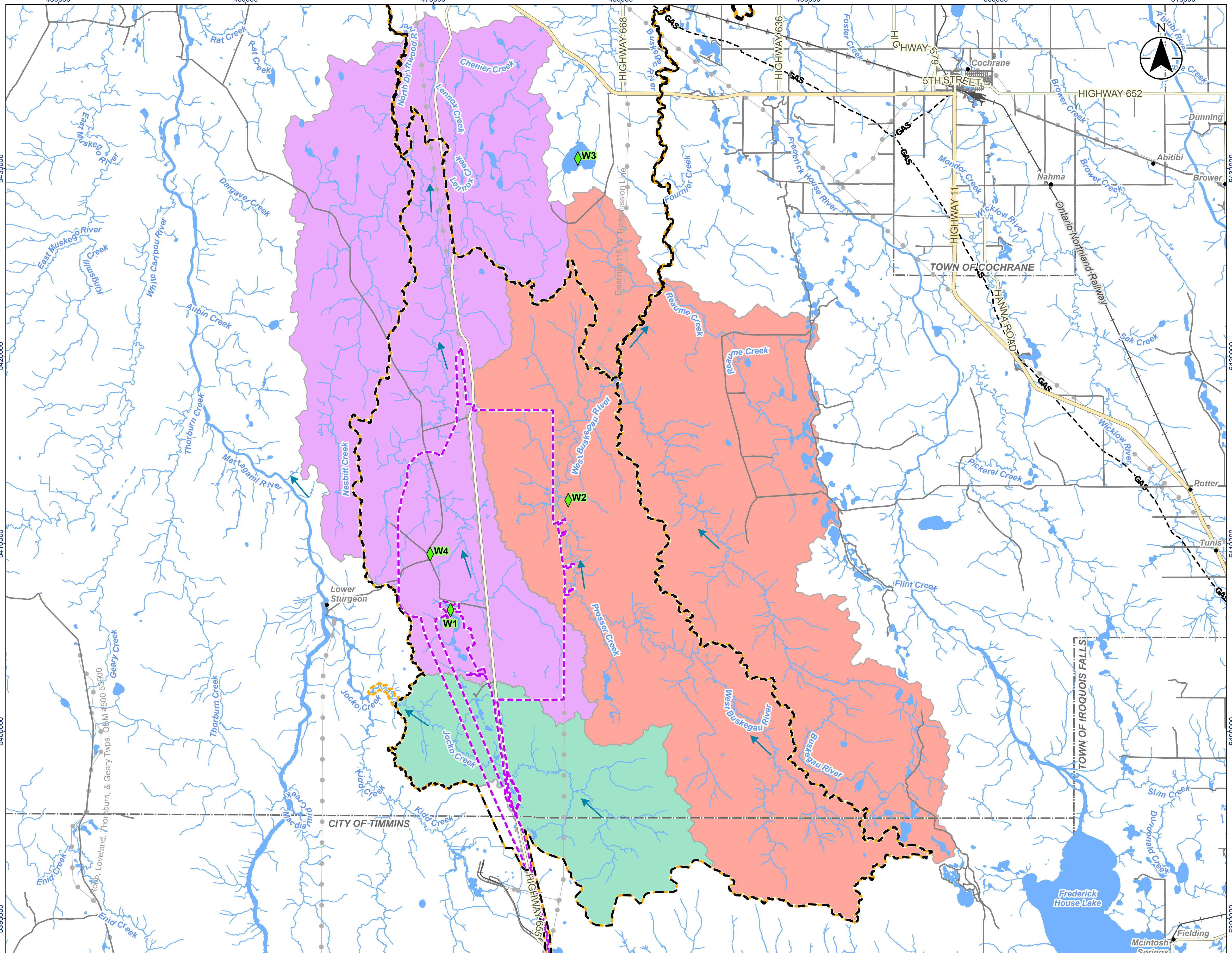


(a) Construction (Mine Year -1)
Flow (m³/d)
Precipitation (mm)
Day Number
Pond 1
Pond 3
Temp. Process Pond 1
Precipitation
(b) Operations Phase 1 (Mine Year 2)
Flow (m³/d)
Precipitation (mm)
Day Number
Pond 1
Pond 3
TMF NE Pond
Temp. Process Pond 1
Precipitation
(c) Operations Phase 2 (Mine Year 17)
Flow (m³/d)
Precipitation (mm)
Day Number
Pond 1
Pond 2
Pond 3
TMF NE Pond
TMF NW Pond
Precipitation


(a) Construction (Mine Year -1)
Flow (m³/d)
Precipitation (mm)
Day Number
Pond 1
Pond 3
Temp. Process Pond 1
Precipitation
(b) Operations Phase 1 (Mine Year 2)
Flow (m³/d)
Precipitation (mm)
Day Number
Pond 1
Pond 3
TMF NE Pond
Temp. Process Pond 1
Precipitation
(c) Operations Phase 2 (Mine Year 17)
Flow (m³/d)
Precipitation (mm)
Day Number
Pond 1
Pond 2
Pond 3
TMF NE Pond
TMF NW Pond
Precipitation
(d) Operations Phase 2 (Mine Year 23)
Flow (m³/d)
Precipitation (mm)
Day Number
Pond 1
Pond 2
Pond 3
TMF NW Pond
Precipitation
(e) Operations Phase 3 (Mine Year 35)
Flow (m³/d)
Precipitation (mm)
Day Number
Pond 2
Pond 3
Precipitation
(f) Operations Phase 3 (Mine Year 41)
Flow (m³/d)
Precipitation (mm)
Day Number
Pond 2
Pond 3
Precipitation
(g) Total Discharge: Pit Full
Flow (m³/d)
Precipitation (mm)
Day Number
To West Buskegau
To North Driftwood
Precipitation



Legend

- Project Area
- Local Study Area
- Regional Study Area

Base Features

- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Natural Gas Pipeline
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier
- Surface Water Receptor
- Jocko Creek Watershed
- North Driftwood River Watershed
- West Buskegau River Watershed
- Watercourse Flow Direction

0 5 10 km

1:210,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.

Project Location
Timmins, Ontario

160930456 REVA
Prepared by tcoghlan on 2024-09-13

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.17

Title
Acid Deposition Surface Water Receptor Locations

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Figure A.18 Climate Change Adjusted Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB1

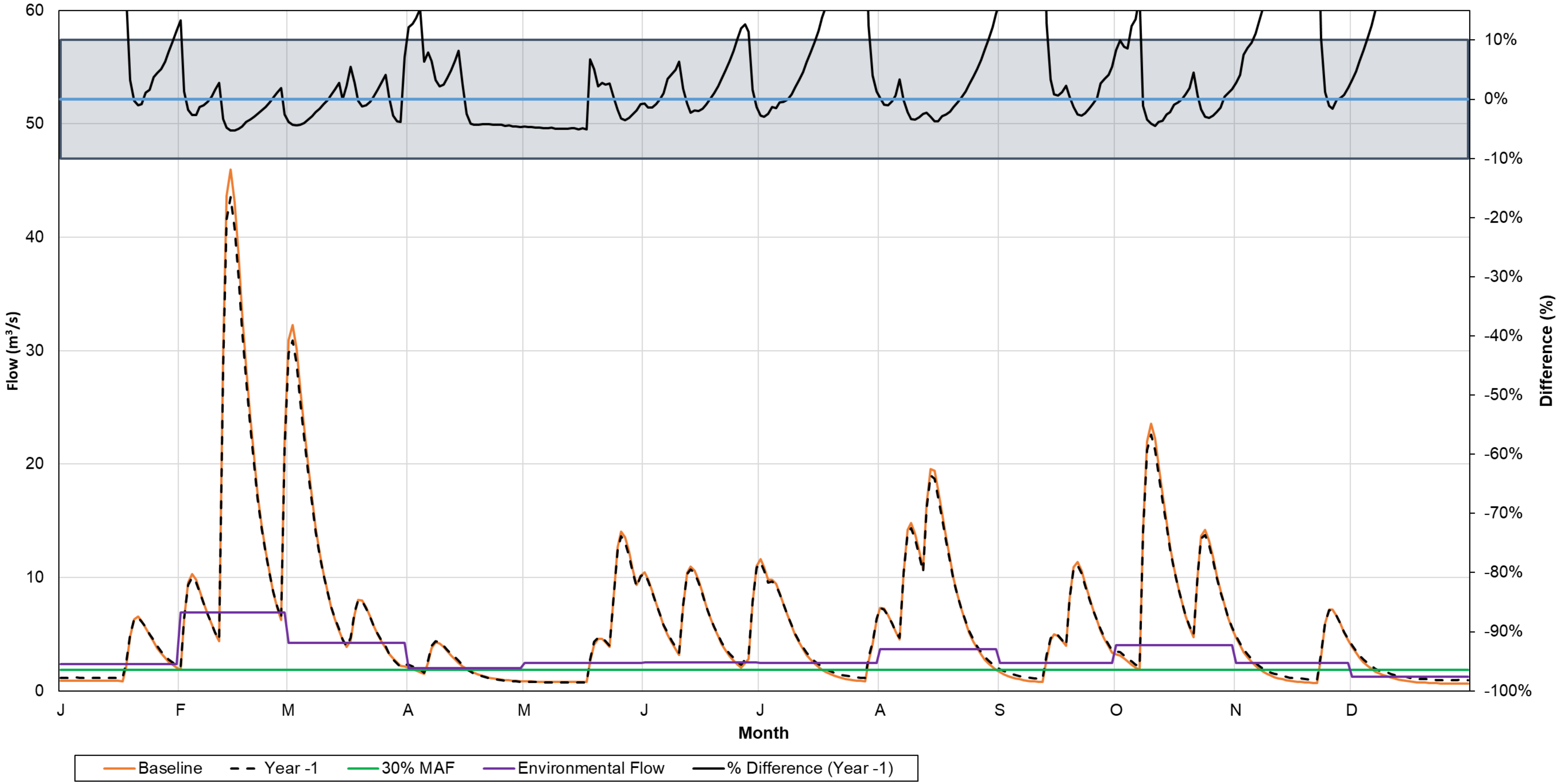


Figure A.19 Climate Change Adjusted Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB1

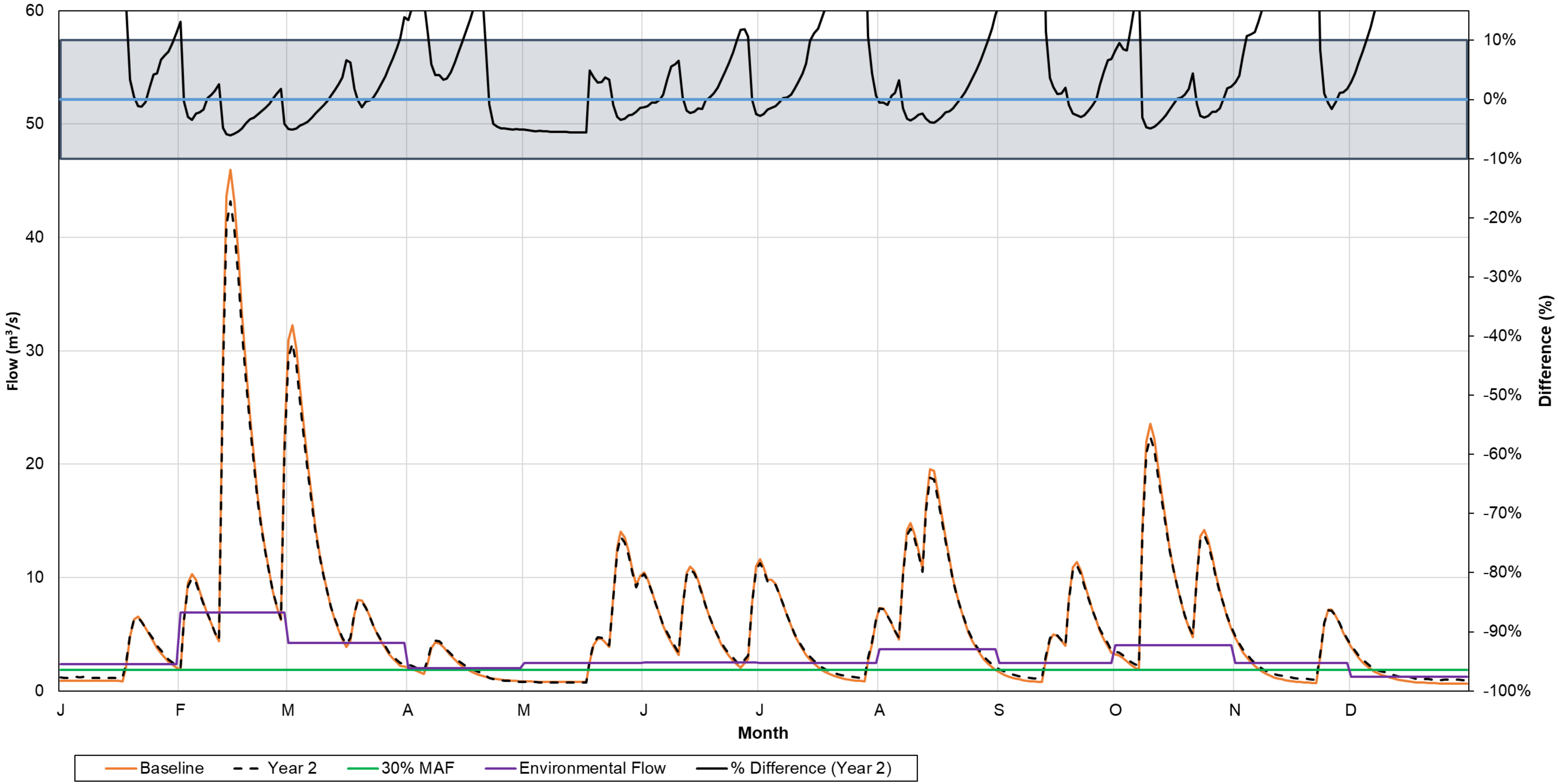


Figure A.20 Climate Change Adjusted Baseline and Year 23 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB1

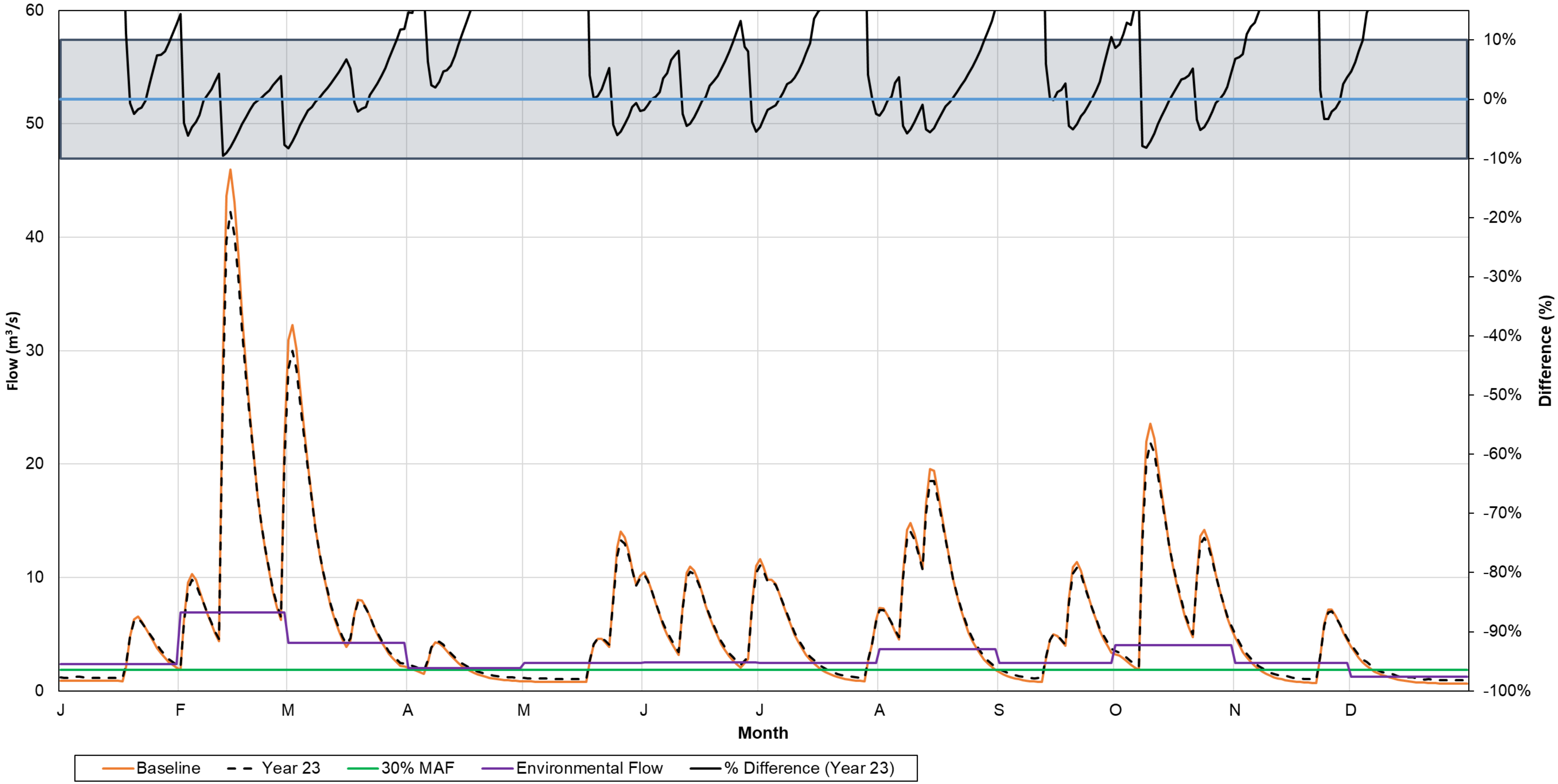


Figure A.21 Climate Change Adjusted Baseline and Year 35 (Operations Phase 3) Flows and Percent Changes for the West Buskegau River Watershed – WB1

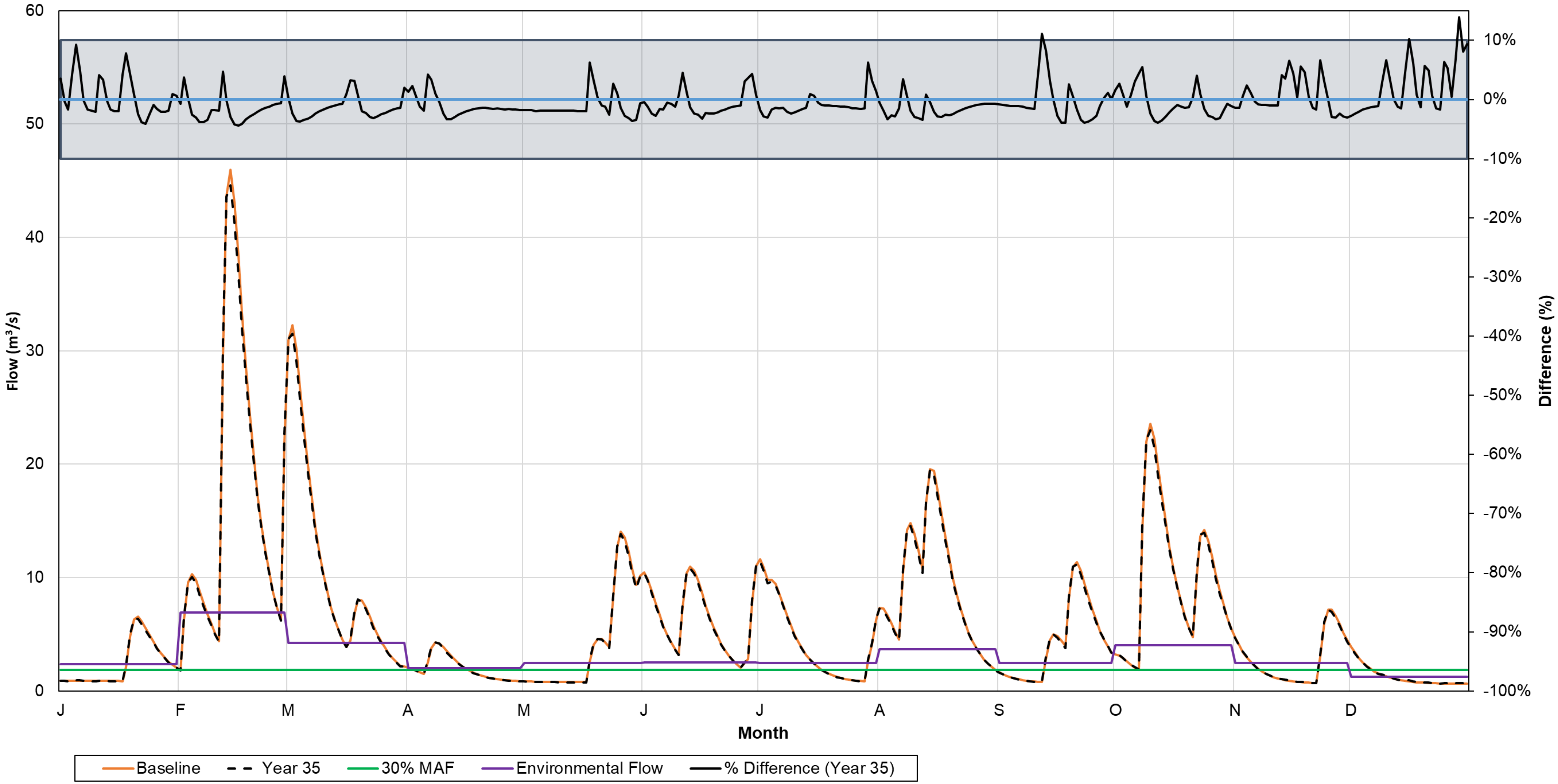


Figure A.22 Climate Change Adjusted Baseline and Year 41 (Operations Phase 3) Flows and Percent Changes for the West Buskegau River Watershed – WB1

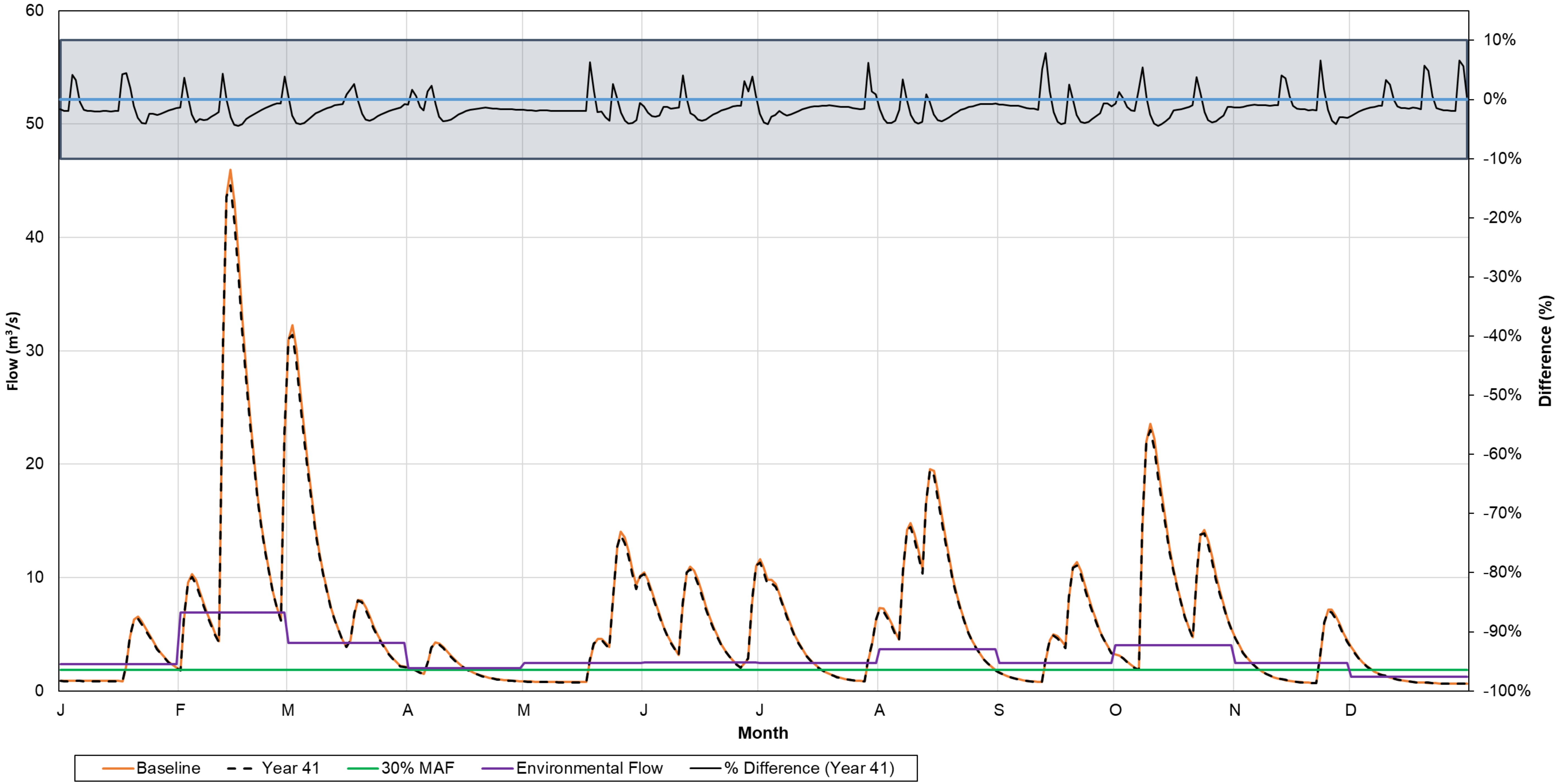


Figure A.23 Climate Change Adjusted Baseline and Year 47 (Passive Closure Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB1

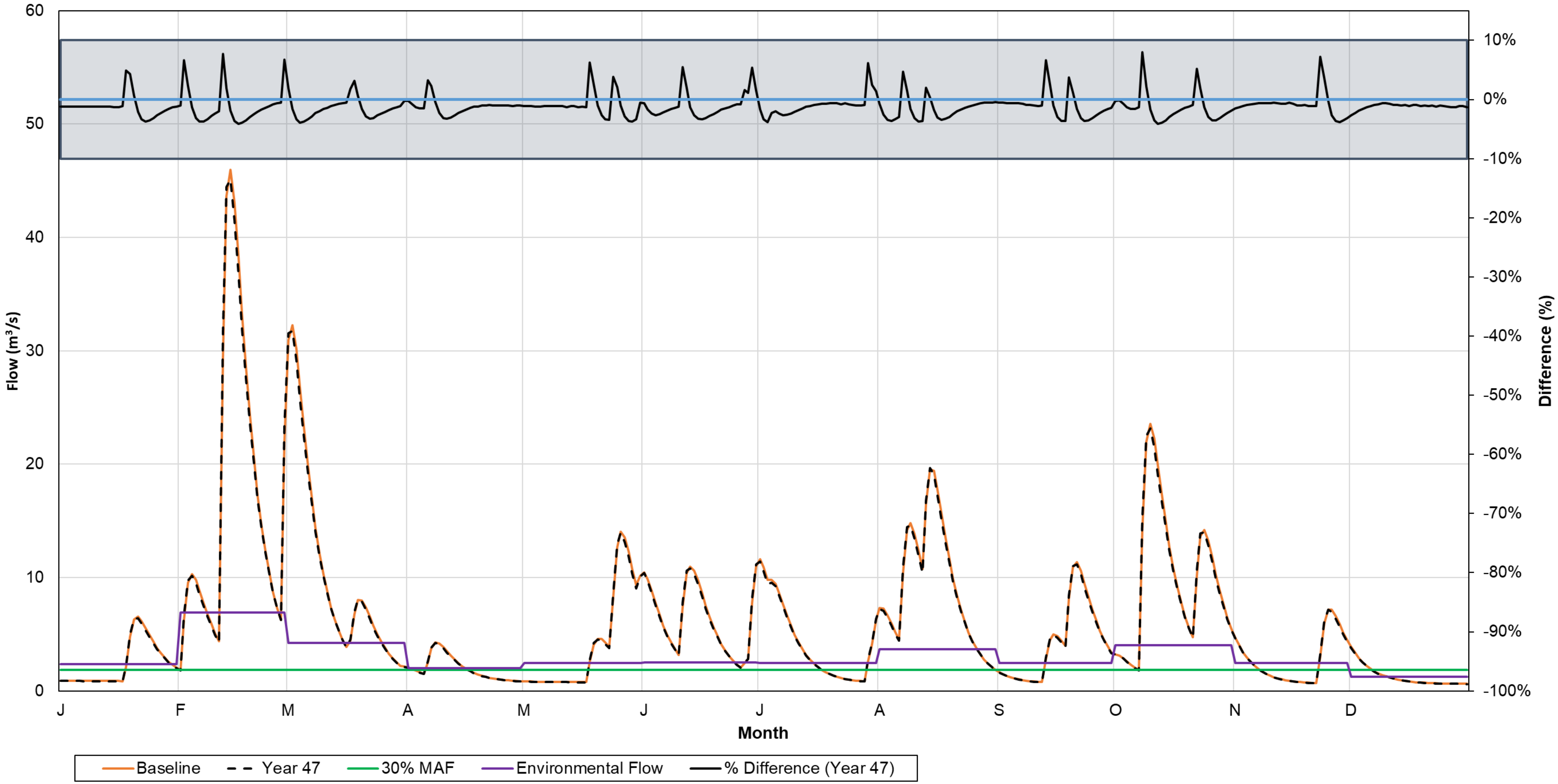


Figure A.24 Climate Change Adjusted Baseline and Pit Full Flows and Percent Changes for the West Buskegau River Watershed – WB1

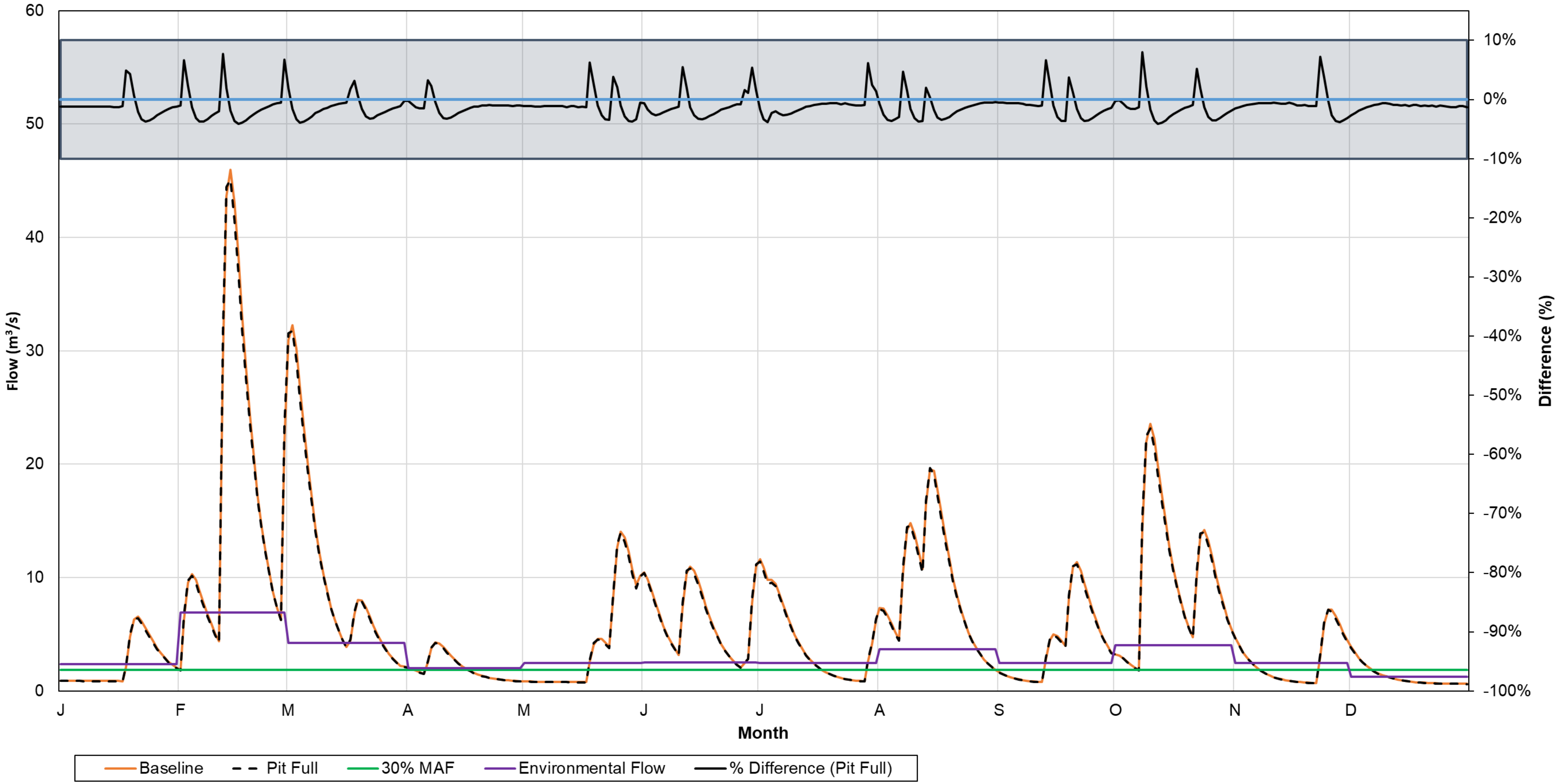


Figure A.25 Climate Change Adjusted Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB5

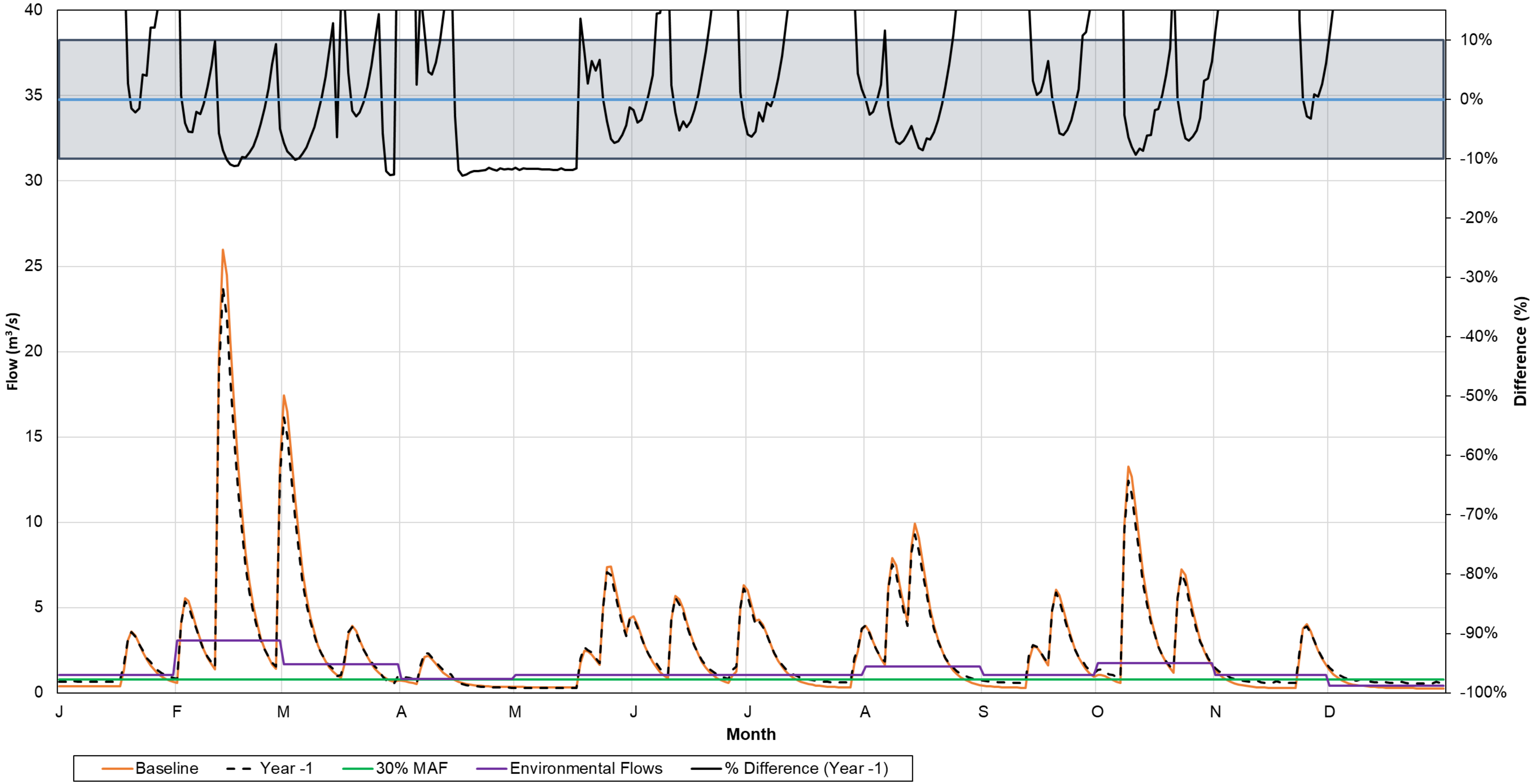


Figure A.26 Climate Adjusted Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB5

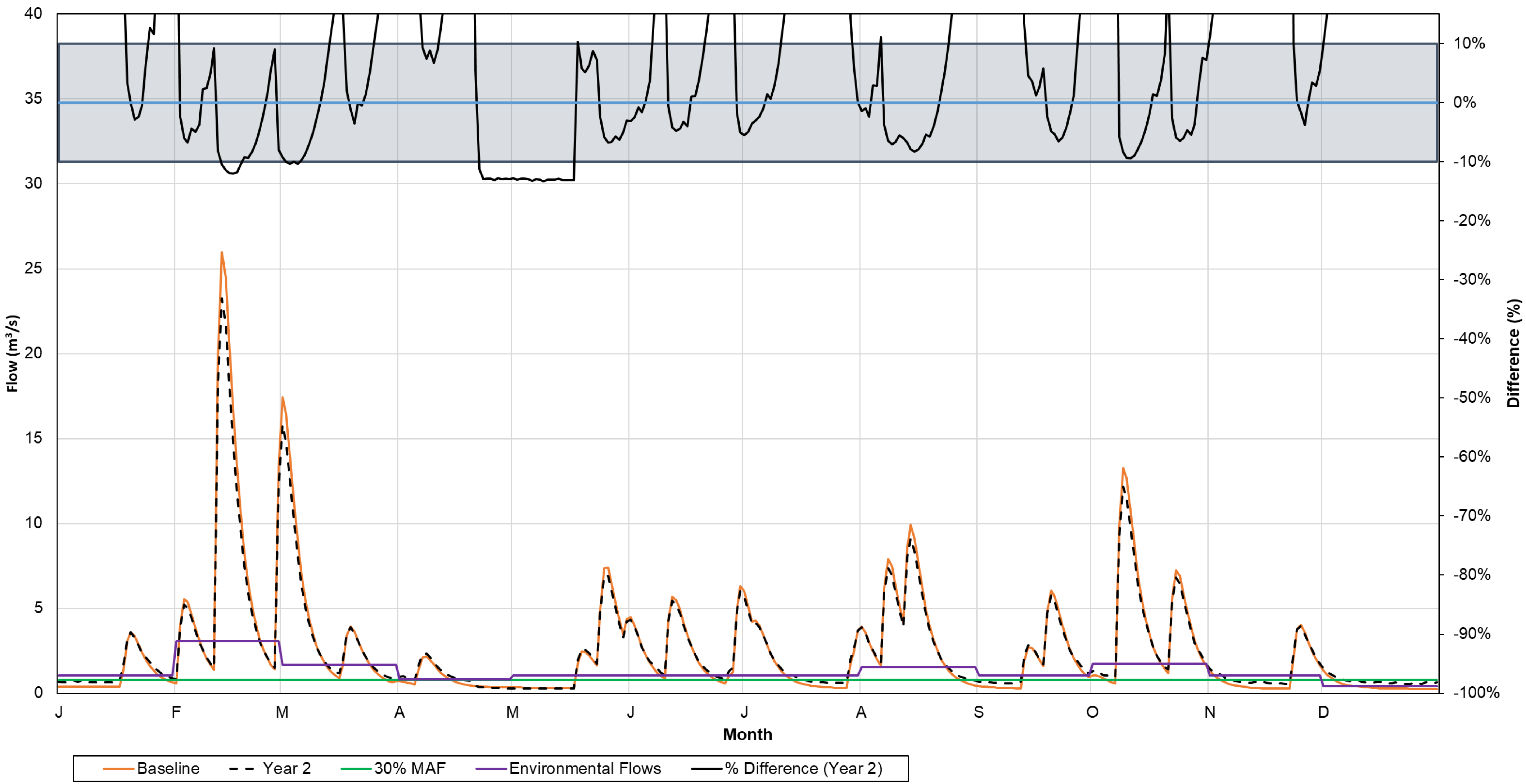


Figure A.27 Climate Change Adjusted Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB5

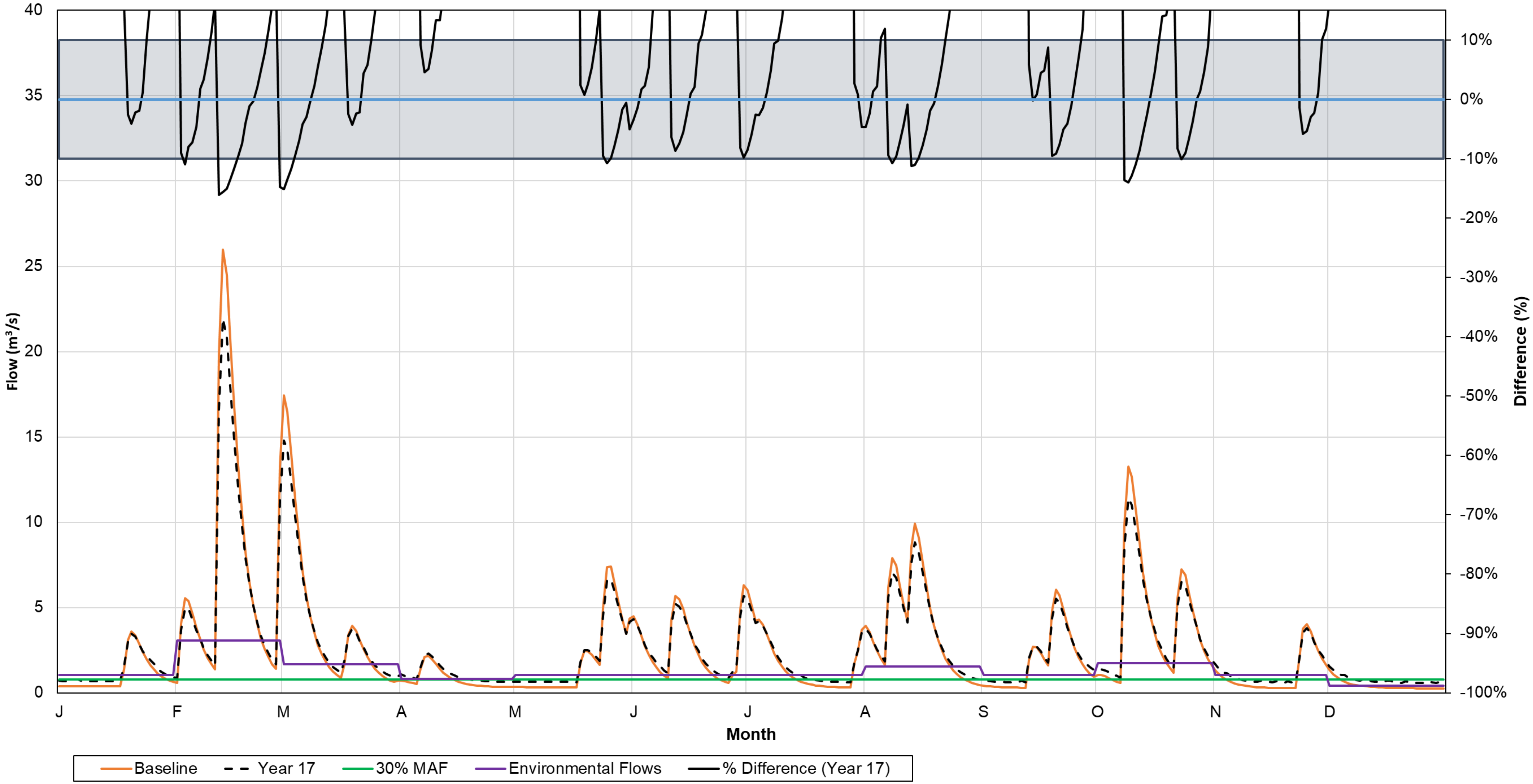


Figure A.28 Climate Change Adjusted Baseline and Year 23 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB5

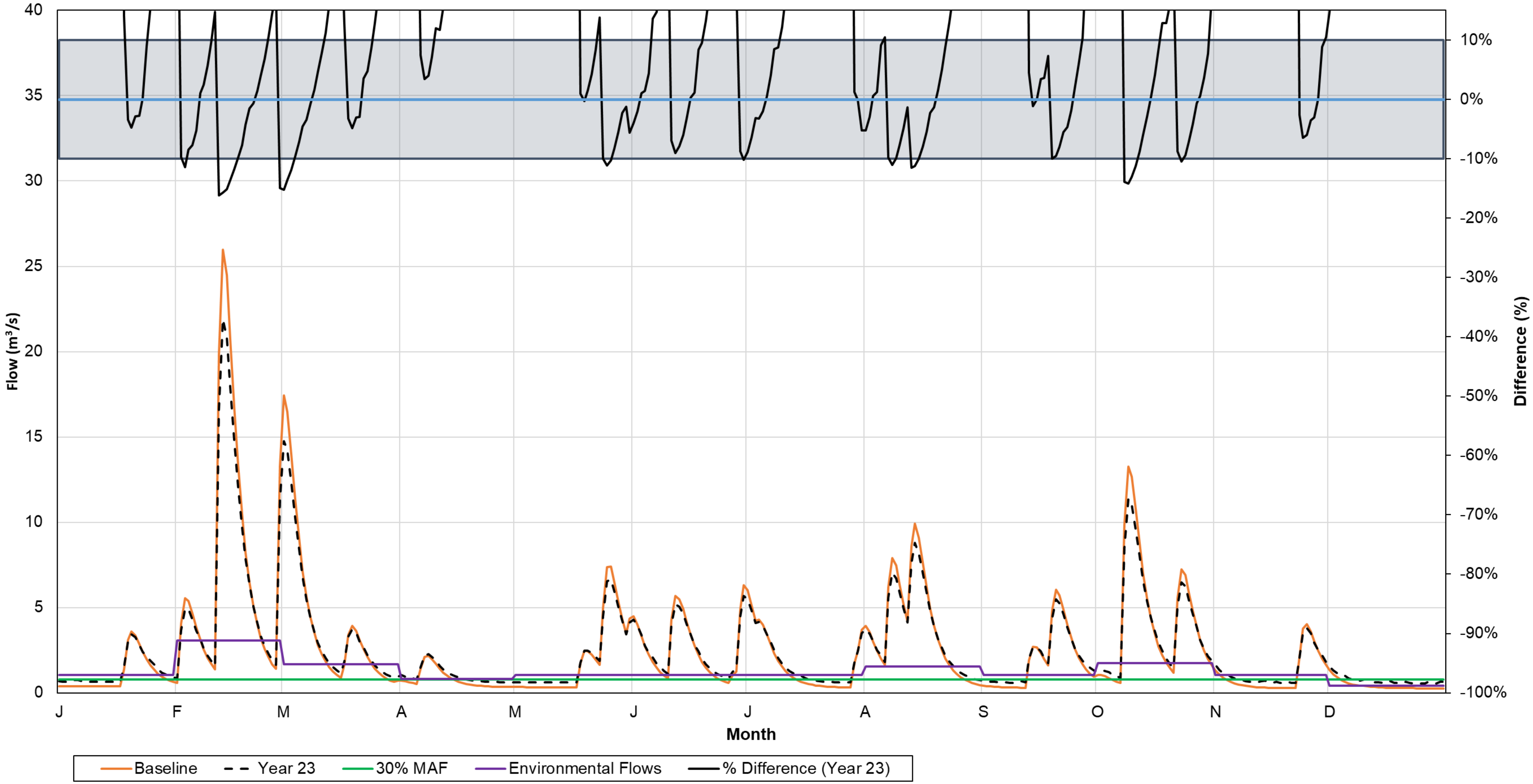


Figure A.29 Climate Change Adjusted Baseline and Year 35 (Operations Phase 3) Flows and Percent Changes for the West Buskegau River Watershed – WB5

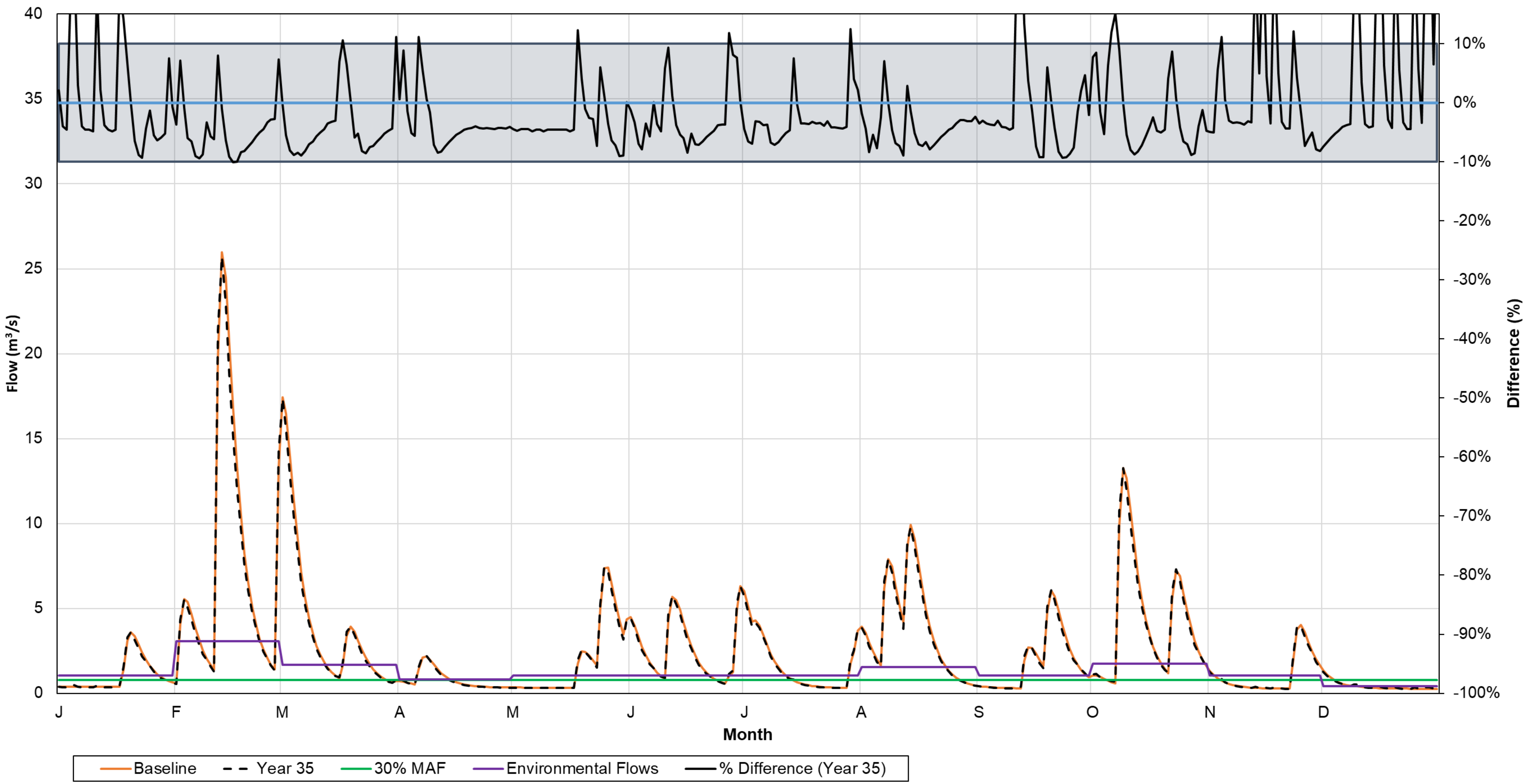


Figure A.30 Climate Change Adjusted Baseline and Year 41 (Operations Phase 3) Flows and Percent Changes for the West Buskegau River Watershed – WB5

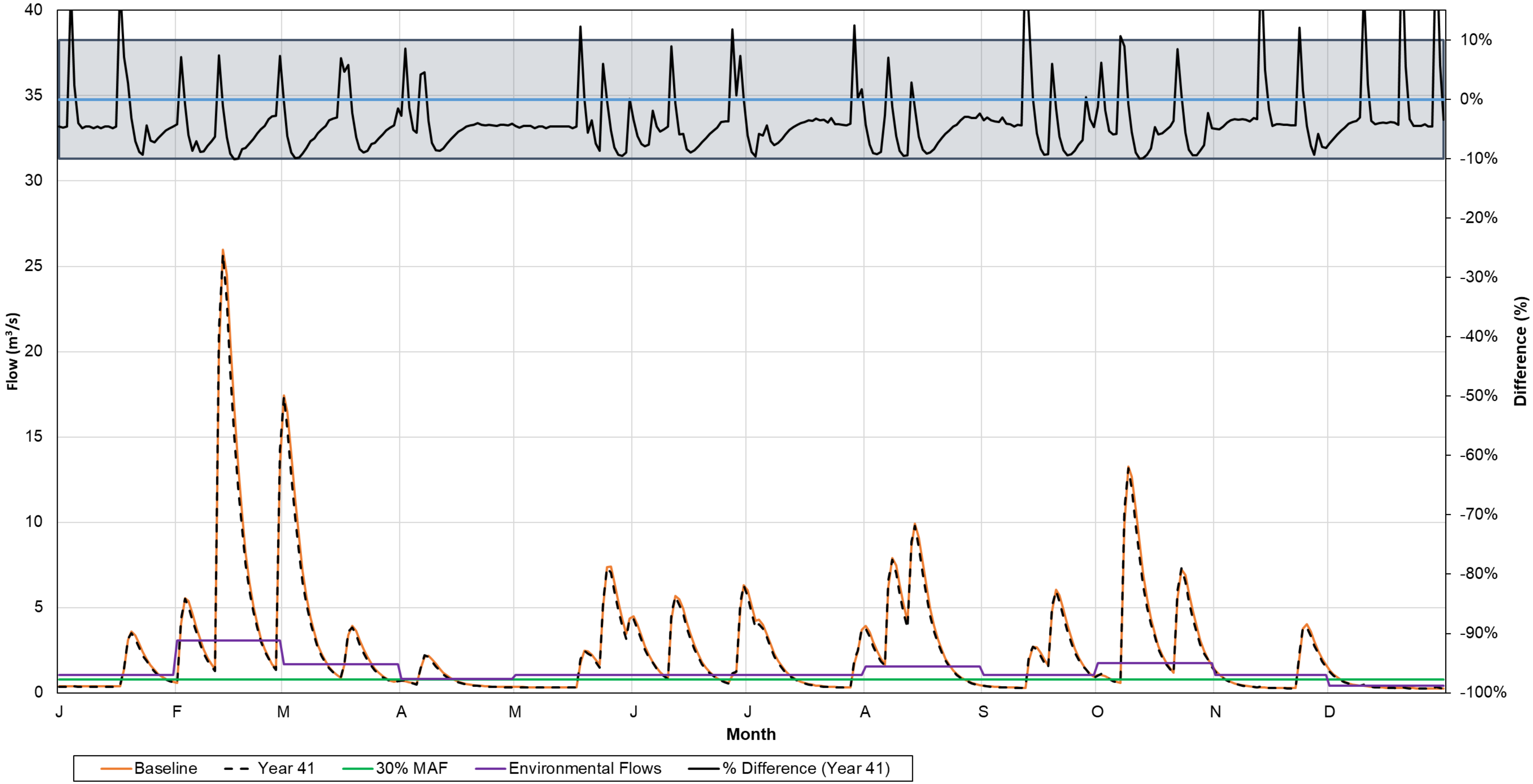


Figure A.31 Climate Change Adjusted Baseline and Year 47 (Passive Closure Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB5

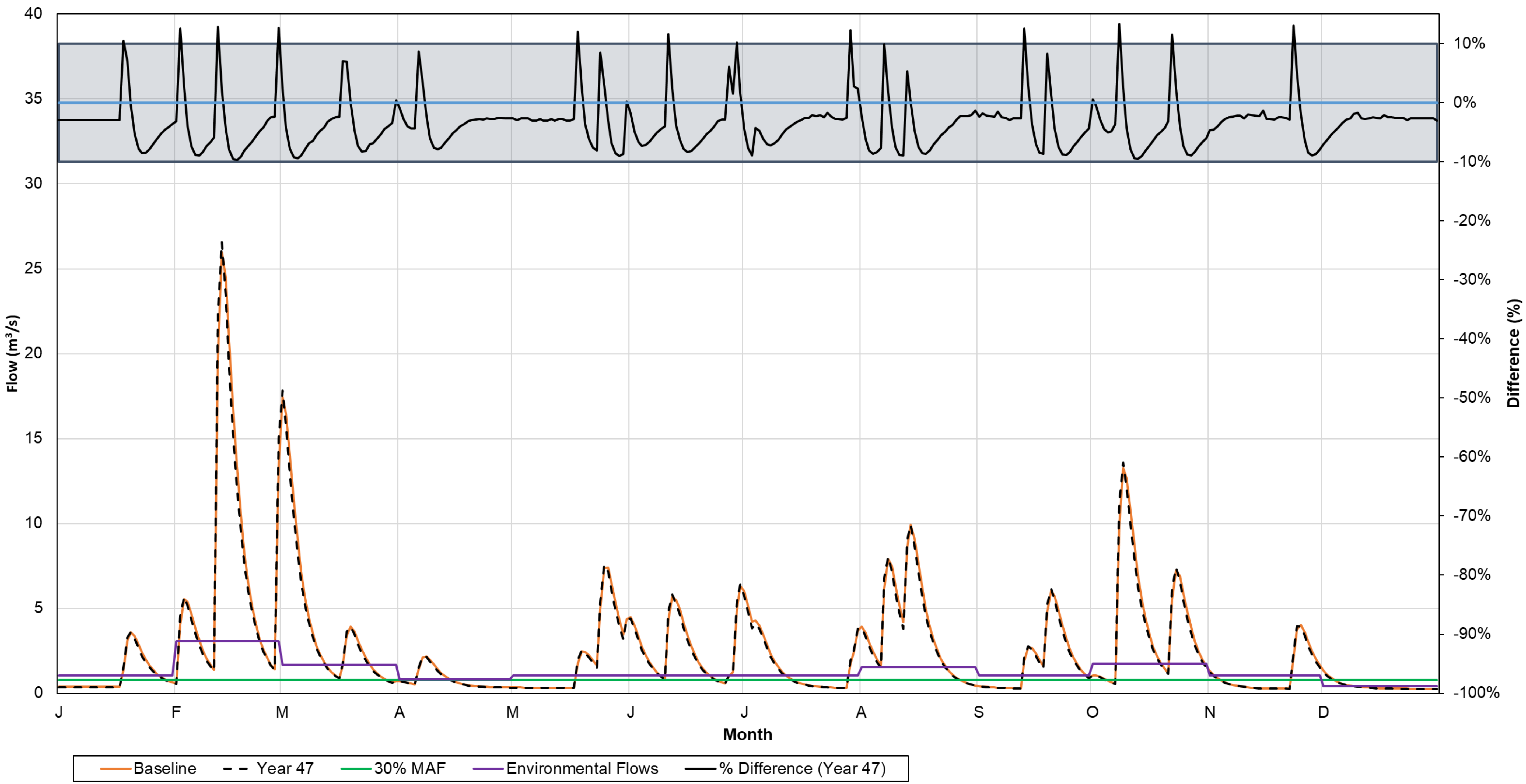


Figure A.32 Climate Change Adjusted Baseline and Pit Full Flows and Percent Changes for the West Buskegau River Watershed – WB5

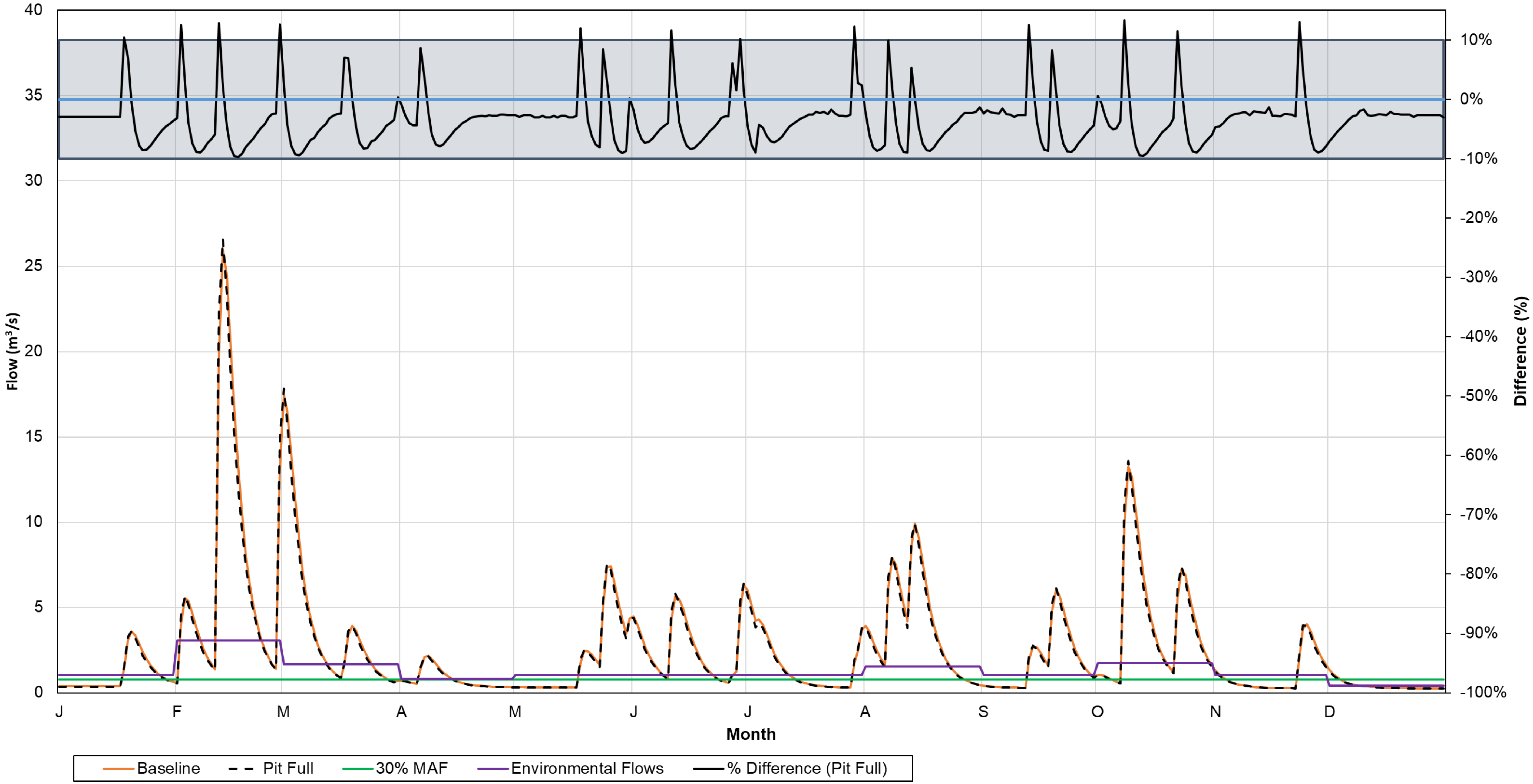


Figure A.33 Climate Change Adjusted Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB9

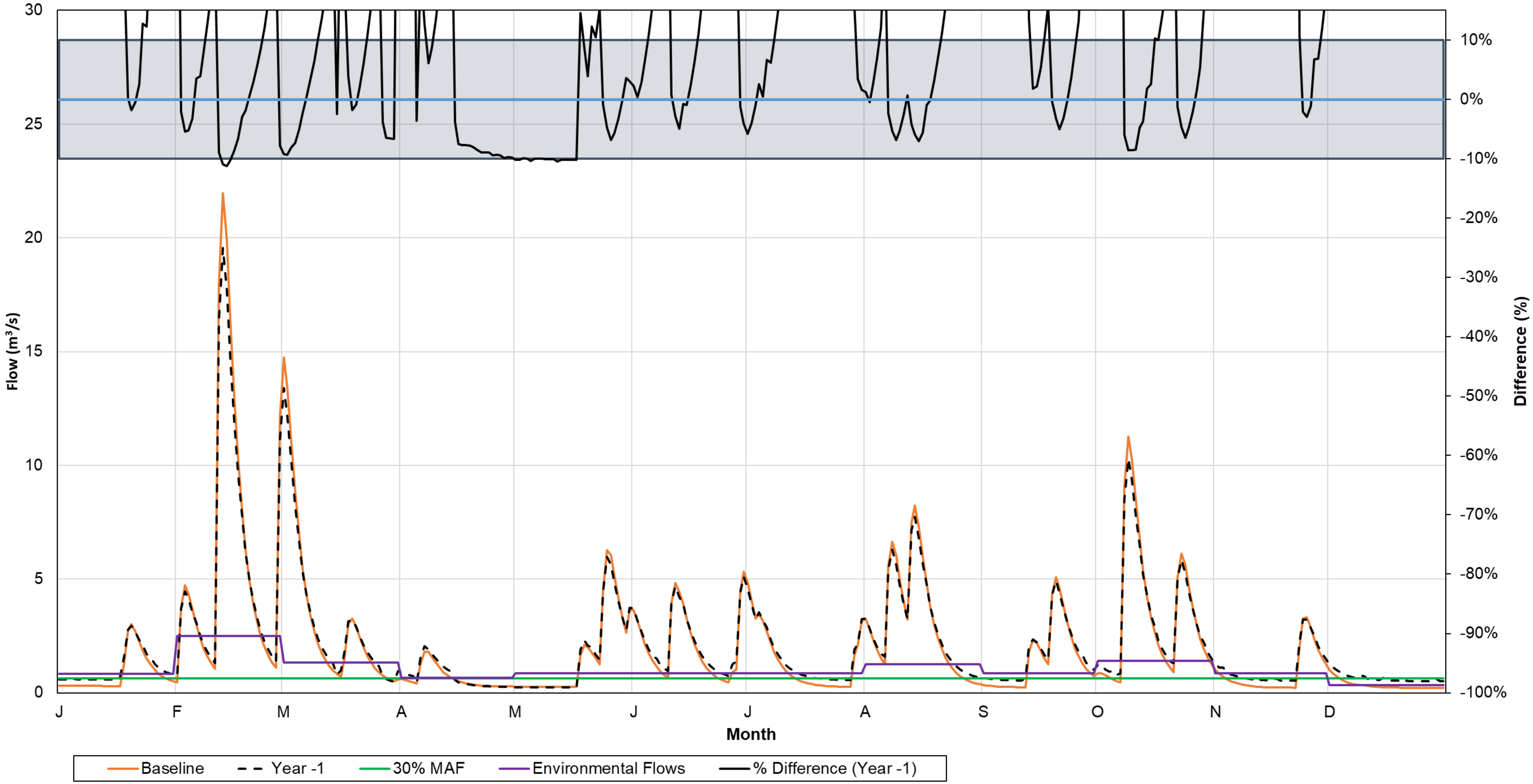


Figure A.34 Climate Change Adjusted Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB9

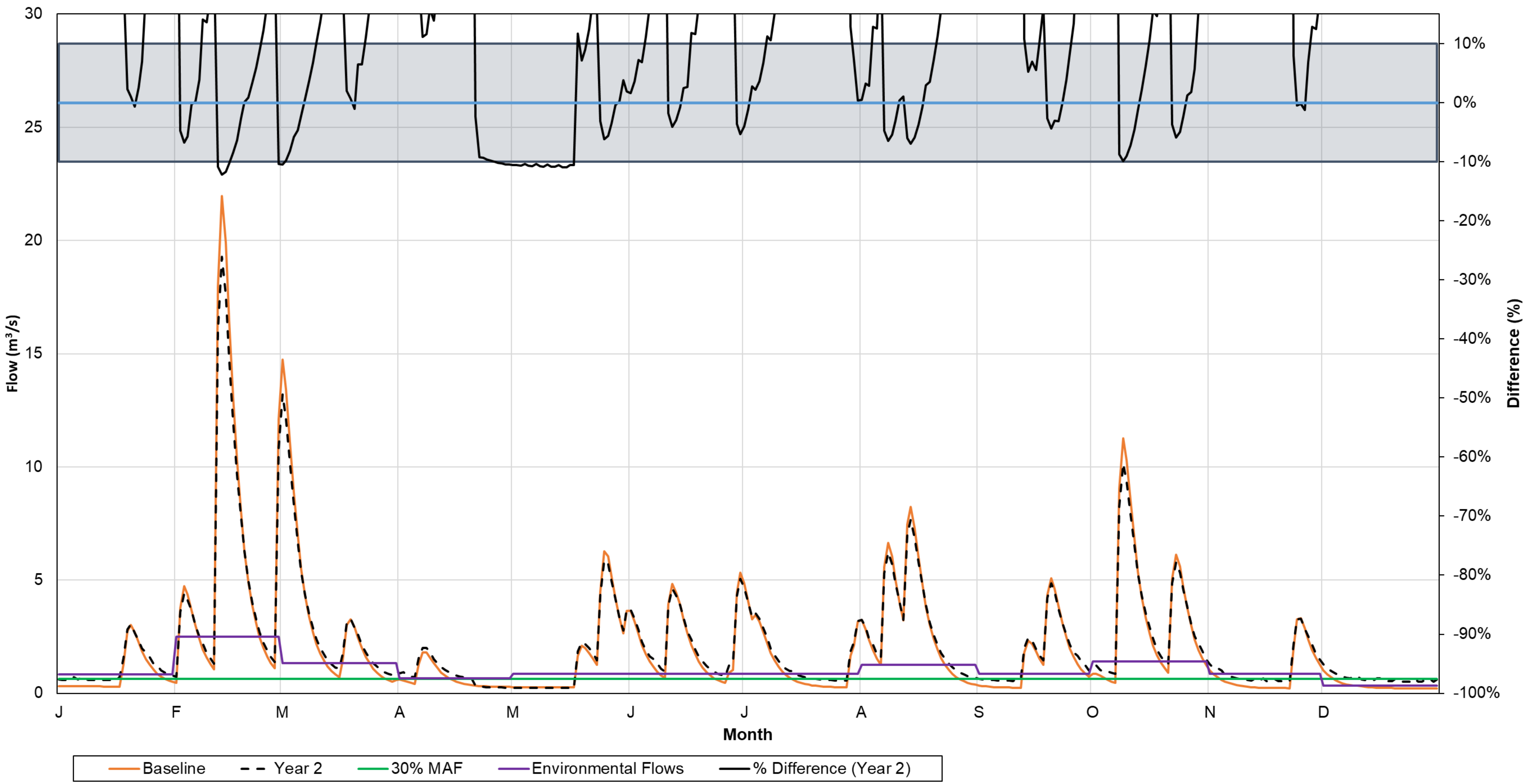


Figure A.35 Climate Change Adjusted Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB9

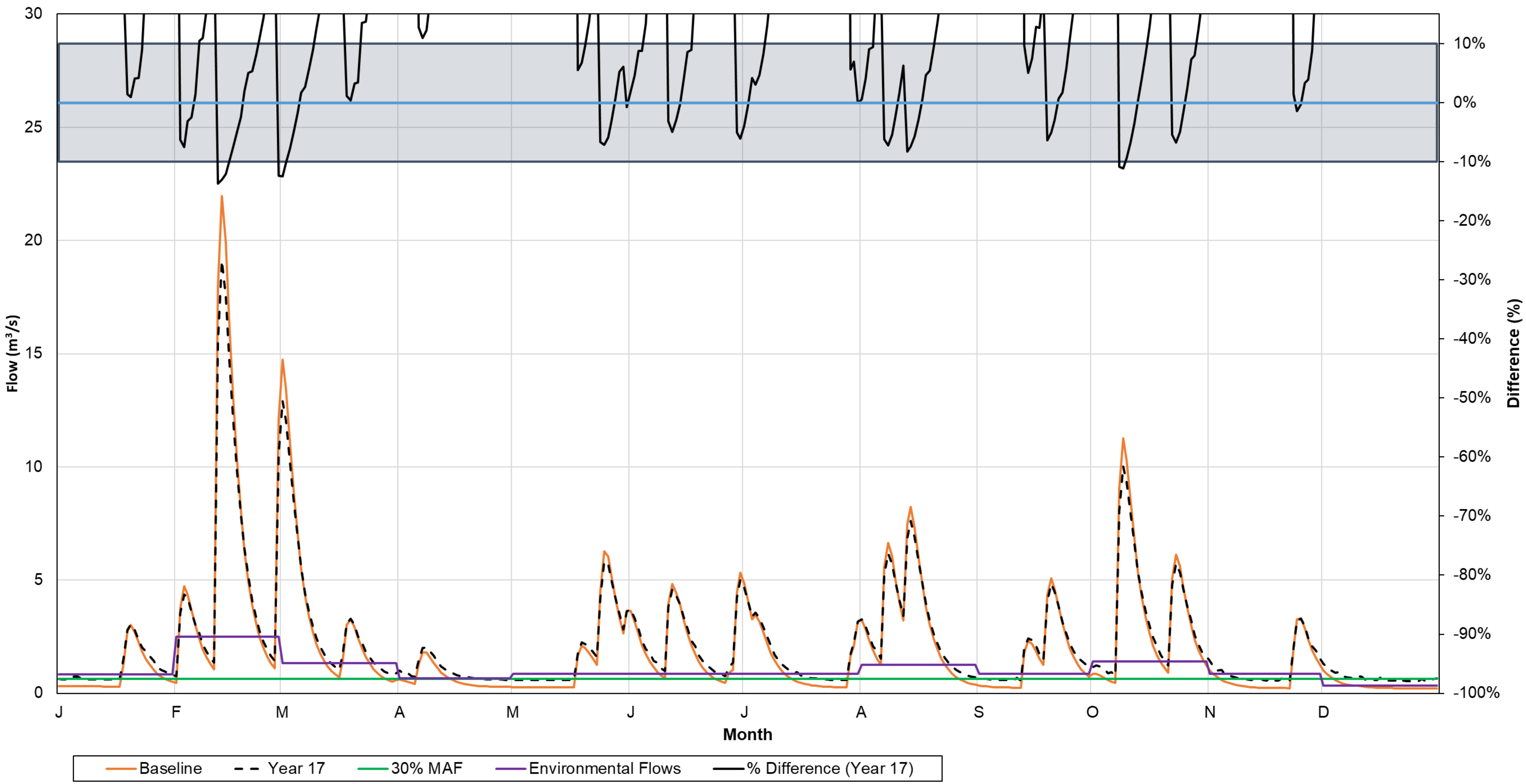


Figure A.36 Climate Change Adjusted Baseline and Year 23 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB9

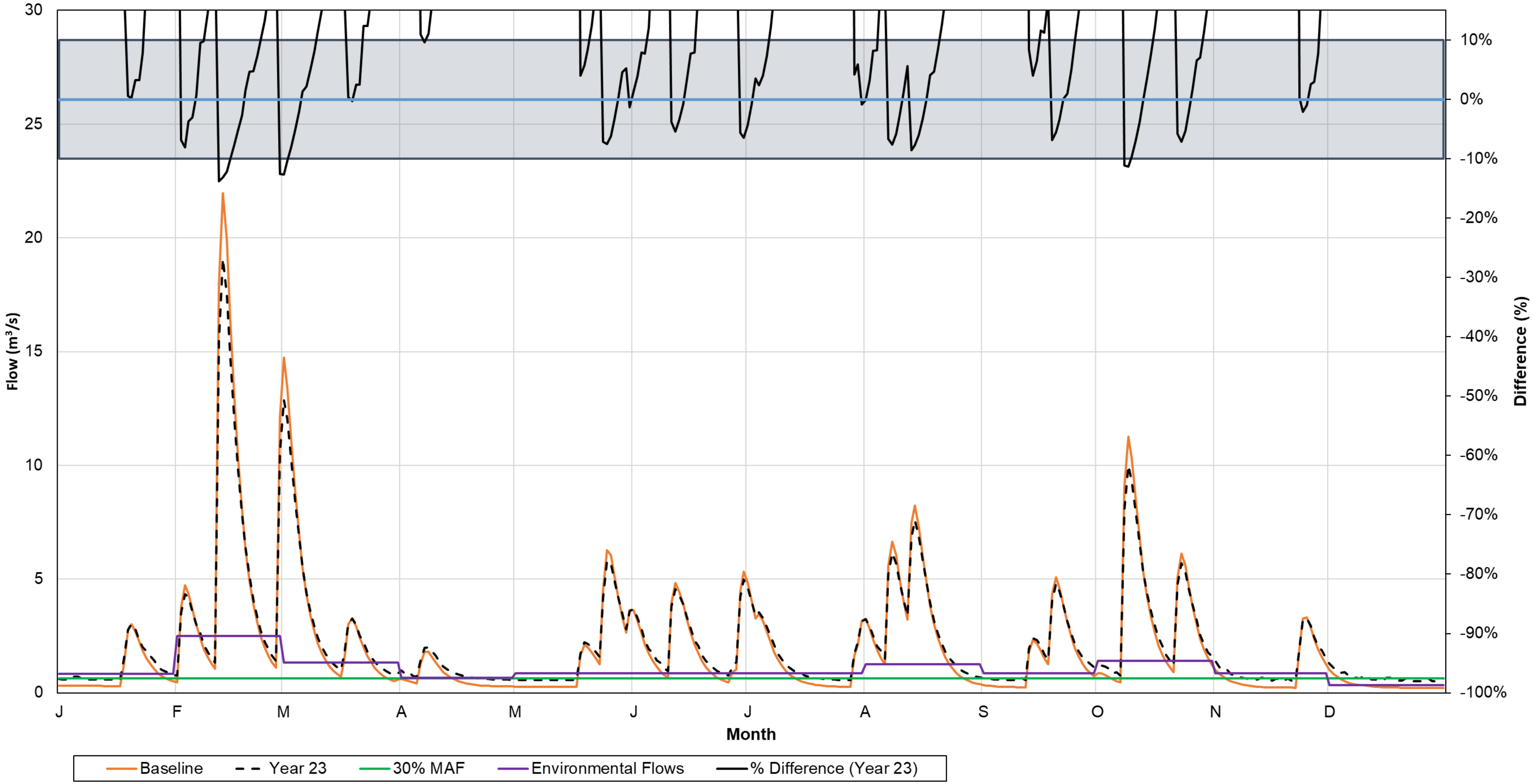


Figure A.37 Climate Change Adjusted Baseline and Year 35 (Operations Phase 3) Flows and Percent Changes for the West Buskegau River Watershed – WB9

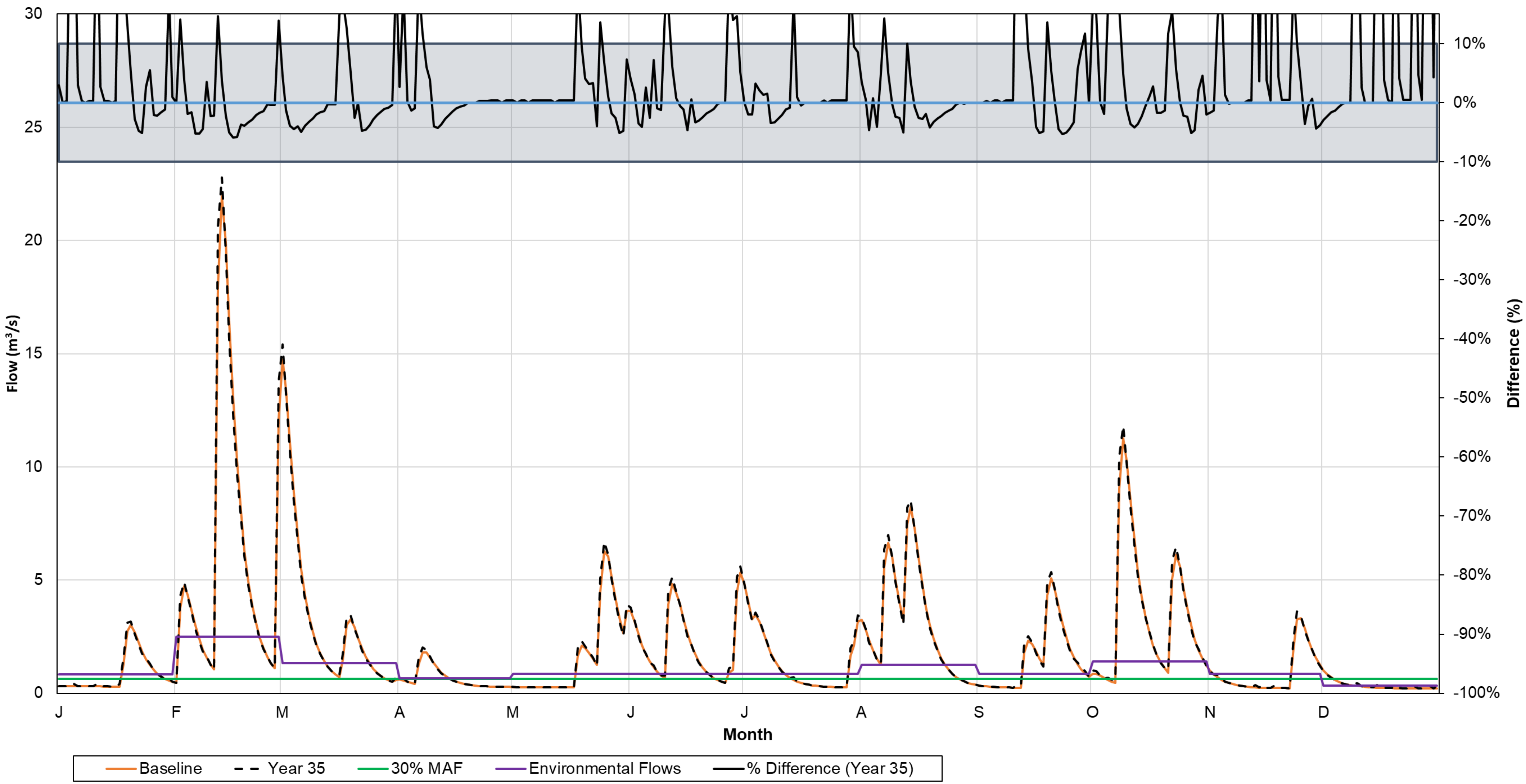


Figure A.38 Climate Change Adjusted Baseline and Year 41 (Operations Phase 3) Flows and Percent Changes for the West Buskegau River Watershed – WB9

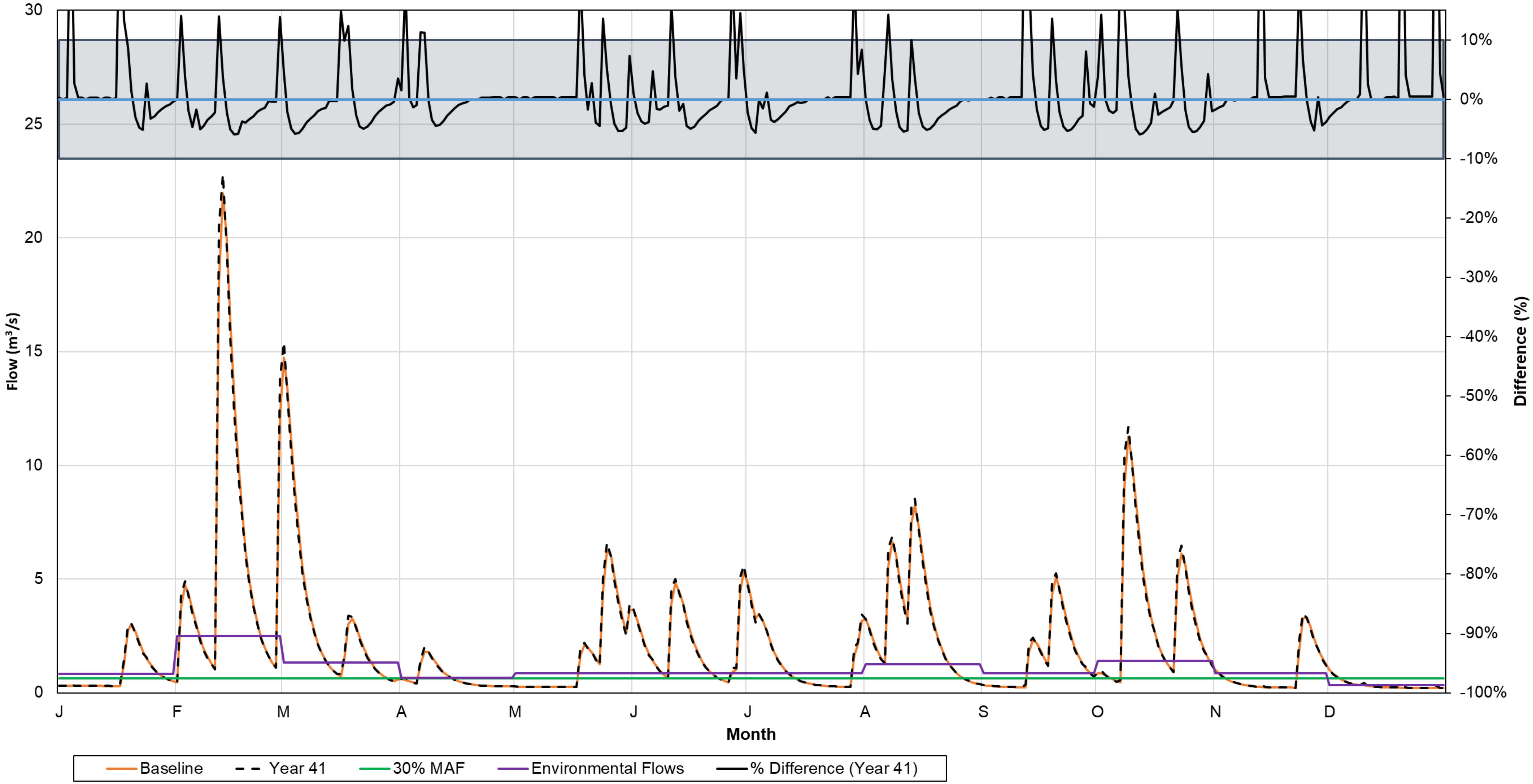


Figure A.39 Climate Change Adjusted Baseline and Year 47 (Passive Closure Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB9

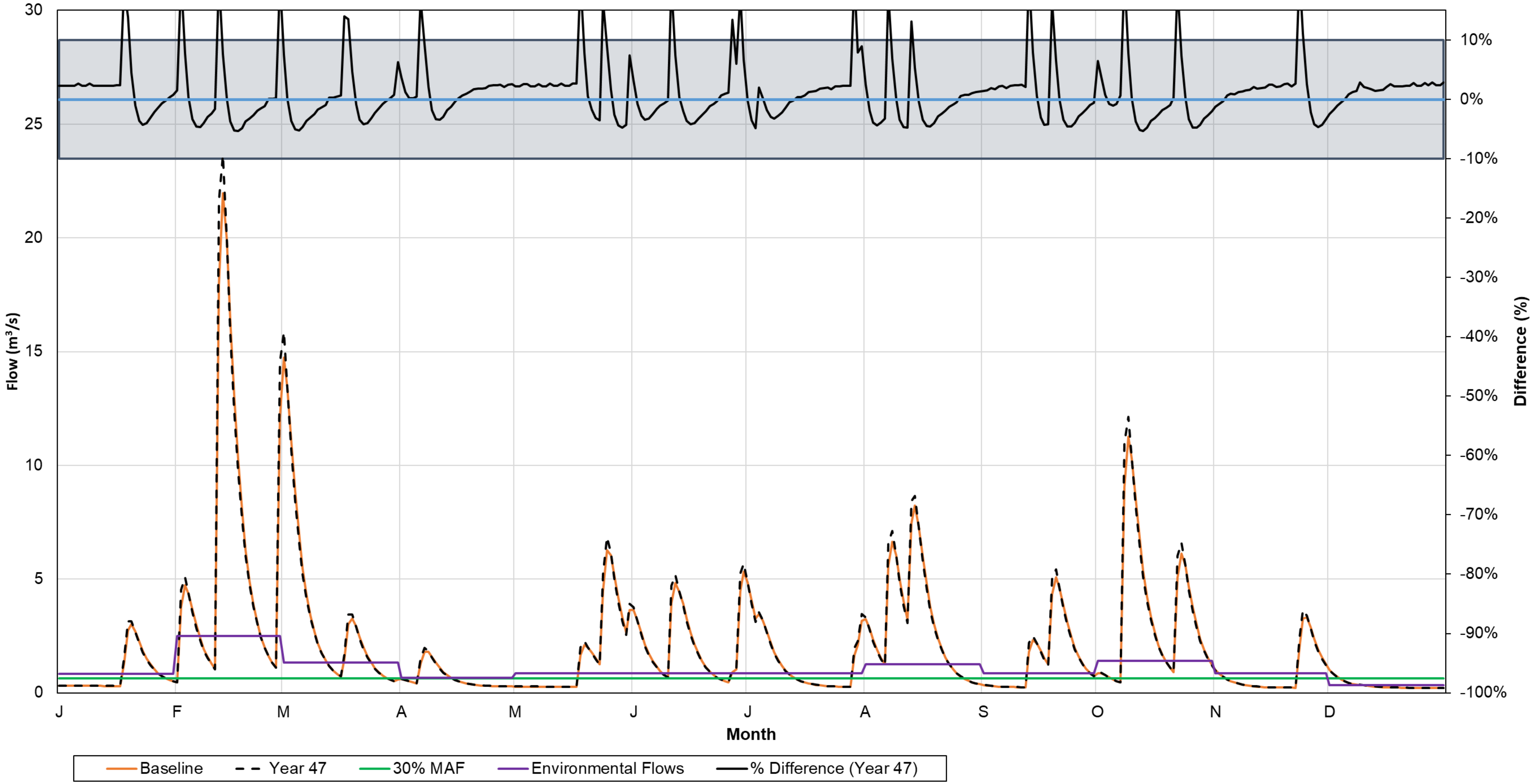


Figure A.40 Climate Change Adjusted Baseline and Pit Full Flows and Percent Changes for the West Buskegau River Watershed – WB9

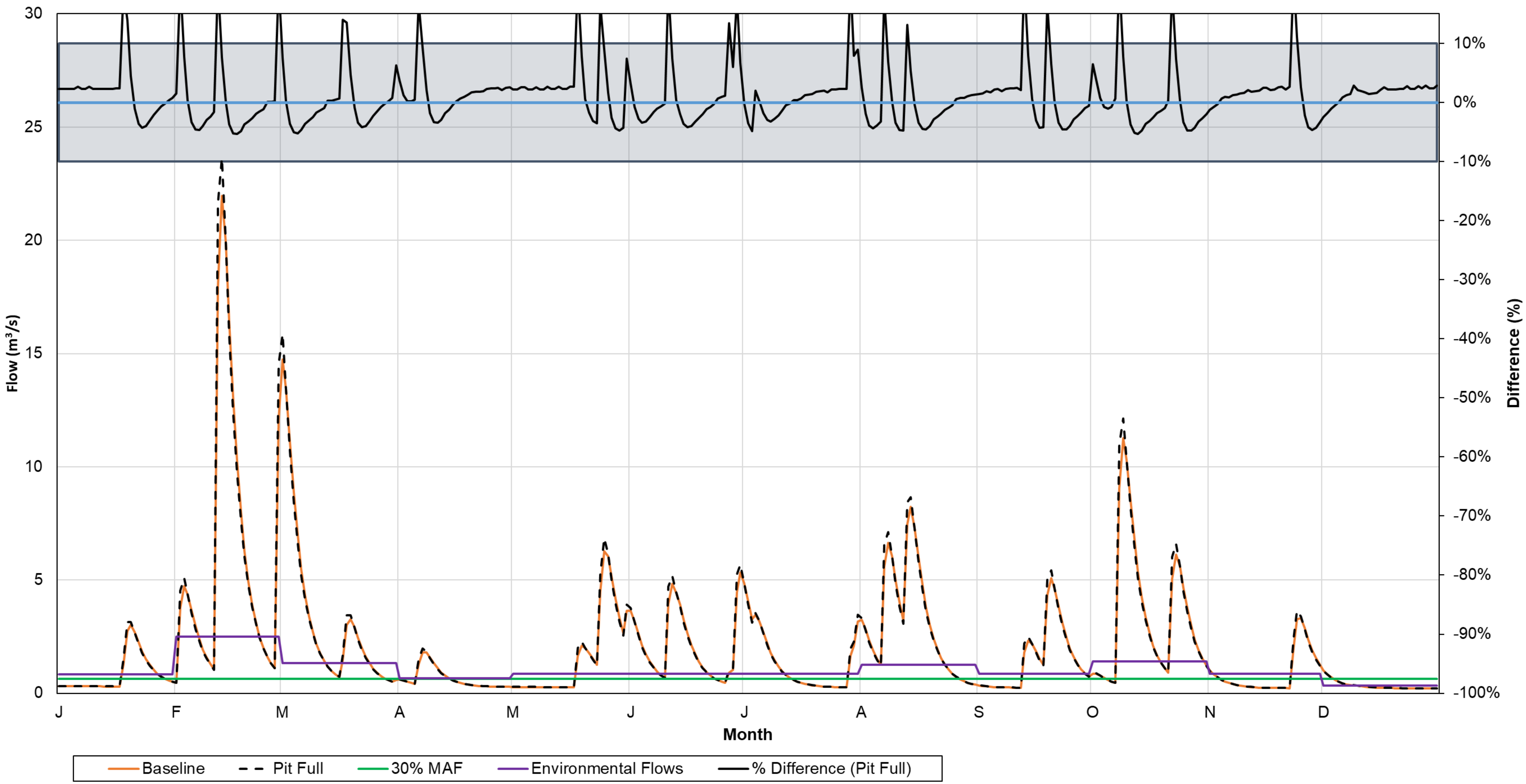


Figure A.41 Climate Change Adjusted Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB14

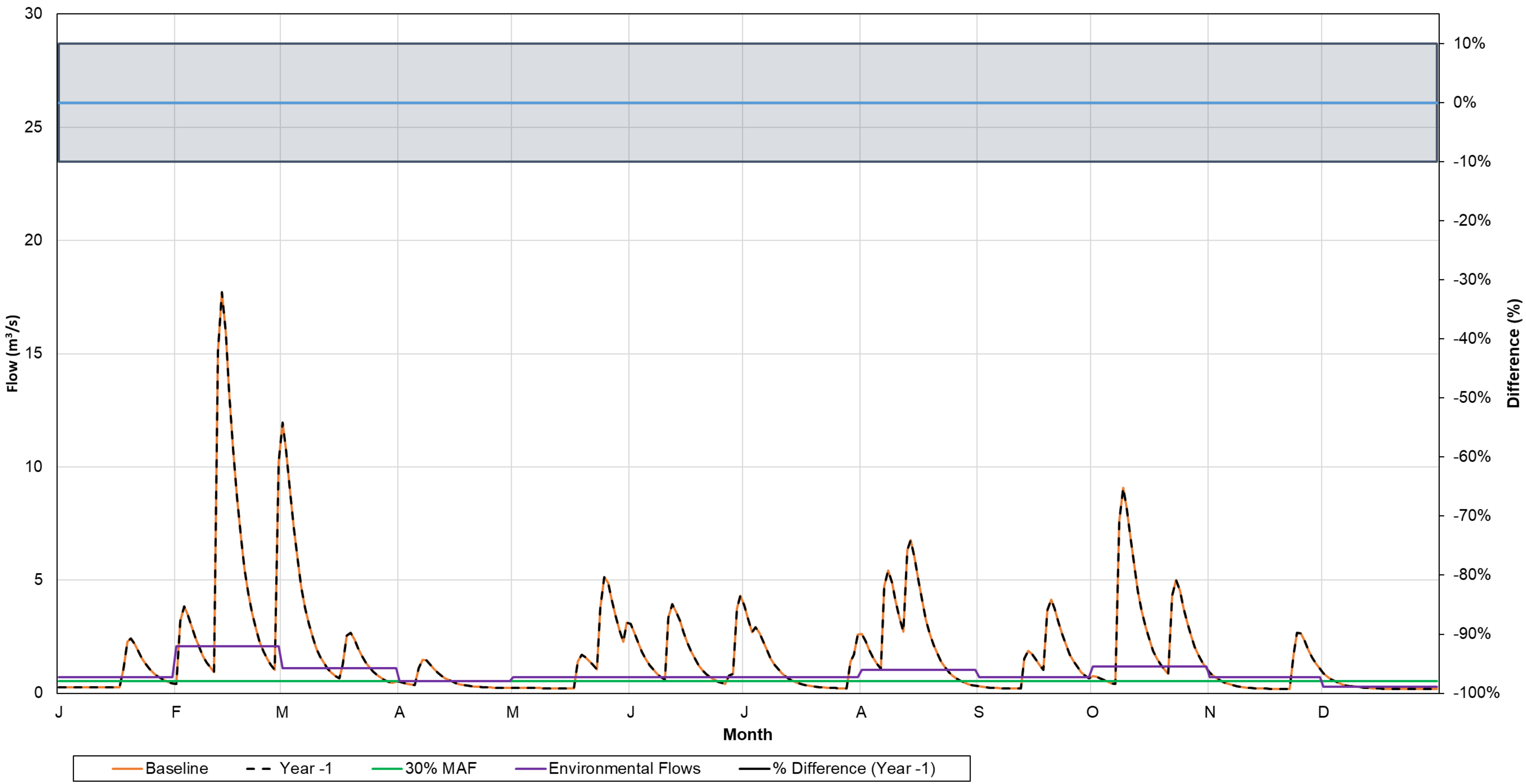


Figure A.42 Climate Change Adjusted Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB14

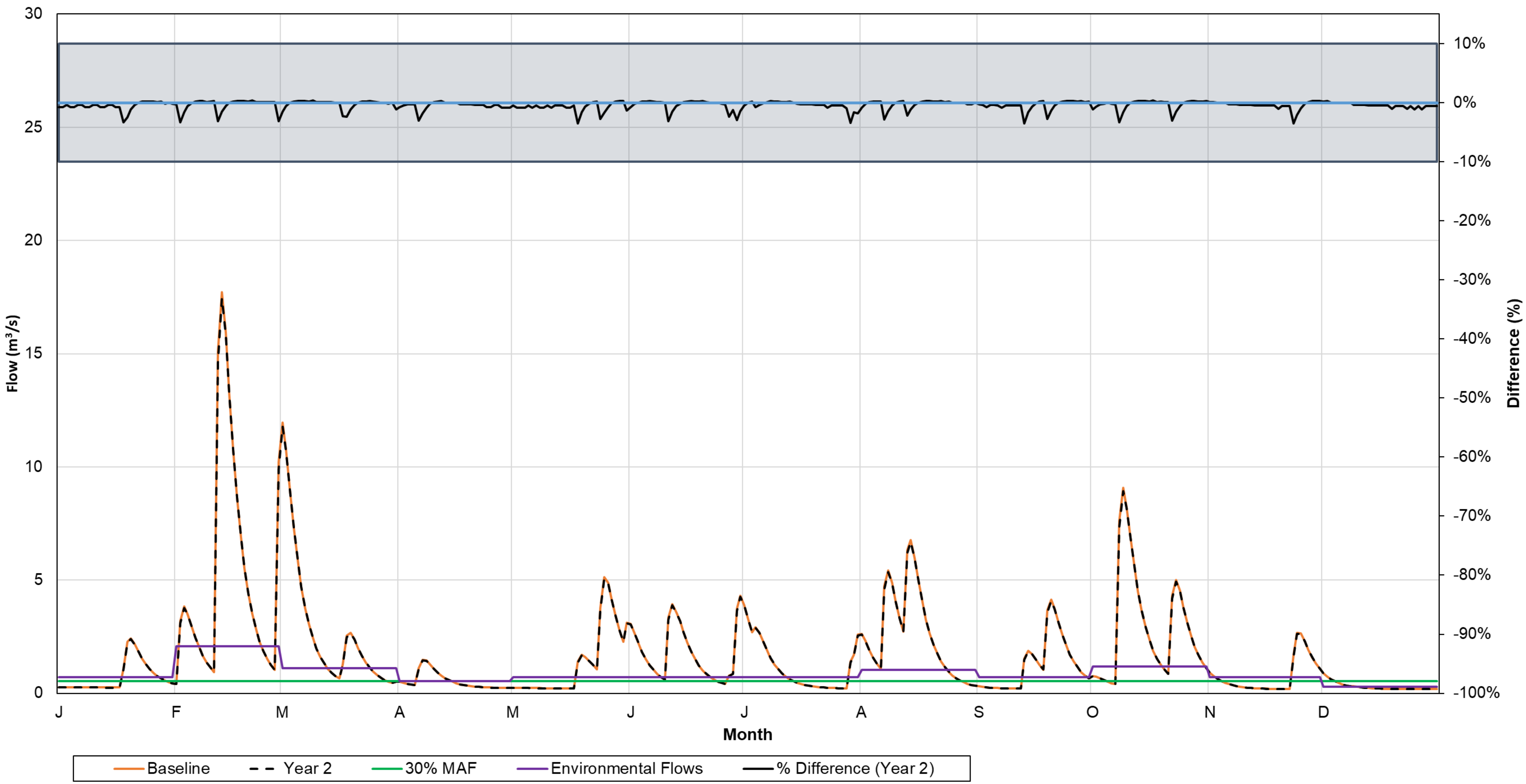


Figure A.43 Climate Change Adjusted Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB14

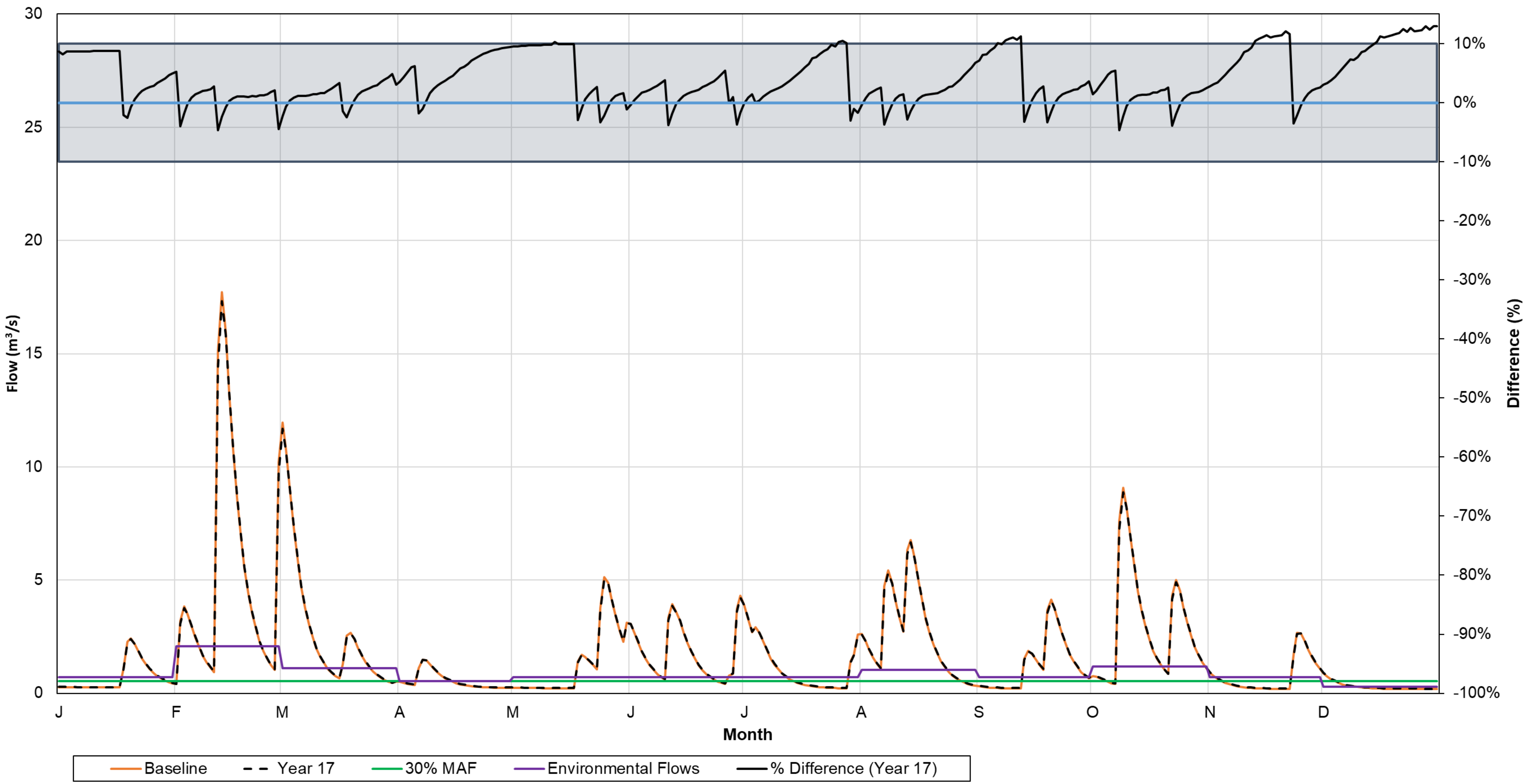


Figure A.44 Climate Change Adjusted Baseline and Year 23 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB14

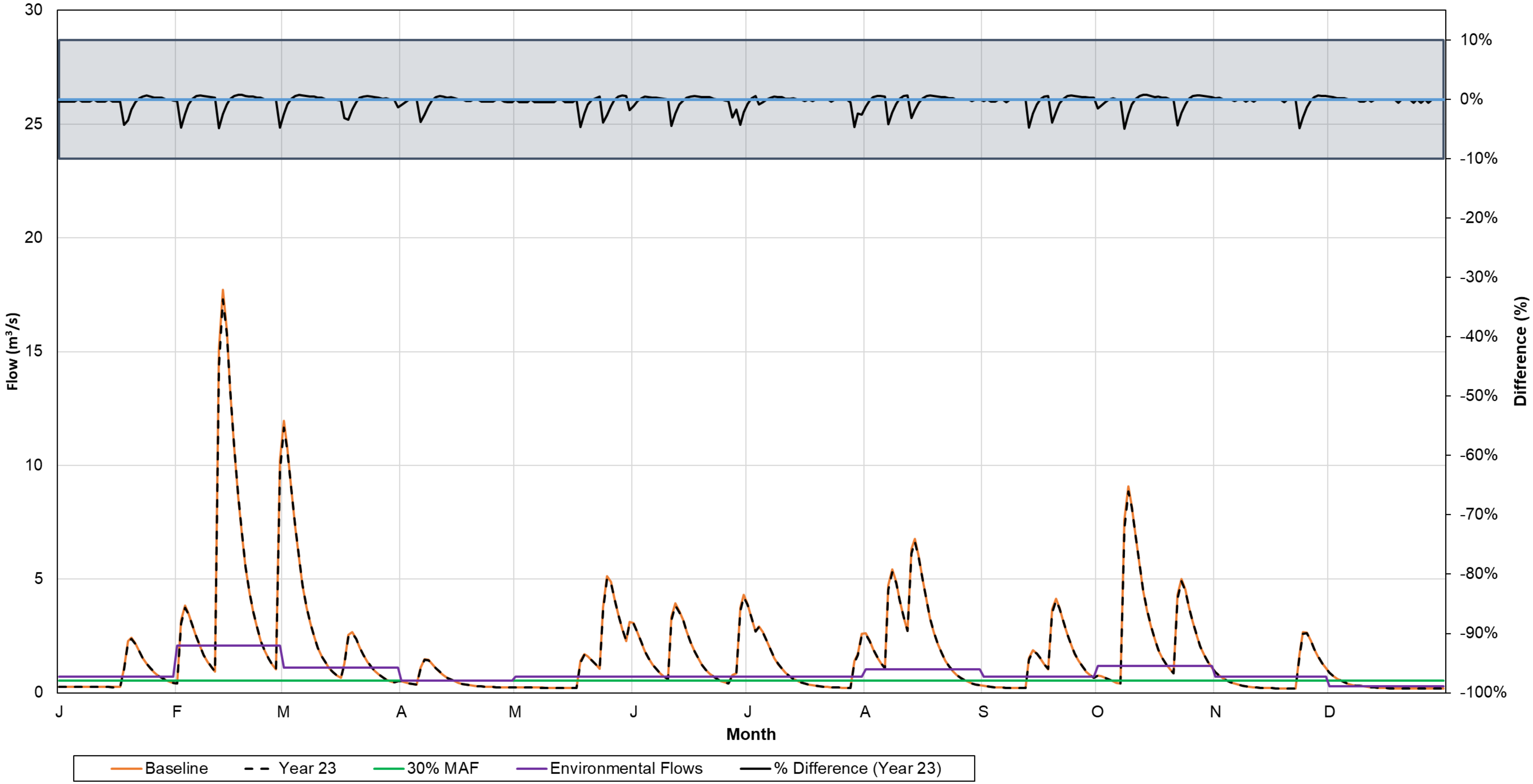


Figure A.45 Climate Change Adjusted Baseline and Year 35 (Operations Phase 3) Flows and Percent Changes for the West Buskegau River Watershed – WB14

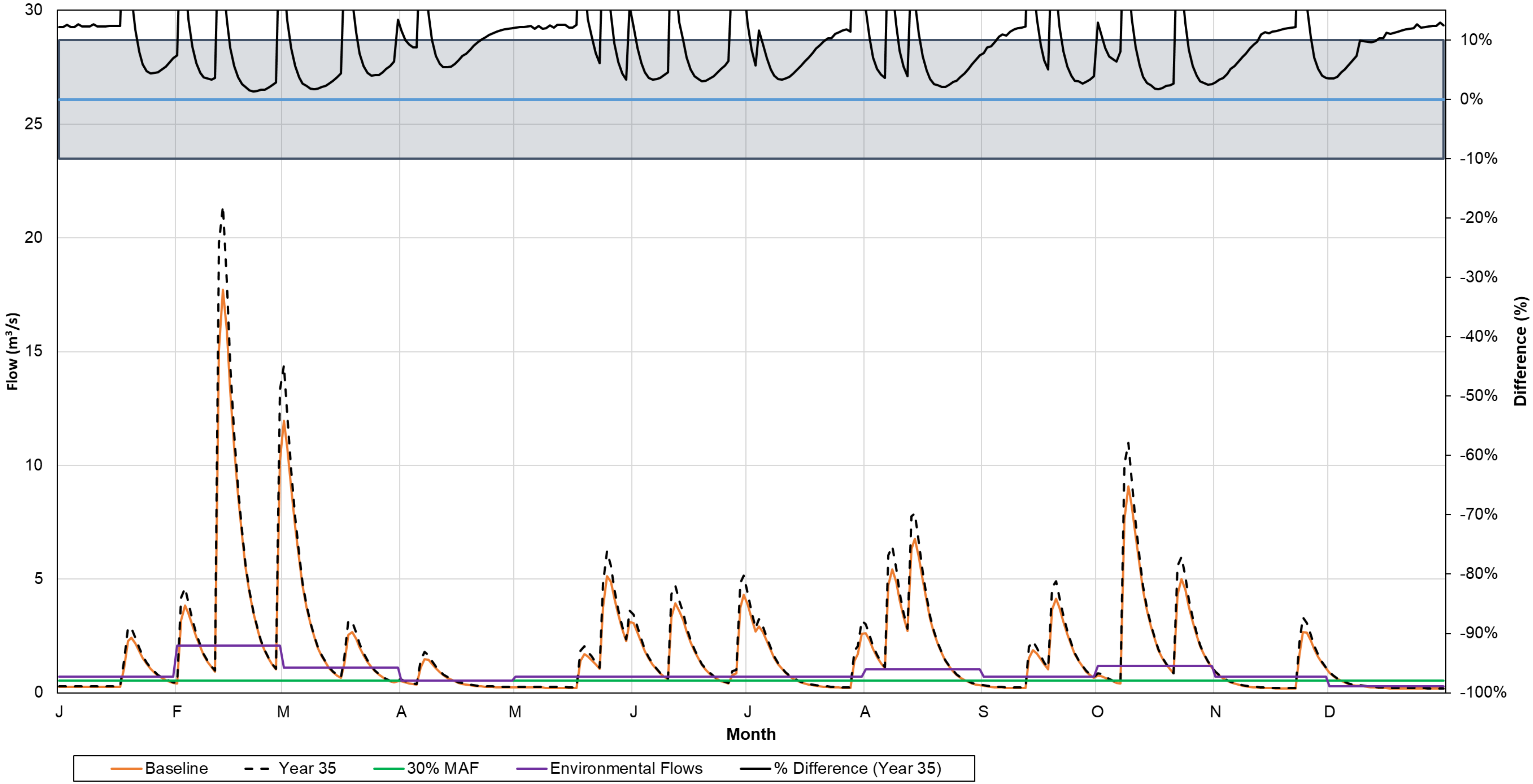


Figure A.46 Climate Change Adjusted Baseline and Year 41 (Operations Phase 3) Flows and Percent Changes for the West Buskegau River Watershed – WB14

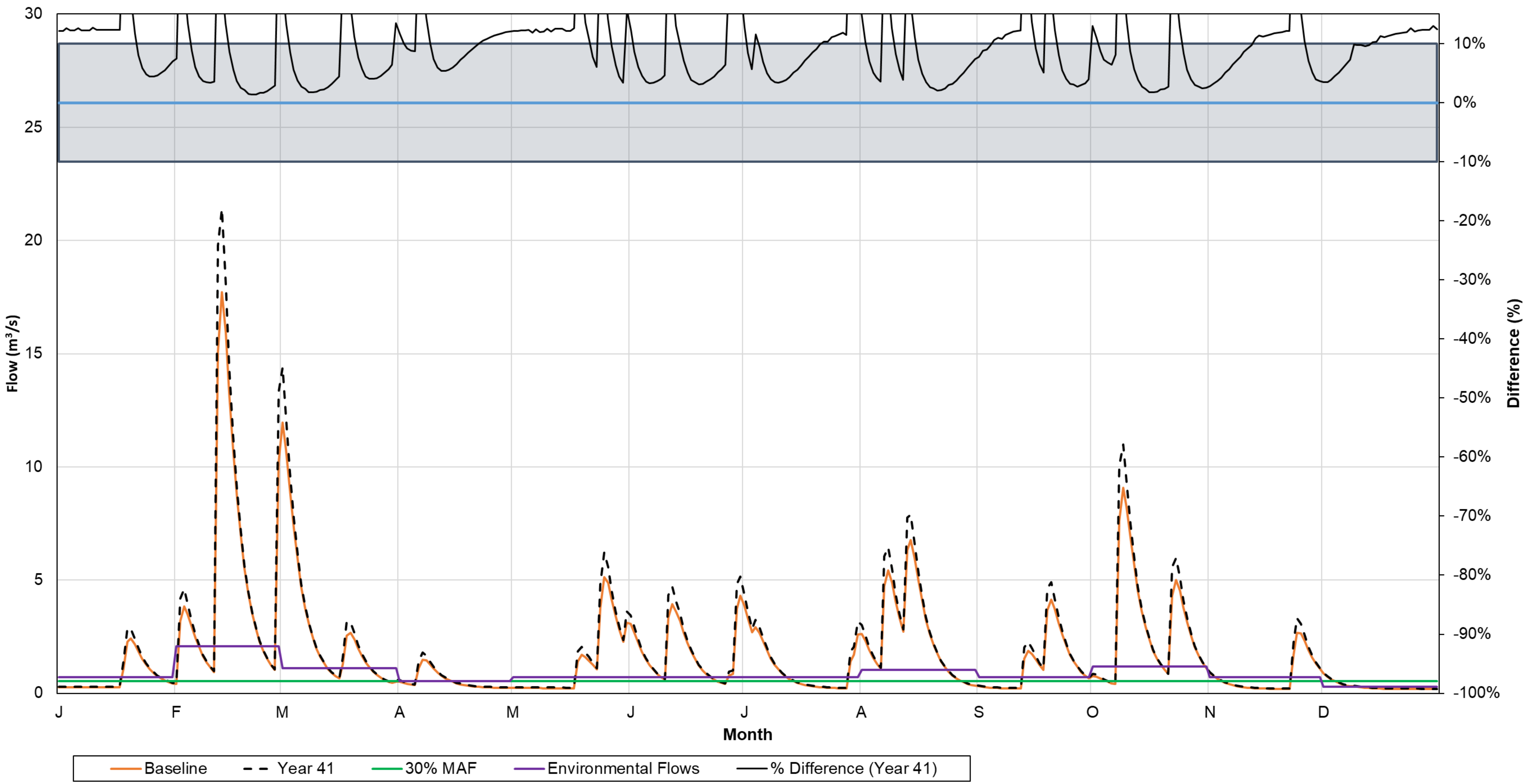


Figure A.47 Climate Change Adjusted Baseline and Year 47 (Passive Closure Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB14

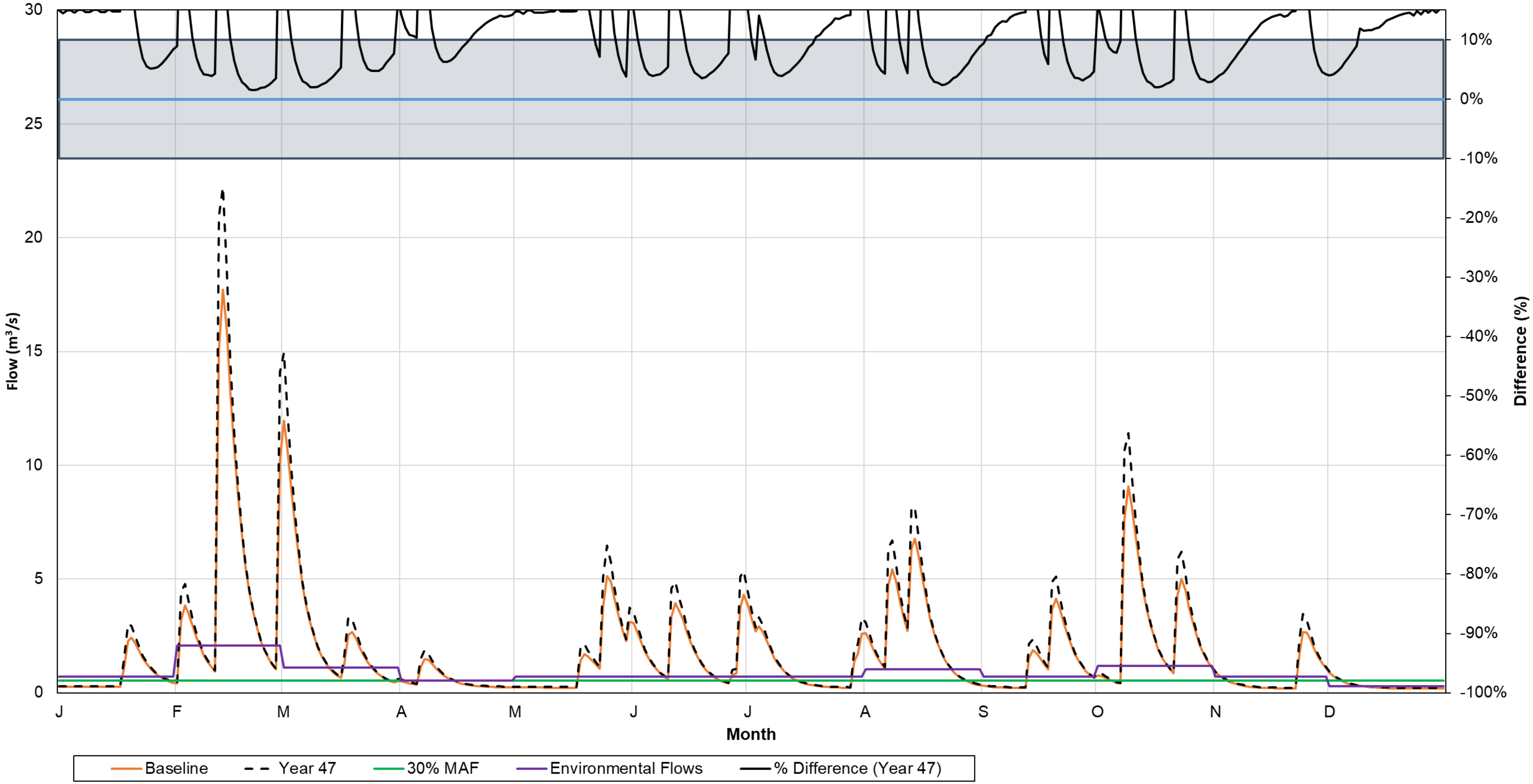


Figure A.48 Climate Change Adjusted Baseline and Pit Full Flows and Percent Changes for the West Buskegau River Watershed – WB14

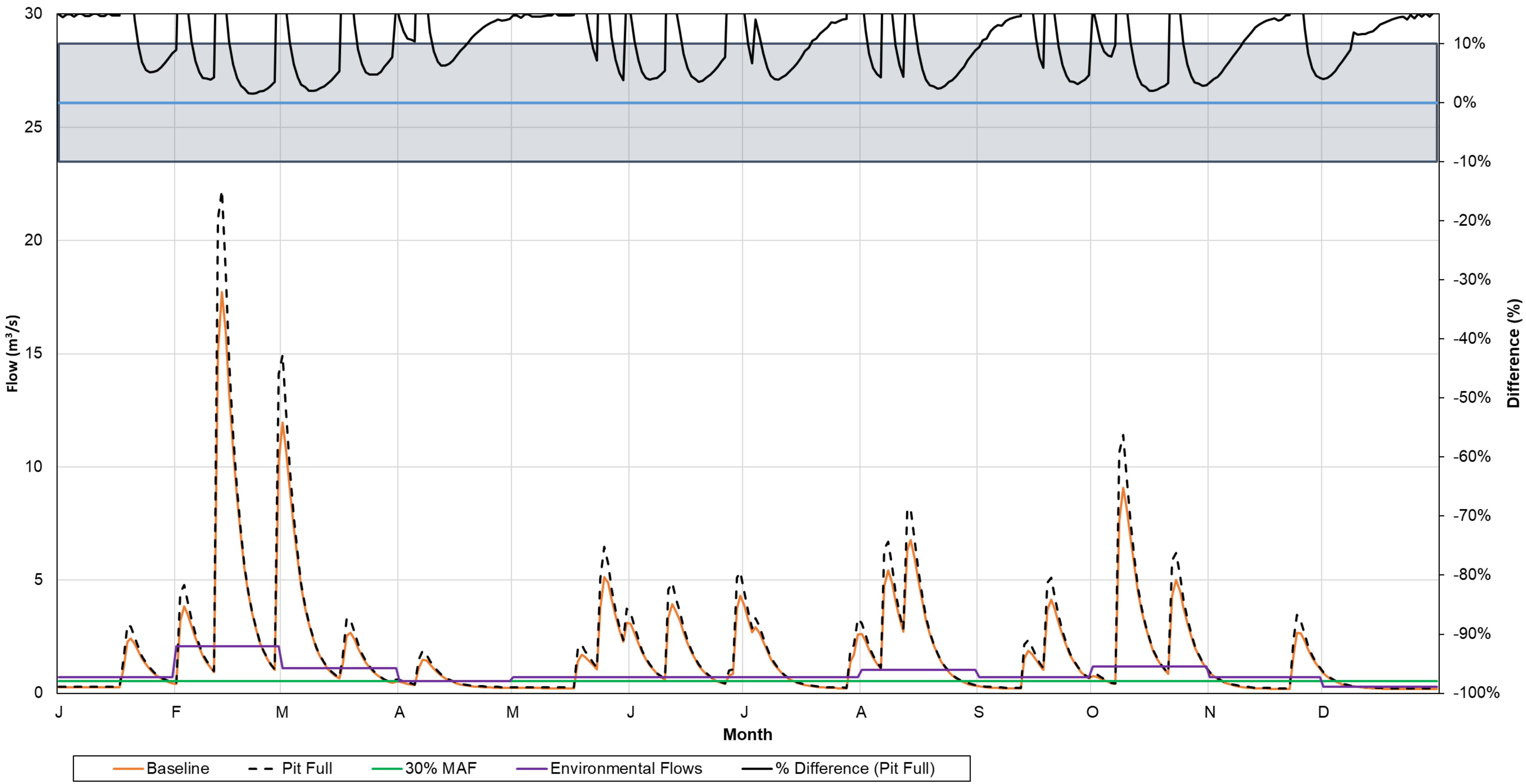


Figure A.49 Climate Change Adjusted Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND1

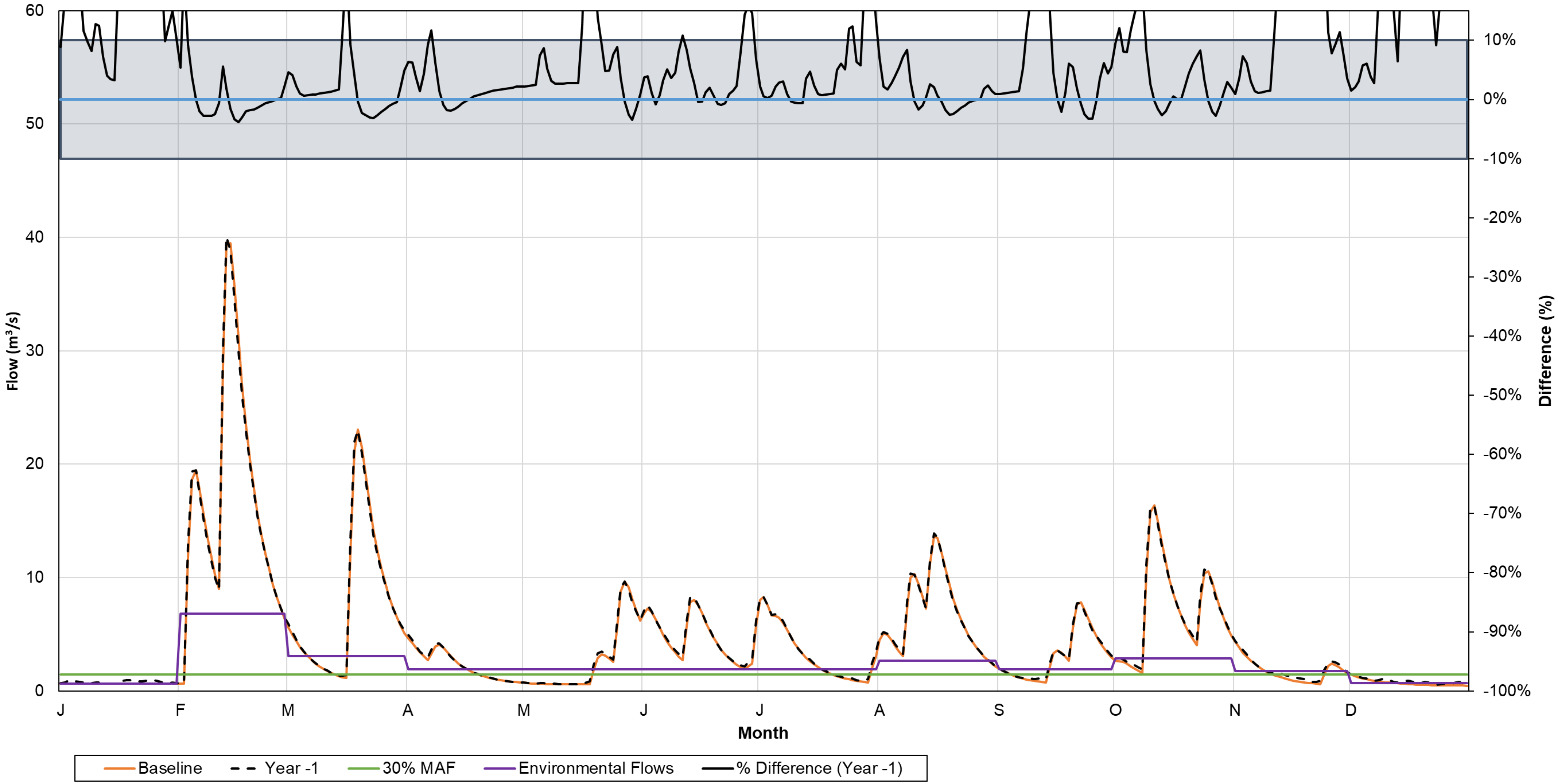


Figure A.50 Climate Change Adjusted Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND1

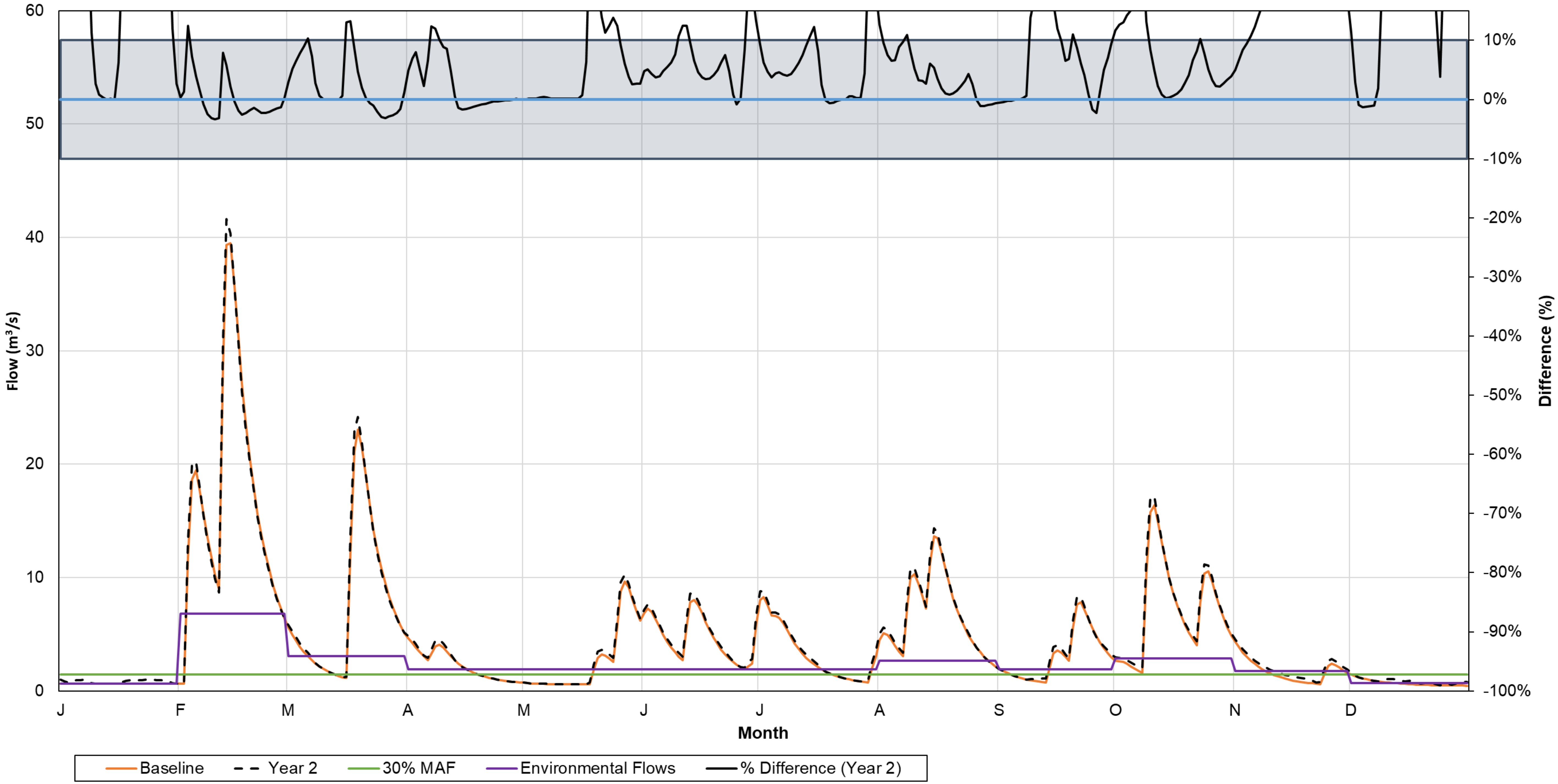


Figure A.51 Climate Change Adjusted Baseline and Year 23 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND1

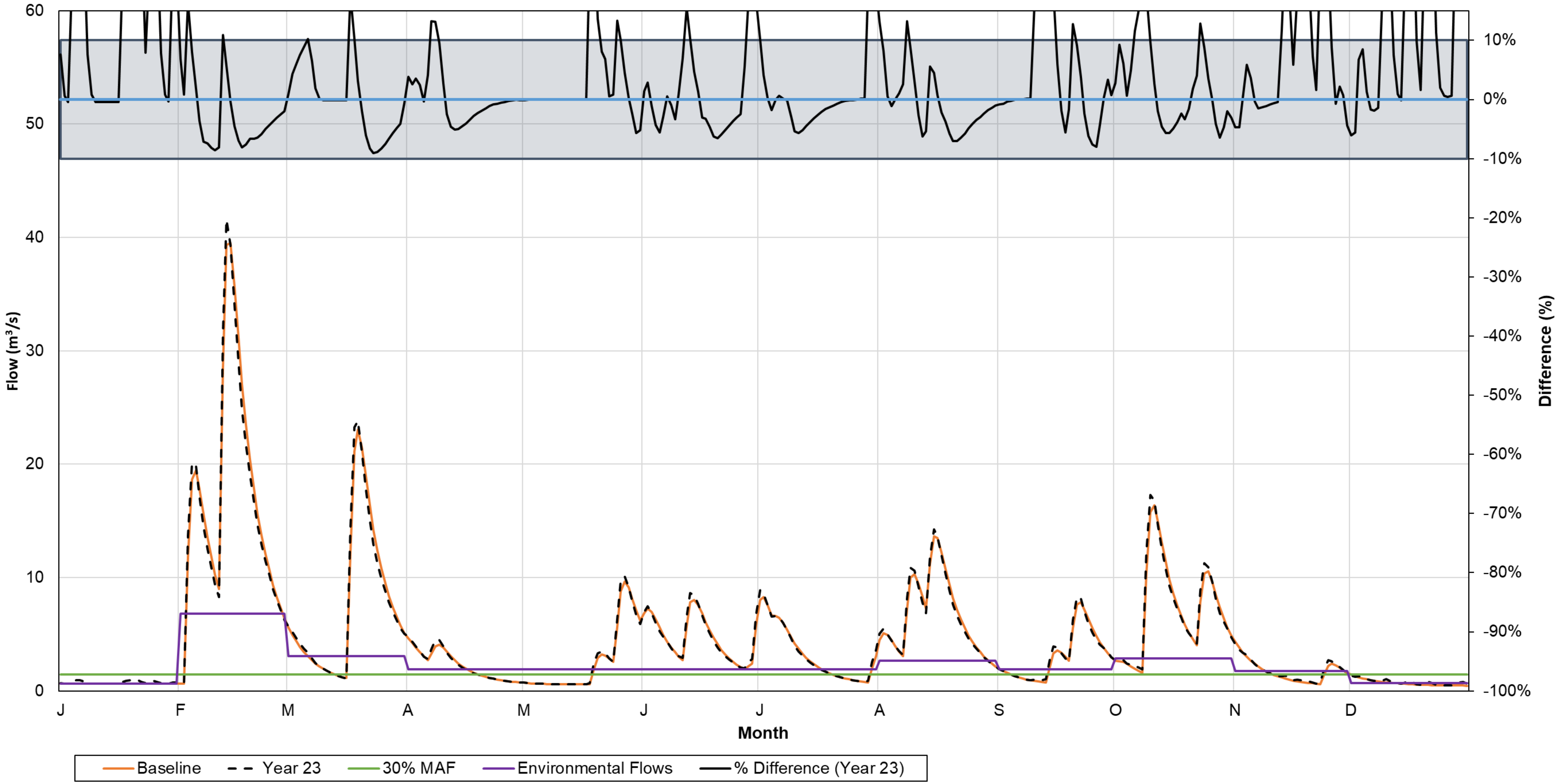


Figure A.52 Climate Change Adjusted Baseline and Year 35 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND1

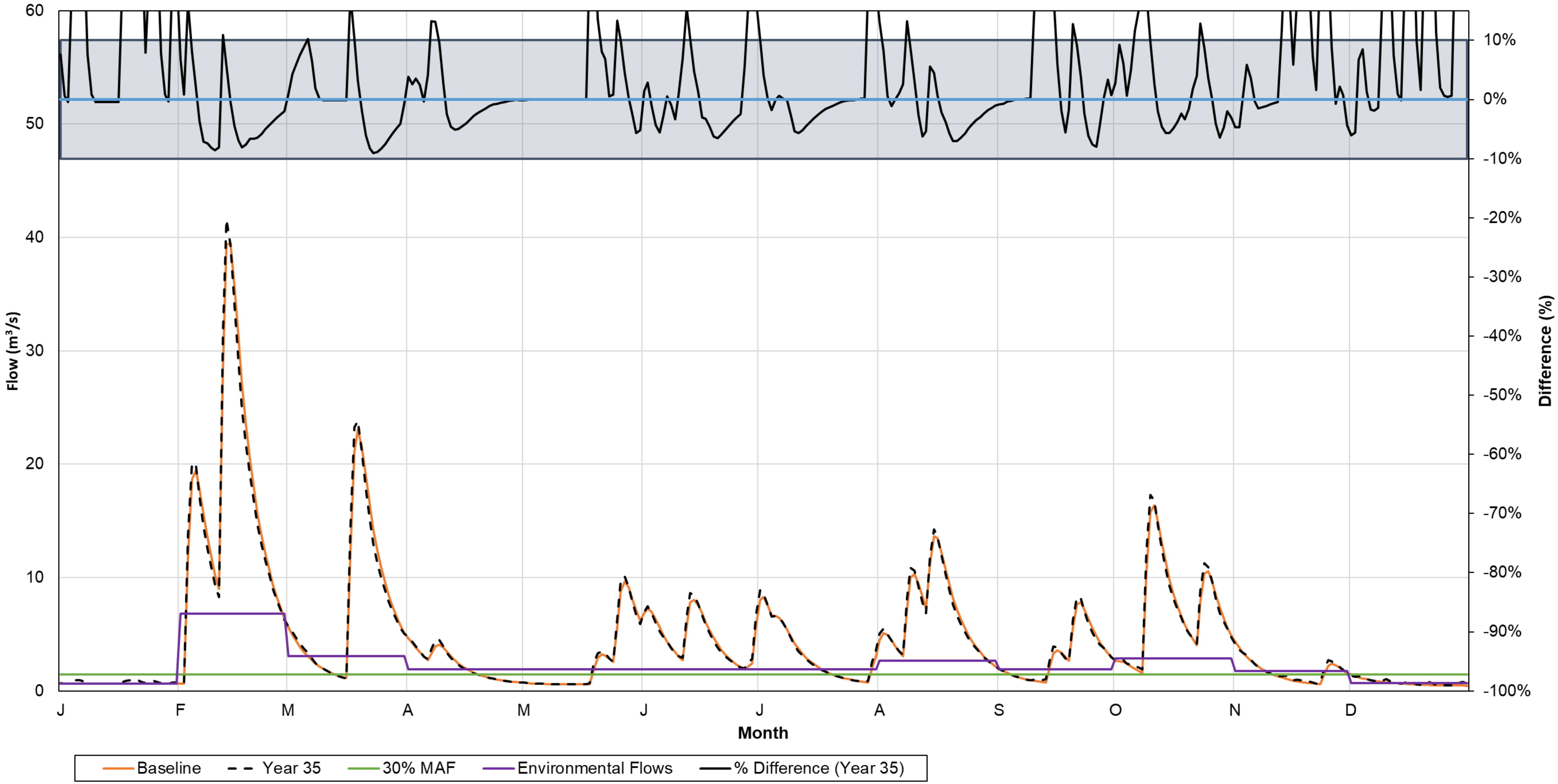


Figure A.53 Climate Change Adjusted Baseline and Year 41 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND1

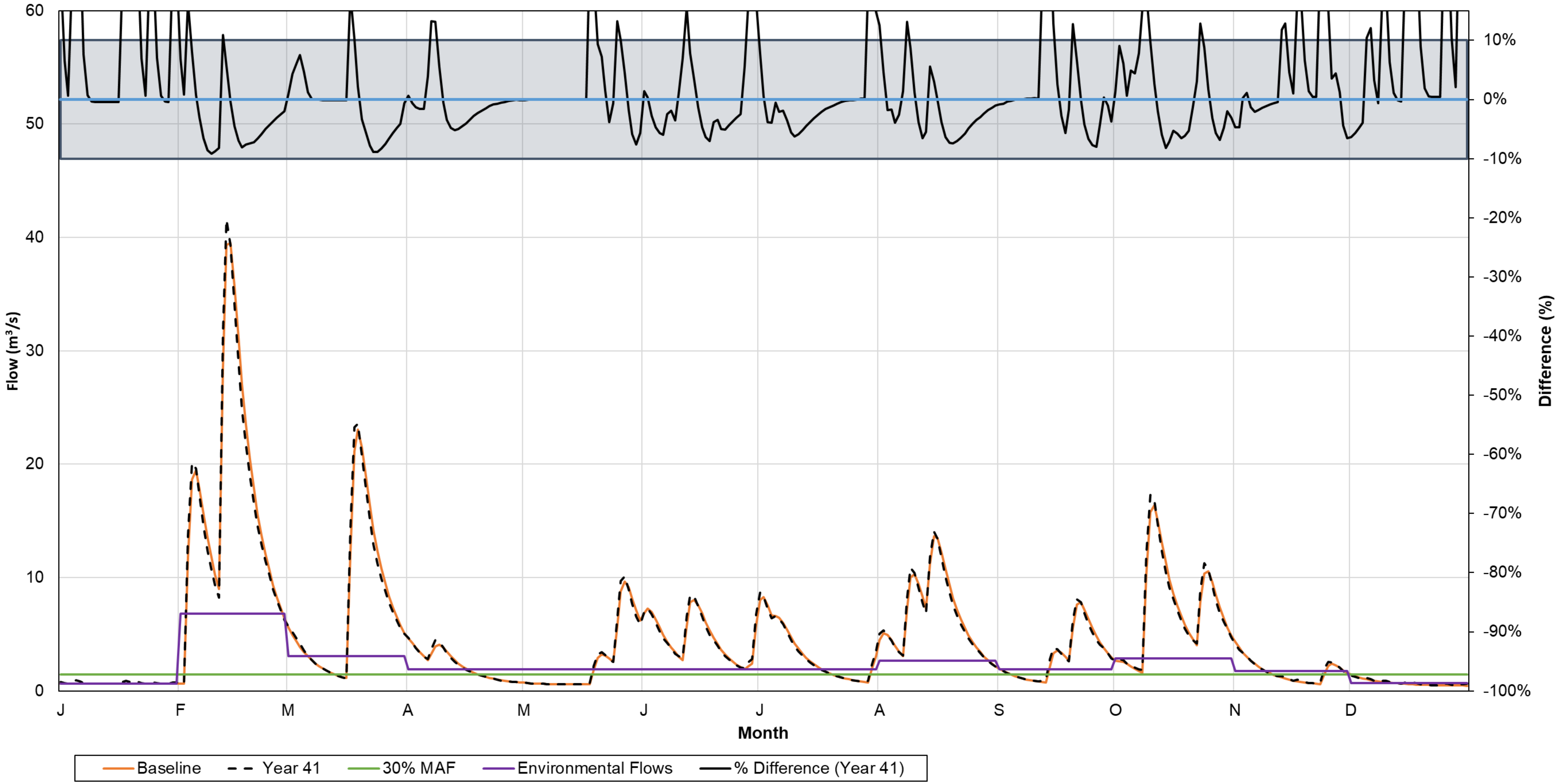


Figure A.54 Climate Change Adjusted Baseline and Year 47 (Passive Closure Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND1

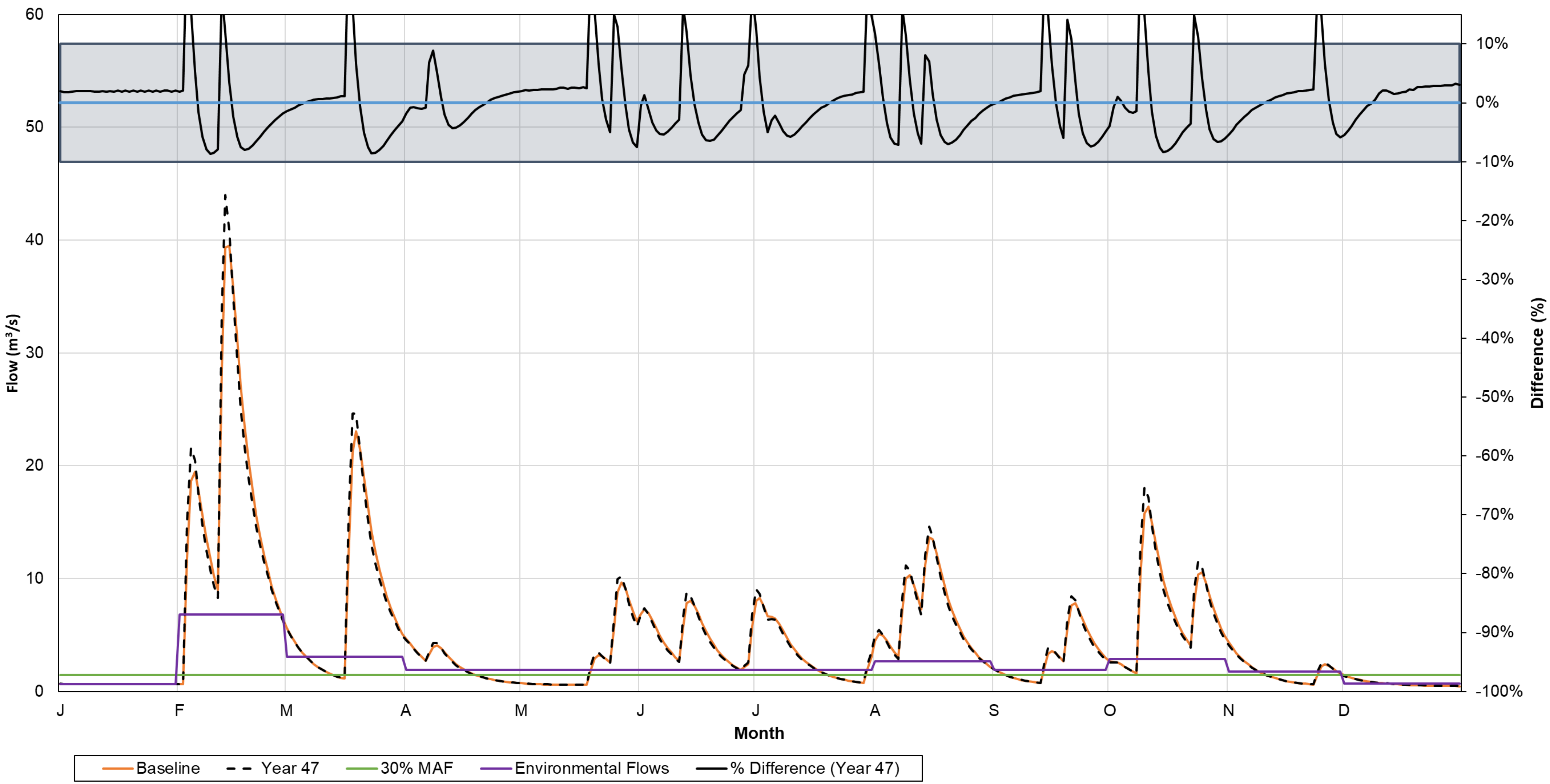


Figure A.55 Climate Change Adjusted Baseline and Pit Full Flows and Percent Changes for the North Driftwood River Watershed – ND1

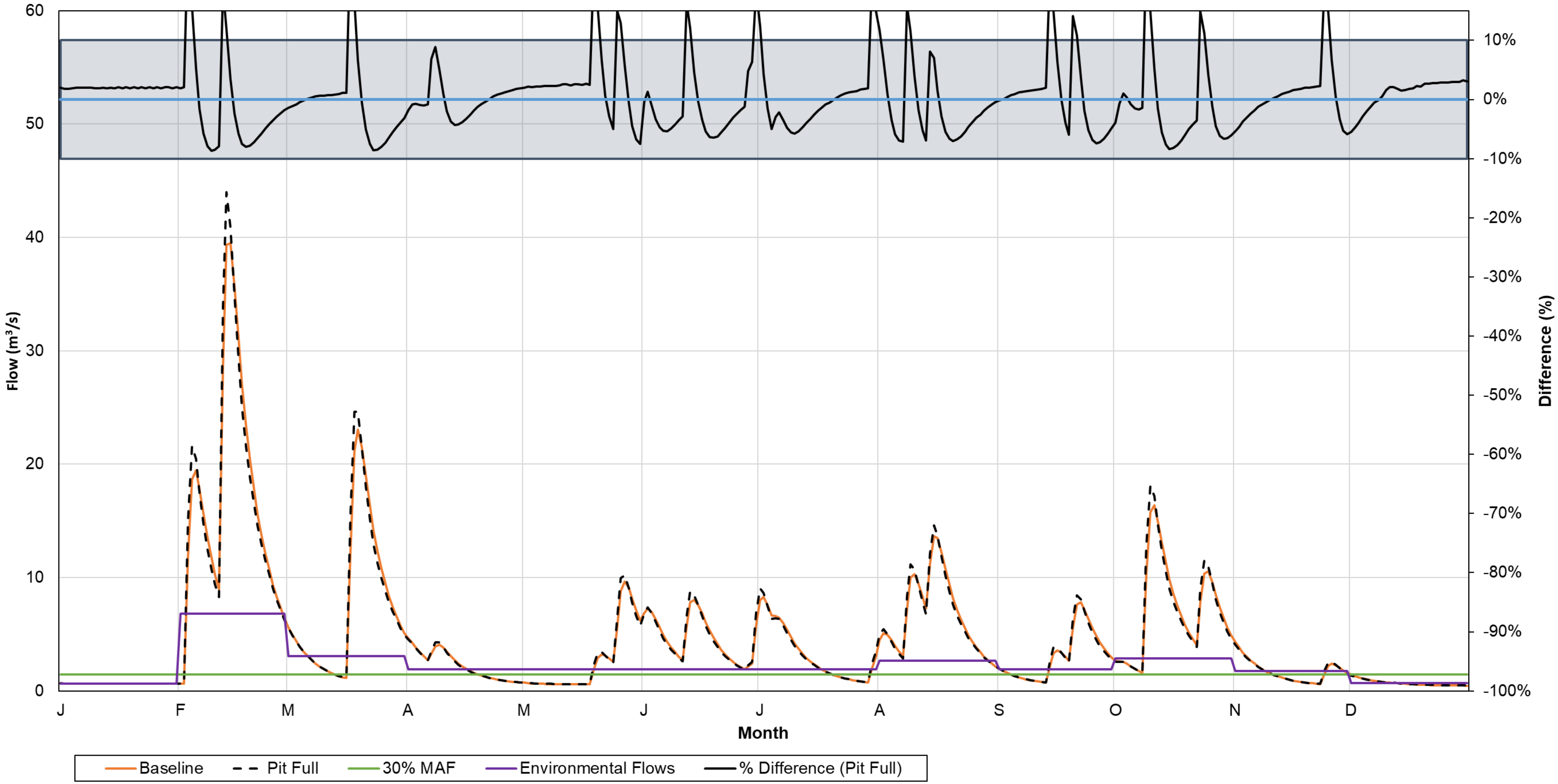


Figure A.56 Climate Change Adjusted Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND3

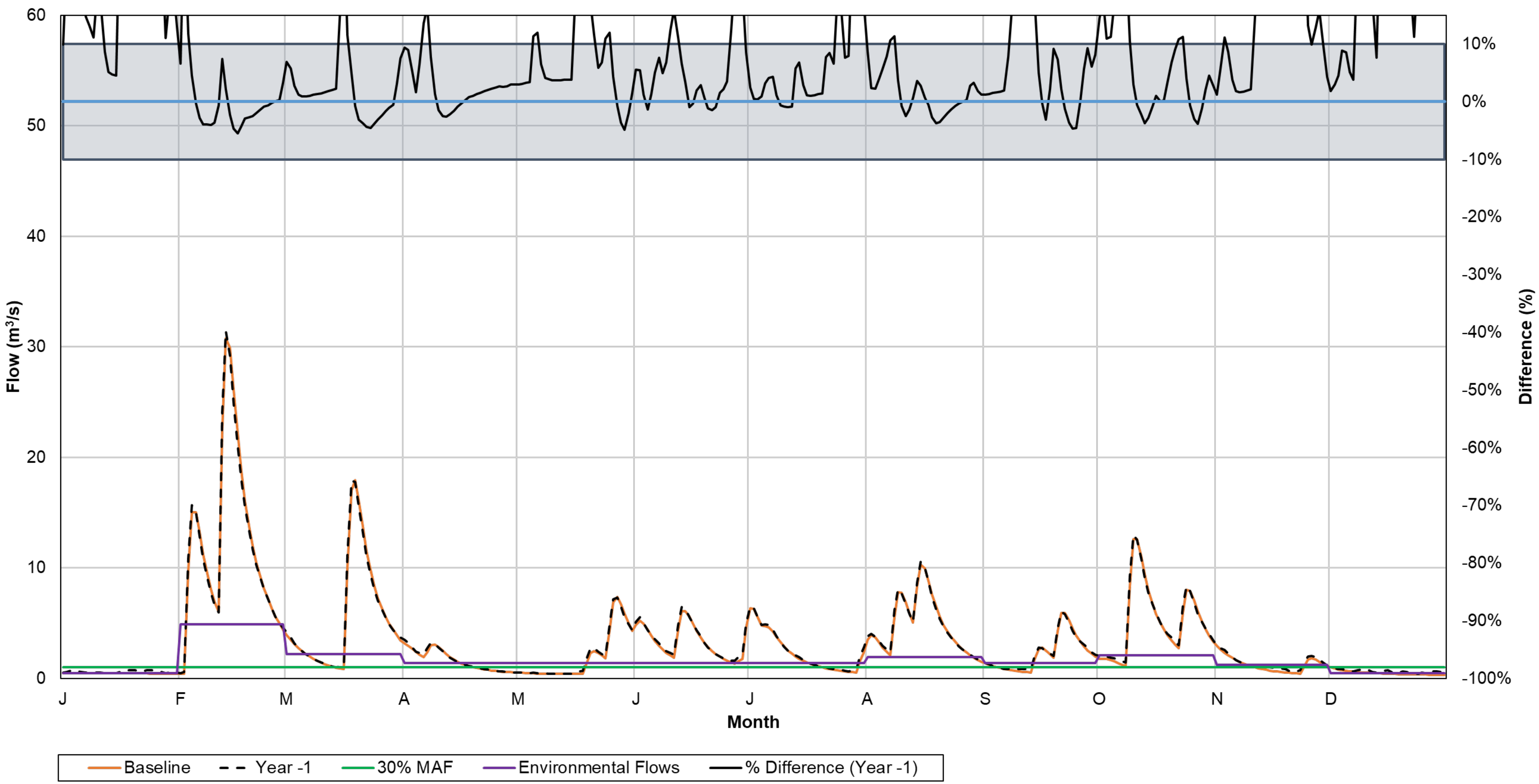


Figure A.57 Climate Change Adjusted Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND3

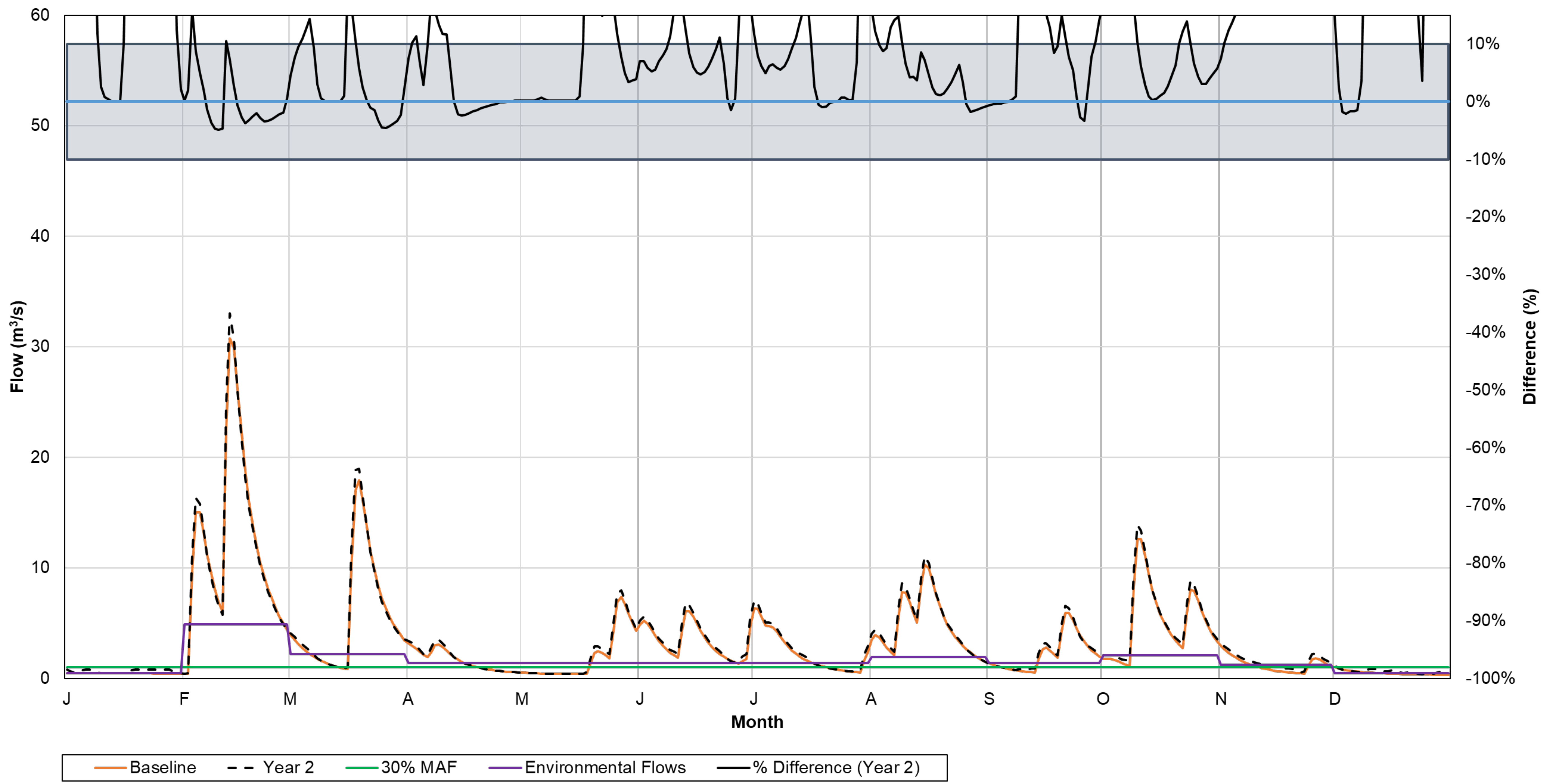


Figure A.58 Climate Change Adjusted Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND3

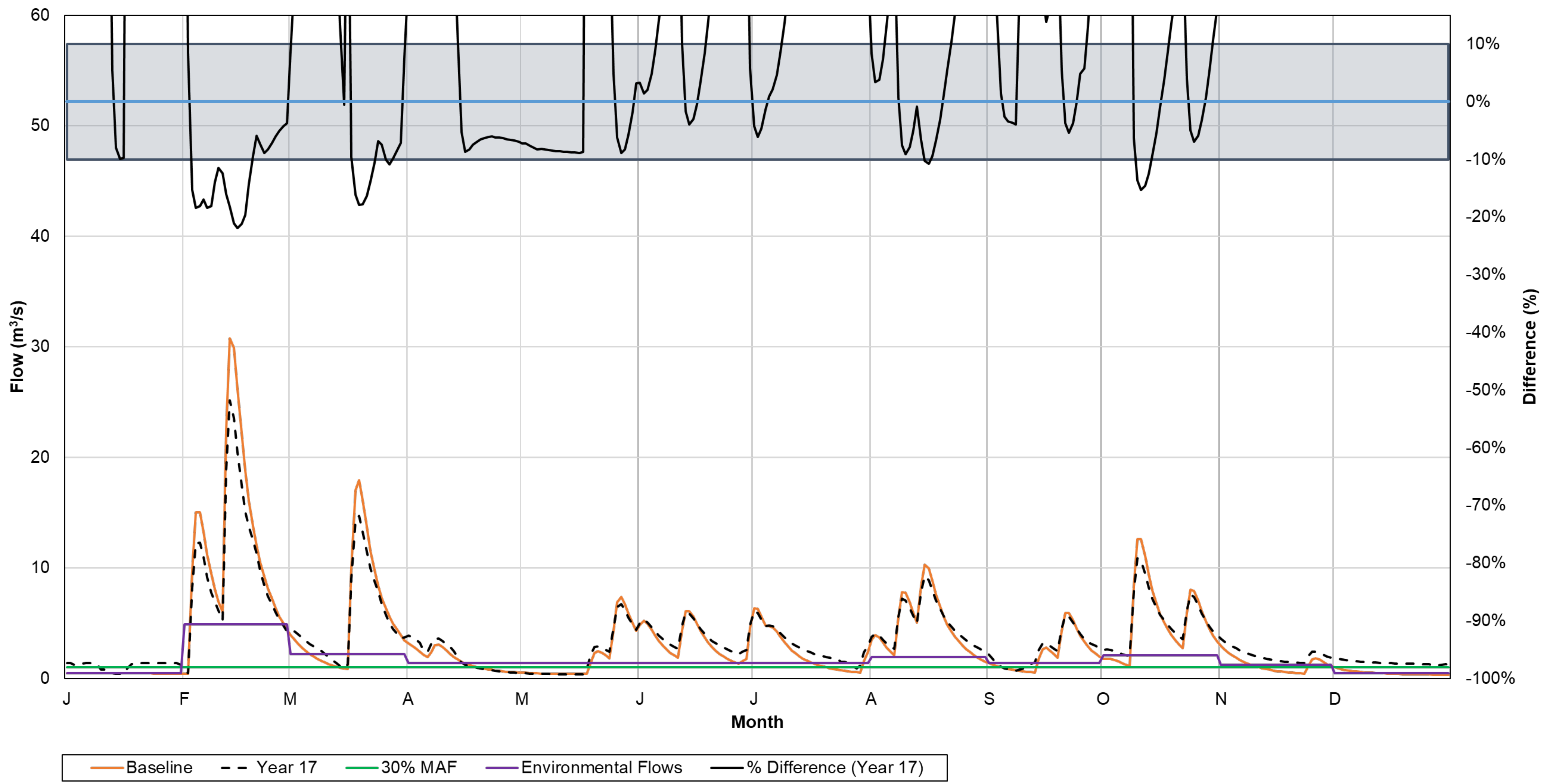


Figure A.59 **Climate Change Adjusted Baseline and Year 23 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND3**

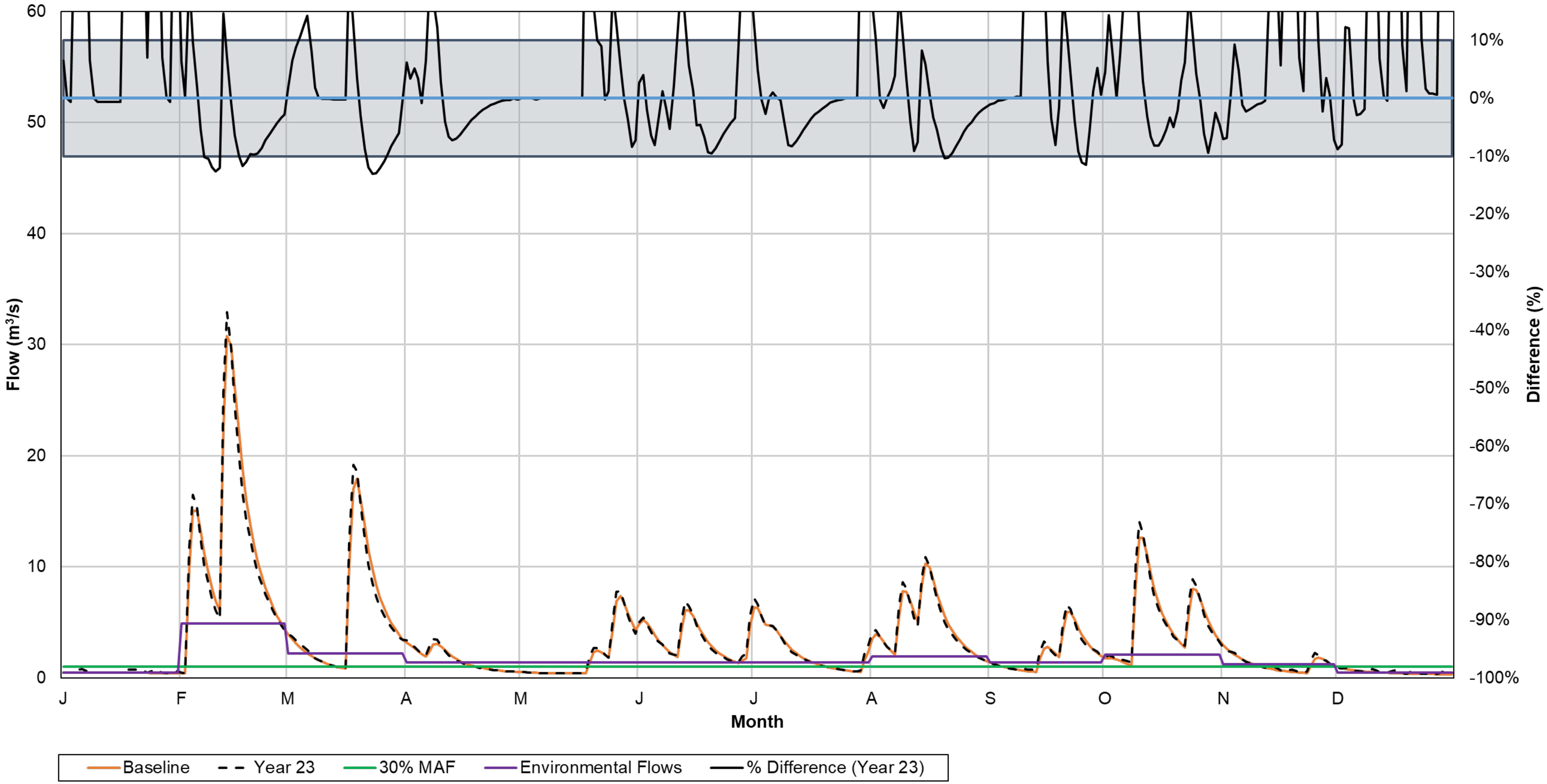


Figure A.60 Climate Change Adjusted Baseline and Year 35 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND3

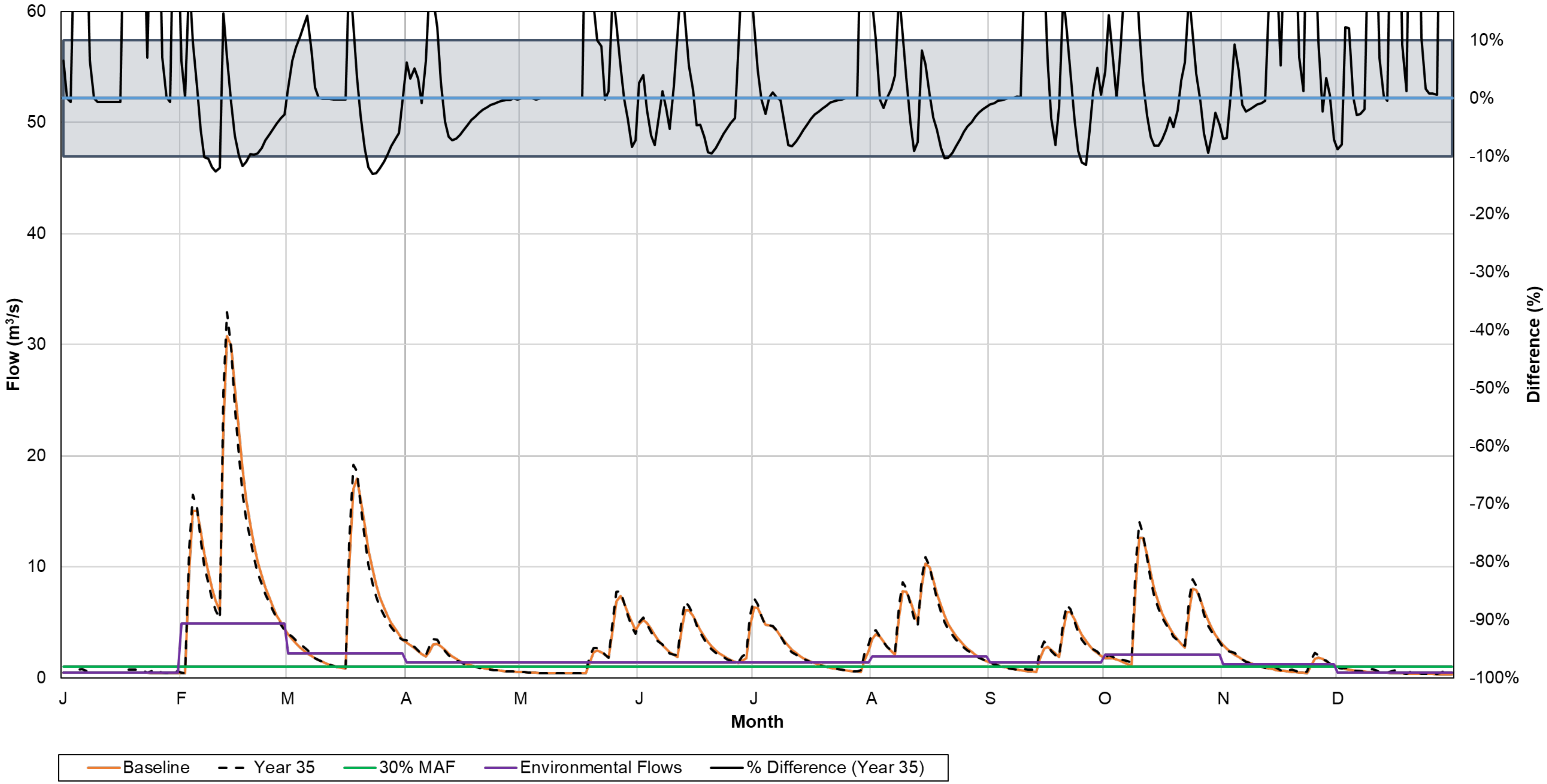


Figure A.61 Climate Change Adjusted Baseline and Year 41 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND3

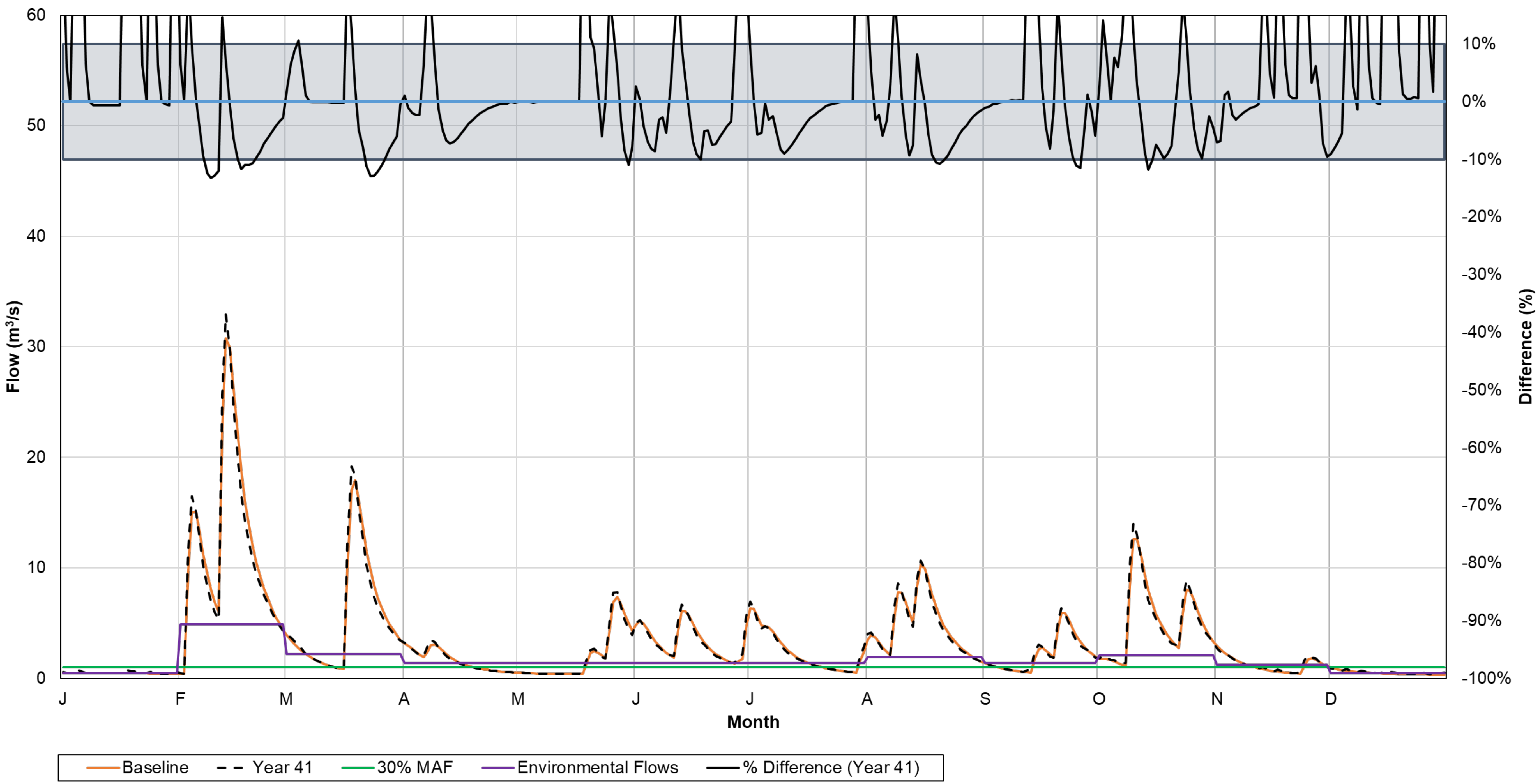


Figure A.62 Climate Change Adjusted Baseline and Year 47 (Passive Closure Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND3

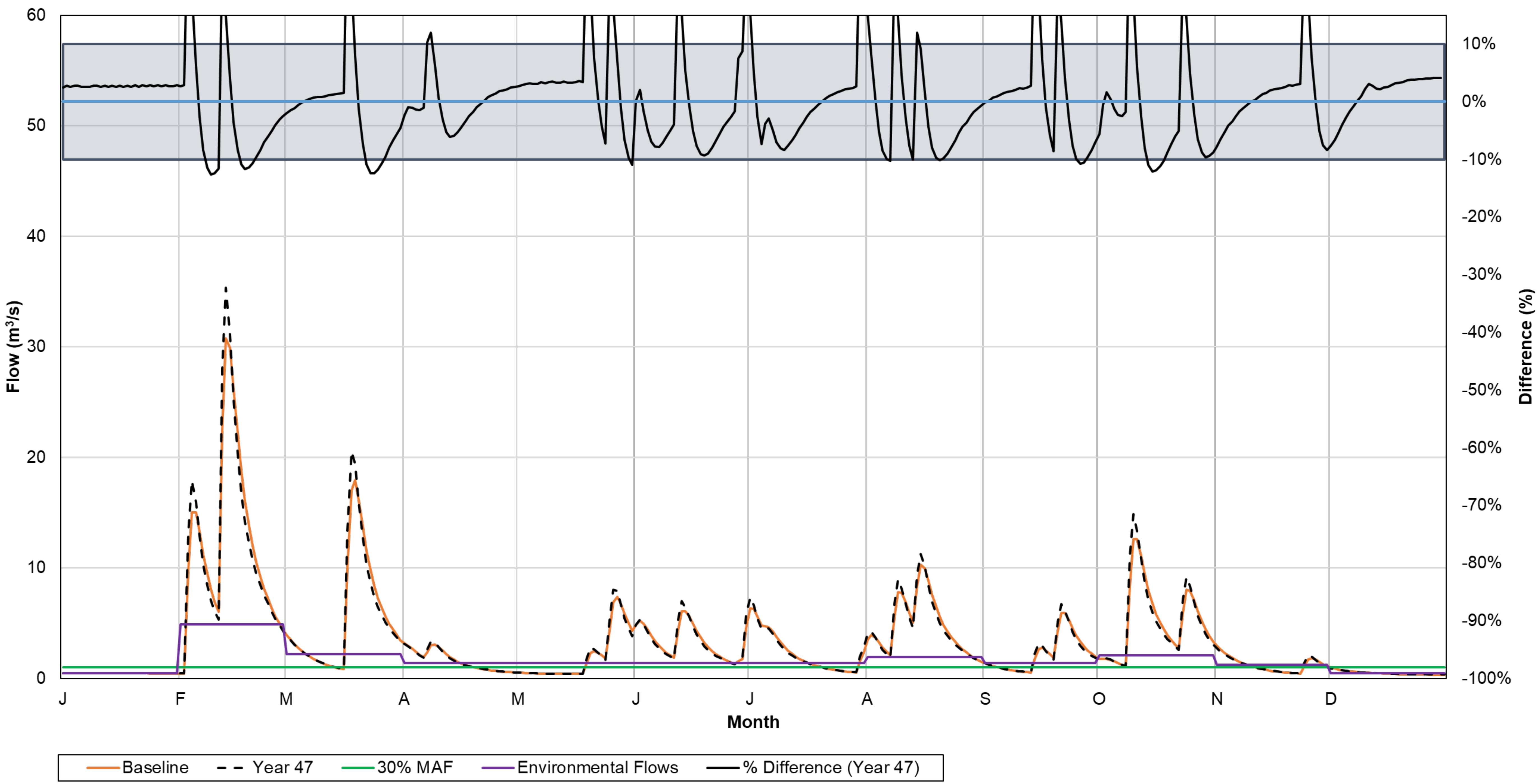


Figure A.63 Climate Change Adjusted Baseline and Pit Full Flows and Percent Changes for the North Driftwood River Watershed – ND3

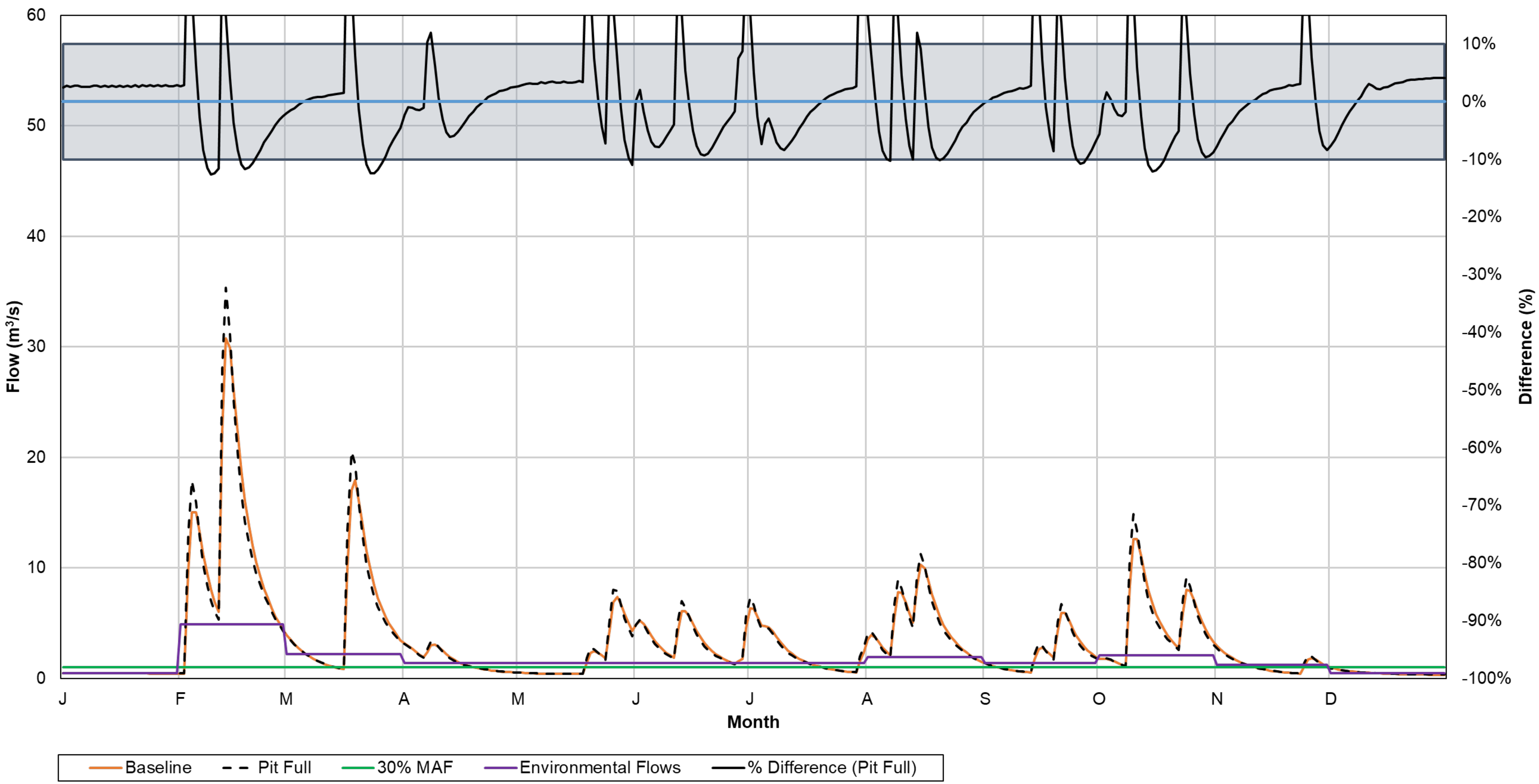


Figure A.64 Climate Change Adjusted Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND5

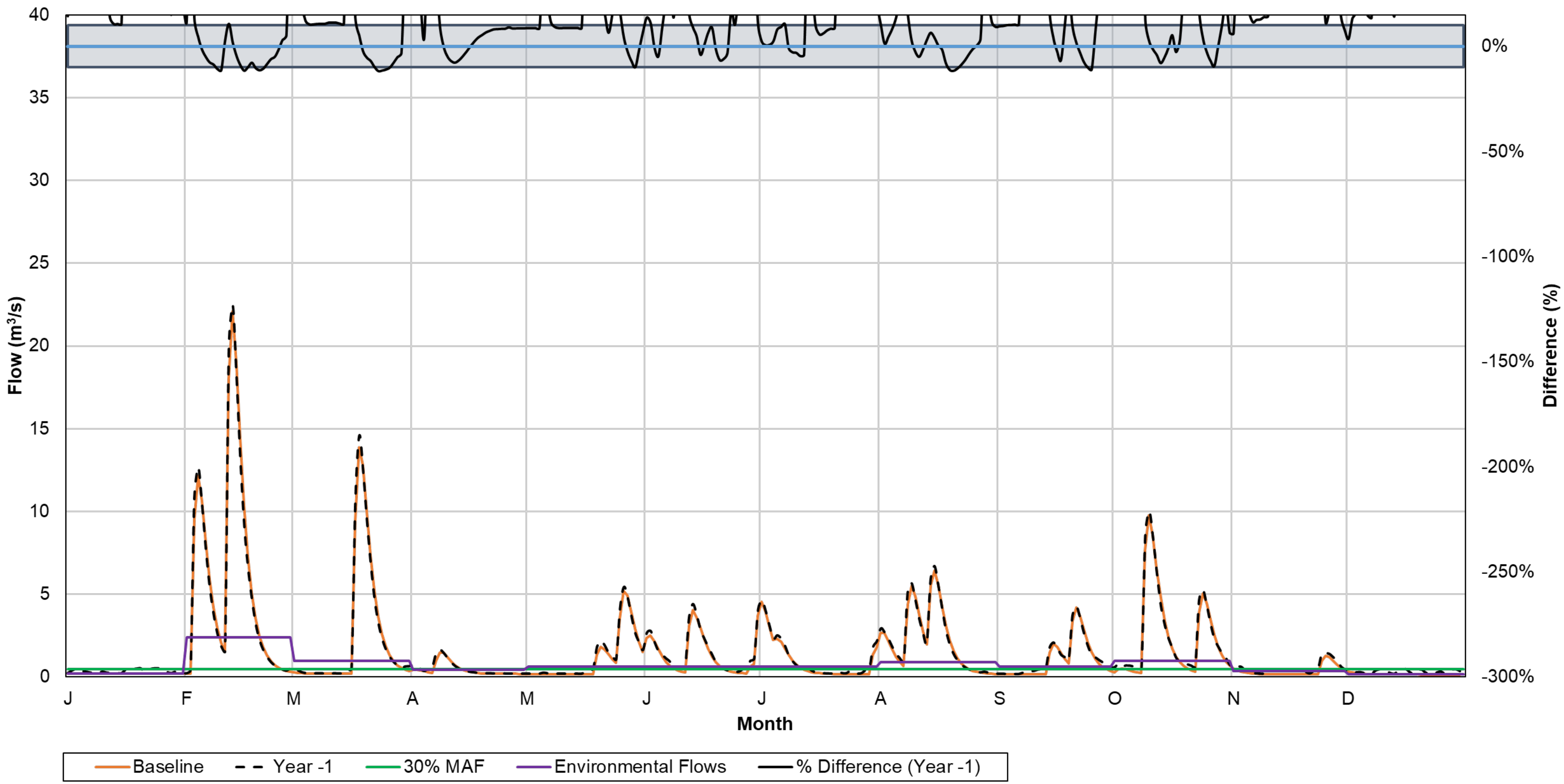


Figure A.65 Climate Change Adjusted Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND5

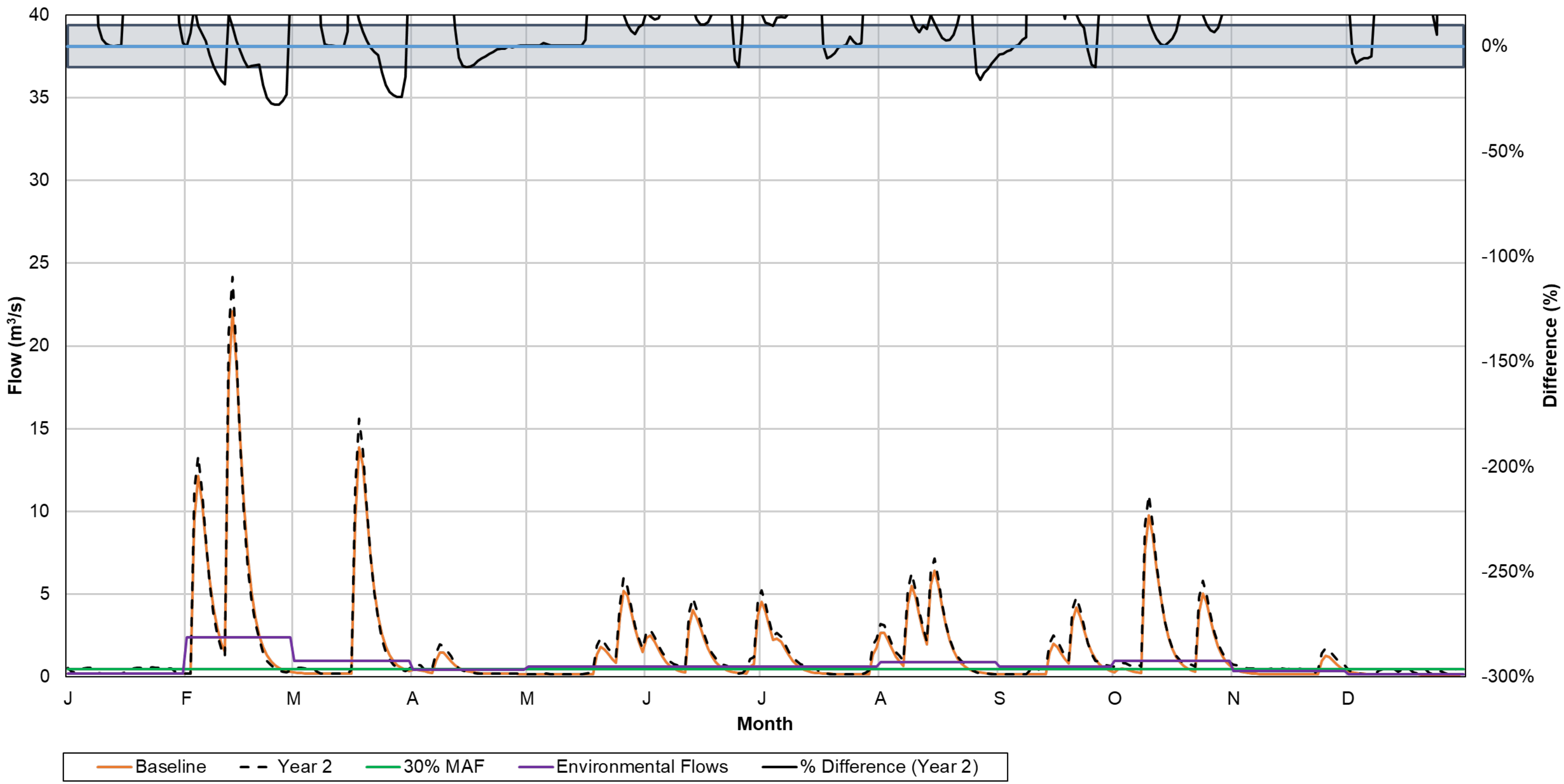


Figure A.66 Climate Change Adjusted Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND5

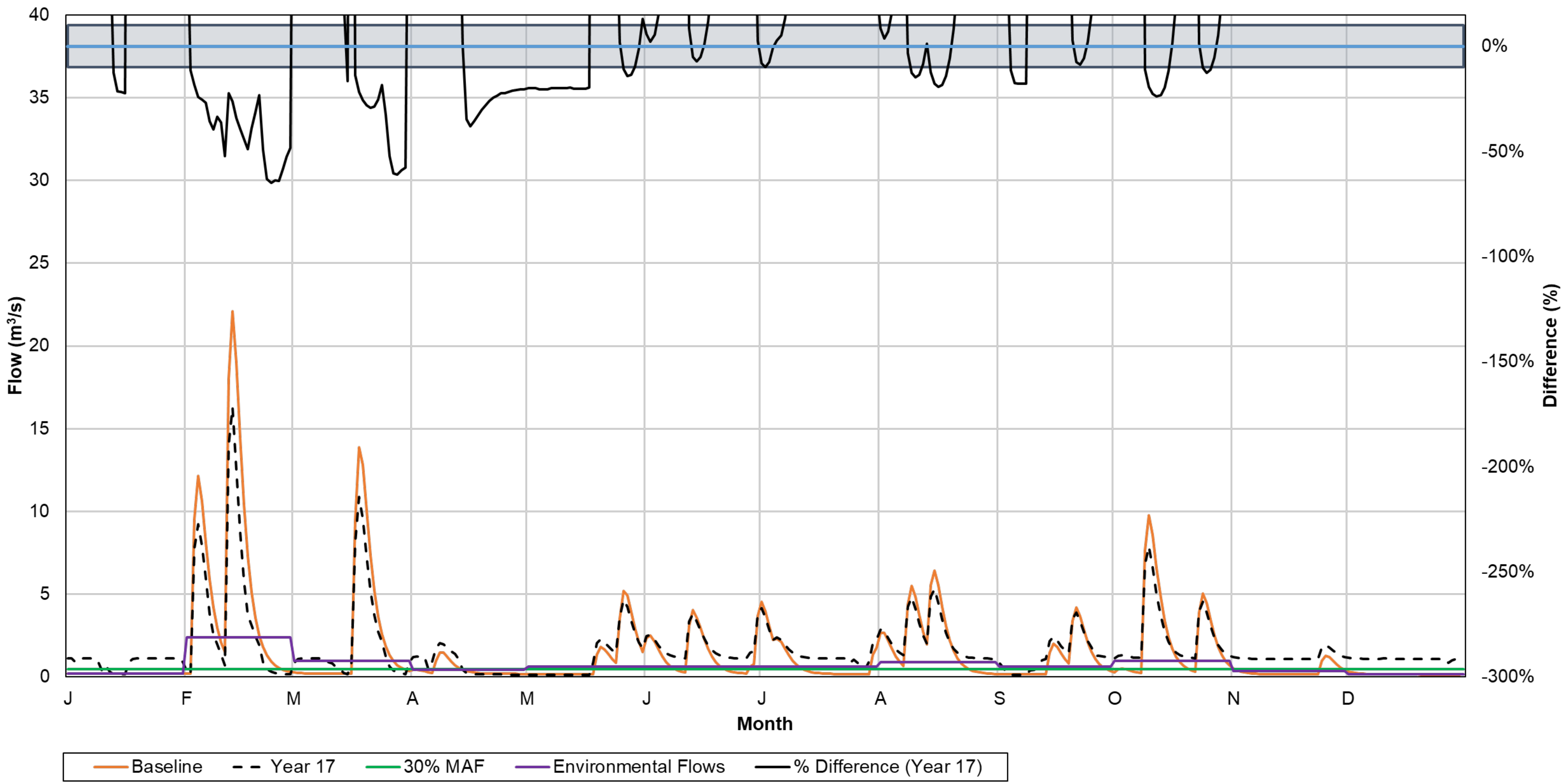


Figure A.67 Climate Change Adjusted Baseline and Year 23 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND5

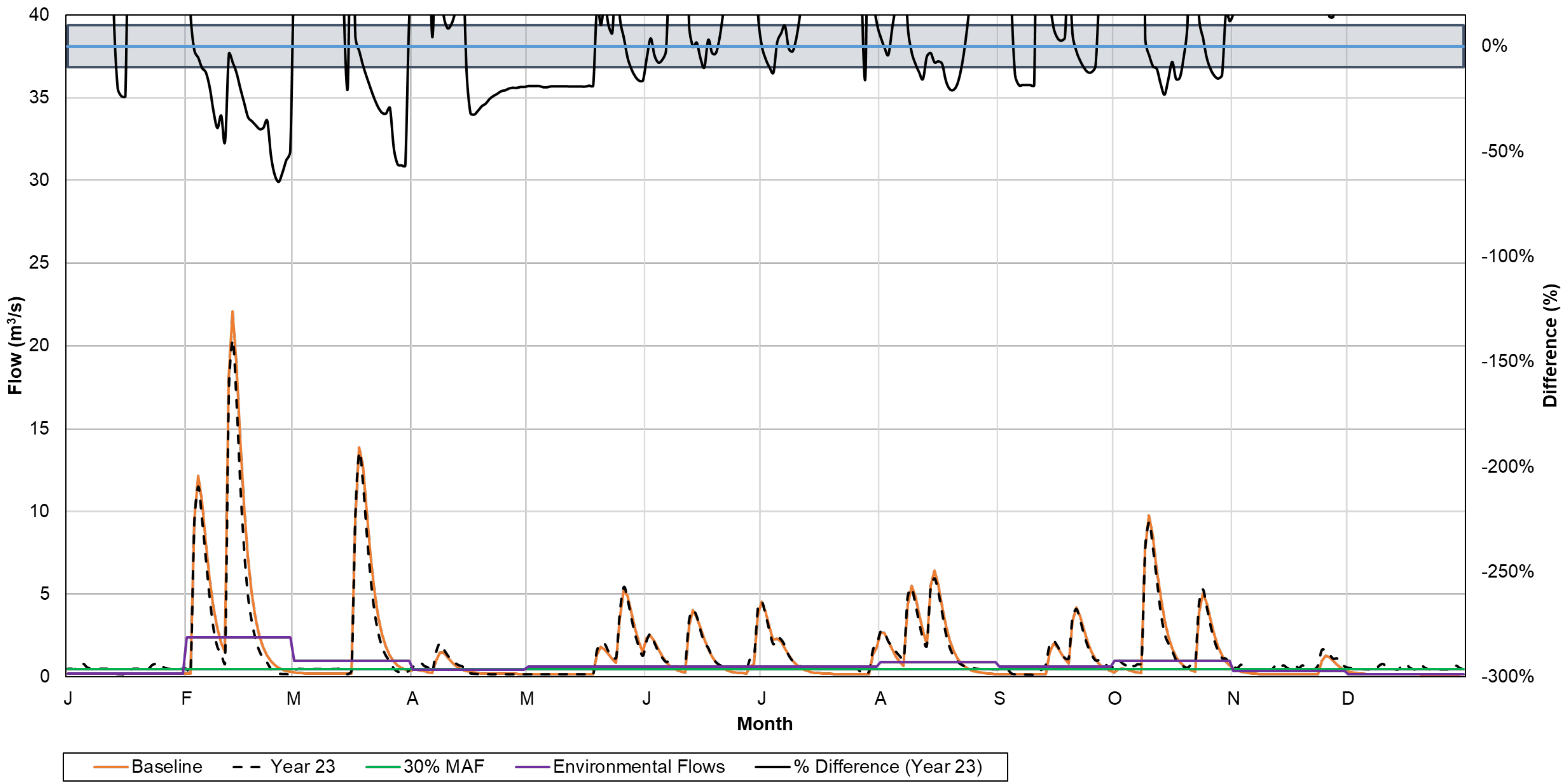


Figure A.68 Climate Change Adjusted Baseline and Year 35 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND5

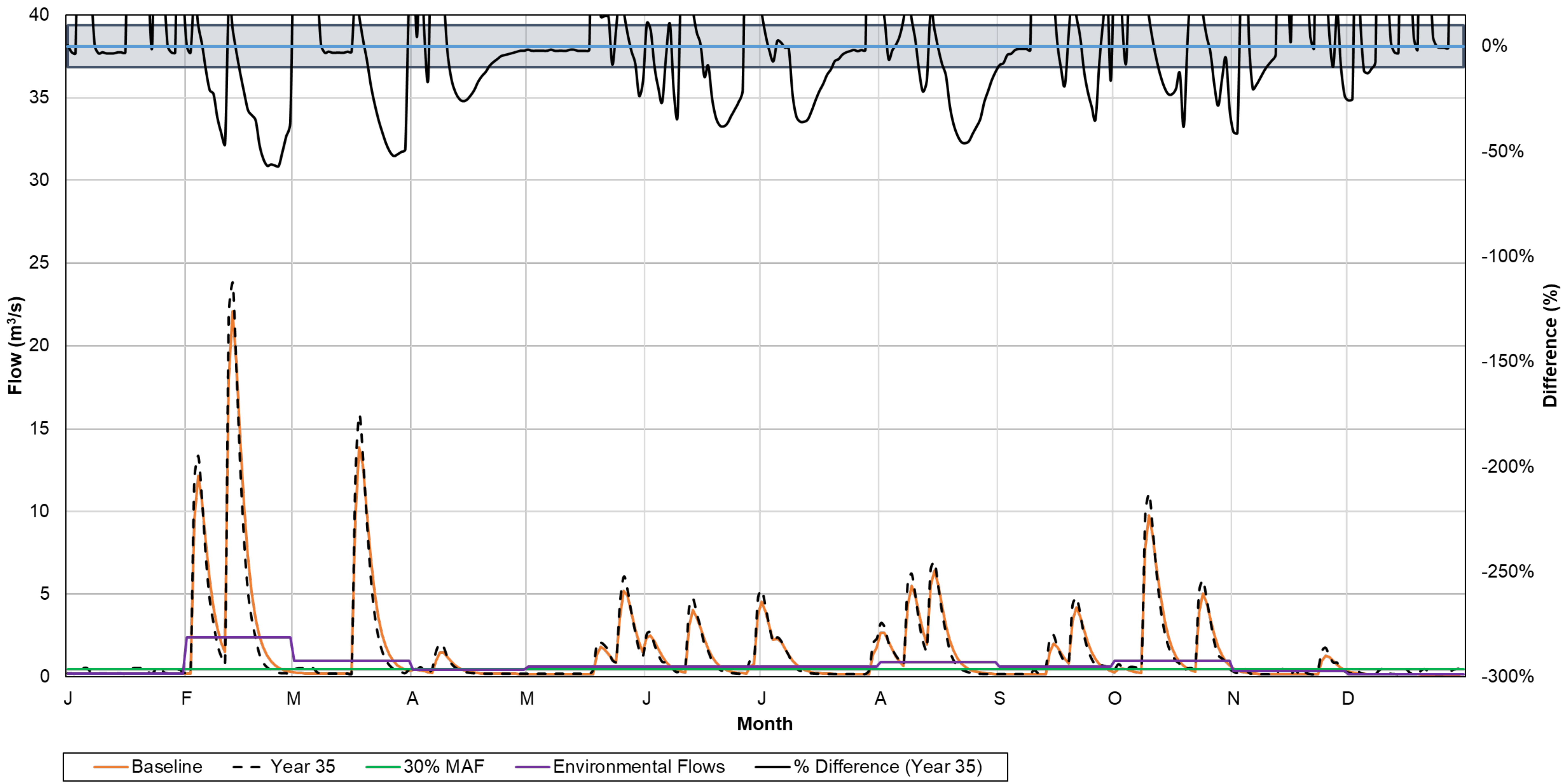


Figure A.69 Climate Change Adjusted Baseline and Year 41 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND5

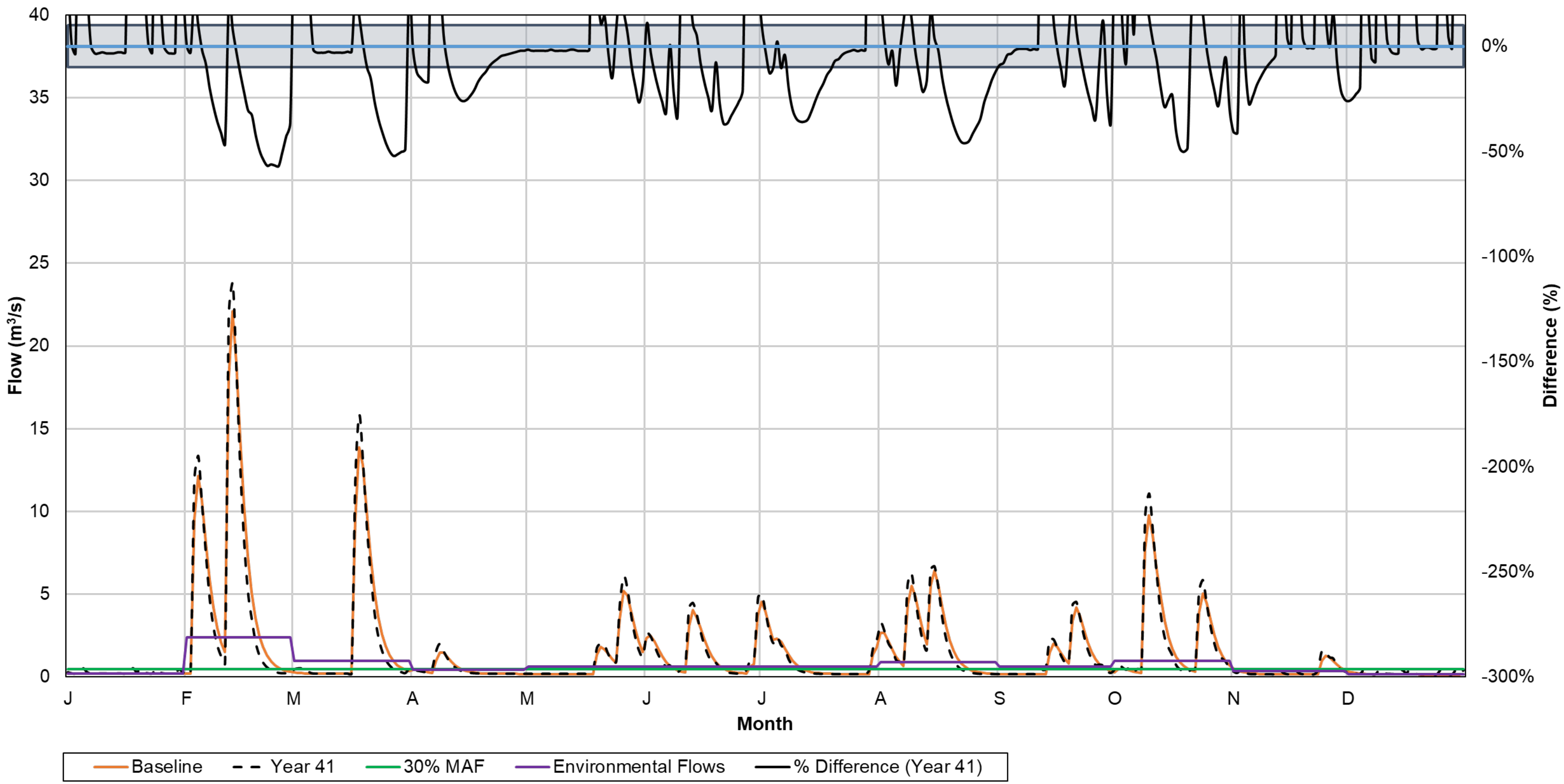


Figure A.70 Climate Change Adjusted Baseline and Year 47 (Passive Closure Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND5

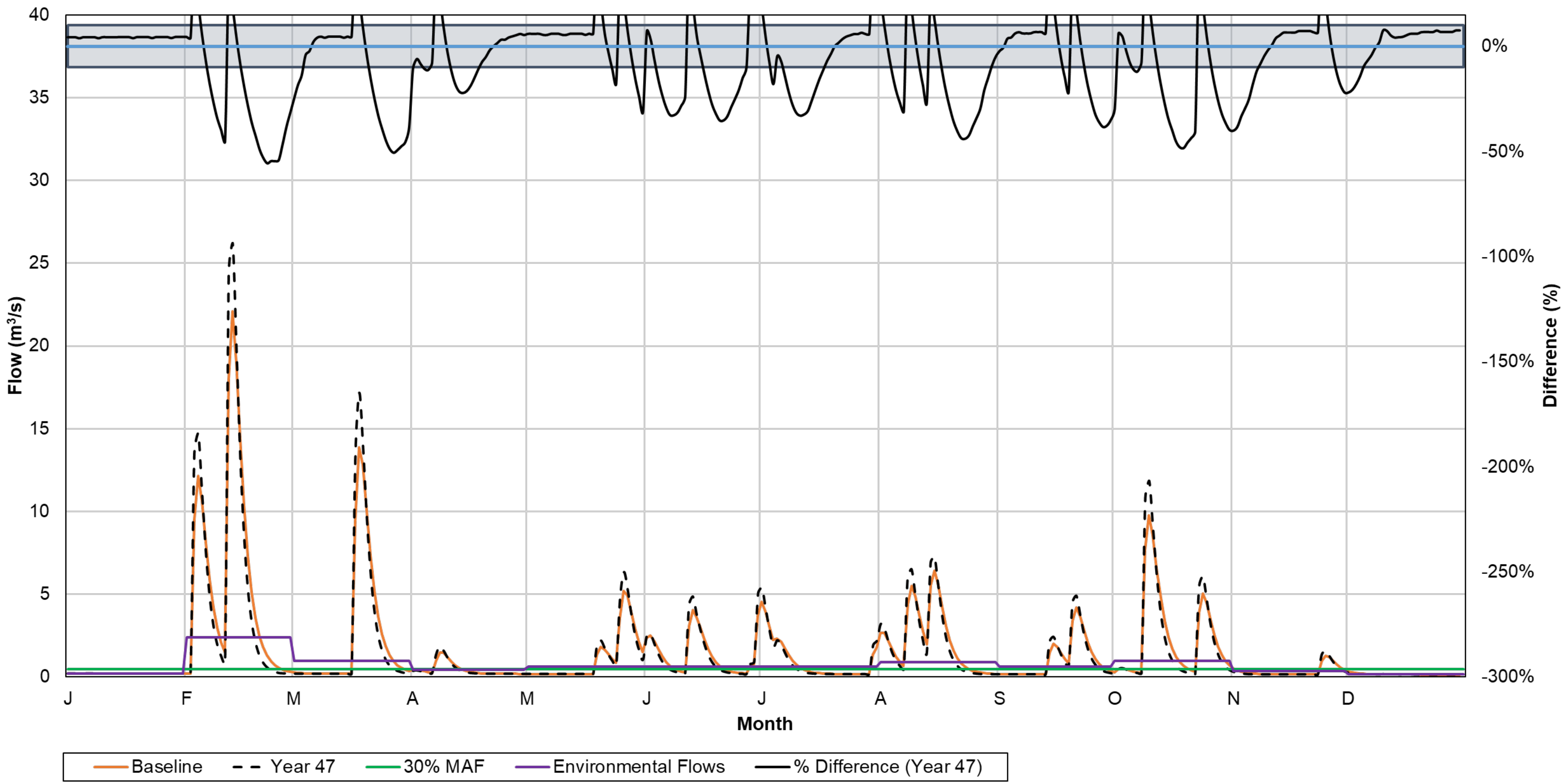


Figure A.71 Climate Change Adjusted Baseline and Pit Full Flows and Percent Changes for the North Driftwood River Watershed – ND5

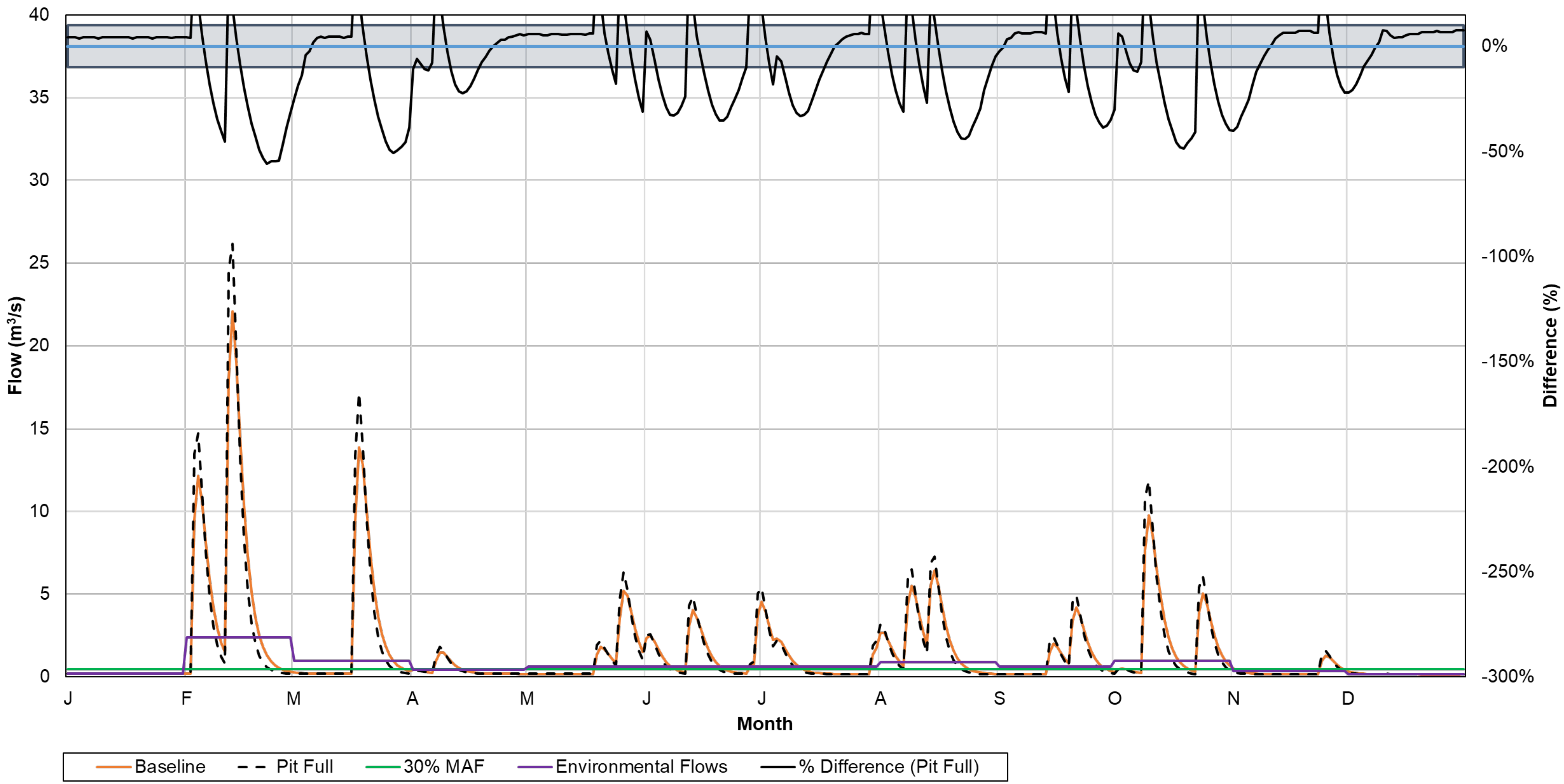


Figure A.72 Climate Change Adjusted Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND8

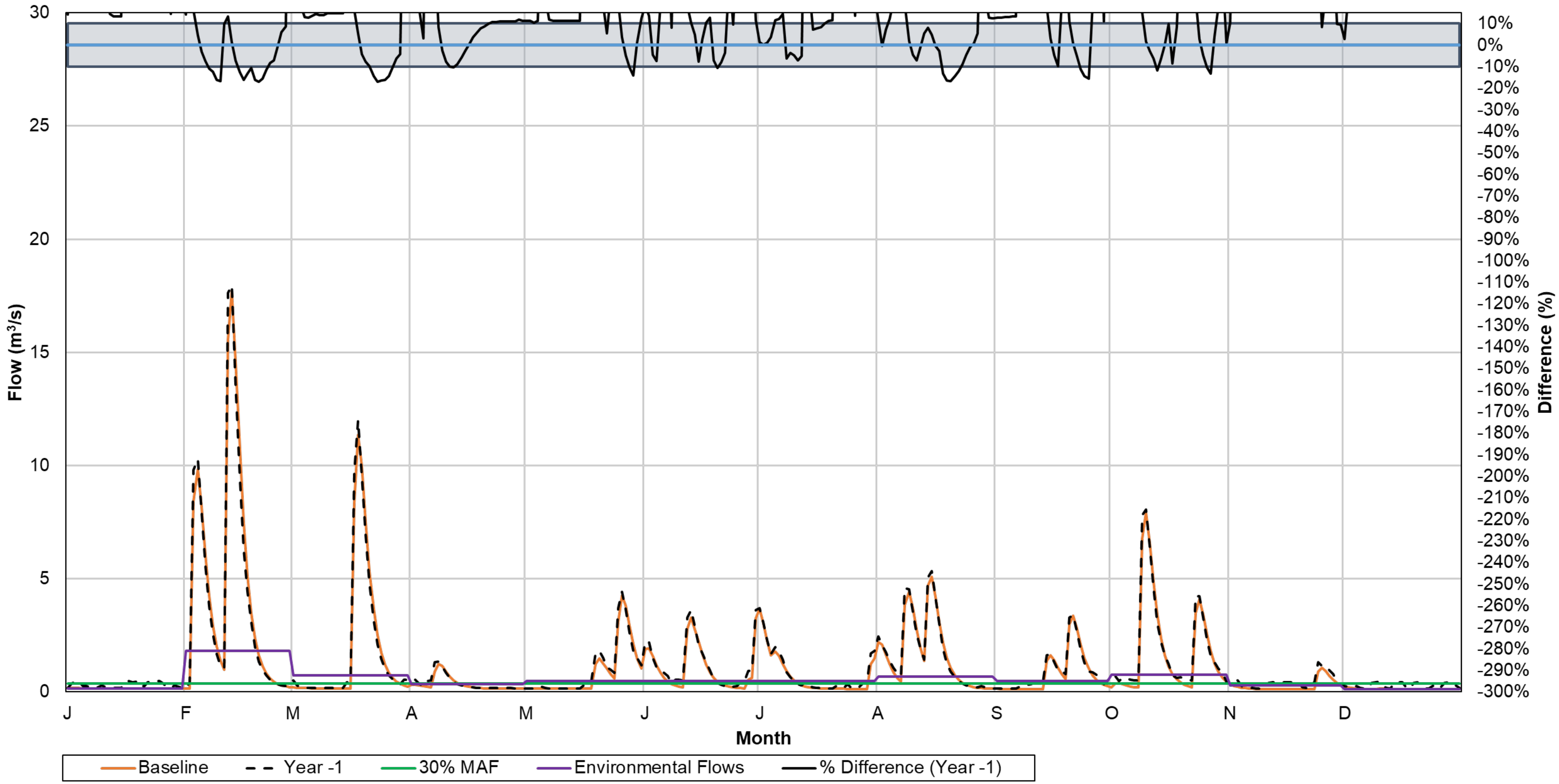


Figure A.73 Climate Change Adjusted Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND8

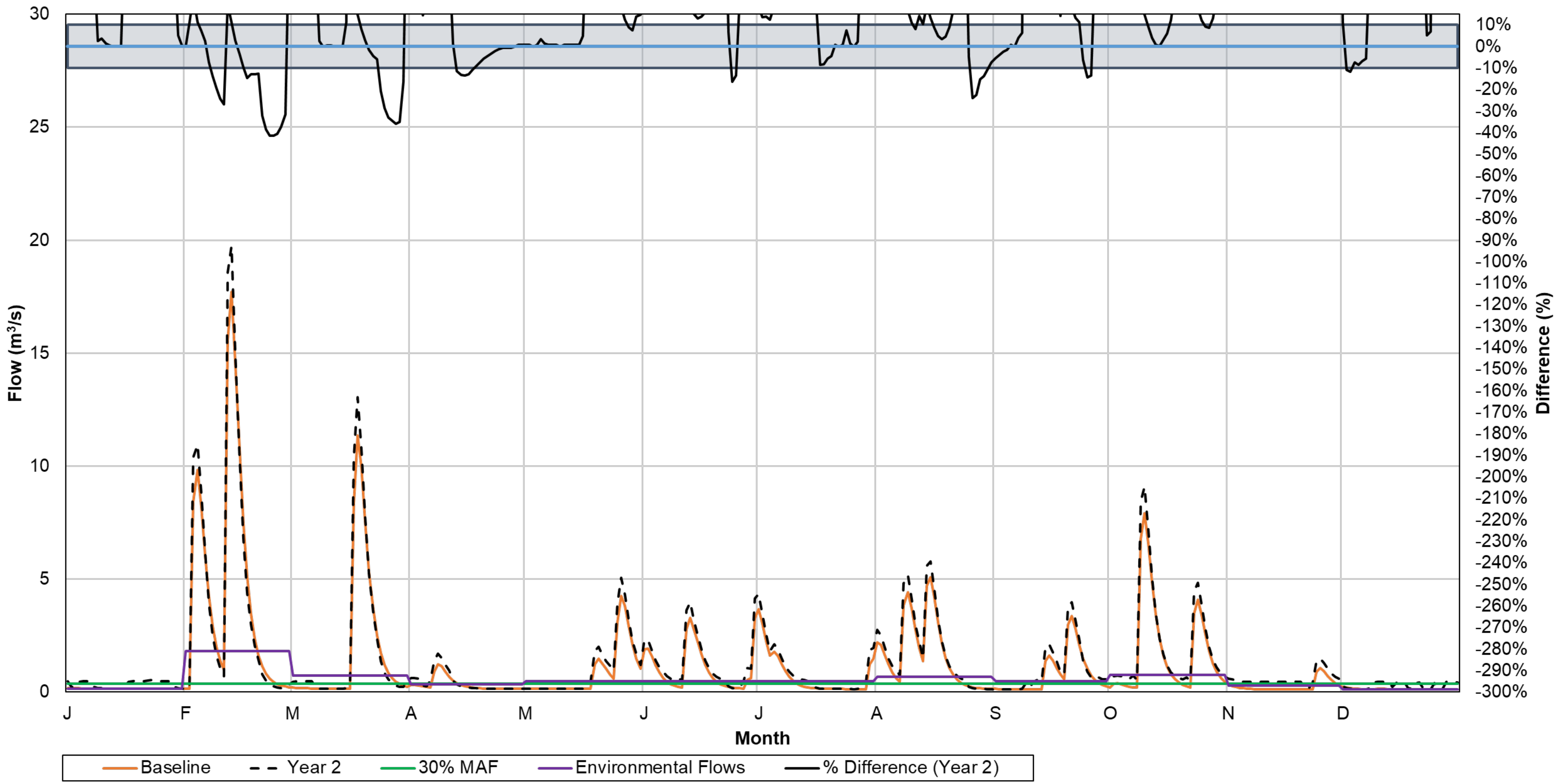


Figure A.74 Climate Change Adjusted Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND8

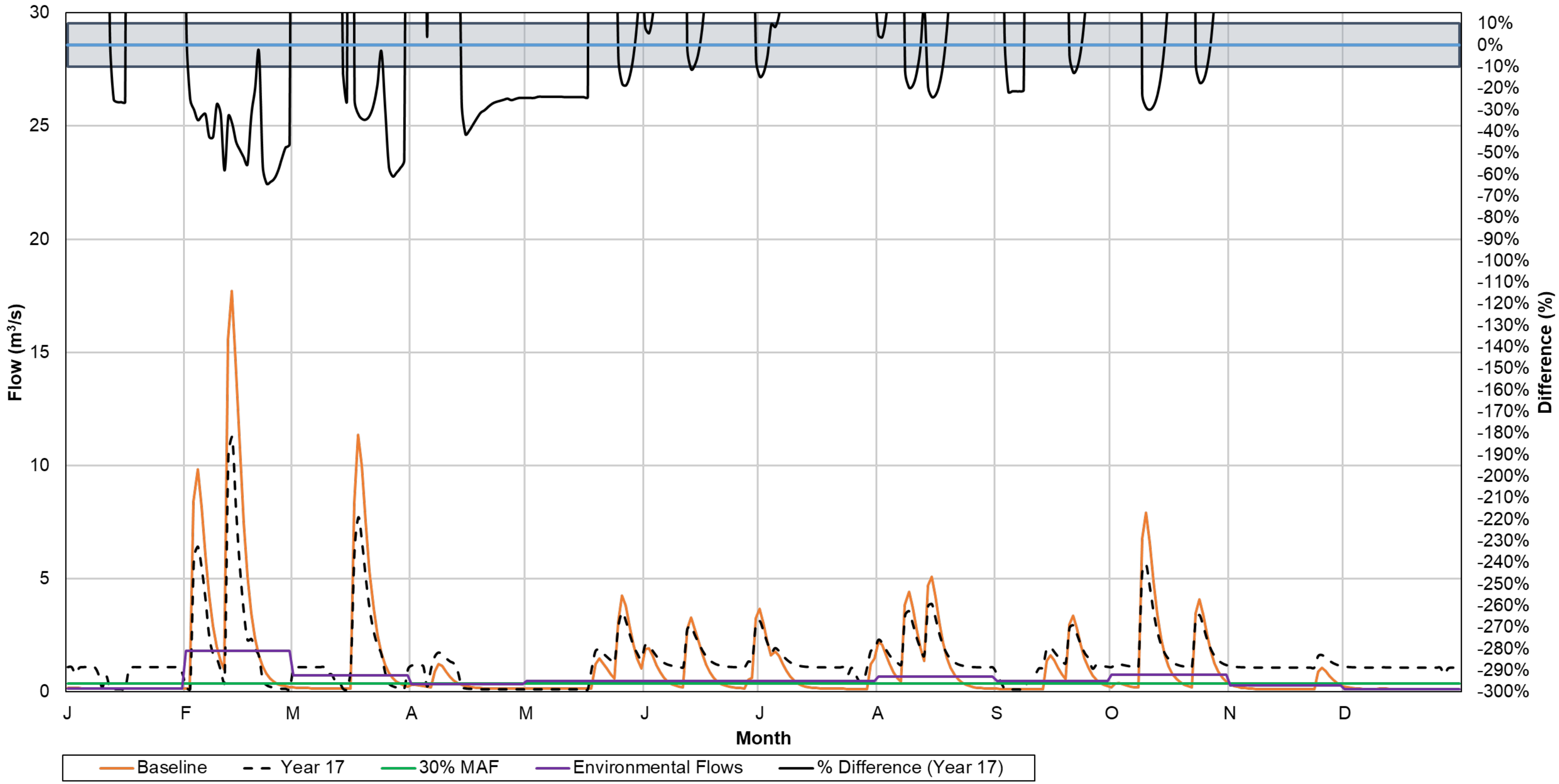


Figure A.75 Climate Change Adjusted Baseline and Year 23 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND8

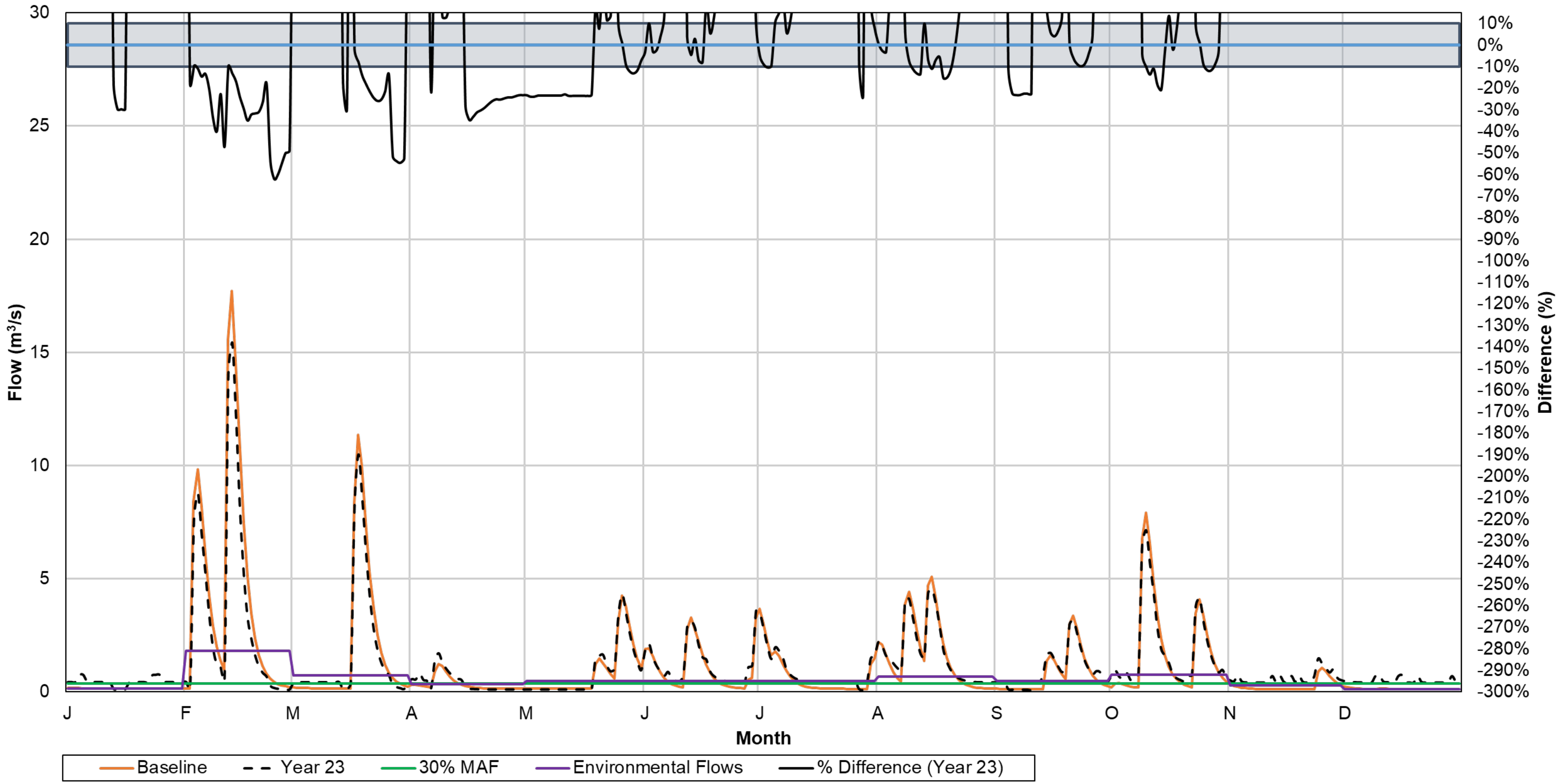


Figure A.76 Climate Change Adjusted Baseline and Year 35 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND8

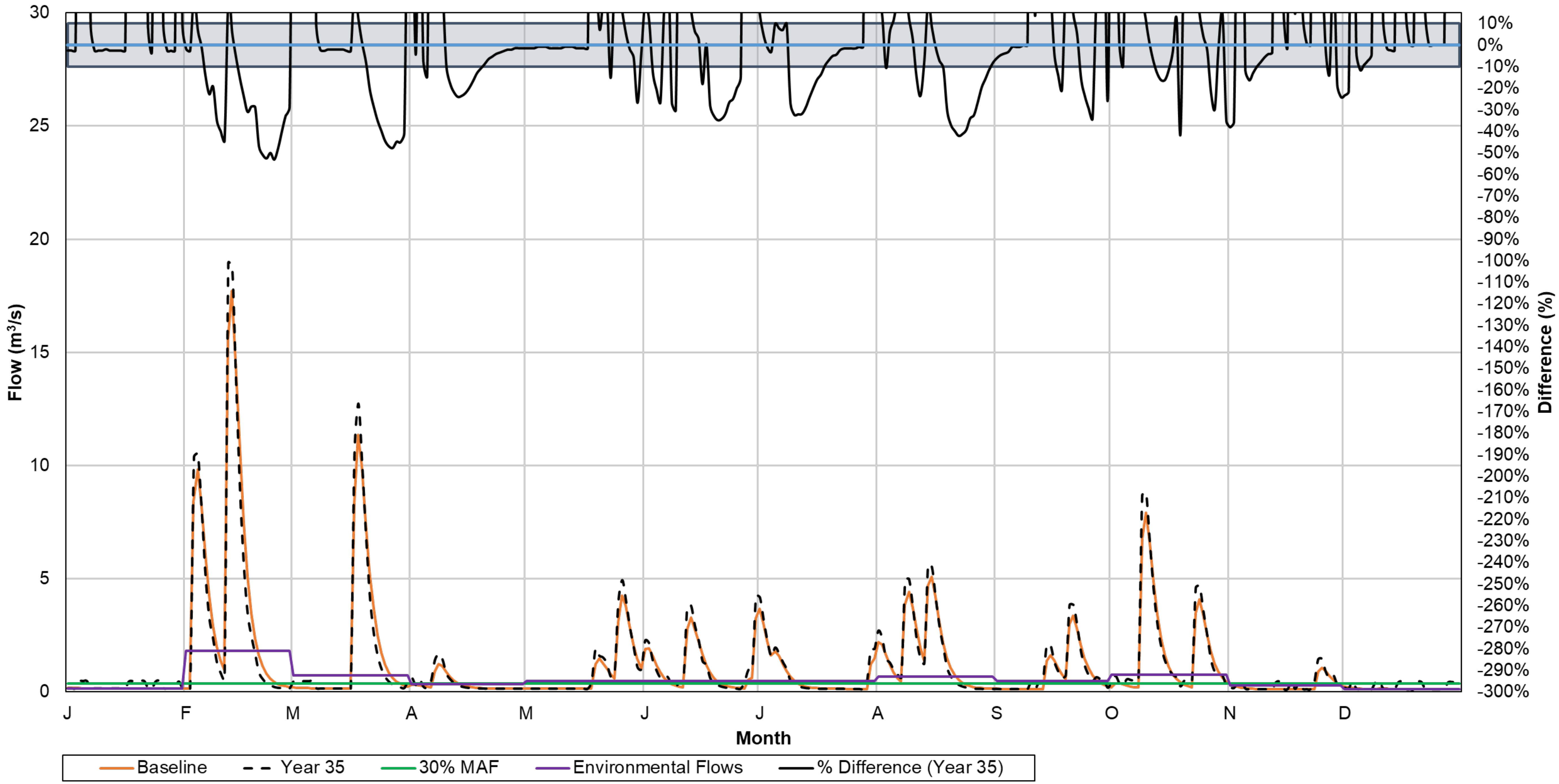


Figure A.77 Climate Change Adjusted Baseline and Year 41 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND8

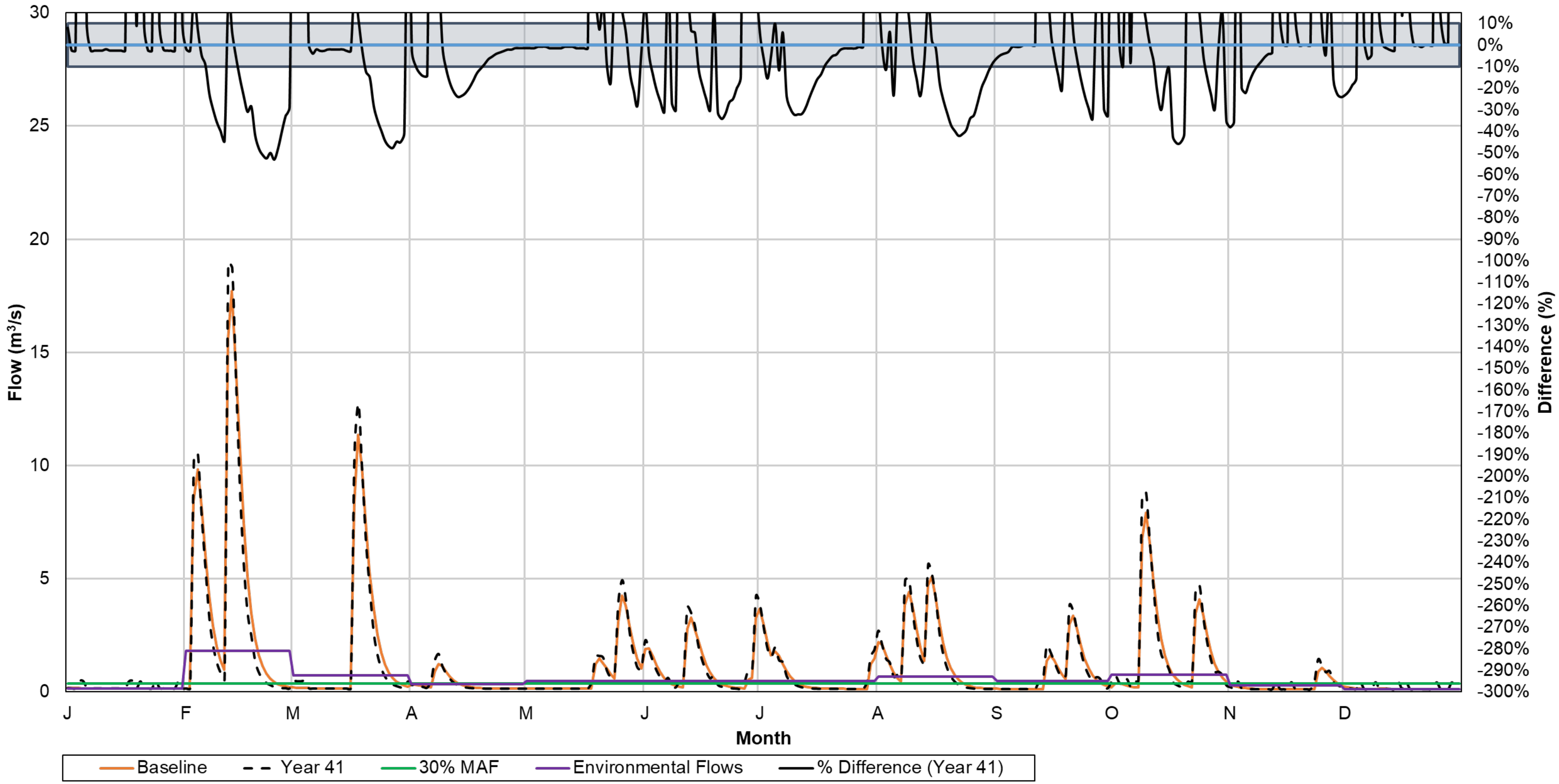


Figure A.78 Climate Change Adjusted Baseline and Year 47 (Passive Closure Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND8

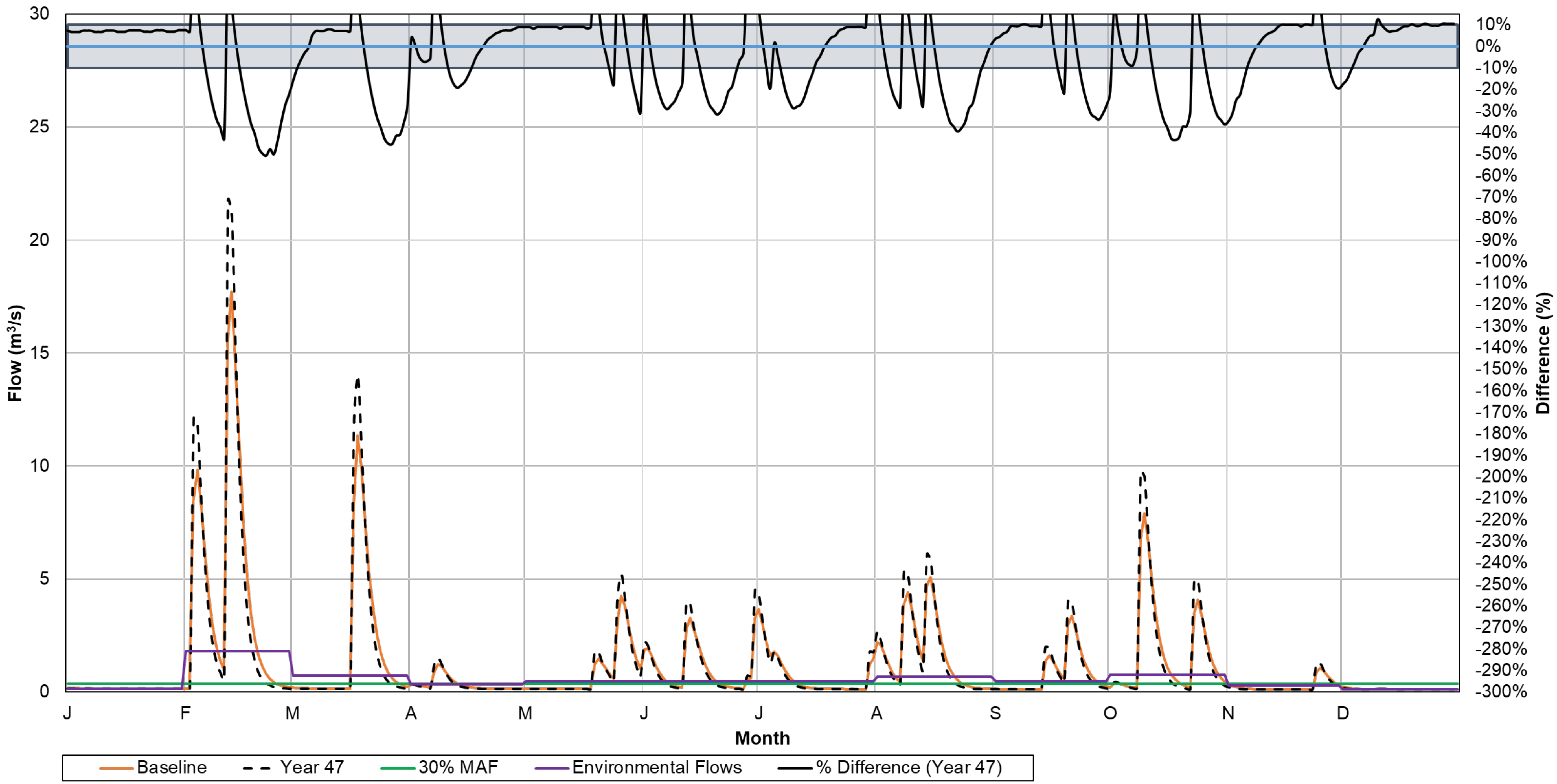


Figure A.79 Climate Change Adjusted Baseline and Pit Full Flows and Percent Changes for the North Driftwood River Watershed – ND8

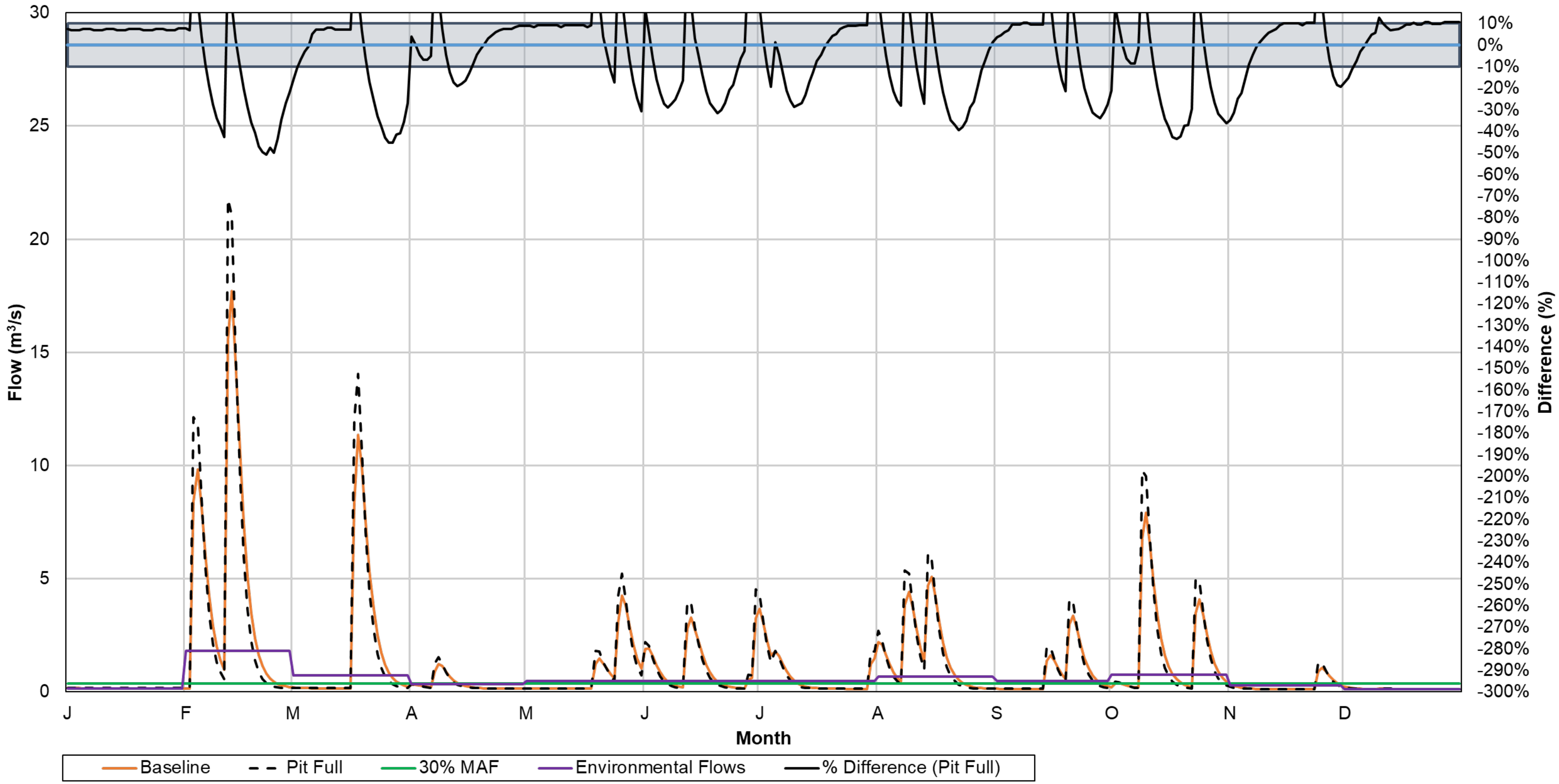


Figure A.80 Climate Change Adjusted Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND18

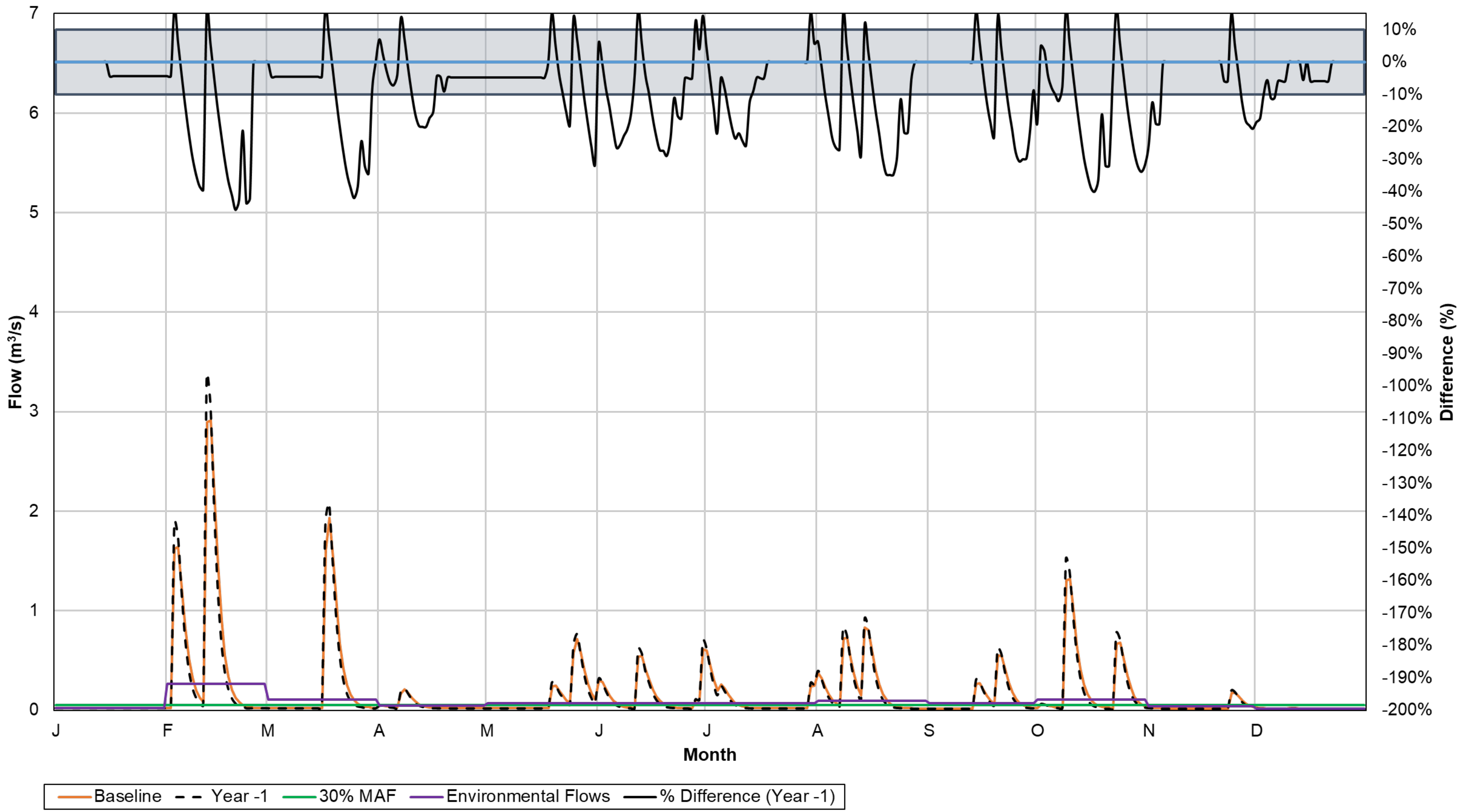


Figure A.81 Climate Change Adjusted Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND18

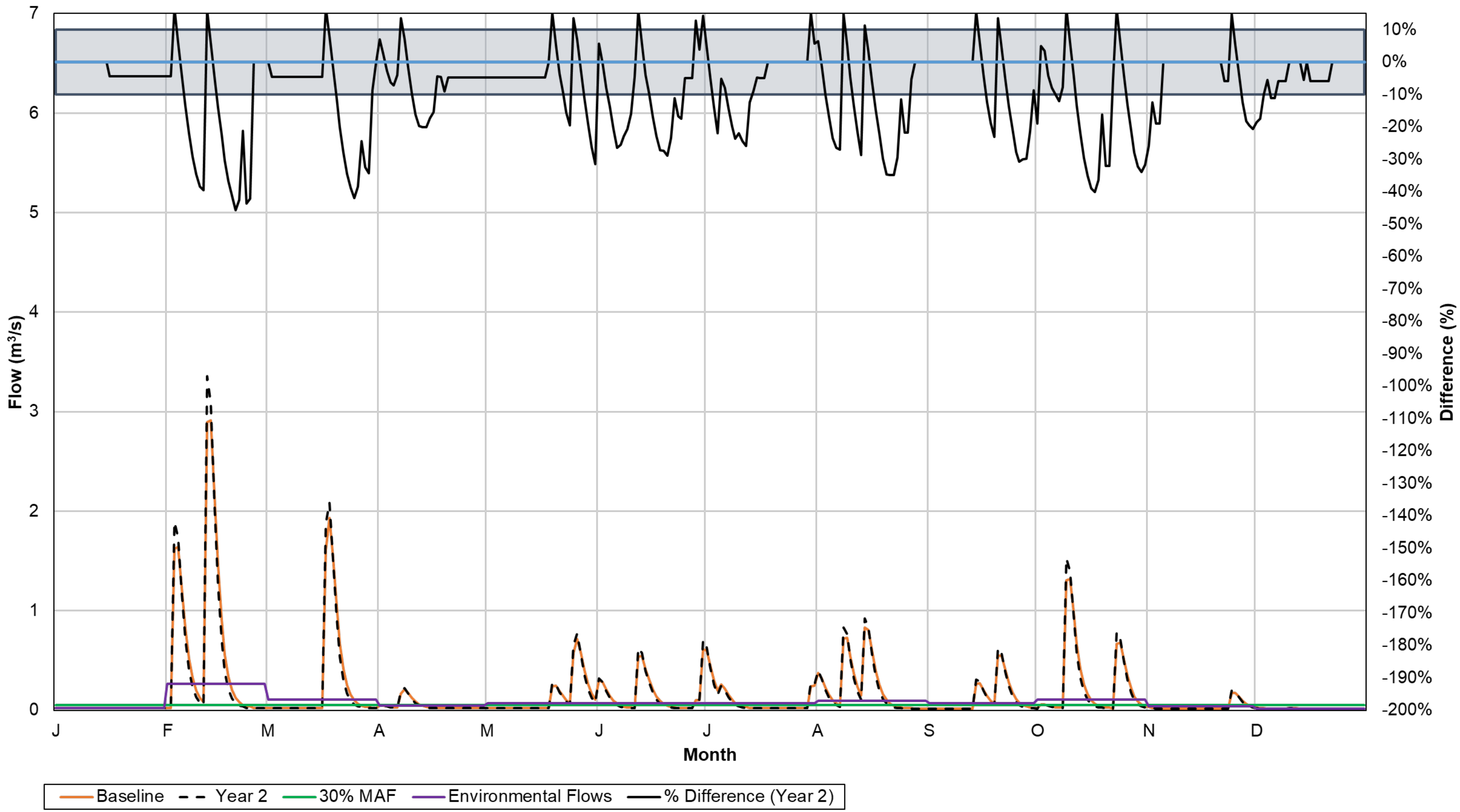


Figure A.82 Climate Change Adjusted Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND18

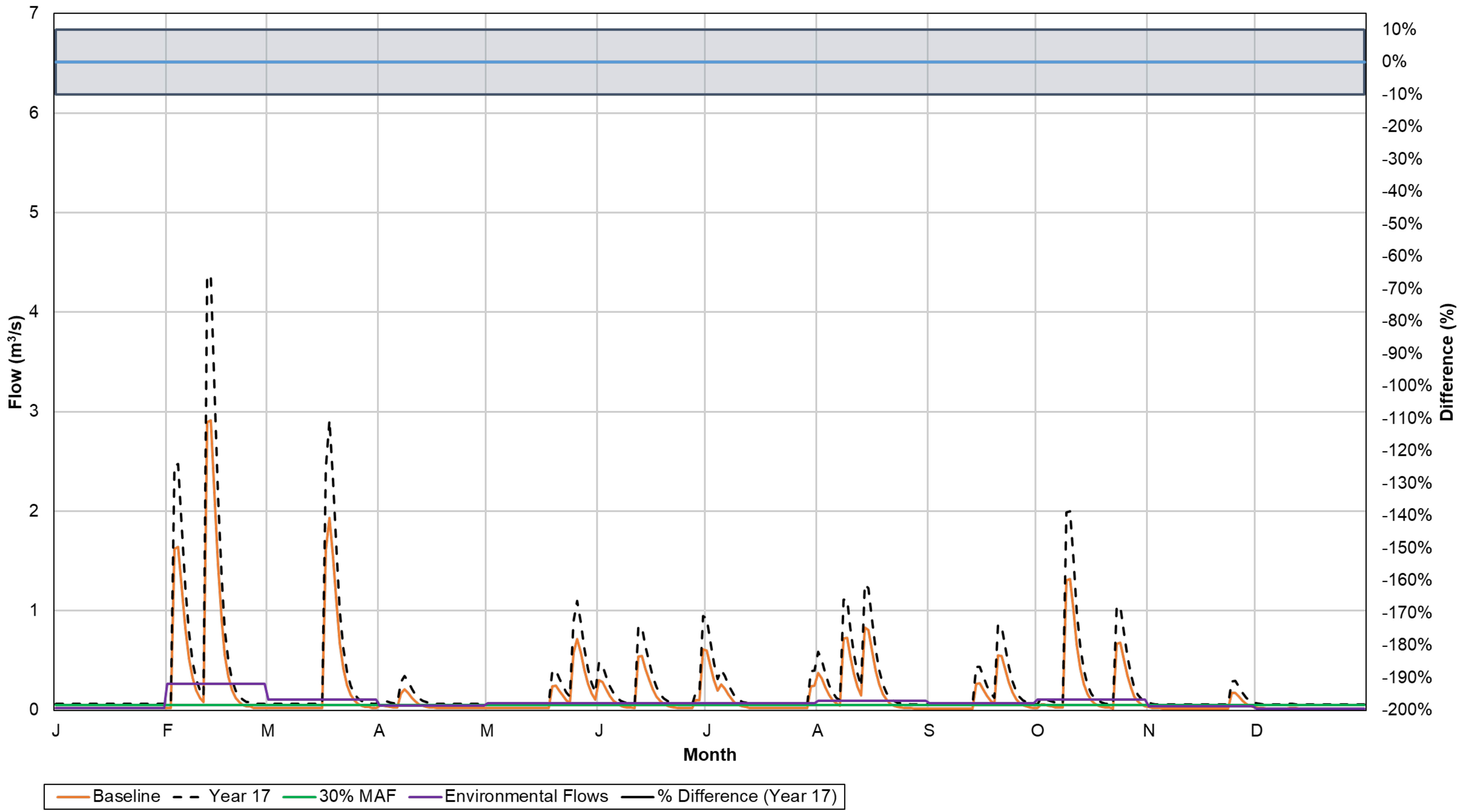


Figure A.83 Climate Change Adjusted Baseline and Year 23 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND18

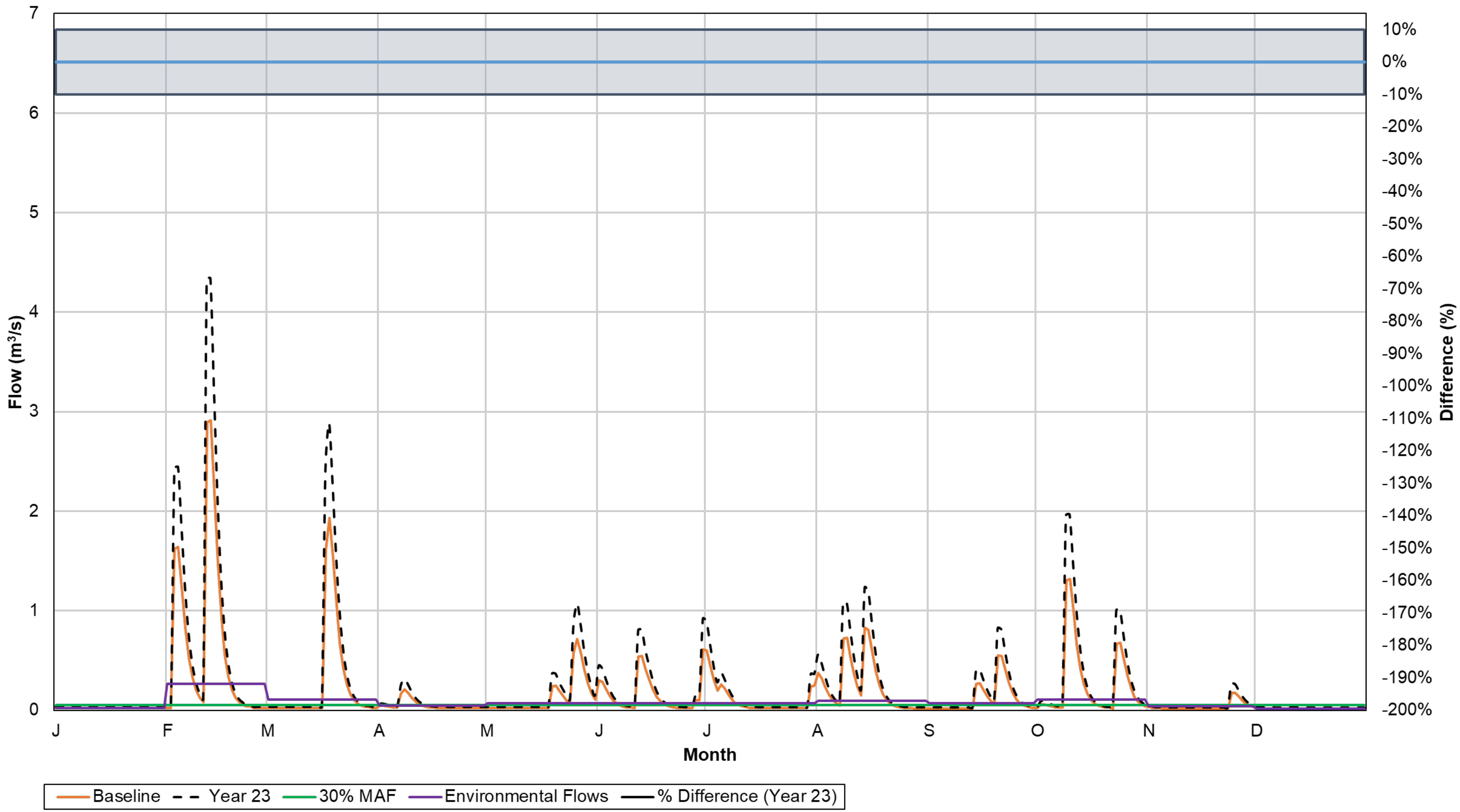


Figure A.84 Climate Change Adjusted Baseline and Year 35 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND18

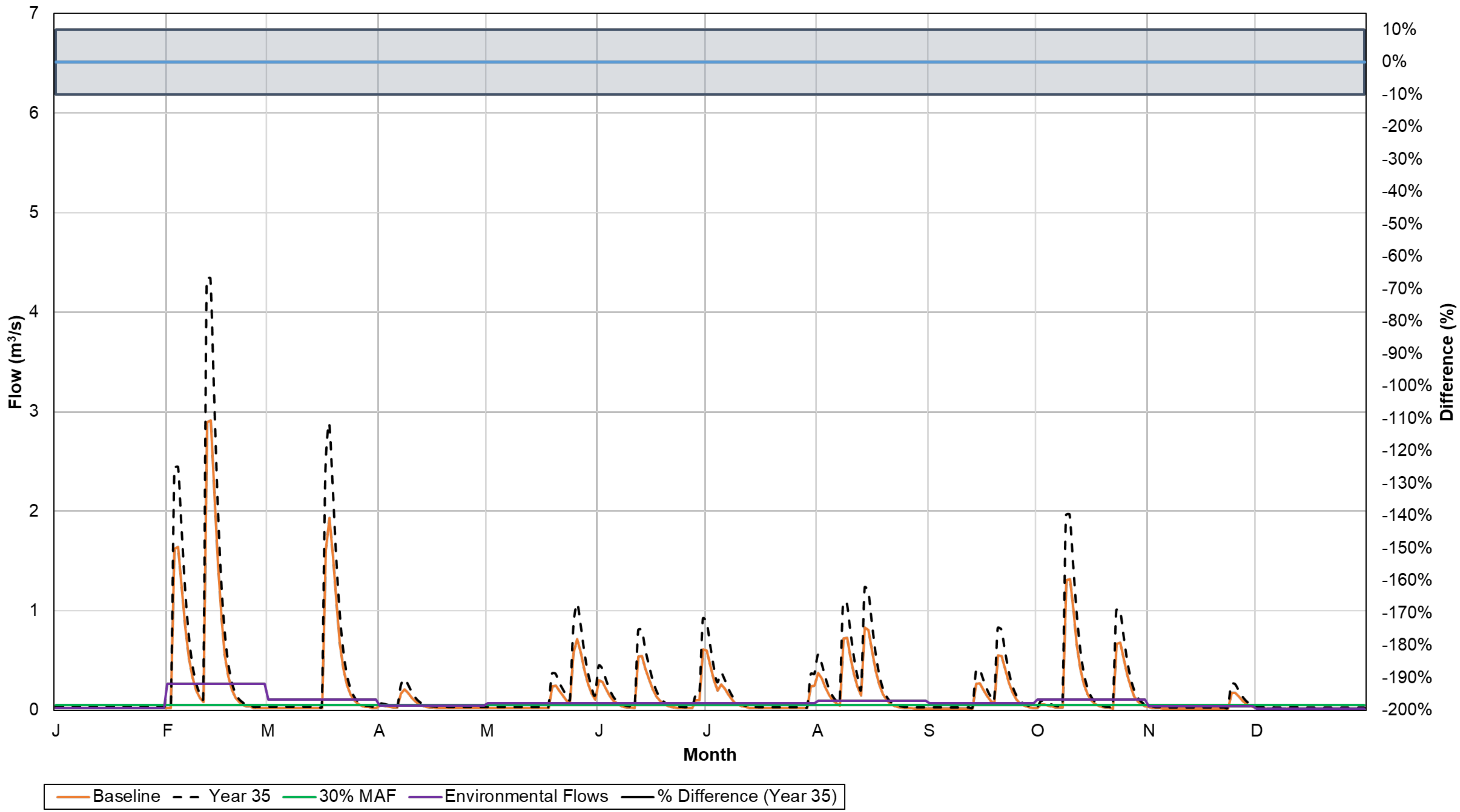


Figure A.85 Climate Change Adjusted Baseline and Year 41 (Operations Phase 3) Flows and Percent Changes for the North Driftwood River Watershed – ND18

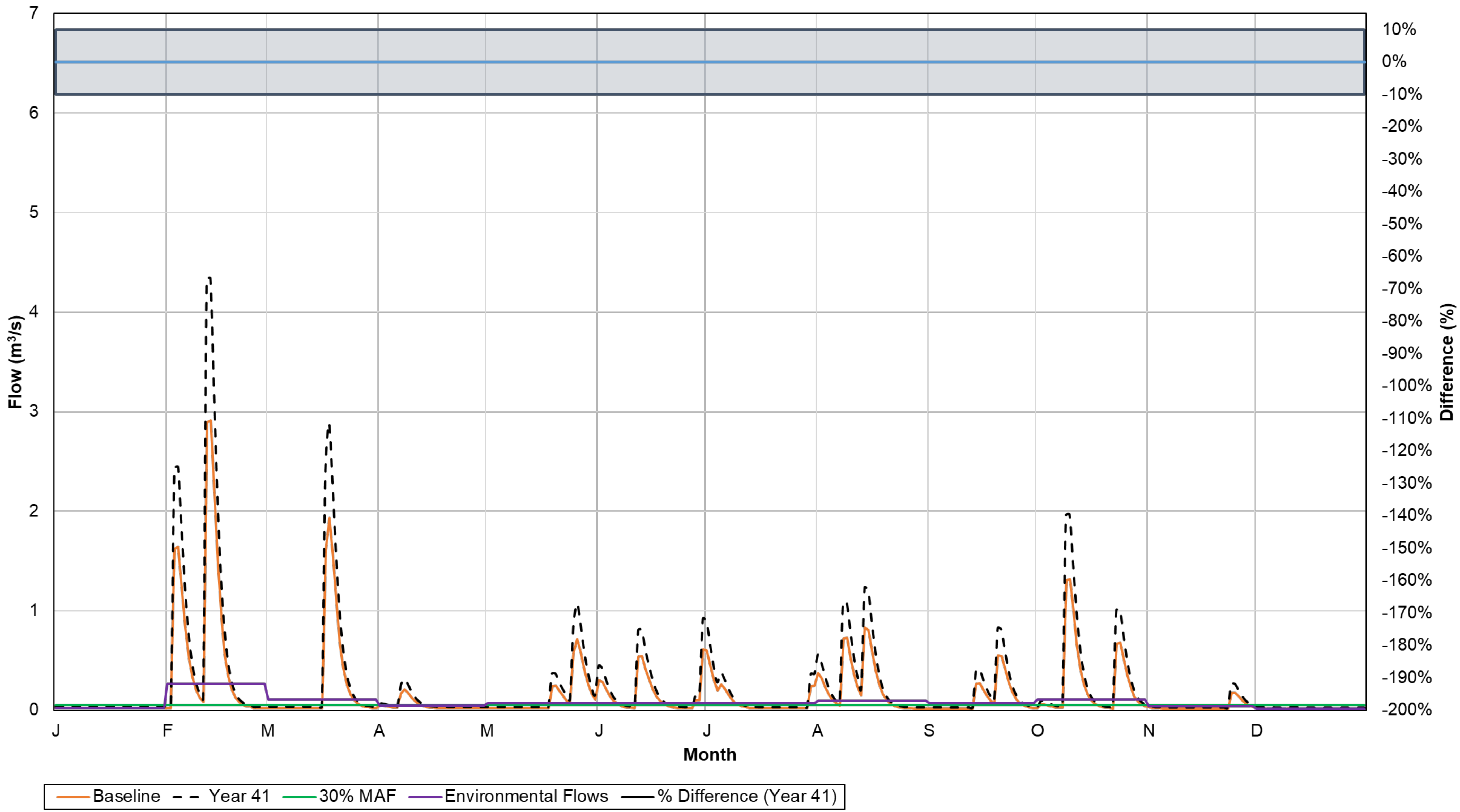


Figure A.86 Climate Change Adjusted Baseline and Year 47 (Passive Closure Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND18

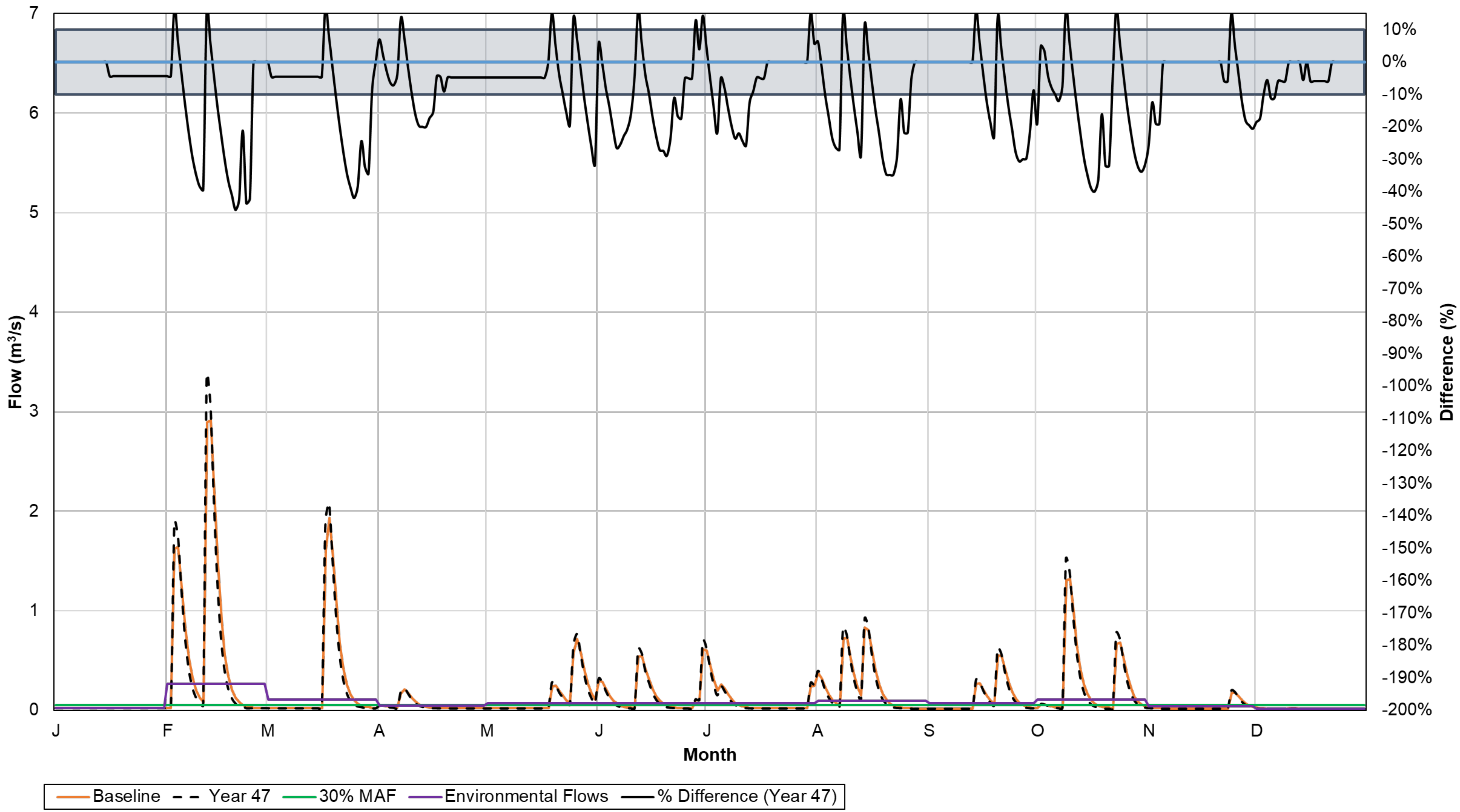


Figure A.87 Climate Change Adjusted Baseline and Pit Full Flows and Percent Changes for the North Driftwood River Watershed – ND18

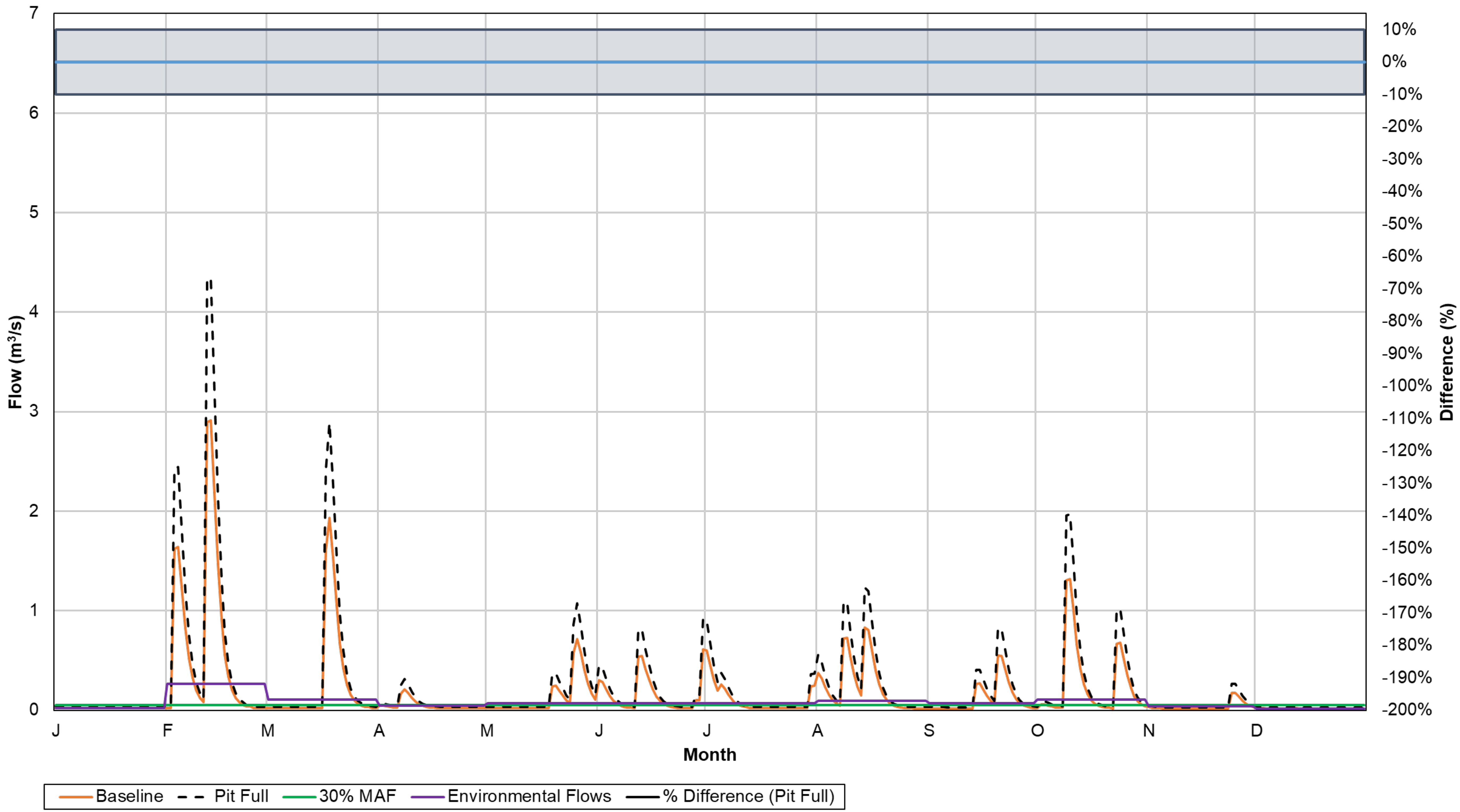


Figure A.88 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the Jocko Creek Watershed – JC_DS

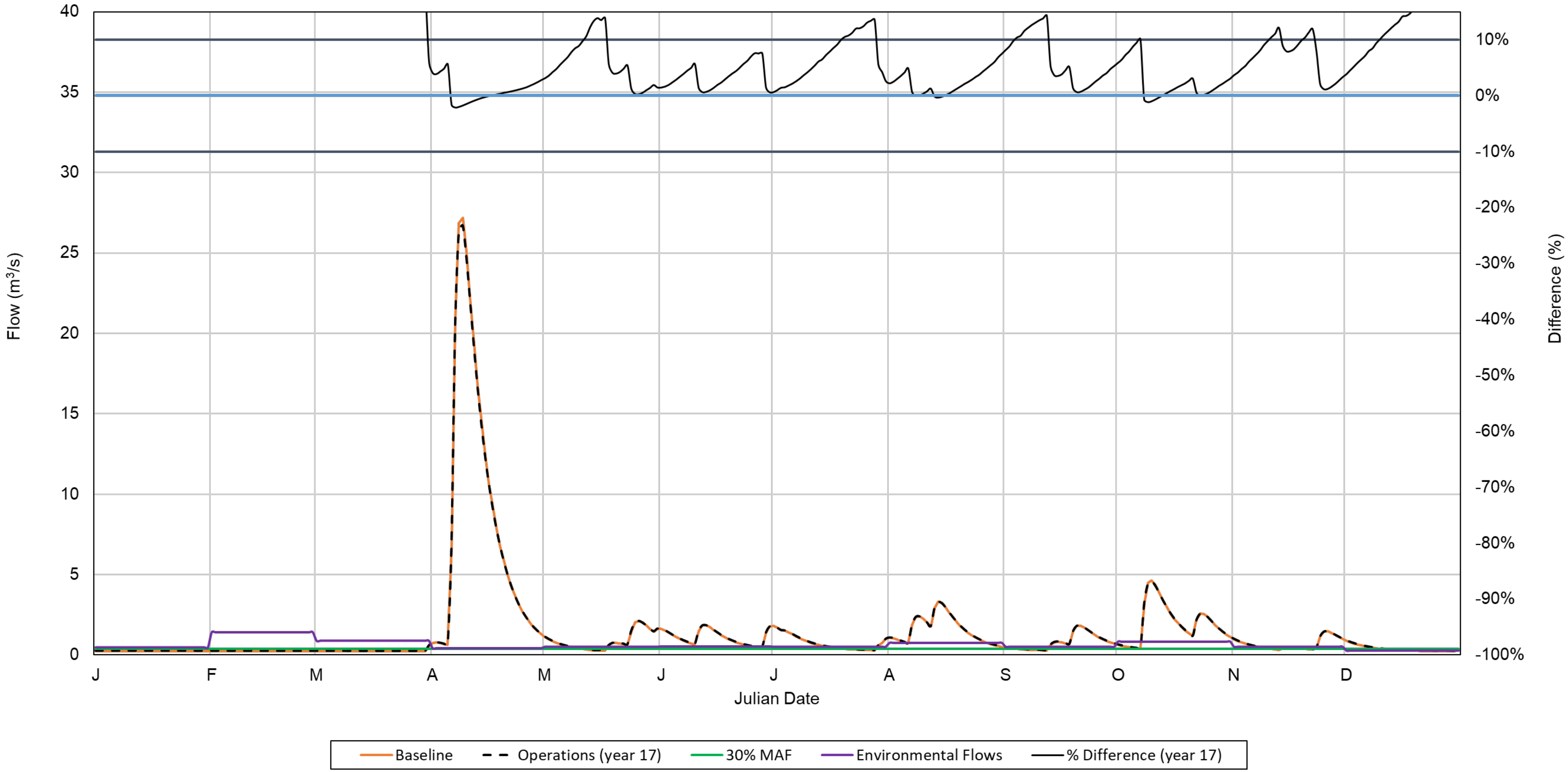


Figure A.89 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB1

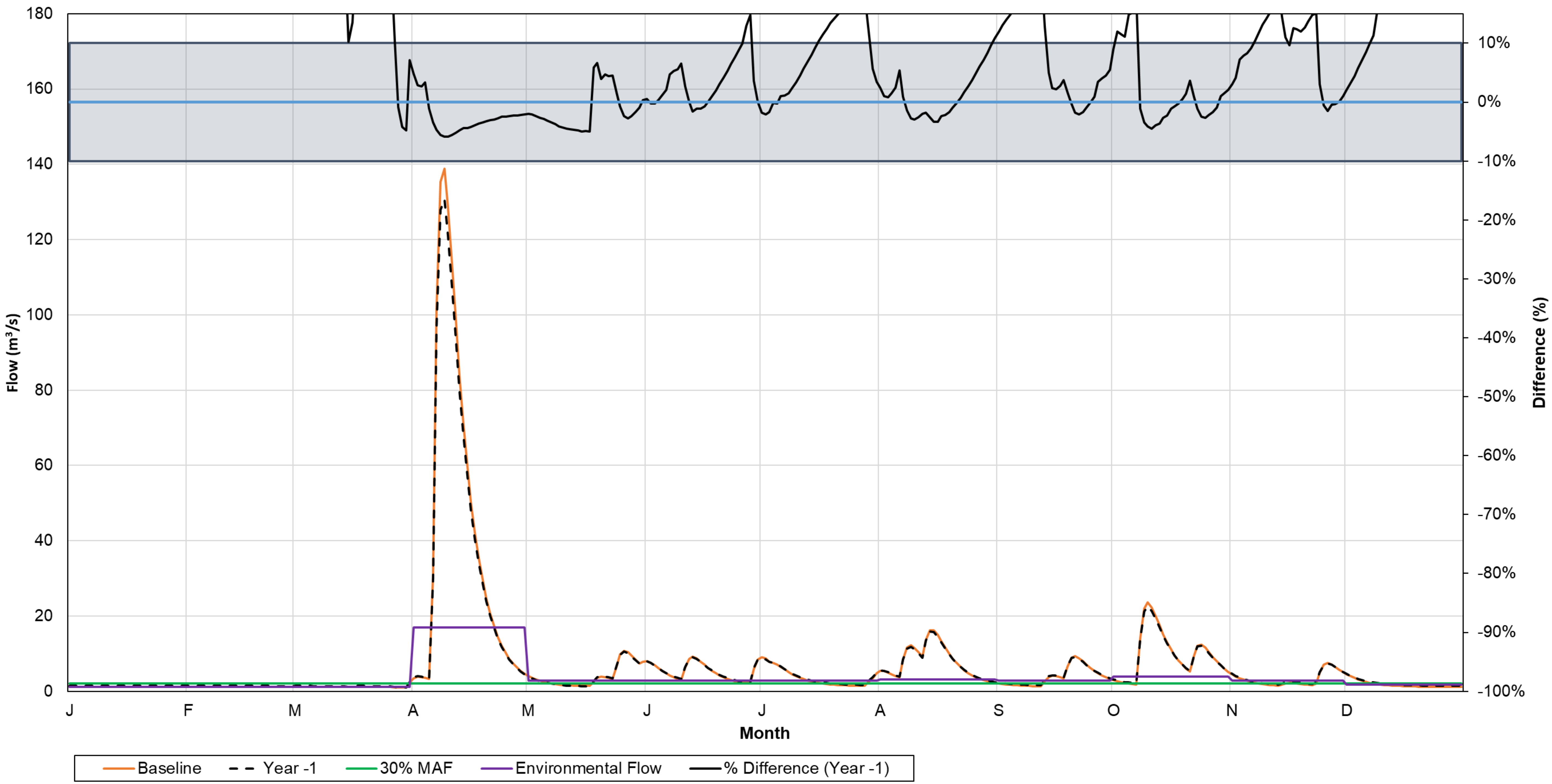


Figure A.90 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB1

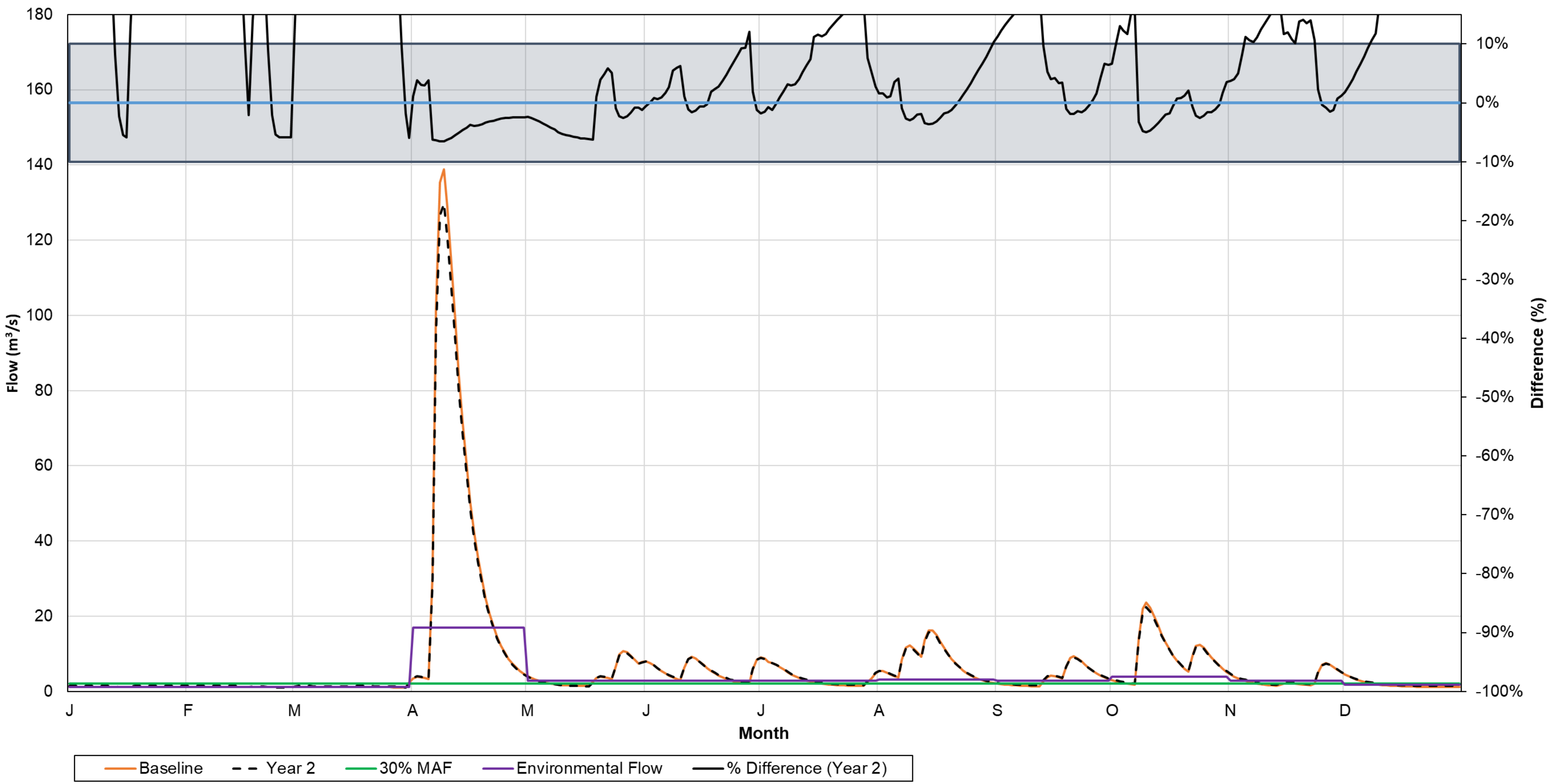


Figure A.91 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB1

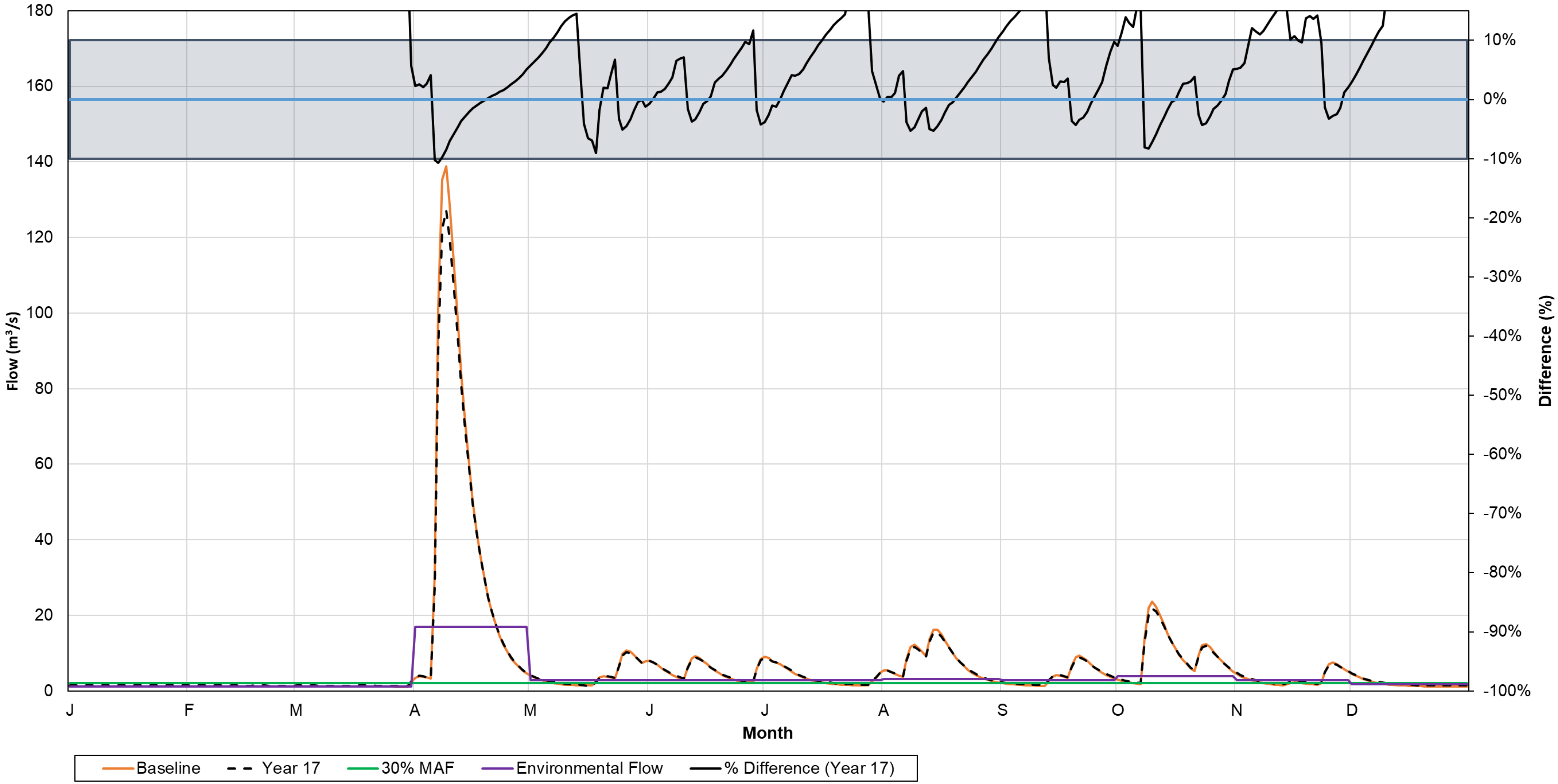


Figure A.92 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB3

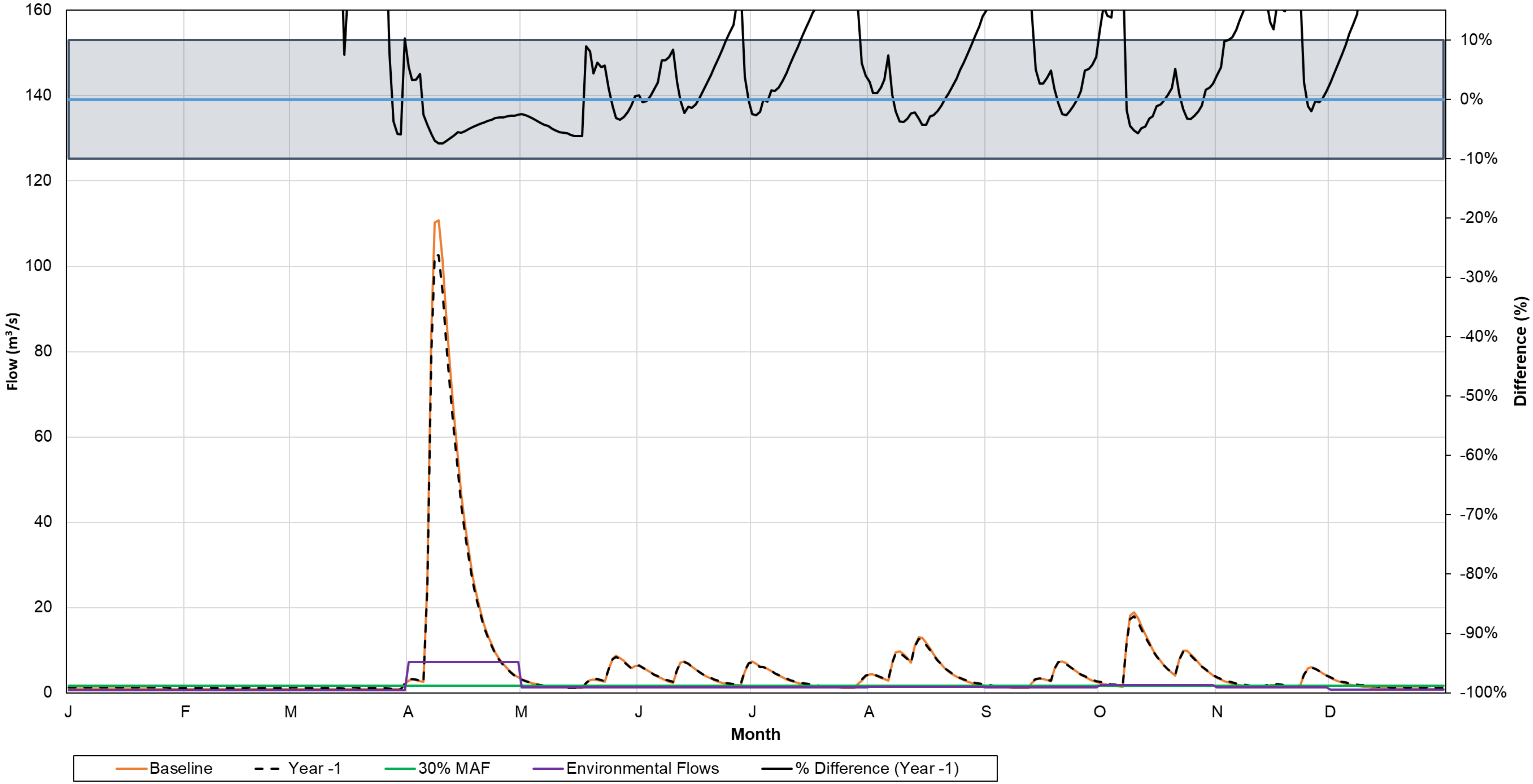


Figure A.93 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB3

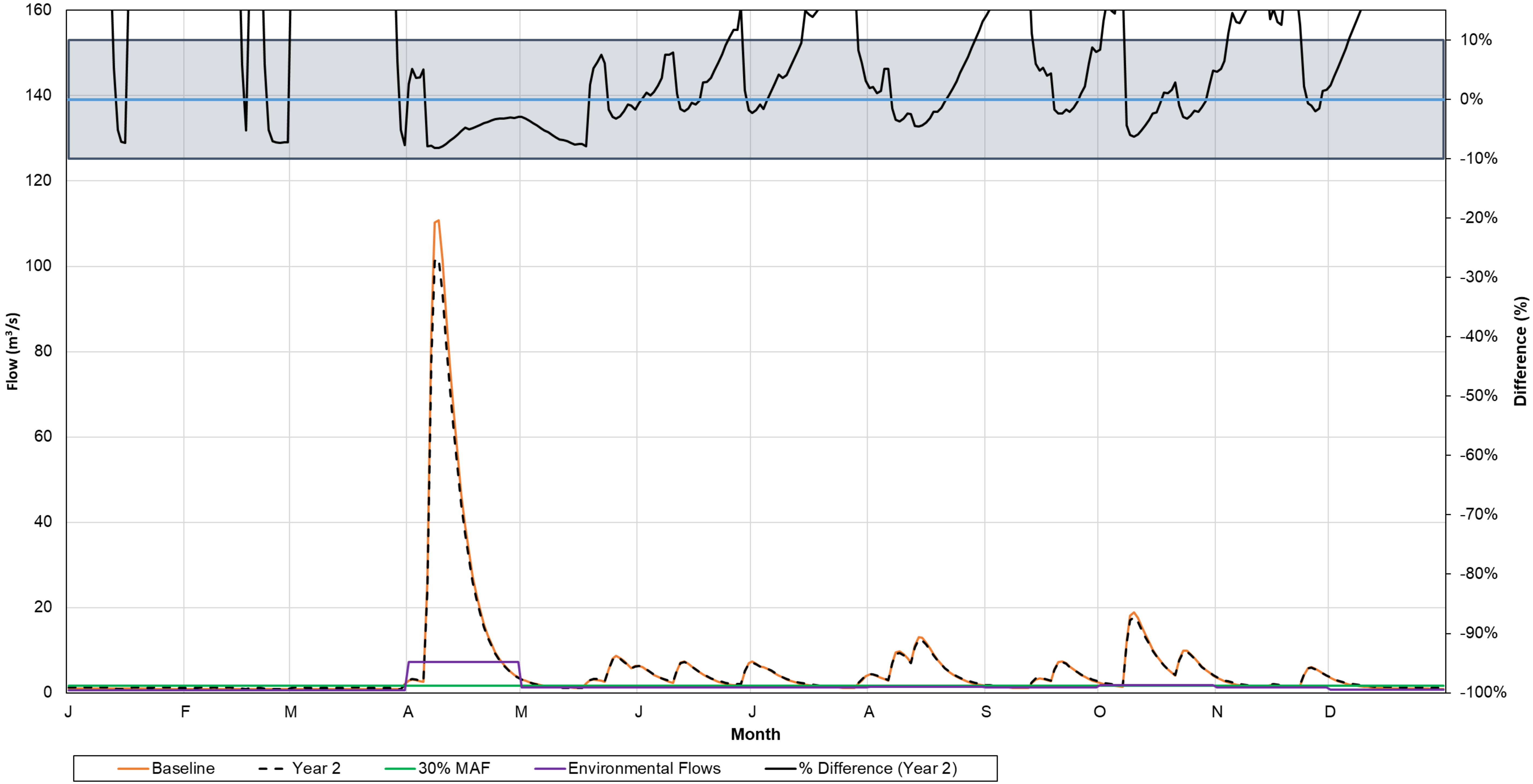


Figure A.94 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB3

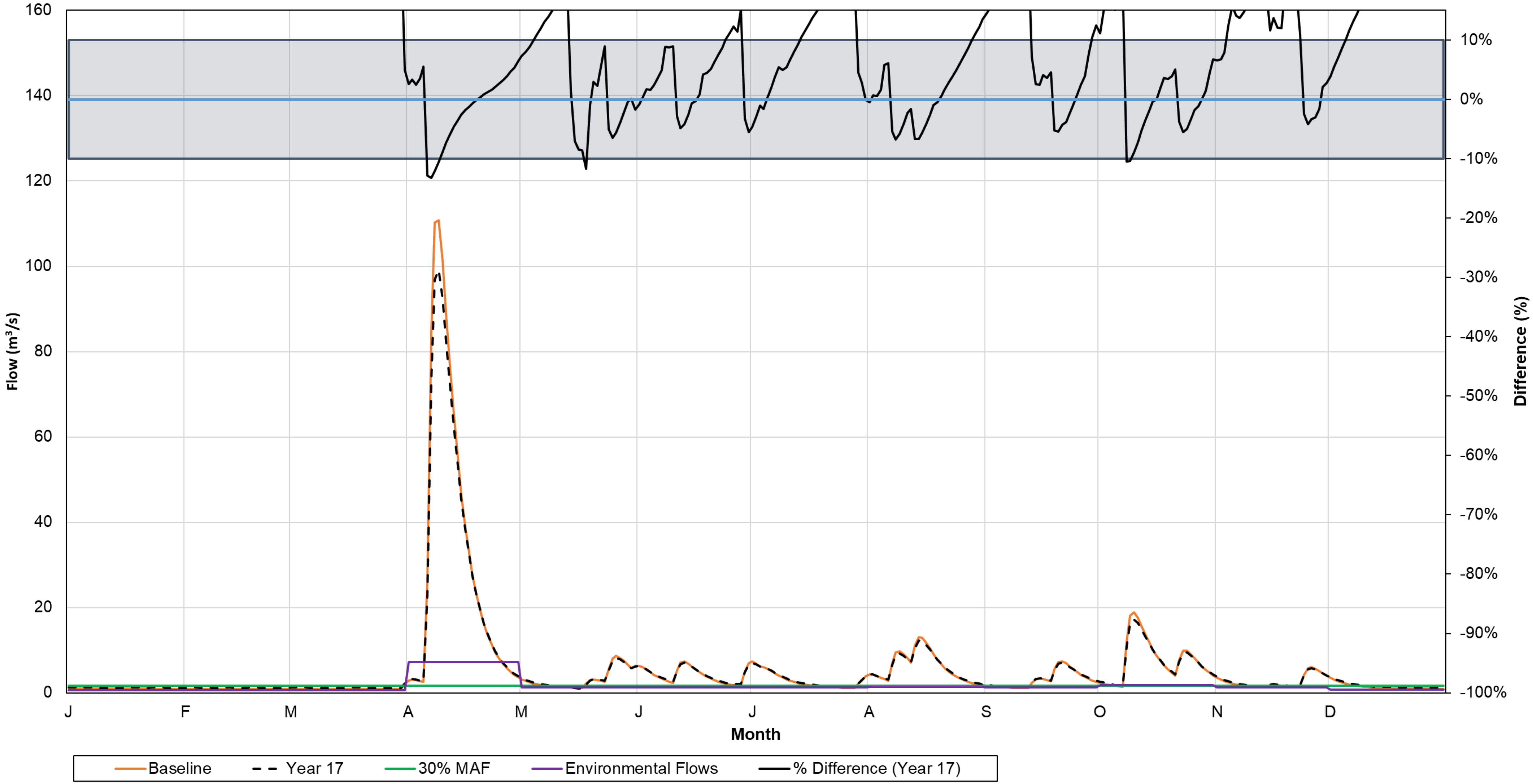


Figure A.95 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB5

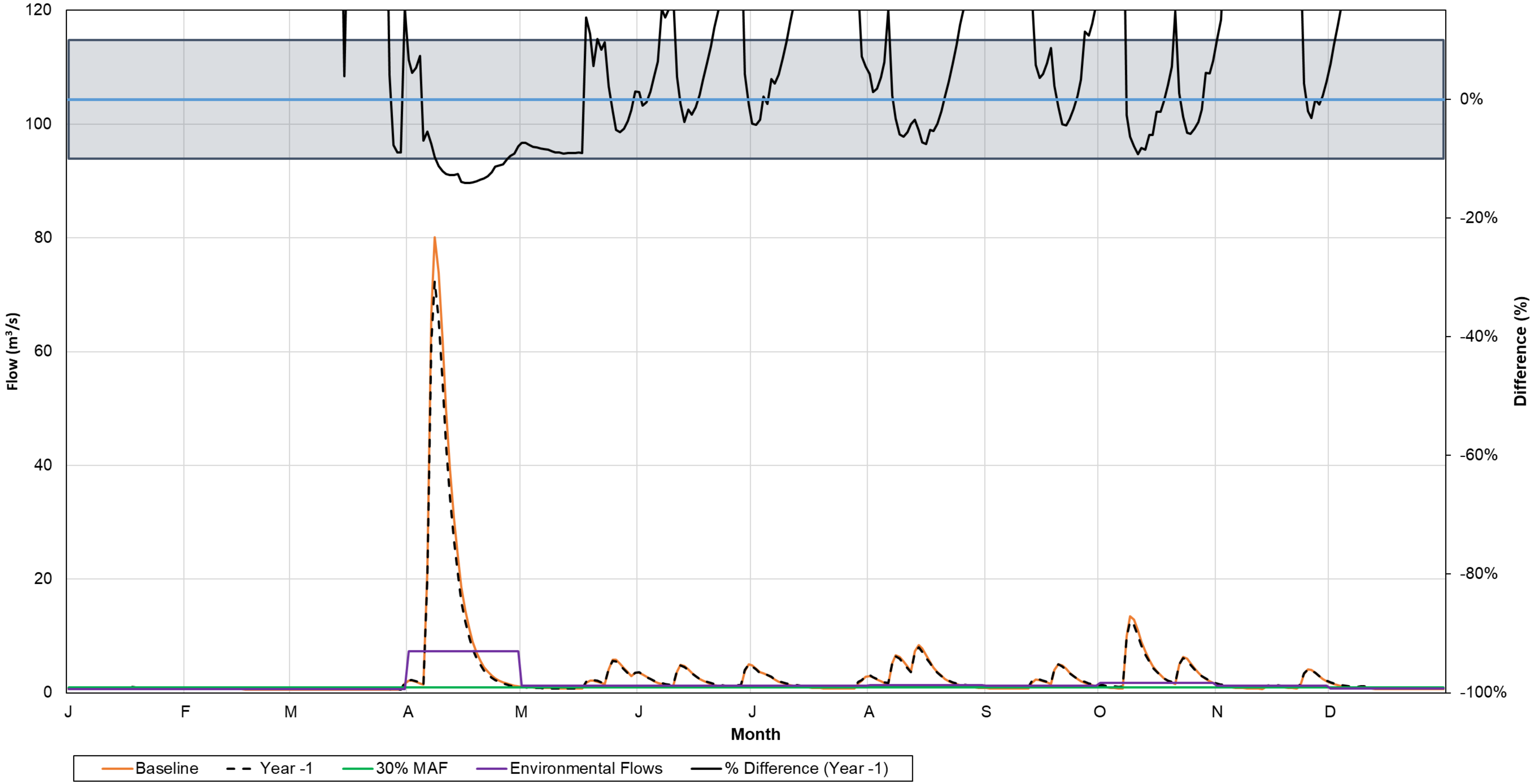


Figure A.96 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB5

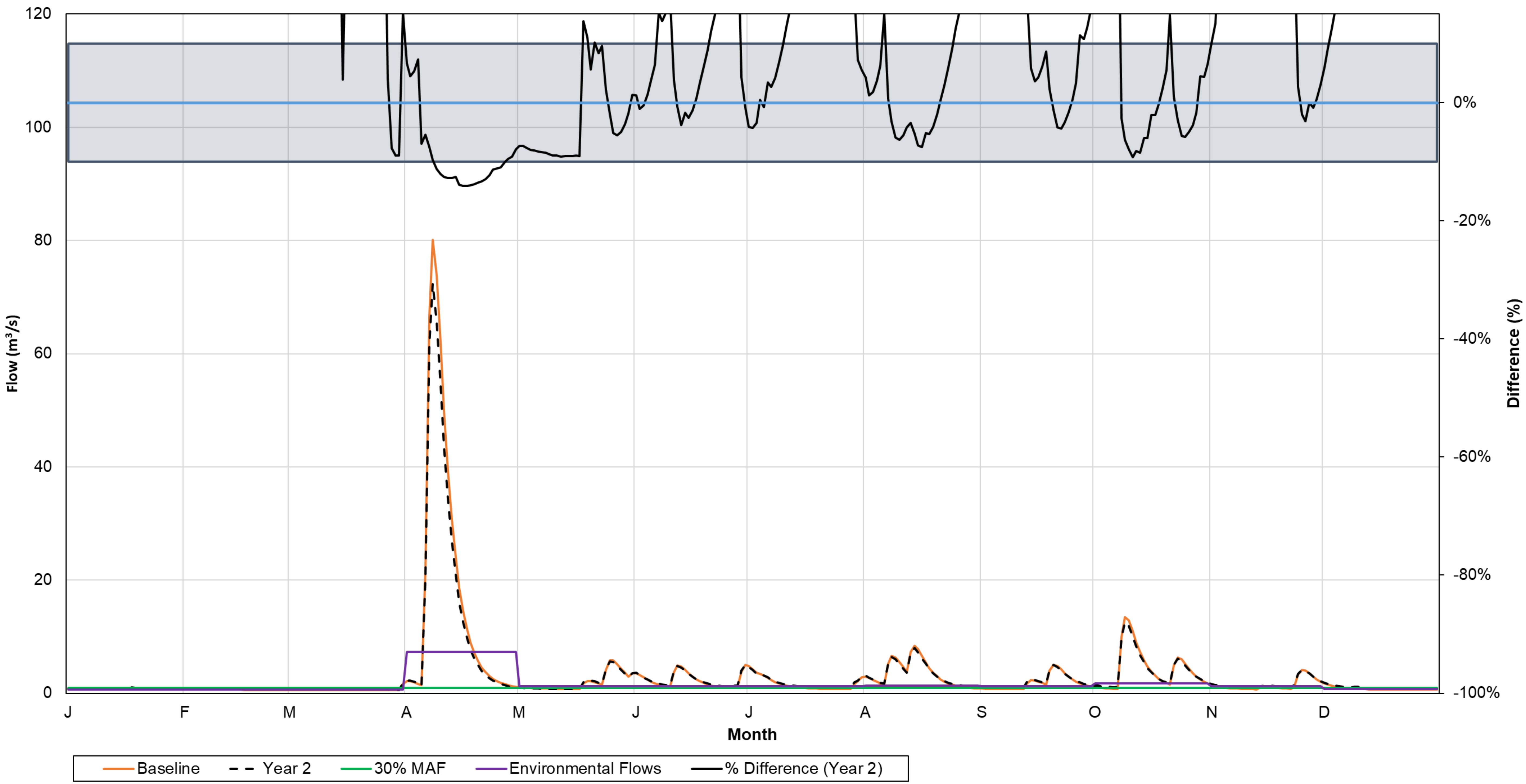


Figure A.97 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB5

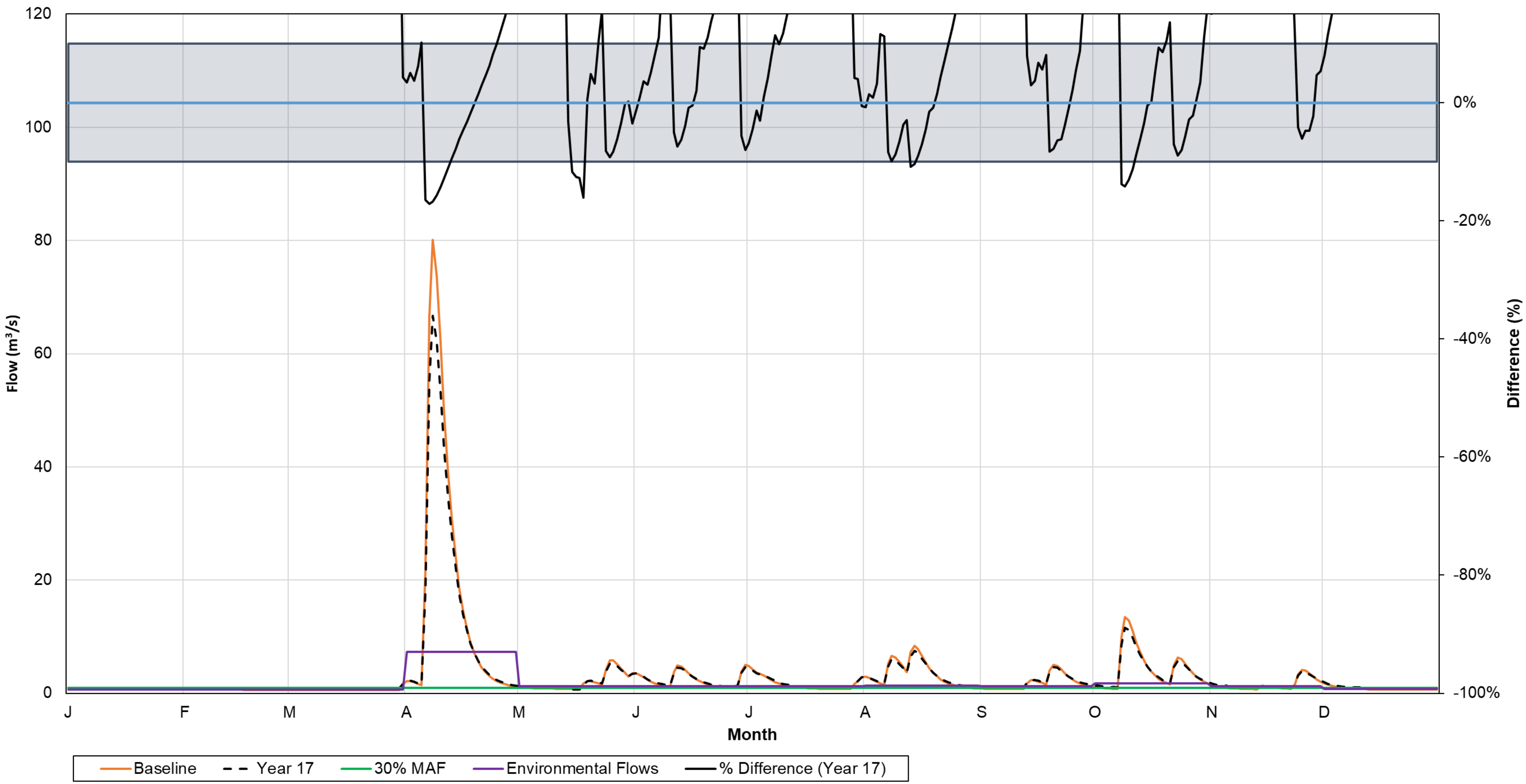


Figure A.98 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB6

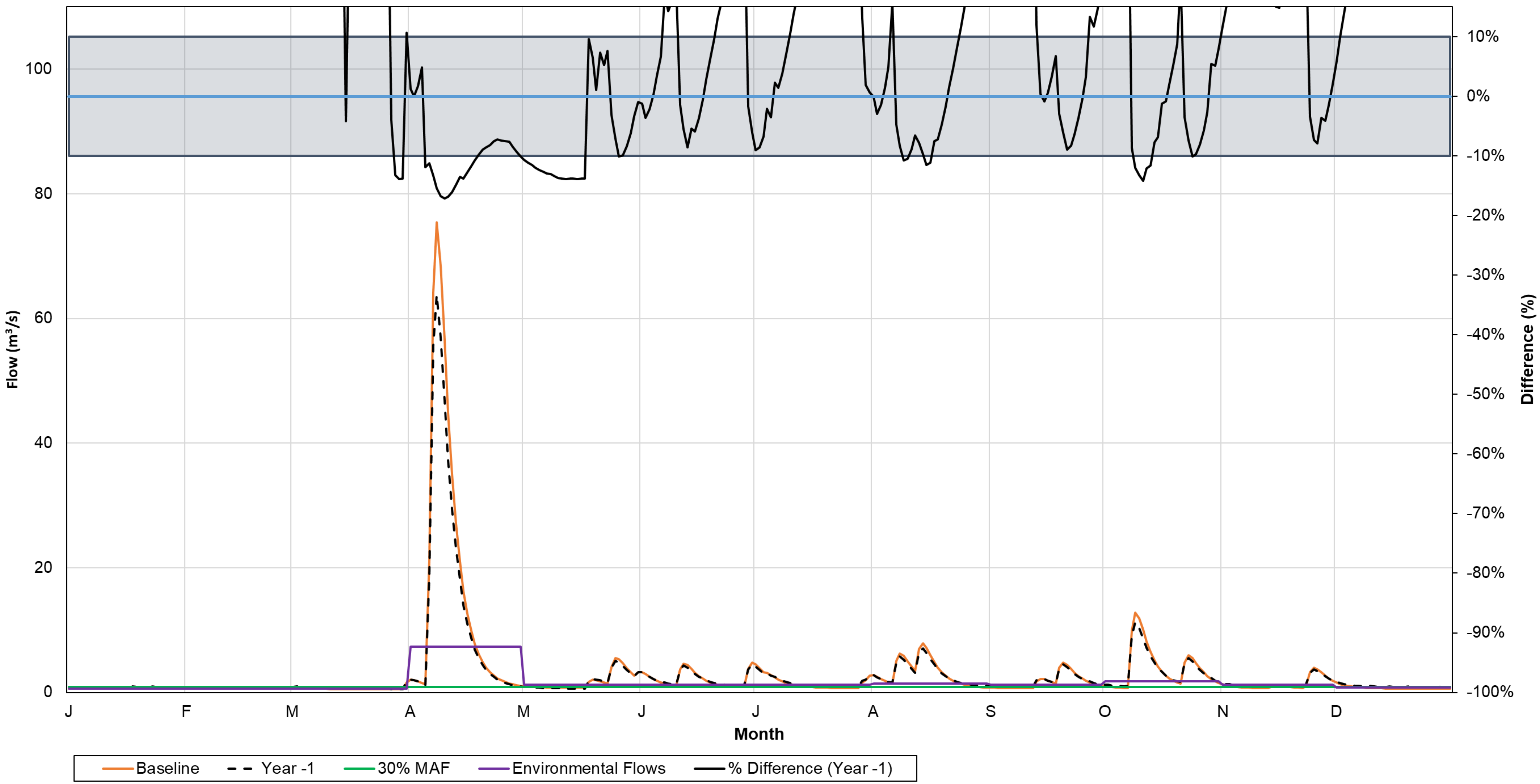


Figure A.99 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB6

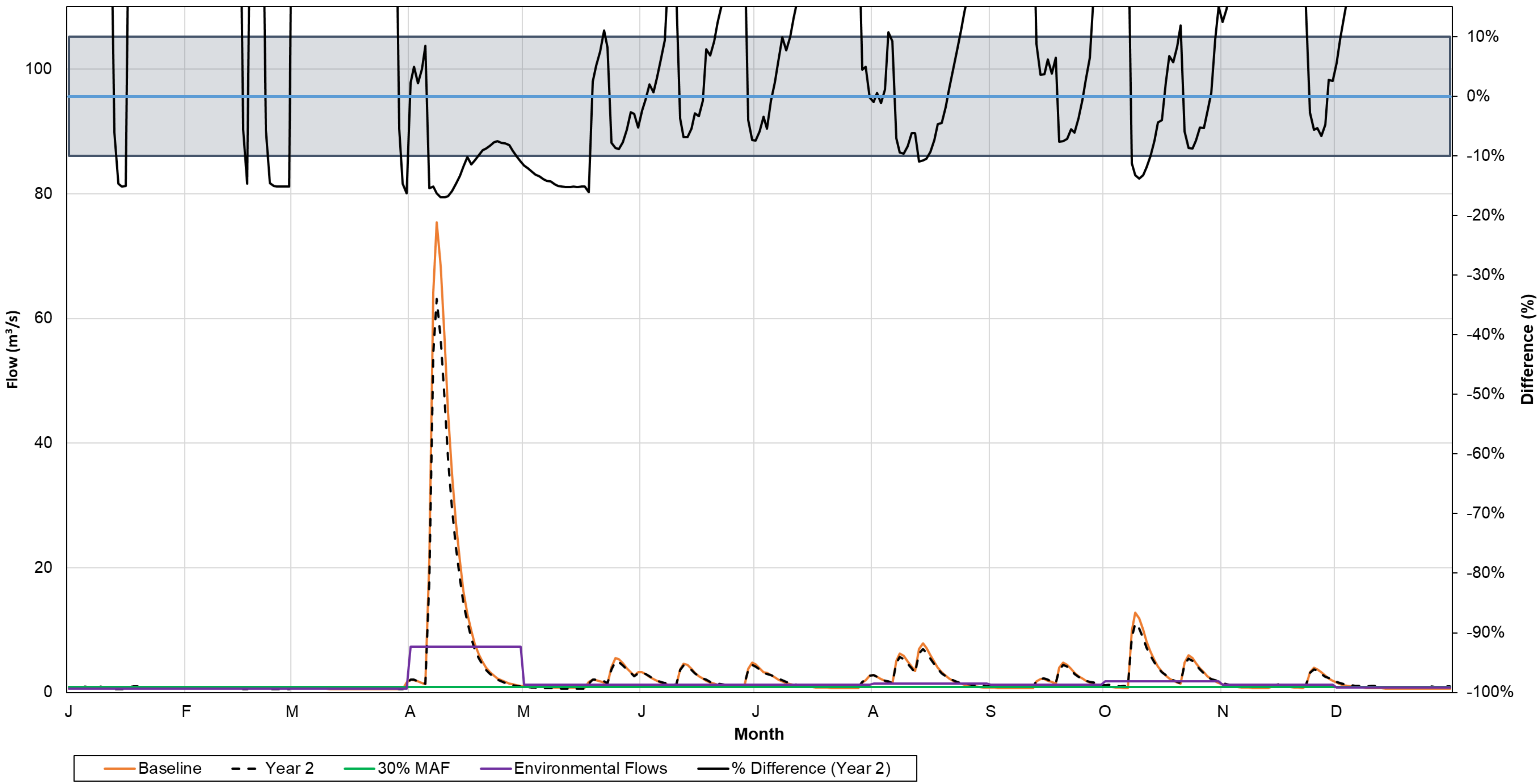


Figure A.100 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB6

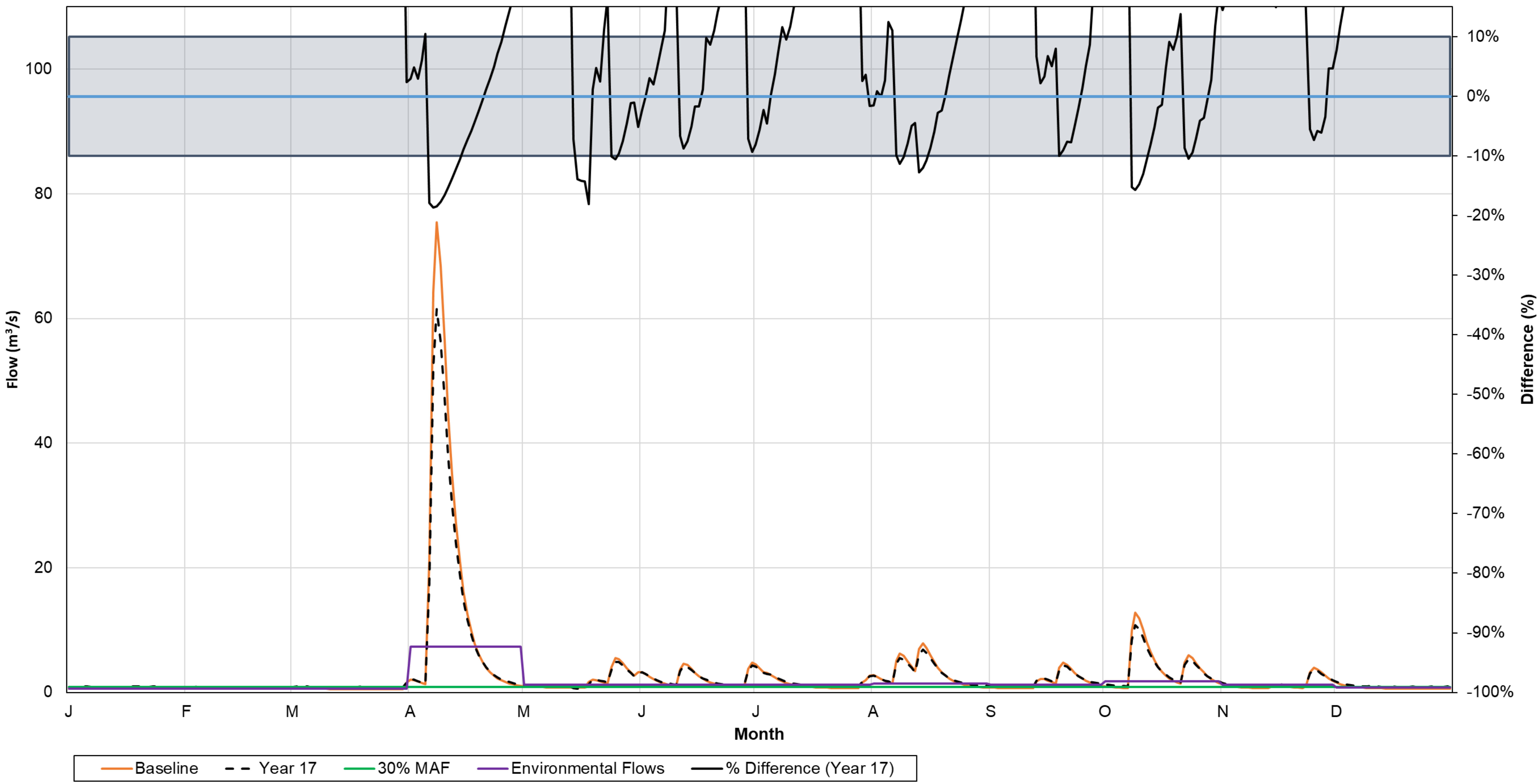


Figure A.101 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB9

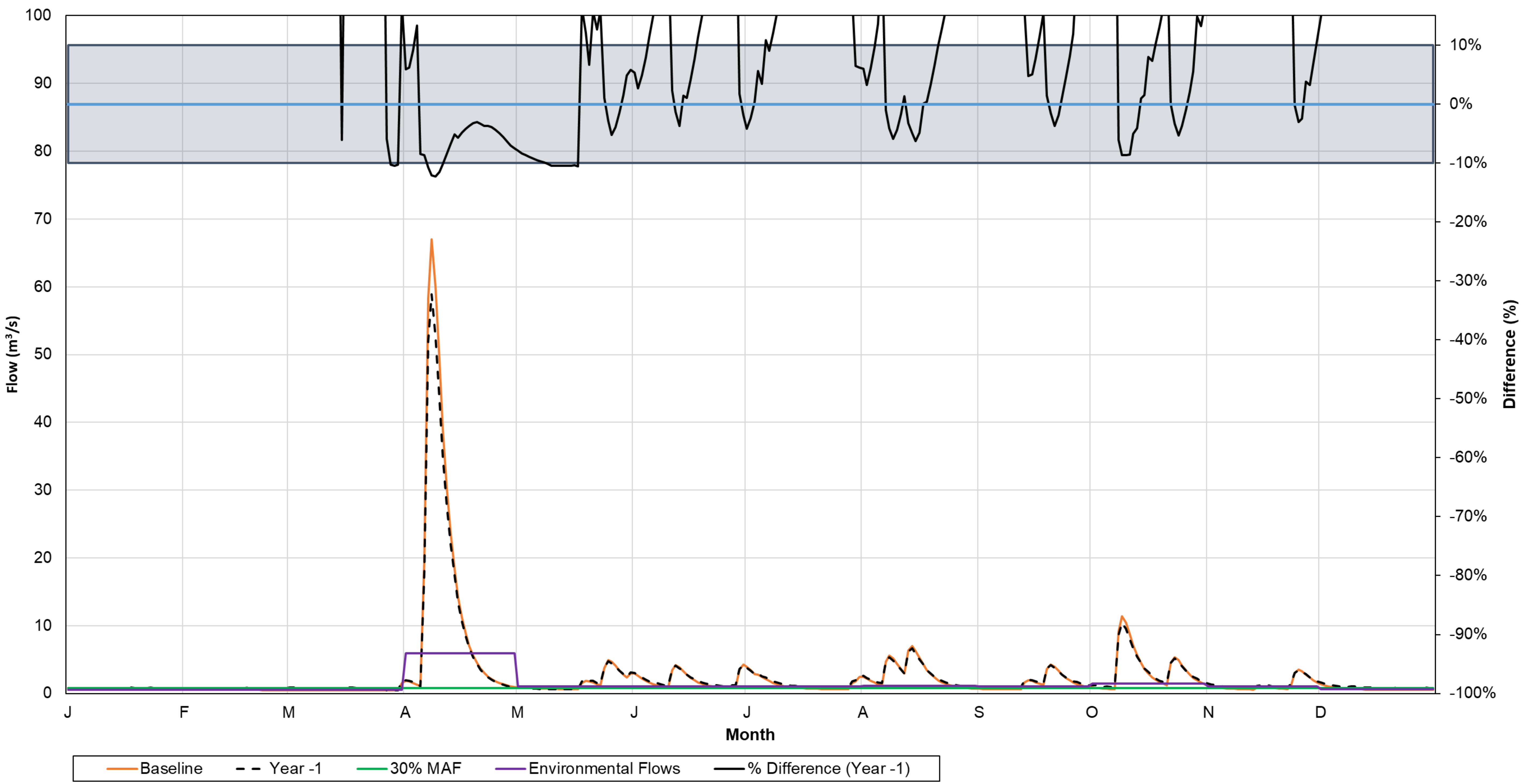


Figure A.102 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB9

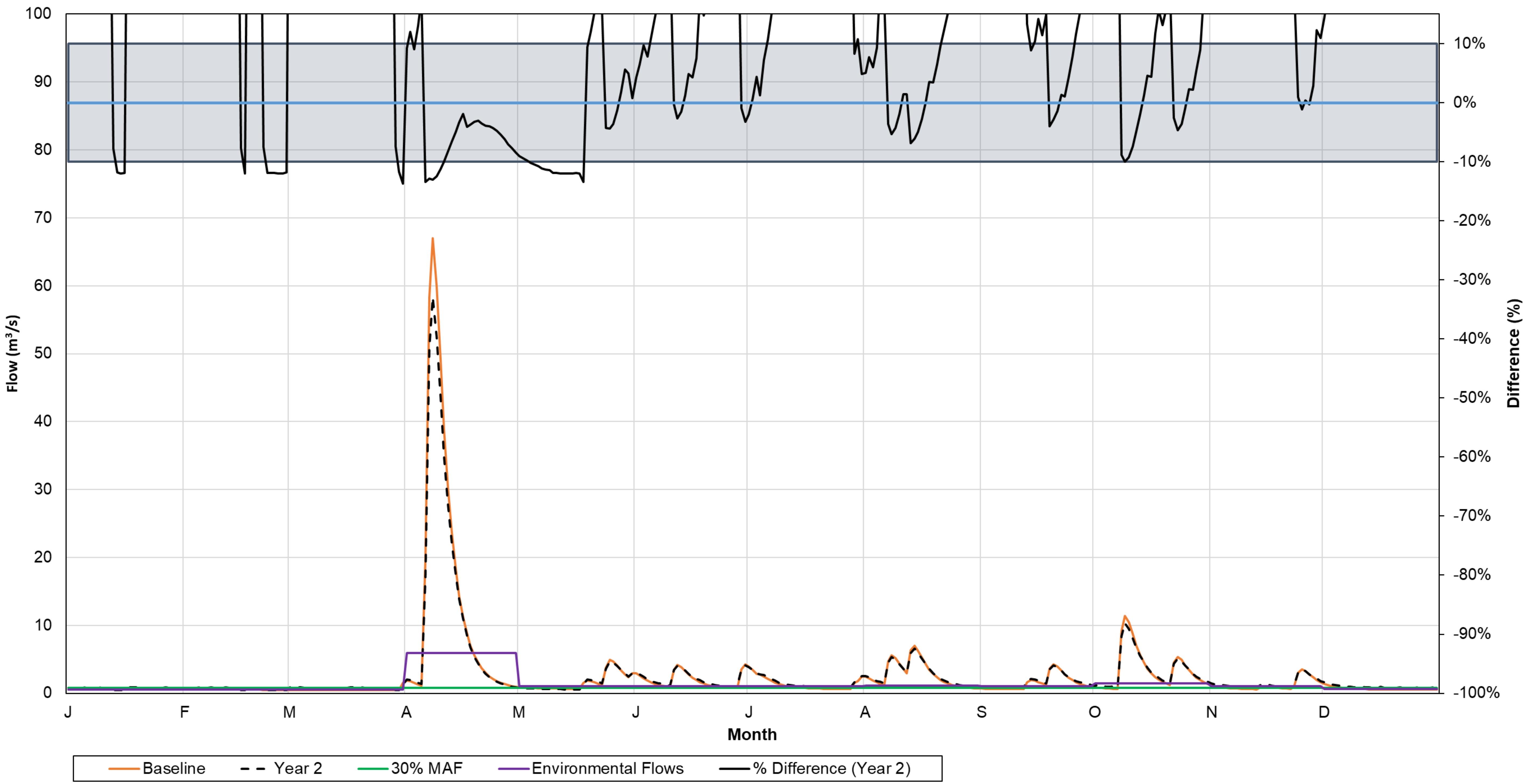


Figure A.103 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB9

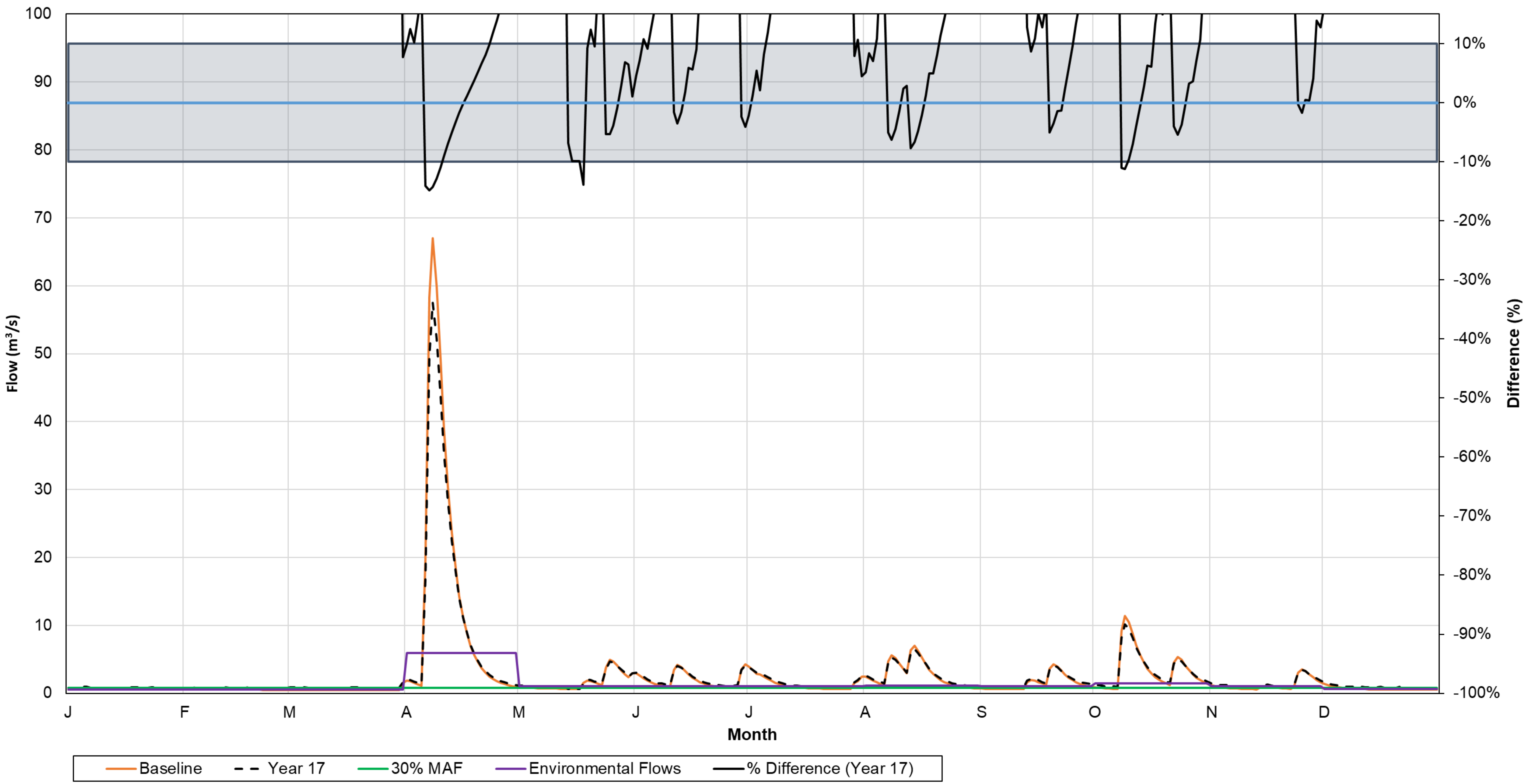


Figure A.104 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the West Buskegau River Watershed – WB14

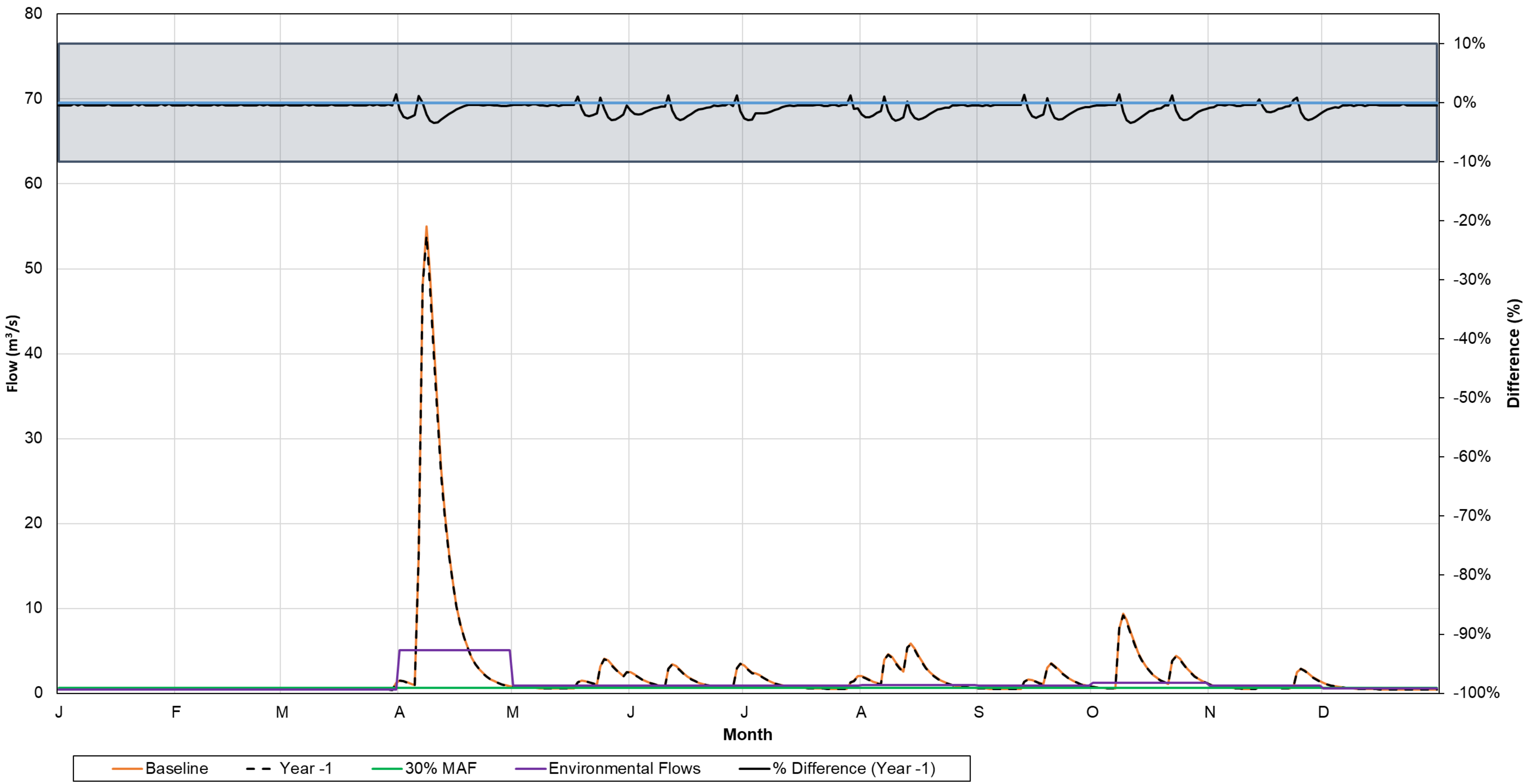


Figure A.105 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the West Buskegau River Watershed – WB14

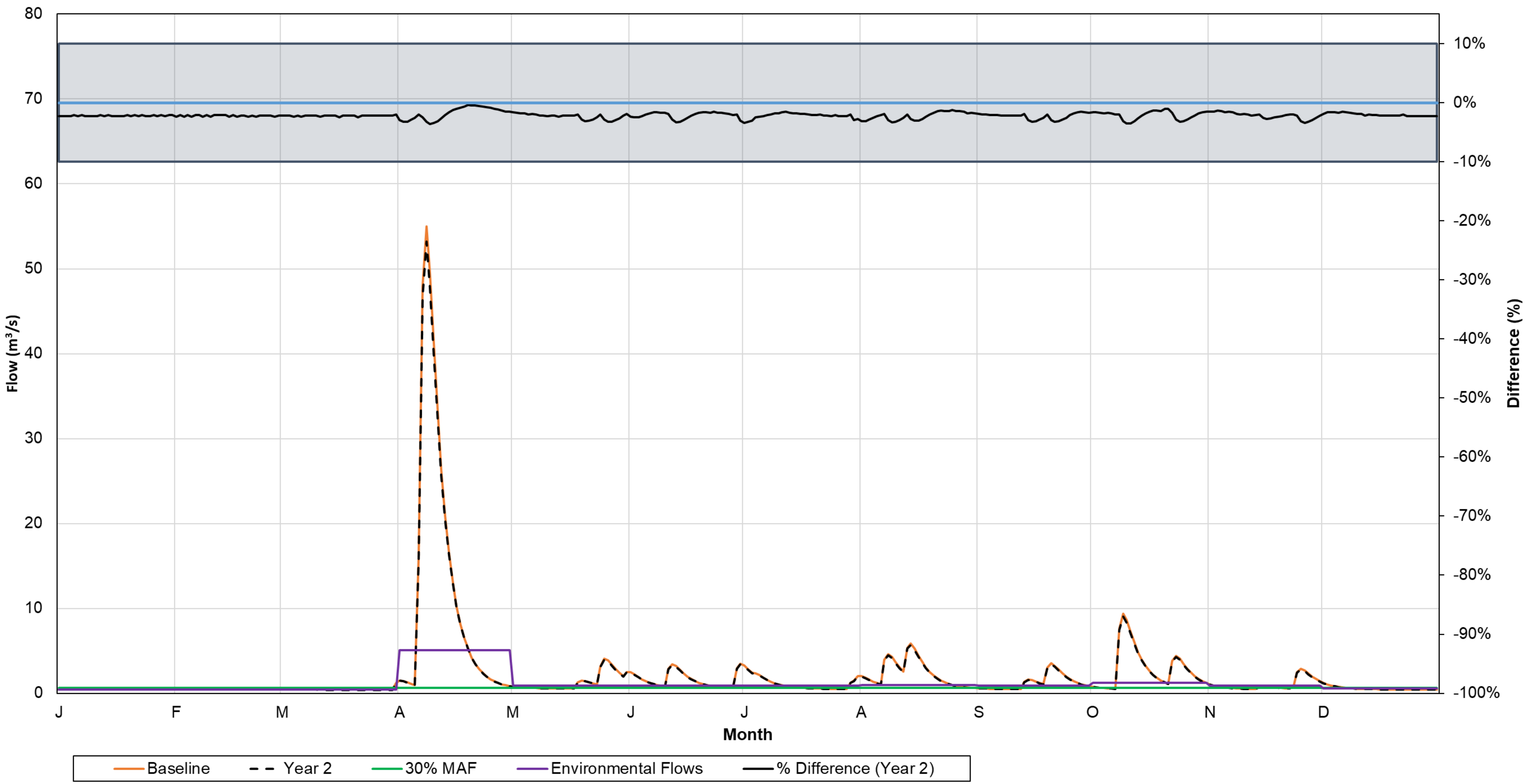


Figure A.106 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the West Buskegau River Watershed – WB14

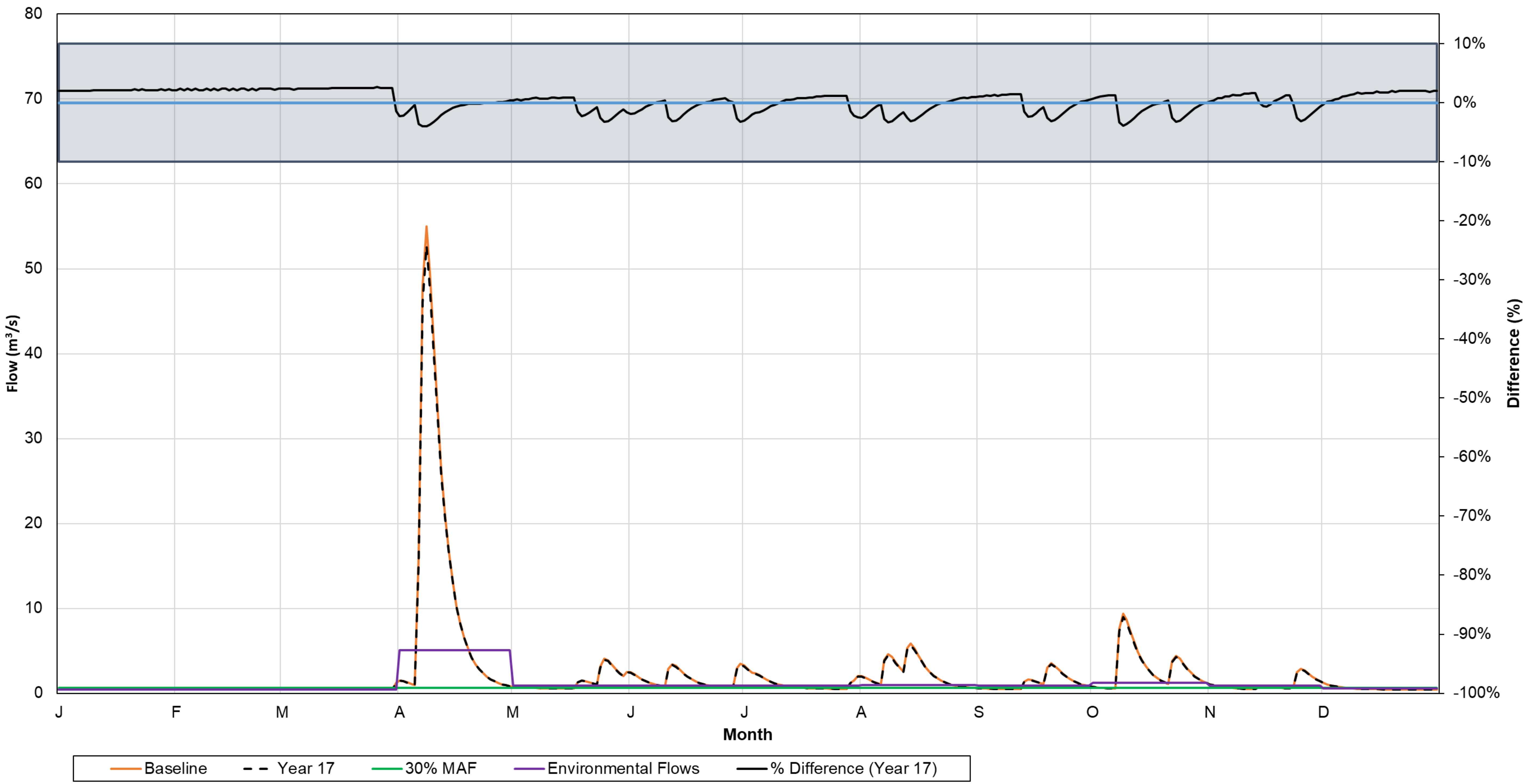


Figure A.107 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND1

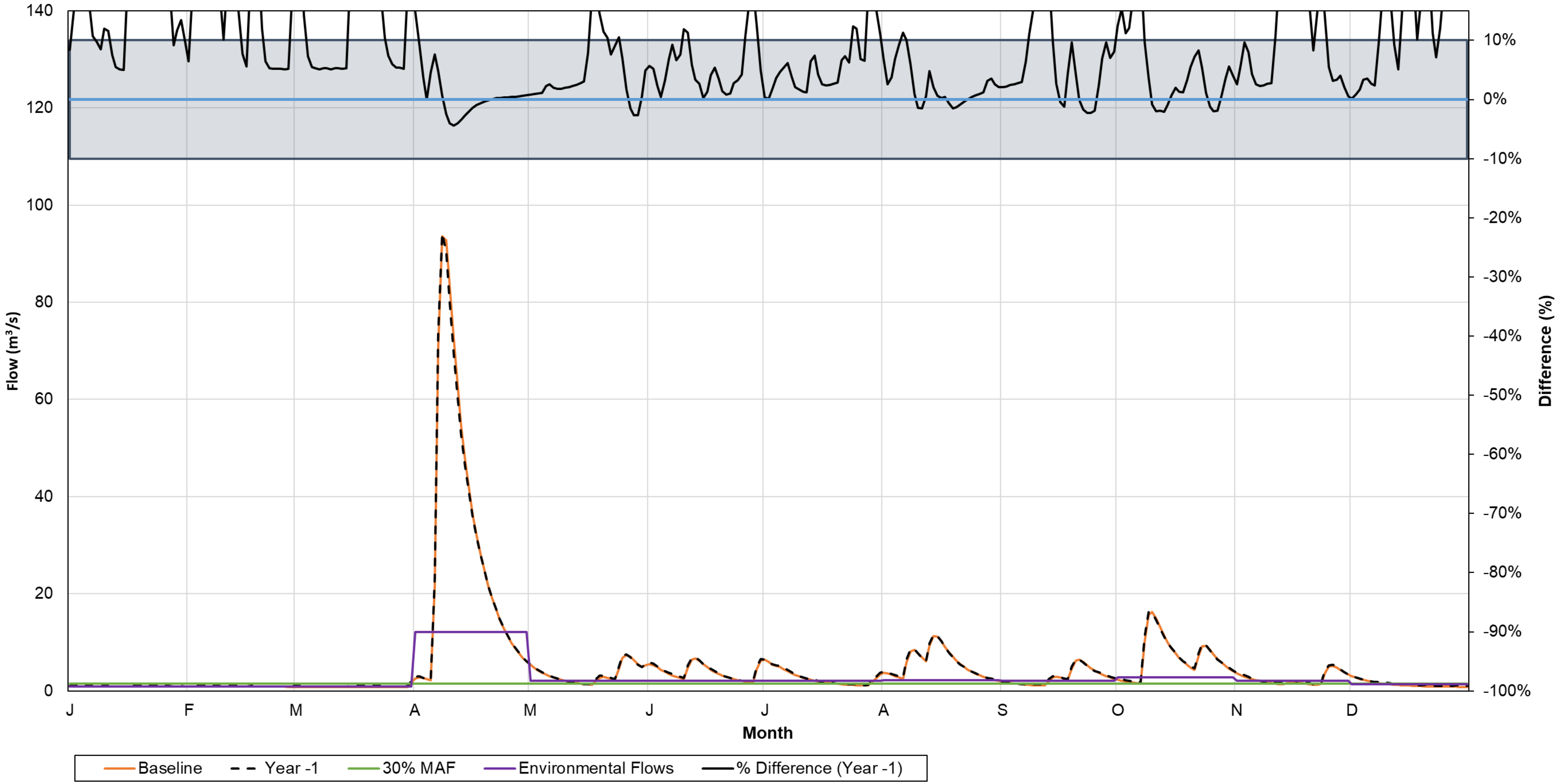


Figure A.108 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND1

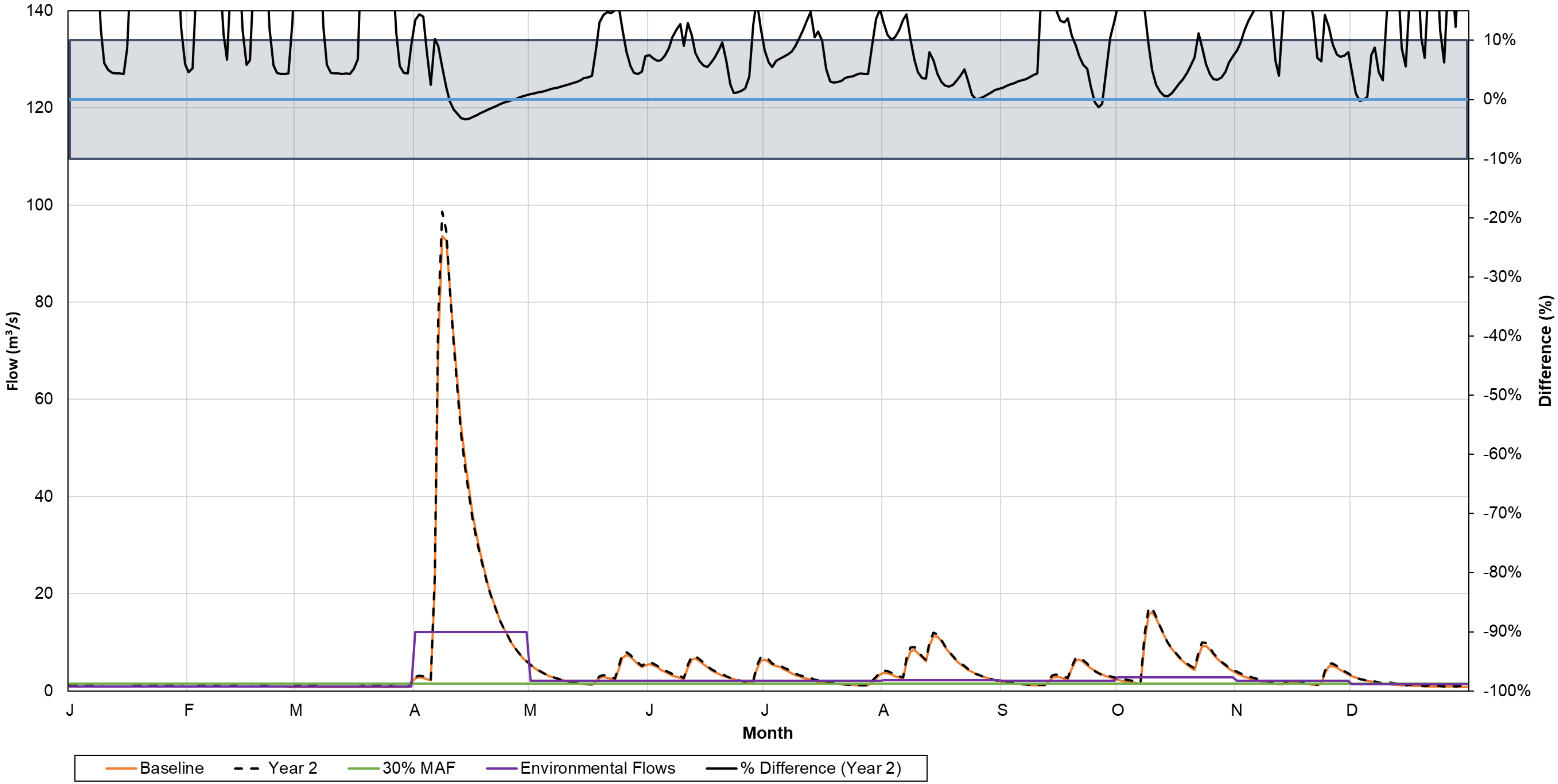


Figure A.109 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND1

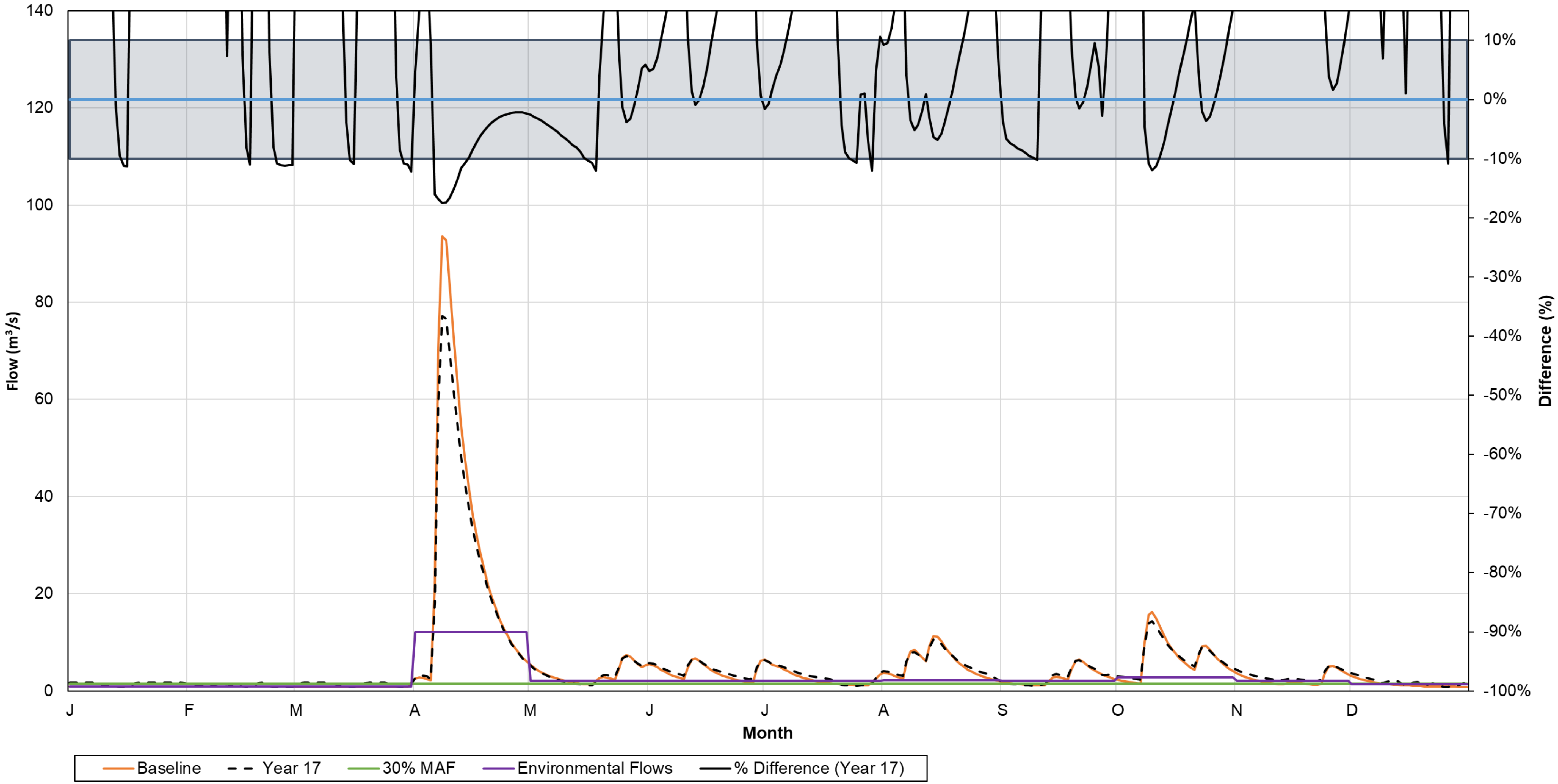


Figure A.110 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND3

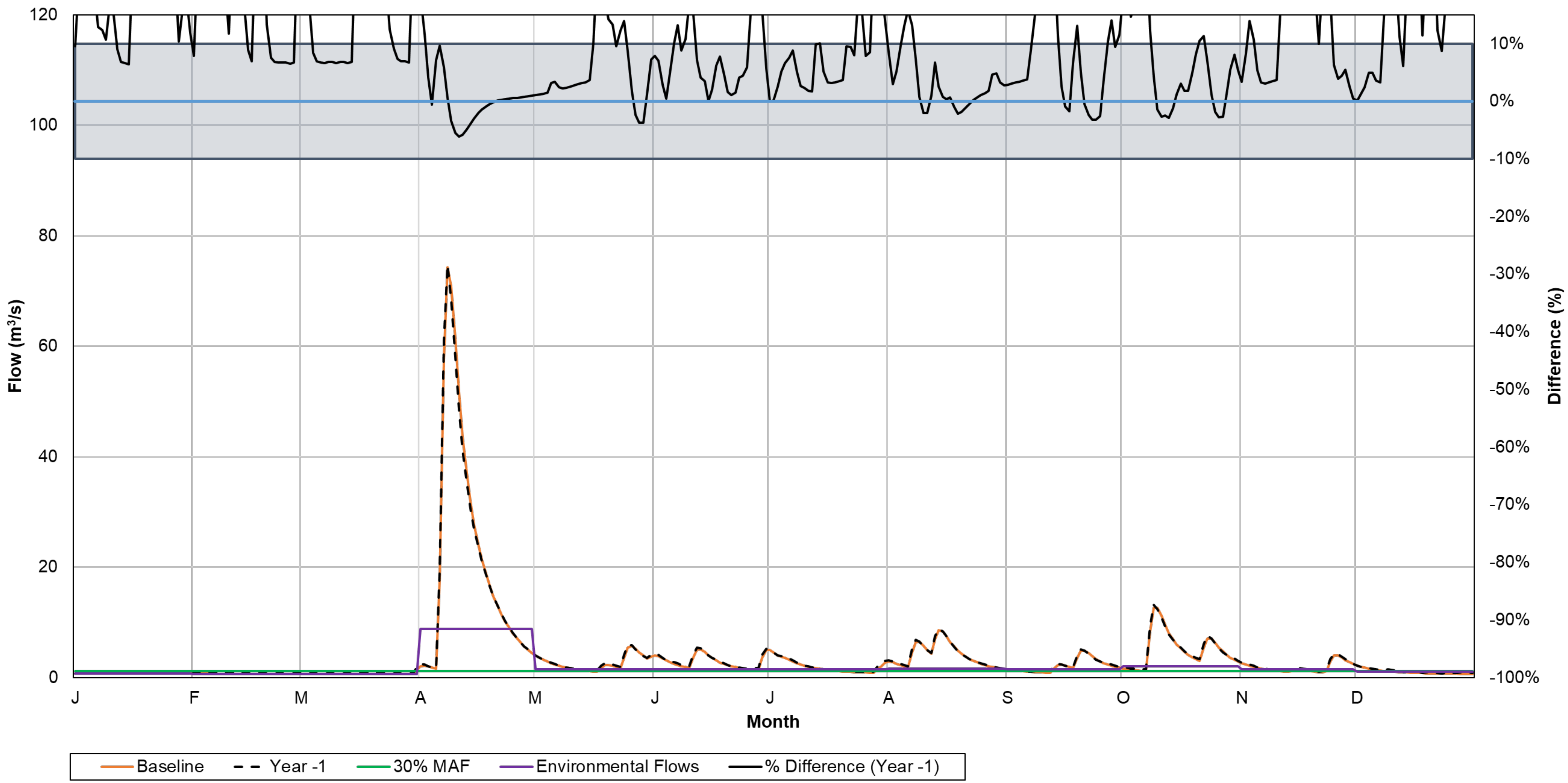


Figure A.111 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND3

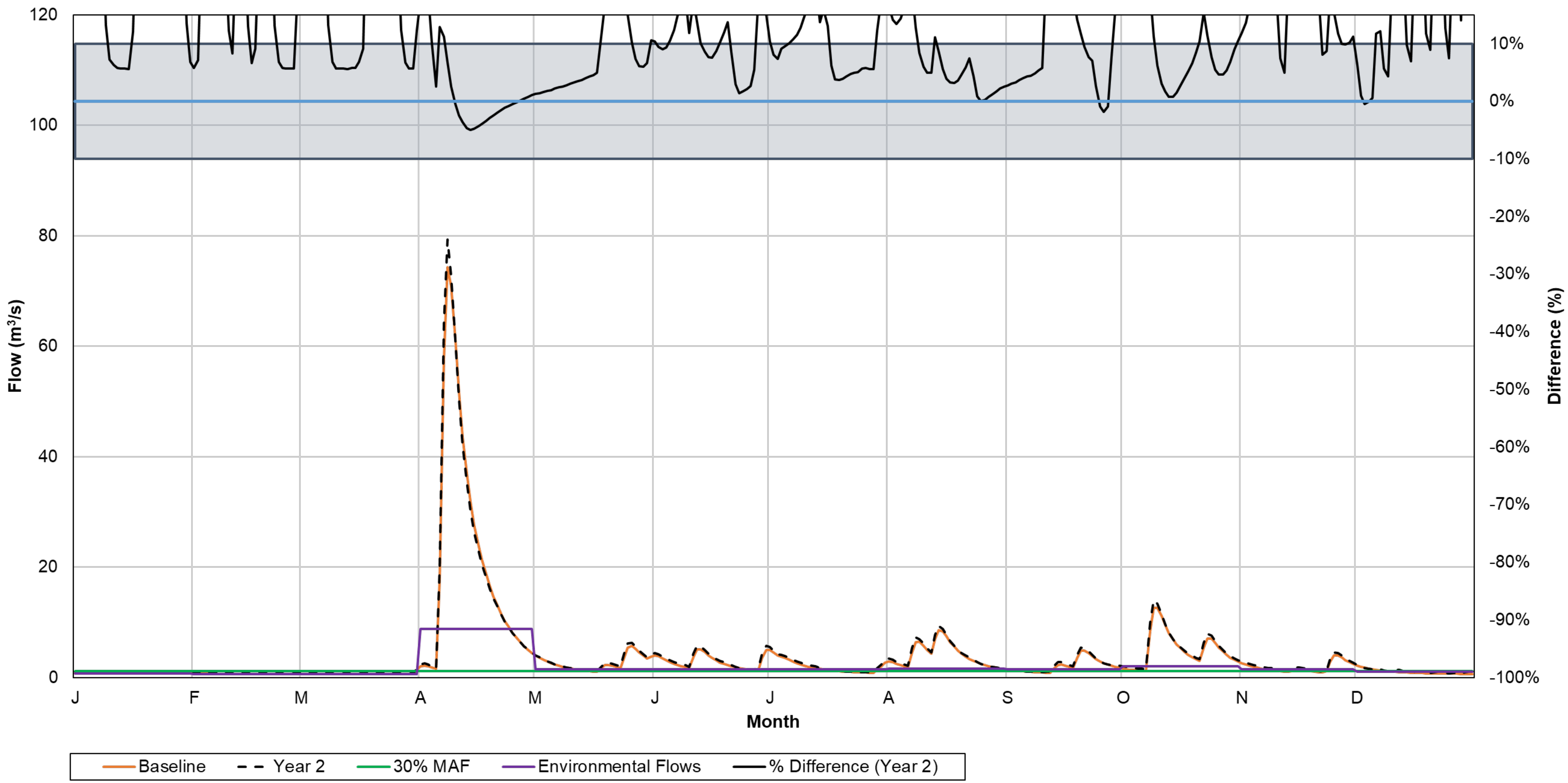


Figure A.112 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND3

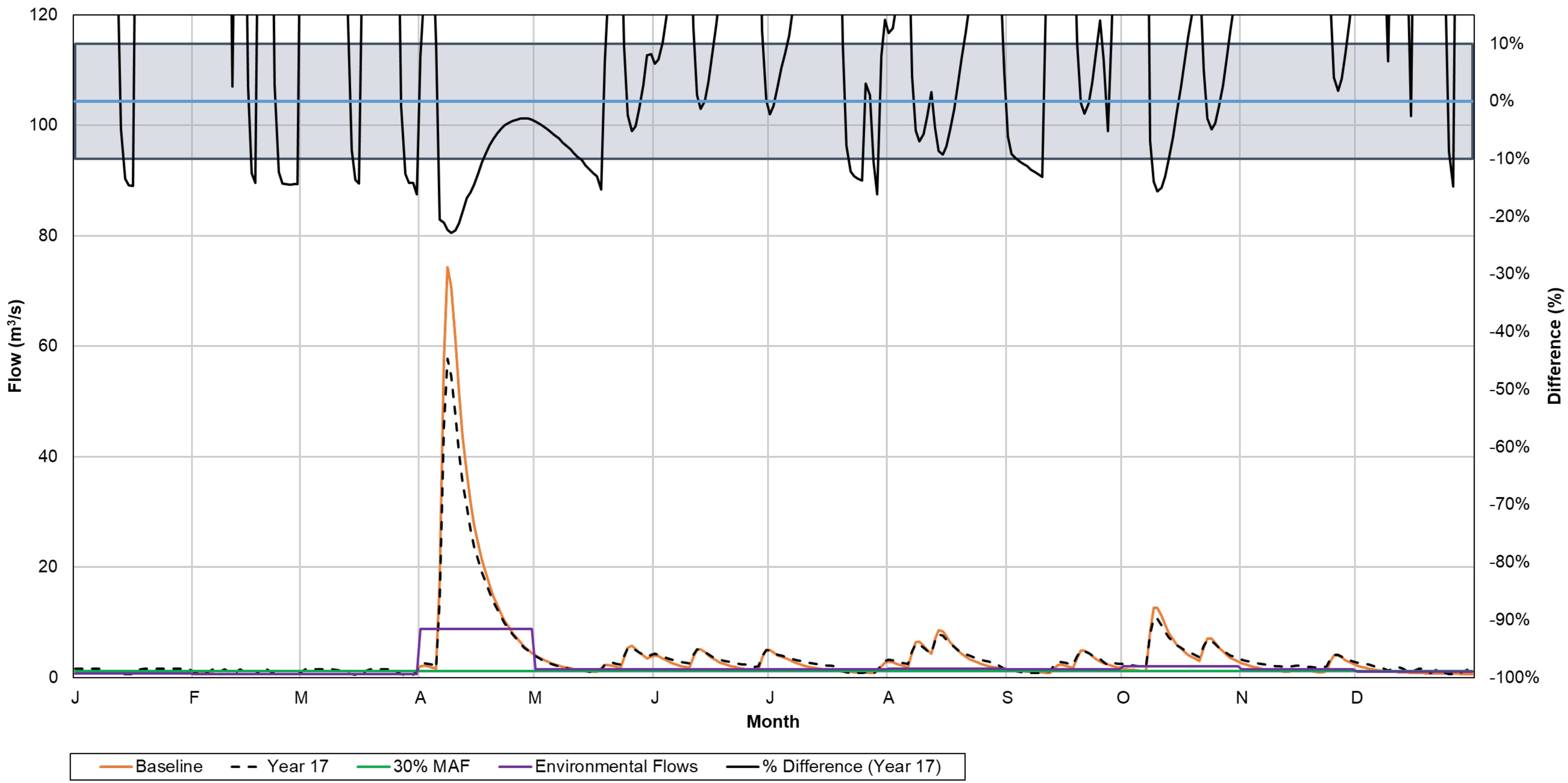


Figure A.113 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND5

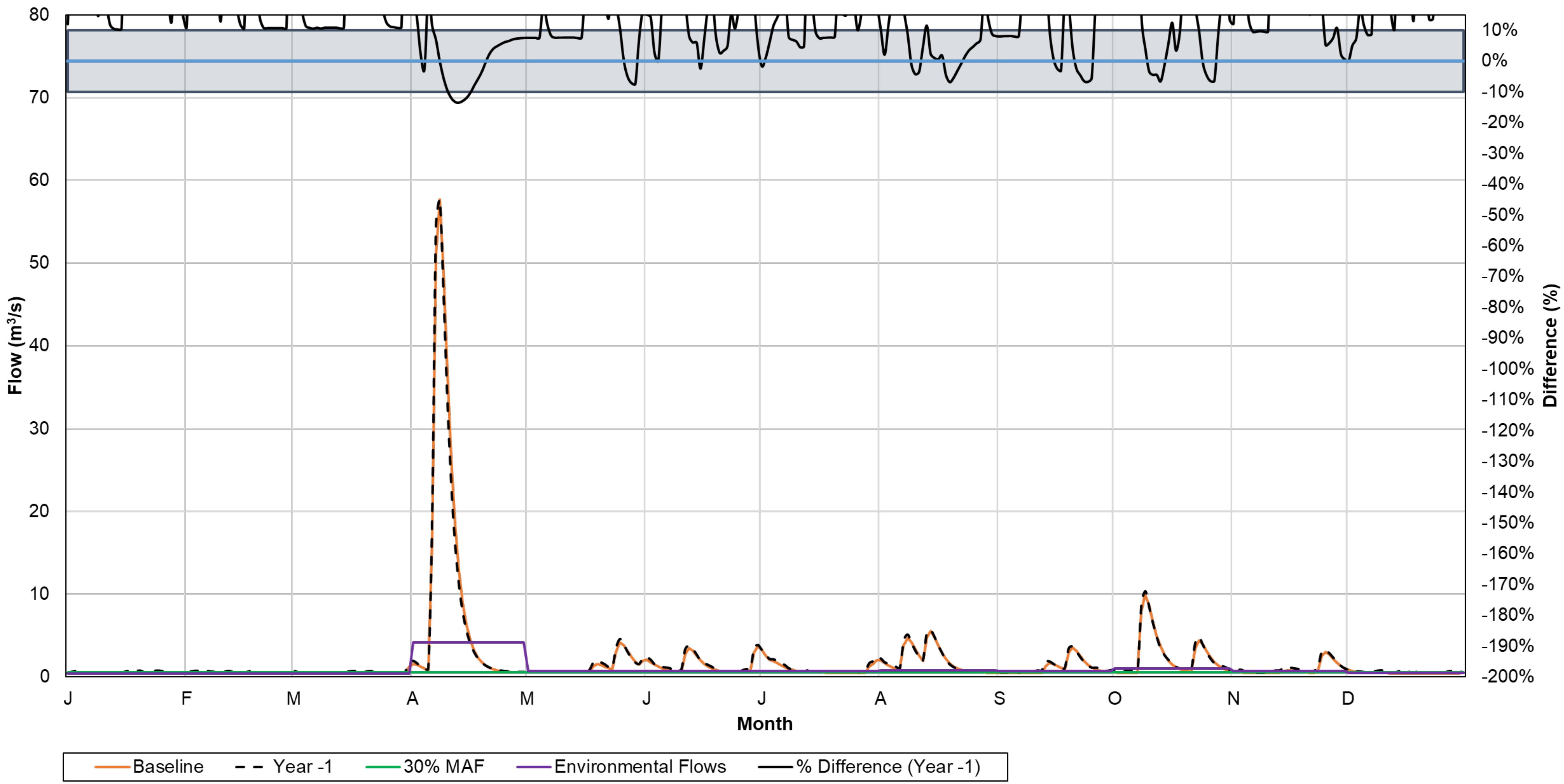


Figure A.114 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND5

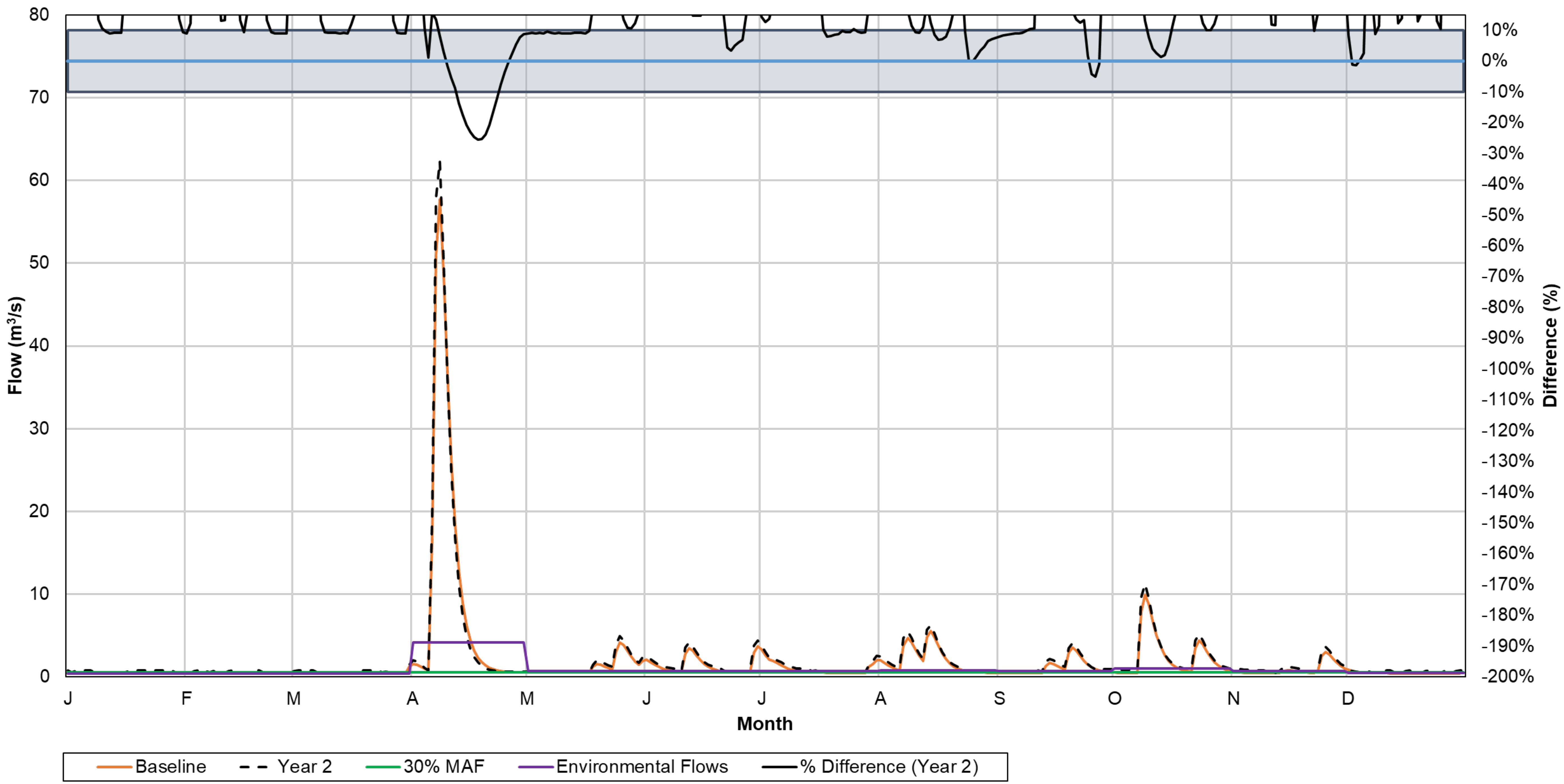


Figure A.115 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND5

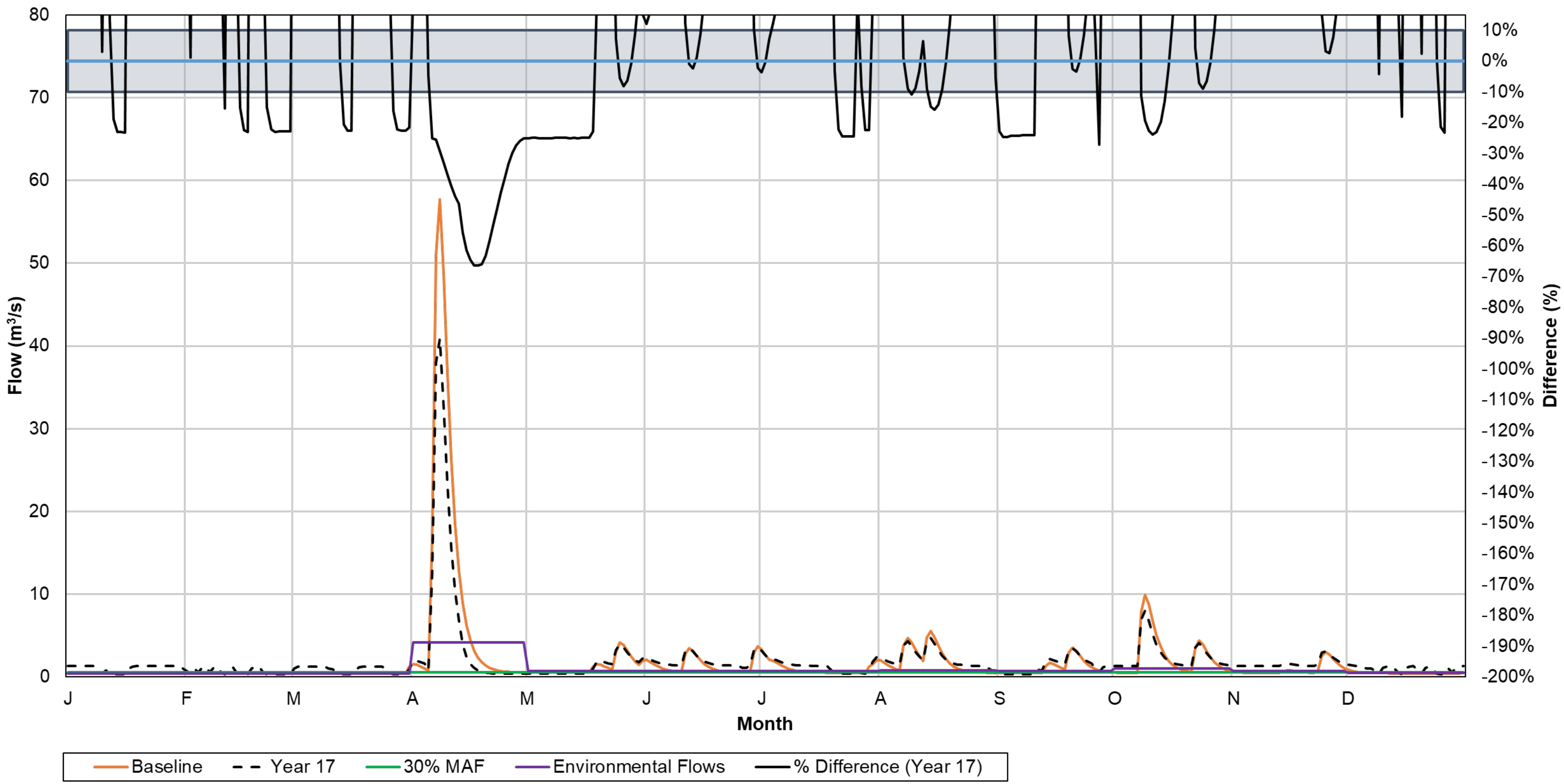


Figure A.116 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND8

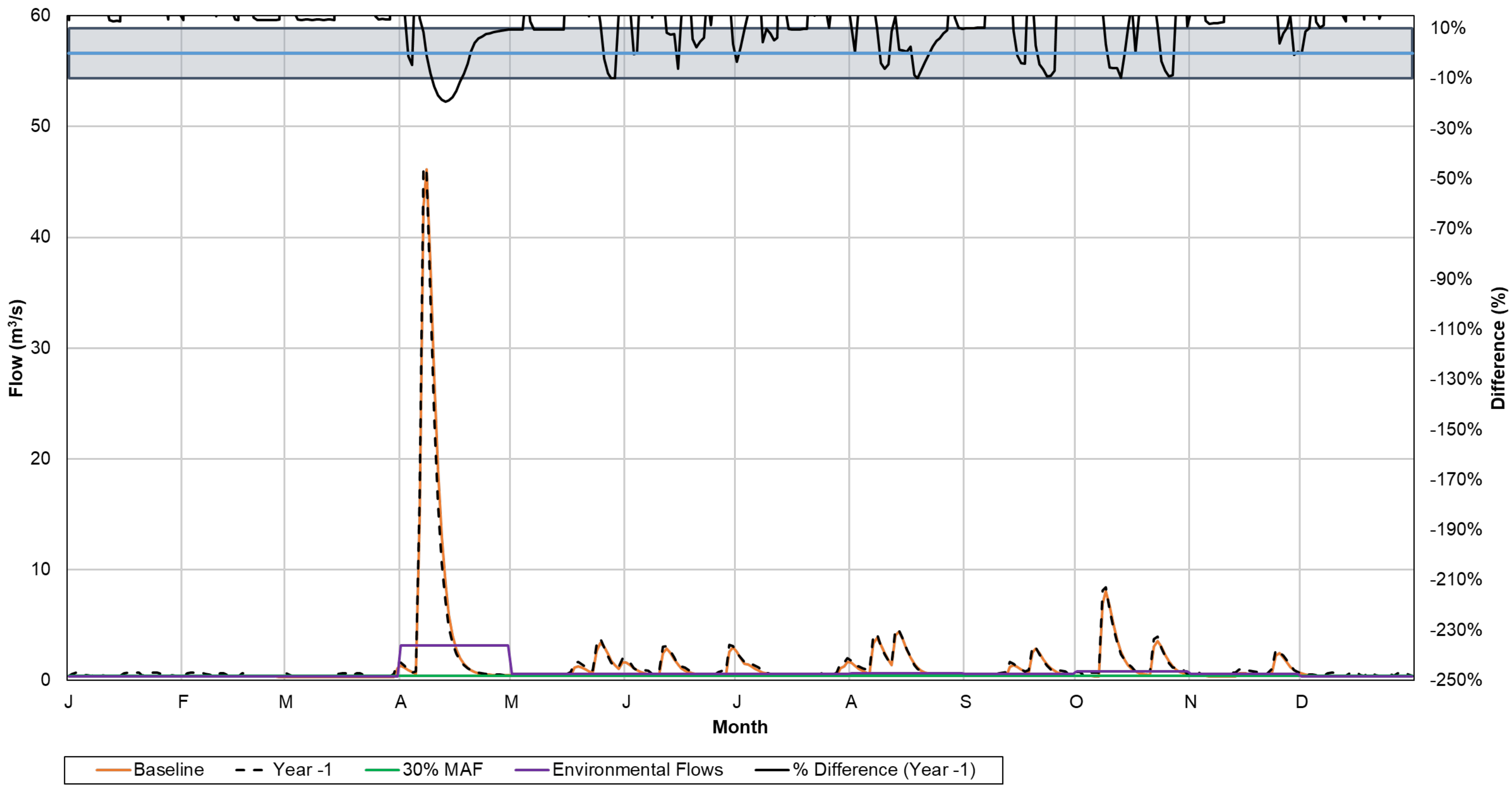


Figure A.117 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND8

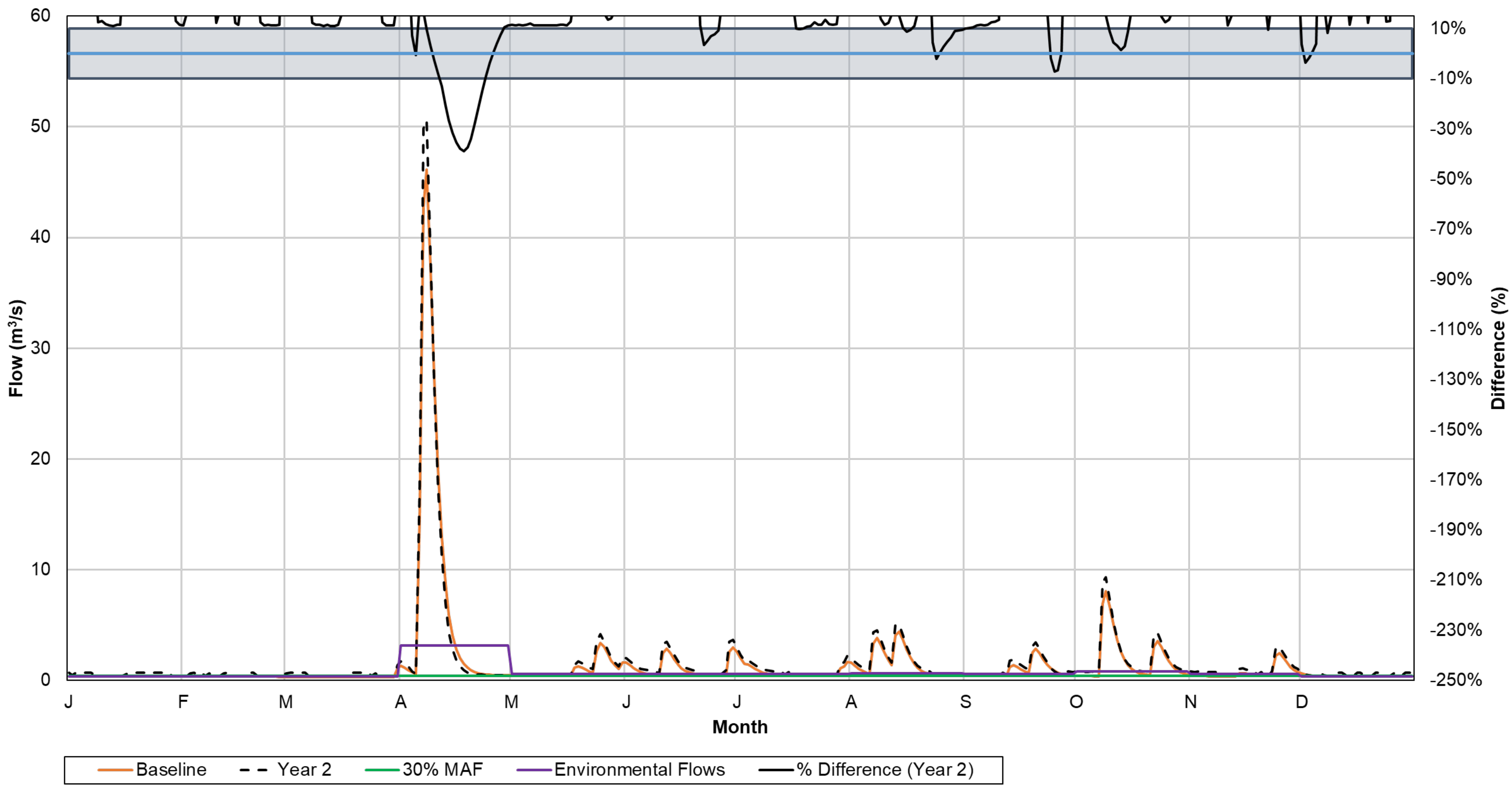


Figure A.118 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND8

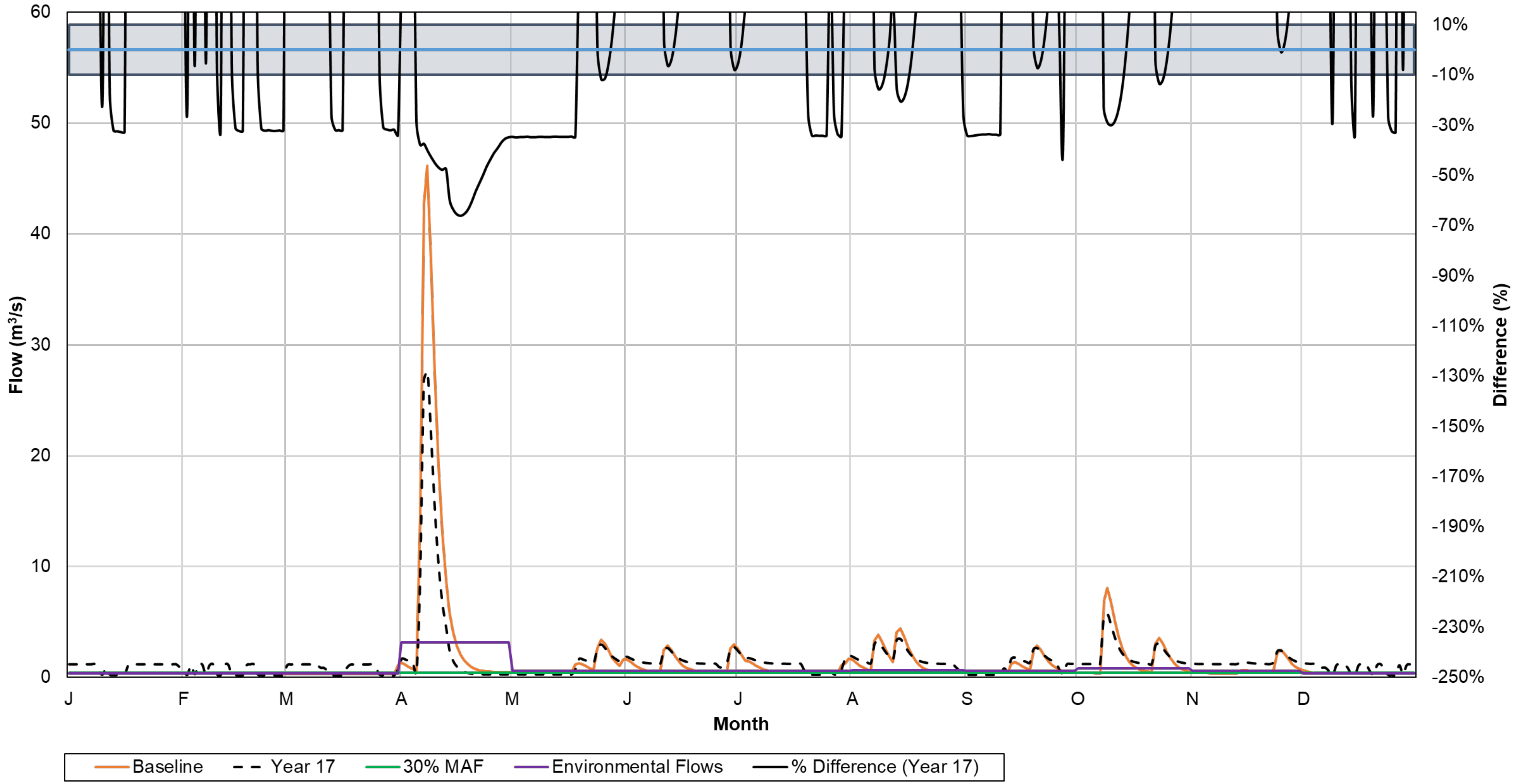


Figure A.119 Existing Climate Baseline and Year -1 (Construction Phase) Flows and Percent Changes for the North Driftwood River Watershed – ND18

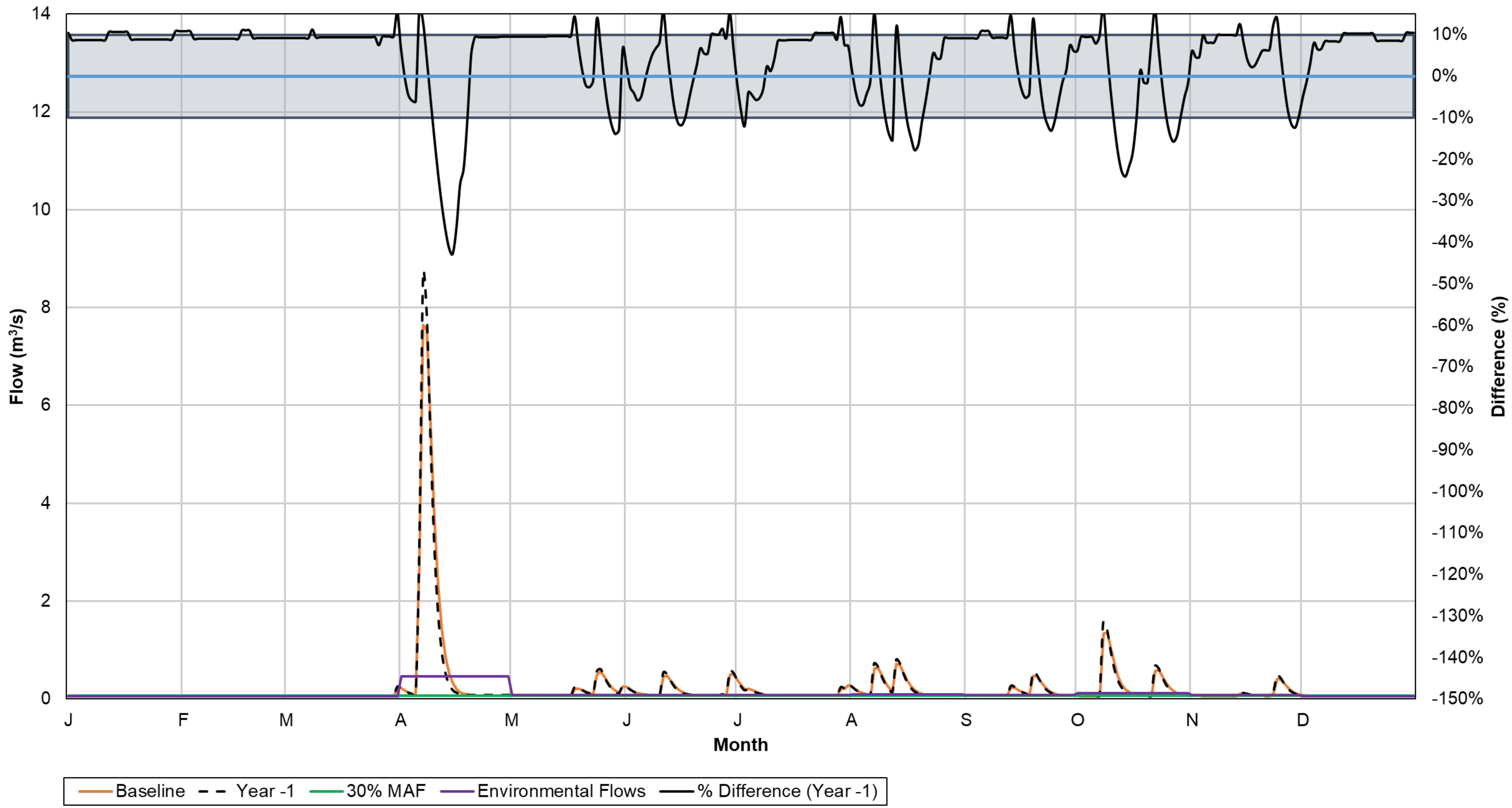


Figure A.120 Existing Climate Baseline and Year 2 (Operations Phase 1) Flows and Percent Changes for the North Driftwood River Watershed – ND18

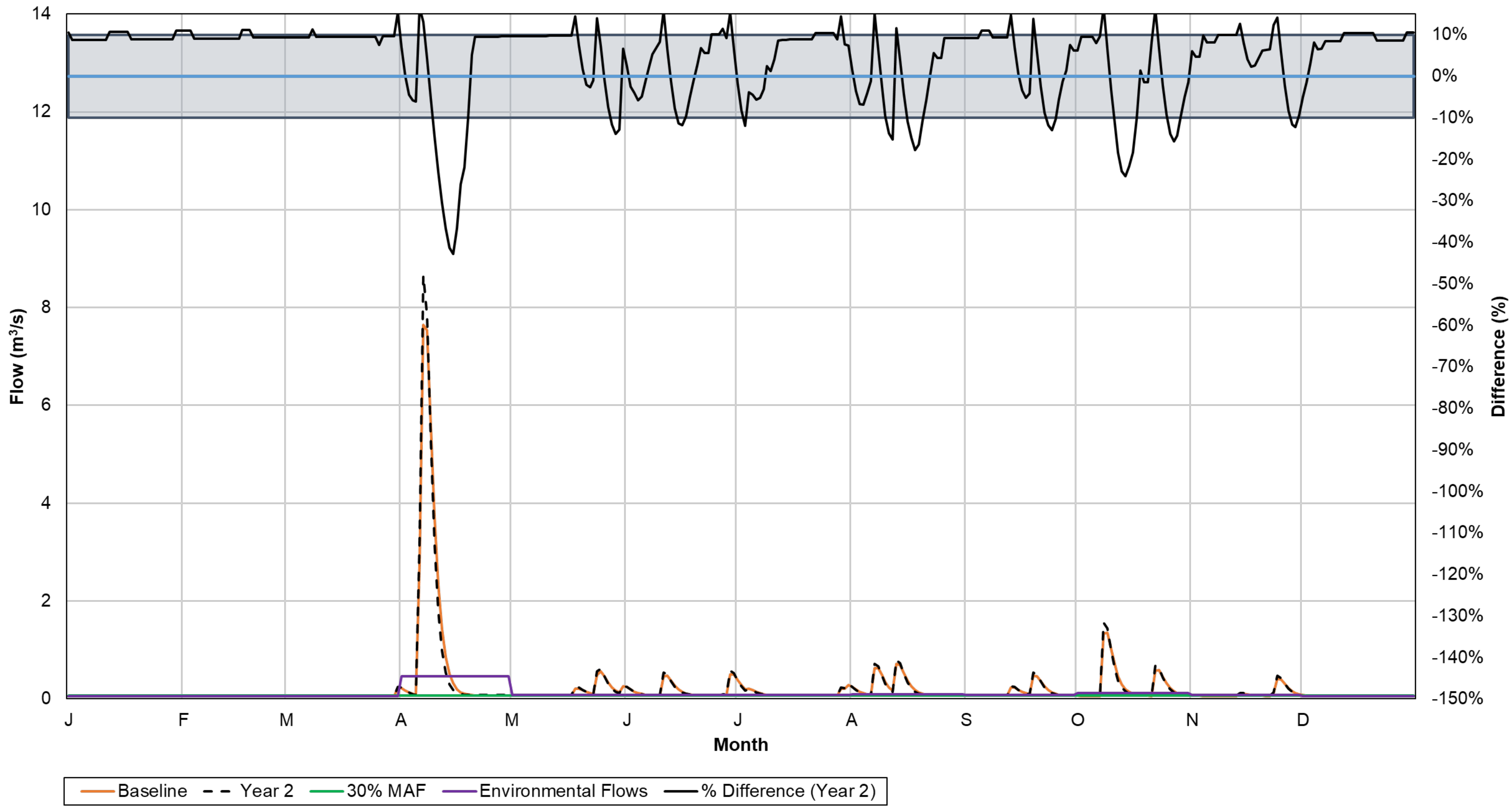
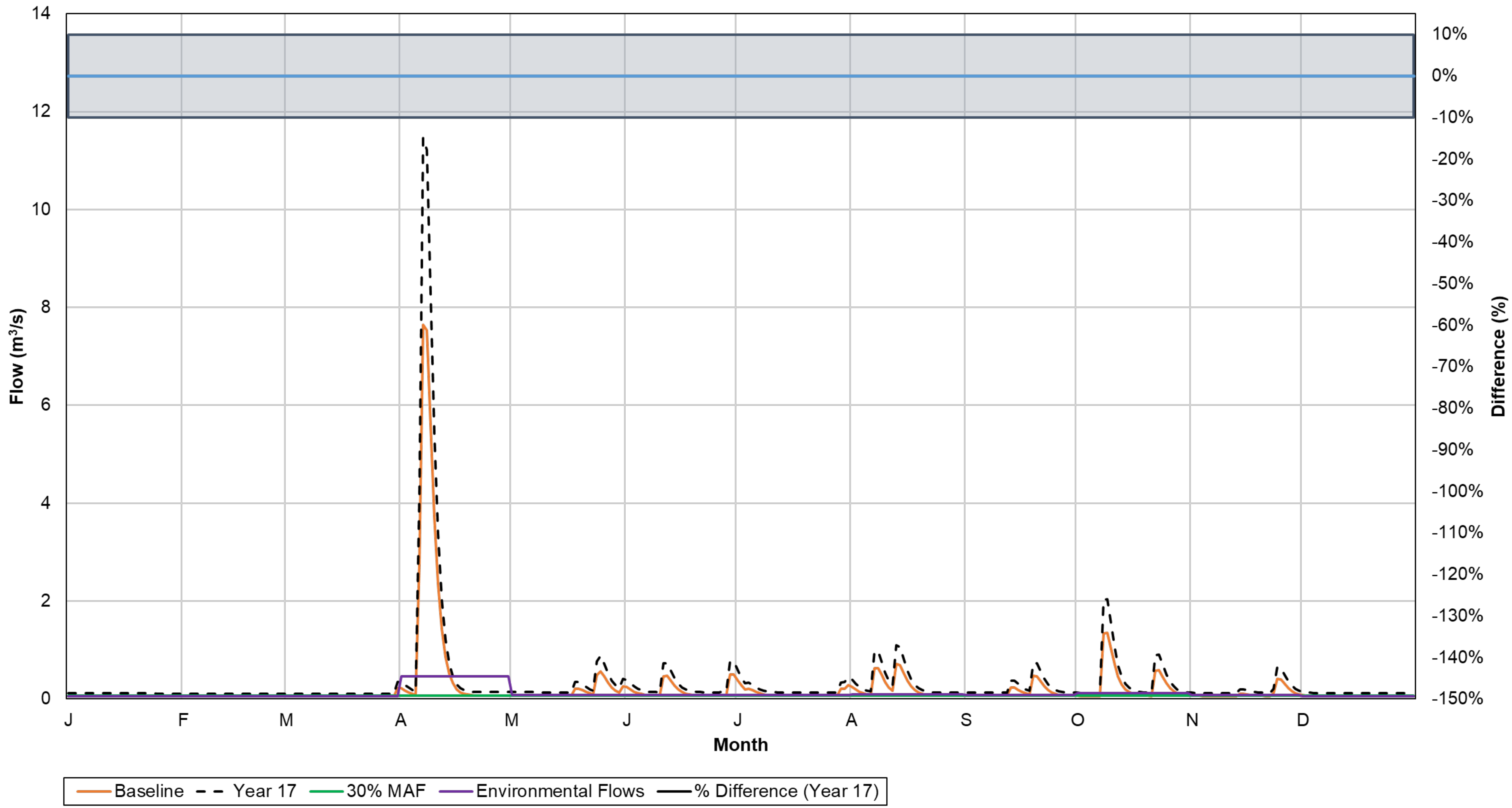


Figure A.121 Existing Climate Baseline and Year 17 (Operations Phase 2) Flows and Percent Changes for the North Driftwood River Watershed – ND18



Appendix B Data Tables

B.1 HEC-HMS Parameters

Table B.1.1 Subbasin Catchments Throughout Mine Life for Jocko Creek Watershed

Subbasin ID	Baseline	Operations	
	Area (km^2)	Area (km^2)	% Change
JC2	71.82	71.82	0%
JC1	19.45	18.14	-7%
JC_DS	18.37	18.37	0%

Table B.1.2 Subbasin Catchments Throughout Mine Life for West Buskegau River Watershed

	Baseline	Construction (Modelled Mine Year -3 to -1; Year -1)		Operations Phase 1 (Modelled Mine Years 1 to 4: Year 2)		Operations Phase 1 and 2 (Modelled Mine Year 4 to 18; Year 4)		Operations Phase 2 (Modelled Mine Year 18 to 30; Year 23)		Operations Phase 3 (Modelled Mine Year 30 to 41; Year 35)		Operations Phase 3 (Modelled Mine Year 30 to 41; Year 41)		Passive Closure (Modelled Mine Year 46+; Year 47)		Pit-Full	
Subbasin ID	Area (km²)	Area (km²)	% Change	Area (km²)	% Change	Area (km²)	% Change	Area (km²)	% Change	Area (km²)	% Change	Area (km²)	% Change	Area (km²)	% Change	Area (km²)	% Change
WB25	28.48	28.48	0%	28.48	0%	28.48	0%	28.48	0%	28.48	0%	28.48	0%	28.48	0%	28.48	0%
WB26	21.28	21.28	0%	21.28	0%	21.28	0%	21.28	0%	21.28	0%	21.28	0%	21.28	0%	21.28	0%
WB24	3.15	3.15	0%	3.15	0%	3.15	0%	3.15	0%	3.15	0%	3.15	0%	3.15	0%	3.15	0%
WB21	18.87	18.87	0%	18.87	0%	18.87	0%	18.87	0%	18.87	0%	18.87	0%	18.87	0%	18.87	0%
WB22	17.85	17.85	0%	17.85	0%	17.85	0%	17.85	0%	17.85	0%	17.85	0%	17.85	0%	17.85	0%
WB23	12.62	12.62	0%	12.62	0%	12.62	0%	12.62	0%	12.62	0%	12.62	0%	12.62	0%	12.62	0%
WB19	7.23	7.23	0%	7.23	0%	7.23	0%	7.23	0%	7.23	0%	7.23	0%	7.23	0%	7.23	0%
WB18	8.04	8.04	0%	8.04	0%	8.04	0%	8.04	0%	8.04	0%	8.04	0%	8.04	0%	8.04	0%
WB20	7.27	7.27	0%	7.27	0%	7.27	0%	7.27	0%	7.27	0%	7.27	0%	7.27	0%	7.27	0%
WB16	8.51	8.51	0%	8.51	0%	8.51	0%	8.51	0%	8.51	0%	8.51	0%	8.51	0%	8.51	0%
WB17	1.87	1.87	0%	1.87	0%	1.87	0%	1.87	0%	1.87	0%	1.87	0%	1.87	0%	1.87	0%
WB15	1.65	1.58A	-4%	1.04	-37%	0.88	-47%	0.88	-47%	0.88	-47%	0.88	-47%	0.88	-47%	0.88	-47%
WB13	6.23	6.23	0%	6.23	0%	6.23	0%	6.23	0%	6.23	0%	6.23	0%	6.23	0%	6.23	0%
WB14	4.91	4.9	0%	4.81	-2%	4.81	-2%	4.81	-2%	4.81	-2%	4.81	-2%	4.81	-2%	4.81	-2%
WB12	6.03	3.14A	-48%	2.78	-54%	2.52	-58%	2.52	-58%	2.52	-58%	2.52	-58%	2.52	-58%	2.52	-58%
WB11	6.85	-A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB10	4.44	-A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB9	10.17	10.38	2%	10.38	2%	10.62	4%	10.62	4%	10.62	4%	10.62	4%	10.62	4%	10.62	4%
WB8	4.68	0.35A	-92%	0.35	-92%	0.35	-92%	0.35	-92%	0.35	-92%	0.35	-92%	0.35	-92%	0.35	-92%
WB7	13.42	-A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB6	9.75	10.22	5%	10.22	5%	10.01	3%	10.01	3%	10.01	3%	10.01	3%	10.01	3%	10.01	3%
WB5	18.92	24.03	27%	22.19	17%	21.27	12%	21.27	12%	21.27	12%	21.27	12%	21.27	12%	21.27	12%
WB27	83.26	83.26	0%	83.26	0%	83.26	0%	83.26	0%	83.26	0%	83.26	0%	83.26	0%	83.26	0%
WB4	80.42	80.42	0%	80.42	0%	80.42	0%	80.42	0%	80.42	0%	80.42	0%	80.42	0%	80.42	0%
WB3	28.71	28.71	0%	28.71	0%	28.71	0%	28.71	0%	28.71	0%	28.71	0%	28.71	0%	28.71	0%
WB2	70.7	70.7	0%	70.7	0%	70.7	0%	70.7	0%	70.7	0%	70.7	0%	70.7	0%	70.7	0%
WB1	38.73	38.73	0%	38.73	0%	38.73	0%	38.73	0%	38.73	0%	38.73	0%	38.73	0%	38.73	0%
WRSA_2	-	-	-	-		-	-	-	-	6.65	100%	6.65	0%	6.65	0%	6.65	0%
WRSA_3	-	-	-	-		-	-	-	-	2.83	100%	2.83	0%	2.83	0%	2.83	0%
WRSA_4	-	-	-	-		-	-	-	-	7.16	100%	7.16	0%	7.16	0%	7.16	0%
WRSA_5	-	-	-	-		-	-	-	-	2.45	100%	2.45	0%	2.45	0%	2.45	0%
LG_East	-	-	-	-		-	-	-	-	-	-	-	-	3.85	100%	3.85	100%

Notes:
A – Construction of the east portion of the Impoundment Facility, Collection Pond 1, Collection Pond 3, and East Stockpile affected noted subwatersheds. Orphaned WB8 and WB11 flow to North Driftwood watershed.

Table B.1.3 Subbasin Catchments Throughout Mine Life for North Driftwood River Watershed

Subbasin ID	Baseline	Construction (Modelled Mine Year -3 to -1; Year -1)		Operations Phase 1 (Modelled Mine Years 1 to 4: Year 2)		Operations Phase 1 and 2 (Modelled Mine Year 4 to 18; Year 4)		Operations Phase 2 (Modelled Mine Year 18 to 30; Year 23)		Operations Phase 3 (Modelled Mine Year 30 to 41; Year 35)		Operations Phase 3 (Modelled Mine Year 30 to 41; Year 41)		Passive Closure (Modelled Mine Year 46+; Year 47)		Pit-Full	
	Area (km^2)	Area (km^2)	% Change	Area (km^2)	% Change	Area (km^2)	% Change	Area (km^2)	% Change	Area (km^2)	% Change	Area (km^2)	% Change	Area (km^2)	% Change	Area (km^2)	% Change
ND23	13.02	13.02	0%	16.1	24%	7.38	-43%	7.38	-43%	7.38	-43%	7.38	-43%	7.38	-43%	7.38	-43%
ND21	10.75	7.1A	-34%	10.658	-1%	-	-	-	-	-	-	-	-	-	-	-	-
ND22	10.66	10.66	0%	10.66	0%	-	-	-	-	-	-	-	-	-	-	-	-
ND18	9.53	9.32 A	-2%	9.32	-2%	9.36	-2%	9.36	-2%	9.36	-2%	9.36	-2%	9.36	-2%	9.36	-2%
ND20	1.65	1.46 A	-11%	1.46	-11%	1.46	-11%	1.46	-11%	1.46	-11%	1.46	-11%	1.46	-11%	1.46	-11%
ND19	2.75	2.75	0%	2.75	0%	3.52	28%	3.52	28%	3.52	28%	3.52	28%	3.52	28%	3.52	28%
ND16	1.07	0.4 A	-63%	0.4	-63%	0.161	-85%	0.161	-85%	0.161	-85%	0.161	-85%	0.161	-85%	0.161	-85%
ND17	0.28	0.28	0%	0.28	0%	-	-	-	-	-	-	-	-	-	-	-	-
ND14	7.19	4.21 A	-41%	4.21	-41%	-	-	-	-	-	-	-	-	-	-	-	-
ND15	5.8	5.59 A	-4%	5.59	-4%	3.235	-44%	3.235	-44%	3.235	-44%	3.235	-44%	3.235	-44%	3.235	-44%
ND13	2.33	2.27 A	-3%	2.26	-3%	-	-	-	-	-	-	-	-	-	-	-	-
WB11_orphaned	-	1.54A	100%	0.75	-51%	-	-	-	-	-	-	-	-	-	-	-	-
ND10	7.71	7.71	0%	7.71	0%	-	-	-	-	-	-	-	-	-	-	-	-
ND11	4.78	4.78	0%	4.78	0%	7.67	61%	7.67	61%	7.67	61%	7.67	61%	7.67	61%	7.67	61%
ND12	2.42	2.42	0%	2.42	0%	2.42	0%	2.42	0%	2.42	0%	2.42	0%	2.42	0%	2.42	0%
WB8_orphaned	-	1.15A	100%	0.7	-39%	-	-	-	-	-	-	-	-	-	-	-	-
ND9	12.25	12.25	0%	12.25	0%	12.25	0%	12.25	0%	12.25	0%	12.25	0%	12.25	0%	12.25	0%
ND8	3.28	3.28	0%	3.28	0%	3.03	-8%	3.03	-8%	3.03	-8%	3.03	-8%	3.03	-8%	3.03	-8%
ND7	6.28	6.28	0%	6.28	0%	6.28	0%	6.28	0%	6.28	0%	6.28	0%	6.28	0%	6.28	0%
ND6	4.8	4.8	0%	4.8	0%	4.8	0%	4.8	0%	4.8	0%	4.8	0%	4.8	0%	4.8	0%
ND5	18.07	18.07	0%	18.07	0%	15.01	-17%	15.01	-17%	15.01	-17%	15.01	-17%	15.01	-17%	15.01	-17%
ND4	102.17	102.17	0%	102.17	0%	102.17	0%	102.17	0%	102.17	0%	102.17	0%	102.17	0%	102.17	0%
ND3	50.61	50.61	0%	50.61	0%	50.61	0%	50.61	0%	50.61	0%	50.61	0%	50.61	0%	50.61	0%
ND2	84.41	84.41	0%	84.41	0%	84.41	0%	84.41	0%	84.41	0%	84.41	0%	84.41	0%	84.41	0%
ND1	21.48	21.48	0%	21.48	0%	21.48	0%	21.48	0%	21.48	0%	21.48	0%	21.48	0%	21.48	0%
TMF_1	-	-	-	-	-	-	-	11.19	100%	11.19	0%	11.19	0%	11.19	0%	11.19	0%
TMF_2	-	-	-	-	-	-	-	12.61	100%	12.61	0%	12.61	0%	12.61	0%	12.61	0%
Pond_1	-	-	-	-	-	-	-	-	-	0.48	100%	0.48	0%	0.48	0%	0.48	0%
WRSA_1	-	-	-	-	-	-	-	-	-	9.78	100%	9.78	0%	9.78	0%	9.78	0%
WRSA_6	-	-	-	-	-	-	-	-	-	4.16	100%	4.16	0%	4.16	0%	4.16	0%
LG_West	-	-	-	-	-	-	-	-	-	-	-	-	-	9.26	100%	9.26	100%

Note:
A. Construction of the east portion of the Impoundment Facility, Collection Pond 1, Collection Pond 3, and East Stockpile affected noted subwatersheds. Orphaned WB8 and WB11 flow to North Driftwood watershed.

Table B.1.4 Modelled Groundwater Seepage Rate Included in HEC_HMS Model Throughout Mine Life

Watershed	Sub Watersheds	Watercourse/Lake	Seepage Rate (m^3/d)					Pit-Full
			Operations Phase 1 and 2 (Modelled Mine Year 4 to 18; Year 17)	Operations Phase 2 (Modelled Mine Year 18 to 30; Year 23)	Operations Phase 3 (Modelled Mine Year 30 to 41; Year 35)	Operations Phase 3 (Modelled Mine Year 30 to 41; Year 41)	Passive Closure (Modelled Mine Year 46+; Year 47)	
Jocko Creek	JC2		1270	9	9	9	9	9
	JC1	Unnamed Lake (South of Zed Lake)	1503	39	39	39	39	39
	JC1		935	262	262	262	262	262
	JC_DS	Zed Lake	43	0	0	0	0	0
	JC_DS		51	31	31	31	31	31
North Driftwood	ND18	Mel Lake	1099	94	94	94	94	94
	ND18	Sutherland Lake	155	13	13	13	13	13
	ND19	Jack Lake	58	0	0	0	0	0
	ND19	Gerry Lake	1453	207	207	207	207	207
	ND11	Unnamed Lake (LG Stockpile West)	-	324	324	324	324	324
	ND8		55	4	4	4	4	4
	ND7		-	8	8	8	8	8
	ND6		14	196	196	196	196	196
	ND5		125	-	-	-	-	-
	ND3		-	320	320	320	320	320
West Buskegau	WB21		-	1	1	1	1	1
	WB19		75	89	89	89	89	89
	WB16		771	32	32	32	30	30
	WB14		1244	10	10	10	8	8
	WB6		67	-	-	-	-	-
	WB5		37	-	-	-	-	-
	WB3		1	-	-	-	-	-

Table B.1.5 Statistics Summary of Model Calibration for Each Watershed

Watershed	Jocko Creek	West Buskegau River	North Driftwood River
HEC-HMS Subwatershed / Hydrometric Station	JC1 / SW-8	WB6 / SW-6b	ND6 / SW-2b
R^2	0.66	0.60	0.54
NSE	0.64	0.46	0.52

B.2 Flow Change Assessment Tables

Table B.2.1 Climate Change Adjusted West Buskegau River Flows – WB1 (Construction Phase & Operations Phase 1 and 2)

		Baseline		Construction Phase (Years -3 to -1: Year -1)				Operations Phase 1 (Years 1 to 4: Year 2)				Operations Phase 1 and 2 (Years 4 to 18: Year 17)				Operations Phase 2 (Years 18 to 30: Year 23)			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
Month	Days in Month	Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	2.34	2.34	0	19	20.4%	0	0	19	21.2%	0	0	21	22.7%	0	0	20	20.9%	0
Feb	28	17.25	6.90	0	1	-1.2%	0	0	1	-1.6%	0	0	1	-1.3%	0	0	1	-1.5%	0
Mar	31	10.52	4.21	0	0	-0.4%	0	0	2	1.3%	0	0	3	2.2%	0	0	3	1.8%	0
Apr	30	1.99	1.99	0	4	1.5%	0	0	11	6.2%	0	0	22	18.4%	0	0	21	16.8%	0
May	31	4.15	2.48	0	0	-2.5%	0	0	0	-2.9%	0	0	17	20.8%	0	0	17	19.0%	0
Jun	30	6.32	2.53	0	4	2.7%	0	0	3	2.6%	0	0	3	3.3%	0	0	2	2.8%	0
Jul	31	4.23	2.48	0	14	11.3%	0	0	15	11.3%	0	0	15	12.7%	0	0	14	11.5%	0
Aug	31	9.18	3.67	0	3	1.0%	0	0	2	0.8%	0	0	4	1.6%	0	0	3	1.2%	0
Sep	30	4.26	2.48	0	13	12.4%	0	0	13	12.7%	0	0	13	13.6%	0	0	13	12.3%	0
Oct	31	10.04	4.02	0	3	1.6%	0	0	3	1.6%	0	0	5	2.2%	0	0	5	1.8%	0
Nov	30	2.74	2.48	0	18	18.6%	0	0	19	19.1%	0	0	19	21.3%	0	0	19	19.7%	0
Dec	31	1.26	1.26	0	27	32.5%	0	0	0	34.1%	0	0	28	36.9%	0	0	27	34.4%	0

Table B.2.2 Climate Change Adjusted West Buskegau River Flows – WB1 (Operations Phase 3 and Passive Closure)

Month	Days in Month	Baseline		Operations Phase 3 (Years 30 to 41: Year 35)				Operations Phase 3 (Years 30 to 41: Year 41)				Passive Closure Phase (Year 41 to 47: Year 47)				Pit Filled			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of – 10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of – 10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of – 10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of – 10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	2.34	2.34	0	0	0.4%	0	0	0	-1.2%	0	0	0	-1.2%	0	0	0	-1.2%	0
Feb	28	17.25	6.90	0	0	-1.6%	0	0	0	-1.7%	0	0	0	-1.0%	0	0	0	-1.0%	0
Mar	31	10.52	4.21	0	0	-1.5%	0	0	0	-1.8%	0	0	0	-1.5%	0	0	0	-1.5%	0
Apr	30	1.99	1.99	0	0	-1.1%	0	0	0	-1.5%	0	0	0	-1.2%	0	0	0	-1.2%	0
May	31	4.15	2.48	0	0	-1.3%	0	0	0	-1.6%	0	0	0	-1.0%	0	0	0	-1.0%	0
Jun	30	6.32	2.53	0	0	-0.7%	0	0	0	-1.2%	0	0	0	-1.0%	0	0	0	-1.0%	0
Jul	31	4.23	2.48	0	0	-0.9%	0	0	0	-1.4%	0	0	0	-1.0%	0	0	0	-1.0%	0
Aug	31	9.18	3.67	0	0	-1.5%	0	0	0	-1.9%	0	0	0	-1.6%	0	0	0	-1.6%	0
Sep	30	4.26	2.48	0	1	-0.3%	0	0	0	-1.2%	0	0	0	-1.1%	0	0	0	-1.1%	0
Oct	31	10.04	4.02	0	0	-0.6%	0	0	0	-1.5%	0	0	0	-1.3%	0	0	0	-1.3%	0
Nov	30	2.74	2.48	0	0	0.6%	0	0	0	-0.9%	0	0	0	-0.9%	0	0	0	-0.9%	0
Dec	31	1.26	1.26	0	2	2.4%	0	0	0	-0.2%	0	0	0	-1.2%	0	0	0	-1.2%	0

Table B.2.3 Climate Adjusted West Buskegau River Flows – WB5 (Construction Phase & Operations Phase 1 and 2)

		Baseline		Construction Phase (Mine Years -3 to -1: Year -1)				Operations Phase 1 (Years 1 to 4: Year 2)				Operations Phase 1 and 2 (Mine Years 4 to 18: Year 17)				Operations Phase 2 (Mine Years 18 to 30: Year 23)			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
Month	Days in Month	Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	1.04	1.04	0	25	49.1%	0	0	25	50.8%	0	0	26	54.6%	0	0	25	50.3%	0
Feb	28	7.66	3.06	4	1	-1.8%	0	6	1	-2.7%	0	7	6	0.1%	0	7	6	-0.6%	0
Mar	31	4.17	1.67	4	5	0.0%	3	4	10	6.1%	0	3	14	9.8%	0	3	13	8.4%	0
Apr	30	0.80	0.80	15	9	2.9%	15	9	15	16.5%	9	0	26	50.9%	0	0	26	46.7%	0
May	31	2.00	1.05	17	1	-6.3%	17	17	1	-7.1%	17	1	18	49.9%	0	3	18	45.6%	0
Jun	30	2.60	1.05	0	12	9.5%	0	0	12	9.4%	0	0	15	12.5%	0	1	14	11.0%	0
Jul	31	1.72	1.05	0	19	35.1%	0	0	19	35.1%	0	0	19	40.2%	0	0	19	36.8%	0
Aug	31	3.87	1.55	0	9	6.5%	0	0	9	6.2%	0	3	12	9.7%	0	4	10	8.3%	0
Sep	30	1.86	1.05	0	17	37.6%	0	0	17	38.7%	0	0	16	42.0%	0	1	16	38.5%	0
Oct	31	4.33	1.73	0	8	6.8%	0	0	8	7.1%	0	5	12	9.7%	0	5	12	8.5%	0
Nov	30	1.11	1.05	0	23	56.6%	0	0	22	57.8%	0	0	24	65.3%	0	0	23	60.5%	0
Dec	31	0.42	0.42	0	31	88.1%	0	0	30	92.3%	0	0	31	100.6%	0	0	31	93.6%	0

Table B.2.4 Climate Change Adjusted West Buskegau River Flows – WB5 (Operations Phase 3 and Passive Closure)

Month	Days in Month	Baseline		Operations Phase 3 (Mine Years 30 to 41: Year 35)				Operations Phase 3 (Mine Years 30 to 41: Mine Year 41)				Passive Closure Phase (Mine Year 46 onward: Year 47)				Pit Filled			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	1.04	1.04	0	5	0.6%	0	0	2	-2.9%	0	0	1	-3.3%	0	0	1	-3.3%	0
Feb	28	7.66	3.06	2	0	-4.6%	0	2	0	-4.8%	0	0	3	-3.7%	0	0	3	-3.7%	0
Mar	31	4.17	1.67	0	2	-3.9%	0	0	0	-4.9%	0	0	0	-4.4%	0	0	0	-4.4%	0
Apr	30	0.80	0.80	0	1	-3.3%	0	0	0	-4.0%	0	0	0	-3.3%	0	0	0	-3.3%	0
May	31	2.00	1.05	0	1	-3.3%	0	0	1	-4.1%	0	0	1	-2.7%	0	0	1	-2.7%	0
Jun	30	2.60	1.05	0	1	-2.3%	0	0	1	-3.7%	0	0	2	-3.3%	0	0	2	-3.3%	0
Jul	31	1.72	1.05	0	1	-2.9%	0	0	1	-4.1%	0	0	1	-3.2%	0	0	1	-3.2%	0
Aug	31	3.87	1.55	0	0	-4.4%	0	0	0	-5.2%	0	0	0	-4.4%	0	0	0	-4.4%	0
Sep	30	1.86	1.05	0	3	-0.9%	0	0	2	-3.2%	0	0	1	-3.3%	0	0	1	-3.3%	0
Oct	31	4.33	1.73	0	2	-1.4%	0	1	1	-4.0%	0	0	2	-4.1%	0	0	2	-4.1%	0
Nov	30	1.11	1.05	0	5	1.4%	0	0	2	-2.6%	0	0	1	-2.8%	0	0	1	-2.8%	0
Dec	31	0.42	0.42	0	9	6.6%	0	0	3	-0.7%	0	0	0	-3.1%	0	0	0	-3.1%	0

Table B.2.5 Climate Change Adjusted West Buskegau River Flows – WB9 (Construction Phase & Operations Phase 1 and 2)

Month	Days in Month	Baseline		Construction Phase (Mine Years -3 to -1: Year -1)				Operations Phase 1 (Years 1 to 4: Year 2)				Operations Phase 1 and 2 (Mine Years 4 to 18: Year 17)				Operations Phase 2 (Mine Years 18 to 30: Year 23)			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.84	0.84	0	27	66.0%	0	0	26	68.8%	0	0	26	73.2%	0	0	26	68.1%	0
Feb	28	6.24	2.50	3	8	5.1%	0	5	9	5.1%	0	4	11	6.4%	0	5	9	5.4%	0
Mar	31	3.33	1.33	0	11	7.9%	0	1	17	16.6%	0	2	18	17.9%	0	2	18	16.3%	0
Apr	30	0.65	0.65	0	11	8.6%	0	4	20	26.7%	4	0	30	68.8%	0	0	29	63.9%	0
May	31	1.63	0.85	15	4	-3.9%	15	17	4	-3.9%	17	0	20	67.5%	0	0	20	62.4%	0
Jun	30	2.11	0.85	0	17	18.9%	0	0	18	19.7%	0	0	17	21.5%	0	0	17	19.7%	0
Jul	31	1.38	0.85	0	22	49.5%	0	0	23	50.6%	0	0	22	55.0%	0	0	22	51.0%	0
Aug	31	3.11	1.24	0	13	15.3%	0	0	14	15.9%	0	0	13	18.0%	0	0	13	16.3%	0
Sep	30	1.51	0.85	0	20	51.6%	0	0	20	54.0%	0	0	21	57.4%	0	0	20	53.3%	0
Oct	31	3.51	1.40	0	16	15.8%	0	0	16	17.3%	0	2	16	18.2%	0	2	16	16.7%	0
Nov	30	0.90	0.85	0	25	75.7%	0	0	25	78.1%	0	0	24	85.5%	0	0	24	79.9%	0
Dec	31	0.34	0.34	0	31	115.2%	0	0	31	121.6%	0	0	31	129.7%	0	0	31	121.5%	0

Table B.2.6 Climate Change Adjusted West Buskegau River Flows – WB9 (Operations Phase 3 and Passive Closure)

Month	Days in Month	Baseline		Operations Phase 3 (Mine Years 30 to 41: Year 35)				Operations Phase 3 (Mine Years 30 to 41: Mine Year 41)				Passive Closure Phase (Mine Year 46 onward: Year 47)				Pit Filled			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m³/s)	Flows (m³/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.84	0.84	0	7	6.6%	0	0	3	2.6%	0	0	2	1.9%	0	0	2	1.9%	0
Feb	28	6.24	2.50	0	3	-0.3%	0	0	3	-0.6%	0	0	3	0.8%	0	0	3	0.8%	0
Mar	31	3.33	1.33	0	4	0.6%	0	0	2	-0.7%	0	0	2	-0.1%	0	0	2	-0.1%	0
Apr	30	0.65	0.65	0	3	1.4%	0	0	3	0.6%	0	0	1	1.5%	0	0	1	1.5%	0
May	31	1.63	0.85	0	2	1.8%	0	0	2	0.9%	0	0	2	2.6%	0	0	2	2.6%	0
Jun	30	2.11	0.85	0	5	2.6%	0	0	3	0.7%	0	0	3	1.2%	0	0	3	1.2%	0
Jul	31	1.38	0.85	0	2	1.6%	0	0	1	0.1%	0	0	1	1.3%	0	0	1	1.3%	0
Aug	31	3.11	1.24	0	2	0.0%	0	0	2	-1.1%	0	0	2	-0.2%	0	0	2	-0.2%	0
Sep	30	1.51	0.85	0	5	4.6%	0	0	3	1.7%	0	0	2	1.4%	0	0	2	1.4%	0
Oct	31	3.51	1.40	0	8	3.8%	0	0	4	0.6%	0	0	2	0.3%	0	0	2	0.3%	0
Nov	30	0.90	0.85	0	7	6.7%	0	0	2	1.8%	0	0	2	1.7%	0	0	2	1.7%	0
Dec	31	0.34	0.34	0	9	13.9%	0	0	3	4.5%	0	0	0	1.6%	0	0	0	1.6%	0

Table B.2.7 Climate Change Adjusted West Buskegau River Flows – WB14 (Construction Phase & Operations Phase 1 and 2)

Month	Days in Month	Baseline		Construction Phase (Mine Years -3 to -1: Year -1)				Operations Phase 1 (Years 1 to 4: Year 2)				Operations Phase 1 and 2 (Mine Years 4 to 18: Year 17)				Operations Phase 2 (Mine Years 18 to 30: Year 23)			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.70	0.70	0	0	0.0%	0	0	0	-0.6%	0	0	0	5.6%	0	0	0	-0.4%	0
Feb	28	5.22	2.09	0	0	0.0%	0	0	0	-0.4%	0	0	0	0.5%	0	0	0	-0.5%	0
Mar	31	2.80	1.12	0	0	0.0%	0	0	0	-0.2%	0	0	0	1.6%	0	0	0	-0.2%	0
Apr	30	0.55	0.55	0	0	0.0%	0	0	0	-0.5%	0	0	0	5.4%	0	0	0	-0.3%	0
May	31	1.35	0.71	0	0	0.0%	0	0	0	-0.7%	0	0	1	5.4%	0	0	0	-0.7%	0
Jun	30	1.78	0.71	0	0	0.0%	0	0	0	-0.4%	0	0	0	1.5%	0	0	0	-0.5%	0
Jul	31	1.16	0.71	0	0	0.0%	0	0	0	-0.4%	0	0	3	4.3%	0	0	0	-0.3%	0
Aug	31	2.61	1.04	0	0	0.0%	0	0	0	-0.2%	0	0	0	1.6%	0	0	0	-0.3%	0
Sep	30	1.26	0.71	0	0	0.0%	0	0	0	-0.5%	0	0	6	4.5%	0	0	0	-0.4%	0
Oct	31	2.93	1.17	0	0	0.0%	0	0	0	-0.3%	0	0	0	1.3%	0	0	0	-0.4%	0
Nov	30	0.76	0.71	0	0	0.0%	0	0	0	-0.4%	0	0	10	6.2%	0	0	0	-0.3%	0
Dec	31	0.29	0.29	0	0	0.0%	0	0	0	-0.4%	0	0	17	9.5%	0	0	0	-0.1%	0

Table B.2.8 Climate Change Adjusted West Buskegau River Flows – WB14 (Operations Phase 3 and Passive Closure)

Month	Days in Month	Baseline		Operations Phase 3 (Mine Years 30 to 41: Year 35)				Operations Phase 3 (Mine Years 30 to 41: Mine Year 41)				Passive Closure Phase (Mine Year 46 onward: Year 47)				Pit Lake Development and Post Closure			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.70	0.70	0	21	11.3%	0	0	21	11.3%	0	0	21	13.7%	0	0	21	13.7%	0
Feb	28	5.22	2.09	0	7	8.6%	0	0	7	8.6%	0	0	9	10.4%	0	0	9	10.4%	0
Mar	31	2.80	1.12	0	7	7.1%	0	0	7	7.1%	0	0	8	8.5%	0	0	8	8.5%	0
Apr	30	0.55	0.55	0	15	10.2%	0	0	15	10.2%	0	0	21	12.3%	0	0	21	12.3%	0
May	31	1.35	0.71	0	25	12.9%	0	0	25	12.9%	0	0	26	15.6%	0	0	26	15.6%	0
Jun	30	1.78	0.71	0	8	9.0%	0	0	8	9.0%	0	0	10	10.9%	0	0	10	10.9%	0
Jul	31	1.16	0.71	0	12	9.5%	0	0	12	9.5%	0	0	16	11.5%	0	0	16	11.5%	0
Aug	31	2.61	1.04	0	8	7.7%	0	0	8	7.7%	0	0	8	9.3%	0	0	8	9.3%	0
Sep	30	1.26	0.71	0	14	10.3%	0	0	14	10.3%	0	0	18	12.5%	0	0	18	12.5%	0
Oct	31	2.93	1.17	0	8	8.2%	0	0	8	8.2%	0	0	10	9.9%	0	0	10	9.9%	0
Nov	30	0.76	0.71	0	14	9.7%	0	0	14	9.7%	0	0	17	11.8%	0	0	17	11.8%	0
Dec	31	0.29	0.29	0	18	9.7%	0	0	18	9.7%	0	0	23	11.7%	0	0	23	11.7%	0

Table B.2.9 Climate Change Adjusted North Driftwood River Flows – ND1 (Construction Phase & Operations Phase 1 and 2)

Month	Days in Month	Baseline		Construction Phase (Years -3 to -1: Year -1)				Operations Phase 1 (Years 1 to 4: Year 2)				Operations Phase 1 and 2 (Years 4 to 18: Year 17)				Operations Phase 2 (Years 18 to 30: Year 23)			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.64	0.64	0	23	24.1%	0	0	23	31.3%	0	0	28	110.3%	0	0	15	17.8%	0
Feb	28	16.98	6.79	0	1	0.5%	0	0	1	0.2%	0	13	2	-4.7%	0	0	2	-2.4%	0
Mar	31	7.62	3.05	0	2	1.8%	0	0	3	2.5%	0	4	15	9.8%	0	0	3	0.2%	0
Apr	30	2.28	1.92	0	1	2.1%	0	0	3	2.6%	0	0	14	5.9%	0	0	2	0.4%	0
May	31	2.65	1.92	0	5	7.1%	0	0	8	5.6%	0	0	7	1.3%	0	0	5	3.2%	0
Jun	30	4.68	1.92	0	4	4.2%	0	0	6	6.6%	0	0	15	15.8%	0	0	5	1.1%	0
Jul	31	3.28	1.92	0	6	5.4%	0	0	5	5.7%	0	0	22	37.0%	0	0	4	1.2%	0
Aug	31	6.67	2.67	0	0	1.2%	0	0	2	4.0%	0	0	11	7.8%	0	0	2	-0.5%	0
Sep	30	3.10	1.92	0	7	7.1%	0	0	9	9.2%	0	0	16	18.3%	0	0	7	4.7%	0
Oct	31	7.19	2.88	0	5	4.4%	0	0	10	7.4%	0	3	12	10.6%	0	0	5	2.4%	0
Nov	30	1.76	1.76	0	15	16.5%	0	0	26	22.9%	0	0	30	68.9%	0	0	10	7.7%	0
Dec	31	0.71	0.71	0	22	25.5%	0	0	23	28.5%	0	0	31	146.2%	0	0	14	16.9%	0

Table B.2.9 Climate Change Adjusted North Driftwood River Flows – ND1 (Operations Phase 3 and Passive Closure)

		Baseline		Operations Phase 3 (Years 30 to 41: Year 35)				Operations Phase 3 (Years 30 to 41: Mine Year 41)				Passive Closure Phase (Year 46 onward: Year 47)				Pit Filled			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
Month	Days in Month	Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.64	0.64	0	15	17.8%	0	0	13	11.9%	0	0	0	2.0%	0	0	0	2.0%	0
Feb	28	16.98	6.79	0	2	-2.4%	0	0	2	-2.5%	0	0	4	-0.9%	0	0	4	-0.9%	0
Mar	31	7.62	3.05	0	3	0.2%	0	0	2	-0.6%	0	0	2	-0.5%	0	0	2	-0.5%	0
Apr	30	2.28	1.92	0	2	0.4%	0	0	2	-0.4%	0	0	0	-0.1%	0	0	0	-0.1%	0
May	31	2.65	1.92	0	5	3.2%	0	0	4	2.1%	0	0	4	3.0%	0	0	4	3.0%	0
Jun	30	4.68	1.92	0	5	1.1%	0	0	4	0.4%	0	0	3	-0.8%	0	0	3	-0.8%	0
Jul	31	3.28	1.92	0	4	1.2%	0	0	3	0.0%	0	0	3	0.2%	0	0	3	0.2%	0
Aug	31	6.67	2.67	0	2	-0.5%	0	0	2	-1.4%	0	0	3	-0.9%	0	0	3	-0.9%	0
Sep	30	3.10	1.92	0	7	4.7%	0	0	5	2.4%	0	0	4	1.0%	0	0	4	1.0%	0
Oct	31	7.19	2.88	0	5	2.4%	0	0	3	0.9%	0	0	4	-0.9%	0	0	4	-0.9%	0
Nov	30	1.76	1.76	0	10	7.7%	0	0	7	4.2%	0	0	2	0.7%	0	0	2	0.7%	0
Dec	31	0.71	0.71	0	14	16.9%	0	0	14	10.7%	0	0	0	1.1%	0	0	0	1.1%	0

Table B.2.7 Climate Change Adjusted North Driftwood River Flows – ND3 (Construction Phase & Operations Phase 1 and 2)

Month	Days in Month	Baseline		Construction Phase (Mine Years -3 to -1: Year -1)				Operations Phase 1 (Mine Years 1 to 4: Year 2)				Operations Phase 1 and 2 (Mine Years 4 to 18: Year 17)				Operations Phase 2 (Mine Years 18 to 30: Year 23)			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.46	0.46	0	26	33.2%	0	0	23	42.9%	0	0	27	152.1%	0	0	15	24.4%	0
Feb	28	12.30	4.92	0	2	0.7%	0	0	2	0.1%	0	16	1	-9.3%	0	7	2	-3.9%	0
Mar	31	5.54	2.22	0	3	2.5%	0	0	6	3.3%	0	8	14	13.2%	0	5	5	-0.1%	0
Apr	30	1.64	1.39	0	2	2.9%	0	0	7	3.6%	0	0	13	7.7%	0	0	3	0.6%	0
May	31	1.97	1.39	0	10	9.8%	0	0	9	7.7%	0	0	7	3.5%	0	0	5	4.3%	0
Jun	30	3.36	1.39	0	7	5.9%	0	0	10	9.4%	0	0	18	22.7%	0	0	6	1.4%	0
Jul	31	2.37	1.39	0	6	7.6%	0	0	9	7.9%	0	0	23	51.3%	0	0	4	1.6%	0
Aug	31	4.82	1.93	0	2	1.6%	0	0	6	5.4%	0	2	13	11.5%	0	2	4	-0.9%	0
Sep	30	2.26	1.39	0	7	9.9%	0	0	13	12.6%	0	0	18	26.1%	0	2	8	6.2%	0
Oct	31	5.22	2.09	0	11	6.3%	0	0	14	10.5%	0	4	14	15.6%	0	0	8	3.3%	0
Nov	30	1.26	1.26	0	19	22.4%	0	0	29	31.2%	0	0	30	94.3%	0	0	10	10.3%	0
Dec	31	0.50	0.50	0	23	35.4%	0	0	23	39.7%	0	0	31	203.7%	0	0	16	23.6%	0

Table B.2.8 Climate Change Adjusted North Driftwood River Flows – ND3 (Operations Phase 3 and Passive Closure)

		Baseline		Operations Phase 3 (Mine Years 30 to 41: Year 35)				Operations Phase 3 (Mine Years 30 to 41: Mine Year 41)				Passive Closure Phase (Mine Year 46 onward: Year 47)				Pit Filled			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
Month	Days in Month	Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.46	0.46	0	15	24.4%	0	0	13	16.3%	0	0	0	2.7%	0	0	0	2.7%	0
Feb	28	12.30	4.92	7	2	-3.9%	0	8	2	-4.1%	0	8	4	-1.8%	0	8	4	-1.8%	0
Mar	31	5.54	2.22	5	5	-0.1%	0	5	3	-1.1%	0	5	2	-1.1%	0	5	2	-1.1%	0
Apr	30	1.64	1.39	0	3	0.6%	0	0	2	-0.6%	0	0	2	-0.1%	0	0	2	-0.1%	0
May	31	1.97	1.39	0	5	4.3%	0	1	5	2.8%	0	1	4	3.9%	0	1	4	3.9%	0
Jun	30	3.36	1.39	0	6	1.4%	0	1	5	0.5%	0	0	3	-1.3%	0	0	3	-1.3%	0
Jul	31	2.37	1.39	0	4	1.6%	0	0	3	-0.1%	0	0	3	0.1%	0	0	3	0.1%	0
Aug	31	4.82	1.93	2	4	-0.9%	0	3	3	-2.2%	0	2	4	-1.7%	1	2	4	-1.7%	1
Sep	30	2.26	1.39	2	8	6.2%	0	2	5	3.2%	0	2	4	1.0%	0	2	4	1.0%	0
Oct	31	5.22	2.09	0	8	3.3%	0	2	7	1.1%	0	5	4	-1.7%	0	5	4	-1.7%	0
Nov	30	1.26	1.26	0	10	10.3%	0	0	7	5.5%	0	0	2	0.8%	0	0	2	0.8%	0
Dec	31	0.50	0.50	0	16	23.6%	0	0	14	15.1%	0	0	0	1.5%	0	0	0	1.5%	0

Table B.2.9 Climate Change Adjusted North Driftwood River Flows – ND5 (Construction Phase & Operations Phase 1 and 2)

		Baseline		Construction Phase (Mine Years -3 to -1: Year -1)				Operations Phase 1 (Mine Years 1 to 4: Year 2)				Operations Phase 1 and 2 (Mine Years 4 to 18: Year 17)				Operations Phase 2 (Mine Years 18 to 30: Year 23)			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
Month	Days in Month	Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.21	0.21	0	31	73.8%	0	0	23	94.1%	0	4	27	338.7%	4	3	28	138.0%	3
Feb	28	5.94	2.38	6	5	3.1%	3	10	3	-6.5%	9	27	1	-35.9%	13	22	2	-24.2%	13
Mar	31	2.41	0.96	4	19	20.5%	0	7	11	29.5%	4	15	16	150.2%	6	12	16	41.8%	6
Apr	30	0.45	0.45	0	7	15.1%	0	0	11	15.4%	0	16	13	38.8%	16	16	12	7.0%	16
May	31	1.15	0.63	0	12	21.8%	0	0	12	14.7%	0	20	8	8.4%	17	22	6	-9.1%	18
Jun	30	1.36	0.63	0	17	26.0%	0	0	28	34.2%	0	0	21	117.0%	0	0	16	32.3%	0
Jul	31	0.99	0.63	0	14	27.1%	0	0	19	26.9%	0	0	25	239.0%	0	2	20	66.7%	1
Aug	31	2.22	0.89	3	8	4.5%	0	4	15	11.0%	4	8	15	96.6%	0	7	12	21.6%	1
Sep	30	1.06	0.63	2	18	39.1%	0	0	18	40.4%	0	5	20	102.9%	5	9	13	42.0%	6
Oct	31	2.45	0.98	0	16	29.8%	0	0	21	42.3%	0	10	17	86.2%	0	10	14	35.5%	1
Nov	30	0.36	0.36	0	28	89.6%	0	0	30	136.1%	0	0	30	414.1%	0	0	30	162.5%	0
Dec	31	0.17	0.17	0	30	95.2%	0	0	24	106.2%	0	0	31	562.4%	0	0	31	215.7%	0

Table B.2.10 Climate Change Adjusted North Driftwood River Flows – ND5 (Operations Phase 3 and Passive Closure)

		Baseline		Operations Phase 3 (Mine Years 30 to 41: Year 35)				Operations Phase 3 (Mine Years 30 to 41: Mine Year 41)				Passive Closure Phase (Mine Year 46 onward: Year 47)				Pit Filled			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
Month	Days in Month	Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.21	0.21	0	15	52.8%	0	0	13	33.7%	0	0	0	4.3%	0	0	0	4.3%	0
Feb	28	5.94	2.38	20	3	-25.3%	13	19	3	-25.9%	13	18	4	-21.9%	13	18	4	-21.9%	13
Mar	31	2.41	0.96	10	10	12.0%	5	10	8	1.7%	5	14	2	-12.5%	9	14	2	-12.5%	9
Apr	30	0.45	0.45	11	6	1.4%	9	14	3	-4.9%	12	11	2	-3.7%	9	11	2	-3.7%	9
May	31	1.15	0.63	2	7	6.1%	0	4	6	3.8%	0	5	4	4.1%	0	5	4	4.1%	0
Jun	30	1.36	0.63	14	10	1.2%	10	16	9	-0.6%	9	19	5	-12.2%	13	19	5	-12.2%	13
Jul	31	0.99	0.63	11	4	-2.5%	10	14	3	-5.6%	10	12	3	-5.9%	8	12	3	-5.9%	8
Aug	31	2.22	0.89	17	6	-12.7%	11	19	5	-15.0%	11	19	5	-14.4%	11	19	5	-14.4%	11
Sep	30	1.06	0.63	7	10	17.7%	1	8	6	7.4%	2	9	4	-3.0%	4	9	4	-3.0%	4
Oct	31	2.45	0.98	11	13	12.6%	4	13	12	3.6%	5	18	4	-15.7%	12	18	4	-15.7%	12
Nov	30	0.36	0.36	7	13	34.5%	7	9	9	14.9%	8	10	2	-4.1%	8	10	2	-4.1%	8
Dec	31	0.17	0.17	5	15	60.7%	3	4	13	40.1%	1	4	0	1.5%	0	4	0	1.5%	0

Table B.2.11 Climate Change Adjusted North Driftwood River Flows – ND8 (Construction Phase & Operations Phase 1 and 2)

Month	Days in Month	Baseline		Construction Phase (Mine Years -3 to -1: Year -1)				Operations Phase 1 (Mine Years 1 to 4: Year 2)				Operations Phase 1 and 2 (Mine Years 4 to 18: Year 17)				Operations Phase 2 (Mine Years 18 to 30: Year 23)			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.16	0.16	0	31	96.1%	0	0	22	121.2%	0	4	26	442.8%	4	4	27	181.5%	4
Feb	28	4.54	1.82	12	5	6.1%	5	15	6	-9.8%	11	26	1	-40.1%	13	25	1	-23.1%	14
Mar	31	1.84	0.74	6	19	29.0%	2	7	12	39.7%	5	15	15	212.2%	7	14	15	64.8%	7
Apr	30	0.34	0.34	2	15	20.0%	0	5	11	20.1%	4	17	12	56.5%	17	17	13	13.7%	17
May	31	0.89	0.48	2	25	29.8%	0	0	13	20.4%	0	20	9	17.3%	17	21	5	-10.0%	18
Jun	30	1.05	0.48	1	19	37.4%	1	2	27	48.3%	2	1	22	177.8%	0	0	20	56.7%	0
Jul	31	0.75	0.48	0	19	36.9%	0	0	20	37.4%	0	2	26	329.5%	0	2	23	96.0%	1
Aug	31	1.68	0.67	5	10	6.4%	2	5	18	14.8%	5	8	18	150.4%	0	7	15	42.0%	0
Sep	30	0.81	0.48	3	22	54.2%	0	2	19	56.0%	0	7	20	145.3%	5	7	13	62.9%	7
Oct	31	1.87	0.75	3	16	42.8%	0	0	23	59.7%	0	9	19	136.2%	0	6	15	63.5%	0
Nov	30	0.27	0.27	0	27	119.2%	0	0	30	182.2%	0	0	30	562.0%	0	0	30	223.8%	0
Dec	31	0.13	0.13	0	30	124.9%	0	2	23	139.6%	0	0	31	748.1%	0	0	31	288.1%	0

Table B.2.12 Climate Change Adjusted North Driftwood River Flows – ND8 (Operations Phase 3 and Passive Closure)

Month	Days in Month	Baseline		Operations Phase 3 (Mine Years 30 to 41: Year 35)				Operations Phase 3 (Mine Years 30 to 41: Mine Year 41)				Passive Closure Phase (Mine Year 46 onward: Year 47)				Pit Filled			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.16	0.16	0	11	70.3%	0	0	7	44.3%	0	0	0	7.3%	0	0	0	7.3%	0
Feb	28	4.54	1.82	20	2	-23.5%	13	19	2	-24.4%	13	18	4	-19.0%	13	18	4	-19.0%	13
Mar	31	1.84	0.74	10	9	24.7%	6	11	7	11.4%	6	13	2	-9.0%	9	13	2	-9.0%	9
Apr	30	0.34	0.34	10	6	6.9%	8	13	3	-1.3%	10	6	2	0.2%	4	6	2	0.2%	4
May	31	0.89	0.48	2	7	10.5%	0	4	6	7.7%	0	5	4	6.0%	0	5	4	6.0%	0
Jun	30	1.05	0.48	15	12	12.0%	10	17	10	9.7%	10	18	6	-8.4%	13	18	6	-8.4%	13
Jul	31	0.75	0.48	9	4	3.3%	8	12	3	-0.5%	9	10	3	-2.3%	6	10	3	-2.3%	6
Aug	31	1.68	0.67	16	8	-8.6%	11	18	6	-11.6%	12	19	5	-11.6%	10	19	5	-11.6%	10
Sep	30	0.81	0.48	7	12	29.0%	1	8	7	15.3%	2	10	6	-0.8%	5	10	6	-0.8%	5
Oct	31	1.87	0.75	8	15	29.2%	2	12	12	16.7%	5	16	5	-13.0%	11	16	5	-13.0%	11
Nov	30	0.27	0.27	8	13	51.8%	6	9	8	26.0%	7	8	10	-0.2%	6	8	10	-0.2%	6
Dec	31	0.13	0.13	3	14	82.7%	1	4	12	57.5%	1	3	10	5.6%	0	3	10	5.6%	0

Table B.2.13 Climate Change Adjusted North Driftwood River Flows – ND18 (Construction Phase & Operations Phase 1 and 2)

Month	Days in Month	Baseline: Mean Monthly Flows – Flows (m^3/s)	Baseline: Environmental Flows – Flows (m^3/s)	Construction Phase (Mine Years -3 to -1: Year -1) Daily Flows: Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Operations Phase 1 (Mine Years 1 to 4: Year 2) Daily Flows: Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Operations Phase 1 and 2 (Mine Years 4 to 18: Year 17) Daily Flows: Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Operations Phase 2 (Mine Years 18 to 30: Year 23) Daily Flows: Days of -10% Change from Baseline (No.)	Days of +10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.02	0.02	0	0	-2.2%	0	0	0	-2.2%	0	0	31	186.7%	0	0	31	63.3%	0
Feb	28	0.66	0.26	16	2	-17.5%	11	16	2	-17.5%	11	0	28	88.7%	0	0	28	47.3%	0
Mar	31	0.27	0.11	10	1	-11.6%	6	10	1	-11.6%	6	0	31	140.9%	0	0	31	55.5%	0
Apr	30	0.05	0.05	6	1	-6.0%	4	6	1	-6.0%	4	0	30	154.8%	0	0	30	58.0%	0
May	31	0.14	0.07	6	2	-5.7%	1	6	2	-5.7%	1	0	31	140.7%	0	0	31	56.2%	0
Jun	30	0.15	0.07	16	3	-10.7%	12	16	3	-10.7%	12	0	30	108.8%	0	0	30	51.5%	0
Jul	31	0.11	0.07	9	1	-6.3%	5	9	1	-6.3%	5	0	31	149.3%	0	0	31	58.1%	0
Aug	31	0.24	0.10	18	2	-12.9%	10	18	2	-12.9%	10	0	31	103.0%	0	0	31	51.0%	0
Sep	30	0.12	0.07	10	2	-6.9%	5	10	2	-6.9%	5	0	30	146.2%	0	0	30	57.5%	0
Oct	31	0.27	0.11	19	2	-15.4%	14	19	2	-15.4%	14	0	31	98.9%	0	0	31	49.0%	0
Nov	30	0.04	0.04	8	1	-4.8%	6	8	1	-4.8%	6	0	30	193.3%	0	0	30	63.9%	0
Dec	31	0.02	0.02	5	0	-4.3%	2	5	0	-4.3%	2	0	31	229.5%	0	0	31	68.0%	0

Table B.2.14 Climate Change Adjusted North Driftwood River Flows – ND18 (Operations Phase 3 and Passive Closure)

Month	Days in Month	Baseline		Operations Phase 3 (Mine Years 30 to 41: Year 35)				Operations Phase 3 (Mine Years 30 to 41: Mine Year 41)				Passive Closure Phase (Mine Year 46 onward: Year 47)				Pit Filled			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows				Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of -10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.02	0.02	0	31	63.3%	0	0	31	63.3%	0	0	31	63.3%	0	0	31	63.3%	0
Feb	28	0.66	0.26	0	28	47.3%	0	0	28	47.3%	0	0	28	47.3%	0	0	28	47.3%	0
Mar	31	0.27	0.11	0	31	55.5%	0	0	31	55.5%	0	0	31	55.5%	0	0	31	55.5%	0
Apr	30	0.05	0.05	0	30	58.0%	0	0	30	58.0%	0	0	30	58.0%	0	0	30	58.0%	0
May	31	0.14	0.07	0	31	56.2%	0	0	31	56.2%	0	0	31	56.2%	0	0	31	56.2%	0
Jun	30	0.15	0.07	0	30	51.5%	0	0	30	51.5%	0	0	30	51.5%	0	0	30	51.5%	0
Jul	31	0.11	0.07	0	31	58.1%	0	0	31	58.1%	0	0	31	58.1%	0	0	31	58.1%	0
Aug	31	0.24	0.10	0	31	51.0%	0	0	31	51.0%	0	0	31	51.0%	0	0	31	51.0%	0
Sep	30	0.12	0.07	0	30	57.5%	0	0	30	57.5%	0	0	30	57.5%	0	0	30	57.5%	0
Oct	31	0.27	0.11	0	31	49.0%	0	0	31	49.0%	0	0	31	49.0%	0	0	31	49.0%	0
Nov	30	0.04	0.04	0	30	63.9%	0	0	30	63.9%	0	0	30	63.9%	0	0	30	63.9%	0
Dec	31	0.02	0.02	0	31	68.0%	0	0	31	68.0%	0	0	31	68.0%	0	0	31	68.0%	0

Table B.2.15 Jocko Creek Flows – JC_DS (Operations)

Month	Days in Month	Baseline		Operations Phase 1 and 2 (Mine Years 4 to 18: Year 17)				Operations Phase 2 (Mine Years 18 to 30: Year 23)			
		Mean Monthly Flows	Environmental Flows	Daily Flows				Daily Flows			
		Flows (m^3/s)	Flows (m^3/s)	Days of - 10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)	Days of - 10% Change from Baseline (No.)	Days of + 10% Change from Baseline (No.)	Average Percent Difference with Baseline (%)	Number of Days With -10% Change from Baseline and Below Environmental Flow (No.)
Jan	31	0.48	0.48	0	17	14.6%	0	0	0	1.3%	0
Feb	28	3.56	1.42	0	1	1.2%	0	0	0	-0.7%	0
Mar	31	2.23	0.89	0	0	2.5%	0	0	0	-0.3%	0
Apr	30	0.43	0.43	0	16	11.9%	0	0	0	1.0%	0
May	31	0.84	0.52	0	17	14.6%	0	0	0	1.2%	0
Jun	30	1.34	0.54	0	0	3.1%	0	0	0	-0.3%	0
Jul	31	0.89	0.52	0	11	8.1%	0	0	0	0.4%	0
Aug	31	1.90	0.76	0	0	2.3%	0	0	0	-0.5%	0
Sep	30	0.88	0.52	0	11	8.5%	0	0	0	0.4%	0
Oct	31	2.08	0.83	0	0	2.4%	0	0	0	-0.5%	0
Nov	30	0.59	0.52	0	14	11.8%	0	0	0	1.0%	0
Dec	31	0.27	0.27	0	25	20.6%	0	0	0	2.4%	0

Table B.2.16 Baseline and Mine Phase Subwatershed Flood Flows

Subbasin ID	Baseline	Construction Phase (Mine Years -3 to -1: Year -1)	Operations Phase 1 (Mine Years 0 to 4: Year 2)	Operations Phase 1 and 2 (Mine Years 4 to 18: Year 4)	Operations Phase 2 (Mine Years 18 to 30: Year 23)	Operations Phase 3 (Mine Years 30 to 41: Year 35)	Operations Phase 3 (Mine Years 30 to 41: Mine Year 41)	Passive Closure Phase (Mine Year 46 onward: Year 47)
	Q_{100} (m^3/s)	Phase Q_{100} (m^3/s)	Phase Q_{100} (m3/s)	Phase Q_{100} (m^3/s)	Phase Q_{100} (m^3/s)	Phase Q_{100} (m^3/s)	Phase Q_{100} (m^3/s)	Phase Q_{100} (m^3/s)
JC_DS	109.64	109.64	109.64	108.33	108.33	108.33	108.33	108.33
ND1	383.29	377.95	379.88	335.25	359.04	373.47	373.47	382.72
ND3	277.41	272.06	273.99	229.36	253.15	267.58	267.58	276.83
ND5	124.63	119.28	121.21	76.58	100.37	114.80	114.80	124.05
ND8	95.49	90.13	92.06	50.49	50.49	50.49	50.49	50.49
ND18	13.93	13.47	13.47	**21.72**	**45.52**	**45.52**	**45.52**	**45.52**
WB1	524.06	496.98	494.15	493.70	493.70	512.78	512.78	516.63
WB5	222.24	195.16	192.33	191.88	191.88	210.96	210.96	214.81
WB9	175.47	161.19	160.20	160.24	160.24	160.24	160.24	160.24
WB14	141.74	140.87	140.87	140.87	140.87	140.87	140.87	140.87

Notes: **BOLD** – Q_{100} flow value is above baseline

Appendix C Assimilative Capacity Study

Crawford Nickel Project: Assimilative Capacity Study

September 30, 2024

Prepared for:

Canada Nickel Company

Prepared by:

Stantec Consulting Ltd.

Limitations and Sign-off

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Table of Contents

List of Tables

List of Appendices

Acronyms and Abbreviations

7Q20	7-day low flow, 20-year return period
AC	assimilative capacity
ACS	Assimilative Capacity Study
CCME	Canadian Council of Ministers of the Environment
CWQG-FAL	Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life
FDP	Final Discharge Point
MAF	Mean Annual Flow
MDMER	Metal and Diamond Mining Effluent Regulations
PA	Project Area
PoPC	Parameters of Potential Concern
PWQO	Provincial Water Quality Objectives
RDL	reportable detection limit
SSP	Shared Socioeconomic Pathway
TMF	Tailings Management Facility
TSS	Total Suspended Solids

1 Introduction

Canada Nickel Company (Canada Nickel) proposes to develop, operate, and progressively reclaim the Crawford Nickel Project (‘the Project’), a new open pit nickel mine and processing facility approximately 42 kilometres (km) north of Timmins, Ontario along Highway 655. The Project is being assessed in accordance with the *Impact Assessment Act*, 2019.

Stantec Consulting Ltd. (Stantec) has been retained by Canada Nickel to conduct an assessment of surface water resources for the Project. This report provides an assessment of assimilative capacity (AC) to determine the impact on the receivers of the treated mine effluent and seepage/groundwater discharge during mine operations and pit lake discharge during the decommissioning and closure of the Project.

The Assimilative Capacity Study (ACS) was conducted to estimate the water quality of watercourses receiving treated discharges to the Project Final Discharge Points (FDPs). The assessment was conducted in a near-field mixing zone and in a far-field mixing zone, extending downstream through the North Driftwood River and the West Buskegau River as the receivers. The effects of seepage/groundwater discharge from the Project Area (PA) on Jocko Creek were also assessed. The ACS was conducted under both regulatory and normal discharge scenarios in the study watersheds: the North Driftwood River, the West Buskegau River, and Jocko Creek. Regulatory construction/operation conditions are considered worst-case and conservative, whereas normal construction/operation conditions represent average expected conditions adjusted for climate change. Effluent quality limits and objectives are derived based on regulatory conditions using the Metal and Diamond Mining Effluent Regulations (MDMER), the Provincial Water Quality Objectives (PWQOs; MOEE 1994b), and when no PWQO guideline exists for a water quality parameter, the Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CWQG-FAL; Canadian Council of Ministers of the Environment [CCME] 2003) are used.

For both regulatory and normal conditions, two phases of mine operations were assessed, which are referred to in this report as ‘Construction/Operation’ and ‘Pit-Full’. The former is related to Project activities during the Project lifetime between Mine Year -3 (construction) and Mine Year 41 (end of operations phase 3), whereas the latter is related to when the mine is decommissioned, and the pit lake is full. This case was simulated for Mine Year 167 when the pit overflows. Assessments were made for a set of Parameter of Potential Concerns (PoPCs) identified as the following:

- receiving water parameters whose baseline 75th percentile exceeds the PWQO or CWQG-FAL
- Project groundwater seepage water quality parameters whose simulated maximum concentration exceed the PWQOs or CWQG-FALs
- the GoldSim^{TM} water quality model predictions for FDPs without treatment with maximum simulated concentrations exceeding the PWQO or CWQG-FAL.

The ACS results for non-PoPCs were assessed and are presented in Appendix C of this report.

Input parameters for the two discharge conditions and the two phases of mine operation assessed in this study are as follows:

- Regulatory Construction/Operation Conditions:
  - Receiver flow: 7Q20 flow (7-day low flow, 20-year return period) derived based on regression analysis adjusted for climate change (Shared Socioeconomic Pathway [SSP]2-4.5 for the time period 2071-2100)
  - Receiver water quality: 75th percentile of baseline concentrations
  - Effluent flow for Construction/Operation: Maximum mine effluent flow rate, assigned as the water treatment plant's rated capacity
  - Effluent flow for Pit-Full: The lowest predicted 7-day average low flow adjusted for climate change from the pit lake in Mine Year 167 into receiving watercourses by the GoldSim™ water balance model (Appendix I of the Impact Statement [Crawford Site-Wide Water Balance Summary Report]). The full pit lake will respond to the same climatic conditions as the local receiving waters. To assess low flow conditions in the receivers, the same climatic conditions would apply to the pit lake overflow and thus the pit lake flow was also set in this case as the lowest water balance model predicted 7-day average low flow.
  - Effluent water quality for Construction/Operation: Maximum daily concentrations at FDPs after treatment during the Project lifetime. Effluent daily concentration limits were developed iteratively between the AC of the local receivers and the limits recommended by treatment technology suppliers.
  - Effluent water quality for Pit-Full: Maximum concentrations in pit lake discharge when the pit is full, simulated by GoldSim™ (Appendix K of the Impact Statement [Water Quality Assessment]).
  - Seepage loads out of the mine to local receivers for both Construction/Operation and Pit-Full: Multiplication of the maximum seepage flow rate and maximum concentrations in the respective phases, simulated by FlowSource (Appendix C.4 of the Impact Statement [Groundwater Assessment]) and GoldSim™ (Appendix K of the Impact Statement [Water Quality Assessment]).
- Normal Construction/Operation Conditions
  - Receiver flow: Mean Annual Flow (MAF) in the receiving watercourses derived based on regression analysis adjusted for anticipated climate change
  - Receiver water quality: Mean concentrations for baseline water quality in the receiving watercourses
  - Effluent flow for Construction/Operation: Average effluent flow rate simulated by the GoldSim™ water balance model adjusted for anticipated climate change (Appendix I of the Impact Statement [Crawford Site-Wide Water Balance Summary Report]).

- Effluent flow for Pit-Full: Average annual discharge from pit lake when it is full simulated by the GoldSim™ water balance model adjusted for anticipated climate change (Appendix I of the Impact Statement [Crawford Site-Wide Water Balance Summary Report]).
- Effluent water quality for Construction/Operation: Target effluent objective at FDPs after treatment. If the target effluent objective for a parameter is higher than the maximum of the average concentrations in the sedimentation ponds, the maximum of the average concentrations in ponds is used.
- Effluent water quality for Pit-Full: Mean concentrations in the discharge from pit lake when it is full
- Seepage loads out of the mine to local receivers for both Construction/Operation and Pit-Full: Multiplication of the average seepage flow rate and average concentrations in the respective phases, simulated by FlowSource (Appendix C.4 of the Impact Statement [Groundwater Assessment]) and GoldSim™ (Appendix K of the Impact Statement [Water Quality Assessment]).

The main goal in the ACS is to determine the extent of the mixing zone based on the resulting concentrations when effluent, seepage and receiver flows are fully mixed near the FDPs and further downstream in ultimate receivers. The mixing zone is defined by the Ministry of the Environment, Conservation and Parks (MECP) as “an area of water contiguous to a point source or definable non-point source where the water quality does not comply with one or more of the Provincial Water Quality Objectives” (MOEE 1994a). Conditions within a mixing zone must not result in irreversible environmental damage, risk to ecosystem integrity or risk to human health (MOEE 1994a). Conditions within the mixing zone should not result in bioconcentration of toxic materials which are harmful to organisms or their consumer (MOEE 1994a).

The near-field mixing model CORMIX (Version 12.0) was used to identify the point of full mixing downstream of FDPs. CORMIX, as a 3D effluent mixing model, has limited predictive capability for far-field mixing zones. As Project effluent mixing zones are expected to extend beyond the CORMIX model boundary, CORMIX was used to predict the point in the mixing zone where the effluent and receiver are fully mixed. Beyond the CORMIX boundary, a mass balance assessment was used to determine the extent of the mixing zone and concentrations at the edge of full mixing and further downstream to the edge of the mixing zone. The mass balance analysis is detailed in Section 6.2 of this report.

Procedure B-1-5 of Water Management (MOEE 1994a) indicates that mixing zones are not to be used as an alternative to reasonable and practical water treatment. Thus, the mixing zone was developed based on reasonable and practical water treatment and receiving water AC.

2 Project Settings

The PA encompasses the Project footprint and is the anticipated area of physical disturbance associated with the construction, operations, and decommissioning and closure of the Project. The PA includes the Open Pit, Stockpiles, Impoundment Facility, Tailings Management Facility (TMF), two ore Processing Plants, and other mine-related infrastructure, as well as a new rail spur line and the relocation of Highway 655 and an existing 500 kV transmission line. Figure A.1 in Appendix A shows the extent of the Project Area, different components of the Project, as well as sedimentation ponds that receive contact water to allow for flow attenuation and water quality treatment prior to discharge to the environment at the respective FDP locations.

The Site-Wide Water Management Plan (Appendix J of the Impact Statement) undertaken by Ausenco Sustainability ULC (Ausenco), presents the sequencing for construction, operations, and decommissioning and closure phases. The schematics of the Site-Wide Water Management Plan sequencing in different phases are illustrated in Figure A.2 (a-e) (Appendix A). Contact water from the Impoundment Facility (waste rock, sand/till, clay), stockpiles (east/west, overburden, reclaim stockpiles), TMF, and the Process Plant Area will be collected in ditches and conveyed to one of the five collection ponds, named as Collection Pond 1, Collection Pond 2, Collection Pond 3, NE TMF Collection Pond, and NW TMF Collection Pond. A temporary sedimentation pond is operational in the construction and early operations phase. Despite the sequencing of the construction and implementation of the sedimentation ponds and their respective FDPs throughout the project life, the focus of this ACS in the construction/operations scenario is when the five collection ponds (Collection Pond 1, Collection Pond 2, Collection Pond 3, NE TMF Collection Pond, and NW TMF Collection Pond) discharge to receivers via treatment plants. Among phases presented in Figure A.2 (Appendix A) that cover the Project between Mine Year -3 (Construction) and Mine Year 41 (End of operations phase 3), the Construction/Operation scenario in the present ACS represents the conservative discharge condition during the part of operations phase 2 (Mine Year 5 to 23) when five sedimentation ponds are in operation. In the Pit-Full case where the five sedimentation ponds are naturalized, the focus is on the mixing of the discharge from the pit lake, when it is full, with the receiver flow.

The Project for the construction/operation scenario will have four FDPs during a part of operations phase 2 (Mine Year 5 to 23) to provide zonal water management. The North Driftwood River receives discharge from two FDPs (TMF Collection Ponds upstream receive water from NE TMF Collection Pond and NW TMF Collection Pond and from Collection Pond 2 discharging downstream). Two FDPs (Collection Pond 3 upstream and Collection Pond 1 discharging downstream) discharge to the West Buskegau River. The effluent flow diagram and the respective receivers are shown in Figure A.3 (Appendix A).

3 Receiving Environment

3.1 Hydrology

A description of local hydrological conditions has been provided in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement). For this ACS, the hydrology of the West Buskegau River and the North Driftwood River, as the watercourses that receive effluent from FDPs, is considered. Moreover, the hydrology of Jocko Creek is considered as this watercourse impacted by seepage from the mine. Two climatic conditions were considered: regulatory (or dry) discharge and climate normal (or average) conditions. Regional regression models, as presented in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement), were used to estimate the natural flow contribution from the receivers' watershed area. The low flow statistic 7Q20 (the minimum 7-day average low flow with a recurrence period of 20 years) was used to represent conservative dry conditions in accordance with MECP Procedure B-1-5 (MOEE 1994a). The 7Q20 regression models were used to estimate low flows as a function of drainage area. Similarly, the expected normal condition was based on the MAF regression relationship. Table 3.1 provides 7Q20 and MAF statistics for receivers (the West Buskegau River and the North Driftwood River) at the four FDP locations, as well as the pourpoint of the Jocko Creek watershed.

Table 3.1 Flow Statistics for Receivers

FDPs	Receiver	Watershed Area, km^2	MAF, L/s	7Q20, L/s
FDP-SP-01	West Buskegau River	158	2,130	224
FDP-SP-02	North Driftwood River	32.3	451	59
FDP-SP-03	West Buskegau River	150	2,020	215
FDP-TMF-SP	North Driftwood River	20.4	290	40
n/a	Jocko Creek	108.3	1,471	163

3.2 Baseline Water Quality Data

Local water quality is characterized in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement). For this ACS, the 75th percentile water quality at the ultimate receivers was considered for regulatory conditions, while mean water quality was considered for climate normal conditions. Table 3.2 presents the mean and 75th percentile concentrations of water quality parameters in the West Buskegau River, the North Driftwood River, and Jocko Creek, respectively. For parameters where the concentration of more than 50% of samples falls below the detection limit, the detection limit was used to characterise both the mean and 75th percentile water quality of the receiver. As described in the Stantec Surface Water Resources Baseline Report (2024), results below the reportable detection limit (RDL) were processed based on guidance in Guidelines for Quality Assurance and Quality Control in Surface Water Quality Programs in Alberta (Mitchell 2006). When more than 50% of results were below the RDL, summary statistics were not calculated, except for the maximum parameter values. For such parameters, the RDL value was selected as the 75th percentile and mean receiver quality value as a conservative case. Total iron, dissolved aluminum, and total phosphorus were identified as PoPCs in receivers because their 75th percentile concentrations exceed the PWQO values when data from the three watercourses within the Project Area (Jocko Creek, North Driftwood River, and West Buskegau River) are combined (Appendix B.6 of the Impact Statement [Surface Water Resources Baseline Report]). In addition, the 75th percentile concentration value of total aluminum exceeded the CWQG-FAL value.

Table 3.2 Baseline Water Quality Data in the West Buskegau River, the North Driftwood River, and Jocko Creek

Parameter	Units	Detection Limit	North Driftwood River Watershed		West Buskegau River Watershed		Jocko Creek Watershed	
			Mean	75th Percentile	Mean	75th Percentile	Mean	75th Percentile
Total Aluminum	µg/L	1	187	260	440	598	304	324
Dissolved Aluminum (0.2 µm, clay-free)	µg/L	1	56	86	107	133	65	75
Total Antimony*	µg/L	0.1	-	-			-	-
Total Arsenic	µg/L	0.1	0.6	0.9	0.9	1.1	0.7	0.8
Barium	µg/L	0.1	8.3	9.5	8.3	9.5	7.3	7.6
Total Boron*	µg/L	2	-	-	-	-	-	-
Total Beryllium*	µg/L	0	-	-	-	-	-	-
Total Bismuth*	µg/L	0.1	-	-	-	-	-	-
Bromine	mg/L	-	-	-	-	-	-	-
Calcium	µg/L	50	17,751	24,500	10,606	15,700	13,569	15,500
Total Cadmium	µg/L	0	0.02	0.03	0.039	0.05	0.042	0.05
Chloride	µg/L	200	2,900	4,200	300	400	6,300	4,600
Chromium III	µg/L	-	-	-	-	-	-	-
Chromium VI	µg/L	-	-	-	-	-	-	-
Total Cobalt	µg/L	0.1	0.3	0.3	0.3	0.4	0.2	0.2
Total Copper	µg/L	0.2	1.2	1.5	1.7	2.2	2.3	2
Total Iron	µg/L	10	503	644	823	1075	560	580
Total Lead	µg/L	0.1	0.28	0.33	0.47	0.59	0.41	0.5
Total Lithium*	µg/L	1	-	-	-	-	-	-
Total Magnesium	µg/L	4	4,526	5,300	2,668	3,590	3,109	3,630
Total Manganese	µg/L	4	66.6	83.3	68.2	75.5	39.5	52.3
Dissolved Manganese	µg/L	0.1	46.4	51.1	50.8	59.2	25.8	38.1
Mercury (Trace)	µg/L	0.01	2.47	3.45	4.77	6.45	3.86	4.91

Parameter	Units	Detection Limit	North Driftwood River Watershed		West Buskegau River Watershed		Jocko Creek Watershed	
			Mean	75th Percentile	Mean	75th Percentile	Mean	75th Percentile
Total Molybdenum*	µg/L	0.1	-	-	-	-	-	-
Total Nickel	µg/L	0.5	0.8	0.9	1	1.4	0.9	1
Total Phosphorus	µg/L	2	23	27	28	37	21	23
Potassium	µg/L	50	488	700	315	438	447	490
Total Selenium	µg/L	0.1	0.13	0.15	0.12	0.15	0.19	0.17
Total Silver*	µg/L	0	-	-	-	-	-	-
Sodium	µg/L	50	1,817	2,860	1,07 8	1,565	4,359	4,220
Total Strontium	µg/L	0.2	27.6	32.6	21	29.6	24.9	23.9
Total Tin*	µg/L	0.1	-	-	-	-	-	-
Total Titanium	µg/L	0.3	6.2	8	14.4	21	10.7	10.9
Total Thallium*	µg/L	0	-	-	-	-	-	-
Total Tungsten*	µg/L	0.1	-	-	-	-	-	-
Total Uranium	µg/L	0	0.03	0.04	0.04	0.07	0.04	0.06
Total Vanadium	µg/L	0.5	0.7	0.8	1.09	1.6	0.8	0.9
Total Yttrium*	µg/L	1	-	-	-	-	-	-
Dissolved Zinc	µg/L	1	5	6	6	7	7	9
Total Zinc	µg/L	1	6	7	7	8	8	10
Nitrite (as N)*	µg/L	10	-	-	-	-	-	-
Nitrate (as N)*	µg/L	20	-	-	-	-	-	-
Un-ionized Ammonia (as N)	µg/L	-	-	-	-	-	-	-
Sulphate	µg/L	300	800	1,000	800	900	6.9	3.7
Fluoride*	µg/L	50	-	-	-	-	-	-

Notes:

* Receiver concentrations was set to detection limit in mass balance assessments

4 Mine Seepage to Receivers

Groundwater seepage from various mine areas can impact the water quality in the receivers, therefore, seepage quantity and quality are considered in this ACS.

4.1 Seepage Flow Rates

A description of the fate of seepage through different components of the mine has been provided in the Groundwater Assessment (Appendix C.4 of the Impact Statement). The fate of seepage was estimated using FlowSource in forward mode to predict the discharge location and flux from each source. The seepage flows predicted to be below 1 m^3/day were set at a flow rate of 0 m^3/day. Seepage flow rates to surface water features within the Local Study Area are shown in Table 4.1, which were obtained from Section 7.2 of the Groundwater Assessment (Appendix C.4 of the Impact Statement). Surface water features include Jocko Creek, the North Driftwood River, the West Buskegau River, as well as eight lakes that are referred to in this report as L1 to L8. L1 is an unnamed lake south of Zed Lake, L2 is Zed Lake, L3 is Mel Lake, L4 is Sutherland Lake, L5 is Jack Lake, L6 is Gerry Lake, L7 is Martin Lake, and L8 is unnamed lake west of stockpile. L1 and L2 flow into Jocko Creek. L3-L8 flow into the North Driftwood River.

For the Construction/Operation case, under regulatory conditions, the highest seepage rate between the Year 15 and Year 30 values was considered. Under normal conditions, it was assumed that Year 30 data represented seepage rates from Mine Year 23 (TMF rehabilitated) until Mine Year 41 (end of operations). A weighted average of Year 15 and Year 30 rates was calculated and considered for the construction/operations case. The weights were specified based on the time length associated with each set of seepage data. For the Pit-Full case, the passive closure phase seepage rates, shown in Table 4.1, were used for both regulatory and normal conditions. In the mass balance assessments explained in Section 6.2, seepage flow and effluent discharge are mixed with receiver flow, while the travel time effect of groundwater is ignored. Section 6.2 provides further detail, noting that mass balance assessments require seepage rates at the subwatershed scale as inputs. These small-scale seepage rates were obtained from groundwater modelling and are provided in Table B.1.1.1 of Appendix B of this report. The summation of subwatershed scale seepage rates within a particular watershed is equal to the respective number shown in Table 4.1.

Table 4.1 Fate of Seepage From TMF, Impoundment Facility, and Stockpiles

Surface Water Feature	Lake ID	Predicted Groundwater Discharge Rate of Seepage Originating from Project Infrastructure (m³/d)											
		TMF			Impoundment Facility			Stockpiles			Tailings Impounded in Pit Lake		
		Year 17	Year 30	Pit-Full	Year 17	Year 30	Pit-Full	Year 17	Year 30	Pit-Full	Year 17	Year 30	Pit-Full
Jocko Creek	-	2,256	199	-	-	-	-	-	-	-	-	103	-
North Driftwood River	-	-	-	-	194	20	538	-	-	-	-	508	-
West Buskegau River	-	2,090	125	-	105	-	435	-	5	-	-	2	-
Unnamed Lake (South of Zed Lake)	L1	1,503	39	208	-	-	-	-	-	-	-	-	-
Zed Lake	L2	43	-	-	-	-	-	-	-	-	-	-	-
Mel Lake	L3	1,099	-	58	-	-	-	-	-	-	-	94	-
Sutherland Lake	L4	155	-	2	-	-	-	-	-	-	-	13	-
Jack Lake	L5	58	-	-	-	-	-	-	-	-	-	-	-
Gerry Lake	L6	1,453	-	528	-	-	-	-	-	-	-	207	2
Martin Lake	L7	-	-	16	-	-	-	-	-	-	-	-	6
Unnamed Lake (near the West Stockpile)	L8	-	-	12	-	324	5	-	-	-	-	-	22

4.2 Seepage Water Quality

The estimated seepage quality was provided by Lorax Environmental Services Ltd. (Lorax) in the Water Quality Assessment (Appendix K of the Impact Statement), where time series of parameter concentrations were given as a function of Mine Years (Appendix K of the Impact Statement [Water Quality Assessment]). Maximum concentrations between the start of the construction phase (Mine Year -3) and the end of operations phase 3 (Mine Year 41) were used to identify PoPCs in groundwater for the Construction/Operation case for parameters with available PWQO values and CWQG-FAL values when PWQO values do not exist. Maximum concentrations were also used in the mass balance assessment under regulatory conditions, as detailed in Section 6.2. Under normal conditions, consistent with seepage flow rates, weighted average concentrations were used in the mass balance assessment. Table B.1.2.1 in Appendix B of this report presents maximum concentrations for the parameters included in model simulations provided by Lorax (Appendix K of the Impact Statement [Water Quality Assessment]). Among those parameters, the following were identified as PoPCs: chloride, nitrate (as nitrogen), nitrite (as nitrogen), un-ionized ammonia (as nitrogen), fluoride, chromium (VI), arsenic, boron, cobalt, copper, uranium, vanadium, zinc, and phosphorus. These PoPCs exceeded PWQO and/or CWQG-FAL values for seepage either from the TMF, the Impoundment Facility, or the ore stockpiles. The predicted quality of seepage from the TMF, the Impoundment Facility, and East and West Stockpiles does not exceed the MDMER values.

For the Pit-Full case, groundwater seepage quality related to the reclaimed Impoundment Facility, reclaimed TMF, and tailings in the pit was considered. Pit-Full water quality concentrations were also provided by water quality model results (Appendix K of the Impact Statement). Table B.1.2.1 in Appendix B of this report shows concentrations in groundwater seepage from the Impoundment Facility. Moreover, the same concentrations as the Construction/Operation case were assumed for seepage quality from the reclaimed TMF, with the same values applied to seepage from tailings stored in the pit.

5 Effluent Discharge and Water Quality

5.1 Effluent Flows

5.1.1 Construction/Operation Case

The expected effluent flow rates from each pond were provided by Ausenco in the Crawford Site-Wide Water Balance Summary Report (Appendix I of the Impact Statement). The maximum discharge was specified as the nameplate flow rate of the water treatment plants. Average flow rates were calculated based on the monthly time series of discharge provided in the Site-Wide Water Management Plan results (Appendix J of the Impact Statement). Maximum flow rates were used for the ACS under the conservative climatic conditions of the regulatory scenario, whereas average flow rates were used in normal conditions. Table 5.1 shows the maximum and average effluent flows at different management ponds at their respective FDPs. Maximum flow rates were used to represent the conservative regulatory scenario for assessing the extent of mixing zones. The FDP-TMF-SP will operate following the temporary construction pond (FDP-SP-TEMP_01) and will receive higher flows from two ponds (NE-TMF-SP and NW-TMF-SP) as such the FDP-TMF-SP represents the more conservative discharge scenario for the North Driftwood River. Climate change adjusted climate normal discharge from the ponds/treatment plants was used to determine effects of normal conditions on the extent of mixing zones. Climate change adjusted precipitation and temperature data using a climate normal for the time period 2071-2100 were generated based on the SSP2-4.5 emissions scenario for the water balance (Appendix B.6 of the Impact Statement [Surface Water Resources Baseline Report]). This climate change adjusted climate normal period was chosen to provide conservative model results.

Table 5.1 Pond/Treatment Plant Flow Rates at FDPs (Construction/Operation)

Pond	FDP	Conservative (Maximum Flow Rate) (Appendix I of the Impact Statement)	Climate Change Adjusted Climate Normal (Mean Flow Rate) (Appendix J of the Impact Statement)
		FDP Flow Rate (L/s)	
SP-01	FDP-SP-01	324	316
SP-02	FDP-SP-02	324	191
SP-03	FDP-SP-03	120	36
NE-TMF-SP	FDP-TMF-SP	648	422
NW-TMF-SP			

5.1.1.1 Sanitary Sewage

During the operations phases (1 to 3), a package sewage treatment system will treat sanitary sewage waste from the office and administrative buildings, and mine dry, which will either discharge to one of the sedimentation ponds where it will undergo additional treatment prior to release via an FDP or discharge immediately adjacent to an FDP to a receiver. A maximum of 1,371 full-time equivalents are expected for staff (Chapter 3 of the Impact Statement [Project Description]). The O.Reg. 332/12 Building Code in Table 8.2.1.3.B for factories (excluding process or cleaning waters) and including showers recommends a daily volume of 125 L be used for sewage system design flows. This equates to a maximum daily volume of 171,375 L/d. A conservative 15% increase is applied to the maximum daily wastewater flow rate for the ACS (200,000 L/d).

5.1.2 Pit-Full Case

The daily time series of the discharge from the pit, when full, was provided in the Site-Wide Water Management Plan (Appendix J of the Impact Statement). The lowest 7-day average low flow and the average discharge in Mine Year 167 were estimated to represent the flow from the pit during regulatory and normal conditions, respectively, as shown in Table 5.2.

Table 5.2 Pit Lake Discharge Flow Rates to Receivers (Pit-Full)

Receiver	Conservative (Climate Change Adjusted Lowest 7-day Average Low Daily Flow in Mine Year 167) (Appendix J of the Impact Statement)	Climate Change Adjusted Climate Normal (Mean Daily Flow Rate in Mine Year 167) (Appendix J of the Impact Statement)
	Flow Rate (L/s)	
West Buskegau River	10.4	29.2
North Driftwood River	5.8	37.8

5.2 Effluent Quality

5.2.1 Construction/Operation Case

The effluent water quality at each FDP at different stages of mine operation was simulated using a GoldSim^{TM} model (Appendix K of the Impact Statement [Water Quality Assessment]). Water quality predictions were provided in both total and dissolved forms. Table B.2.1.1 in Appendix B of this report provides the maximum concentrations for parameters included in the water quality model. Dissolved concentrations are shown only for parameters with available regulatory objectives/guidelines for the dissolved form, which include aluminum, zinc, and manganese. Maximum concentrations for both total and dissolved parameters were used to identify PoPCs – based on available PWQO values for the effluent of each sedimentation pond. When there was no PWQO guideline for a water quality parameter, the CWQG-FAL values were used in the comparative assessment. Both total and dissolved guideline values were considered. Comparisons against guideline values observed PoPCs, which appear in bold font in Table B.2.1.1 of Appendix B of this report, as nitrate (as nitrogen), nitrite (as nitrogen), fluoride, total aluminum, dissolved aluminum, chromium (VI) and (III), arsenic, cobalt, copper, iron, nickel, selenium, uranium, vanadium, total zinc, dissolved zinc and total phosphorus. When regulatory objective/guideline values were hardness-dependant, hardness of the effluent was used as FDP discharge quality predictions were substantially higher than that of the receivers, controlling the hardness of the mixture of effluent and receivers' flow.

5.2.1.1 Treatment

This ACS assumes that mine water will be treated in the sedimentation ponds followed by a mine water treatment system prior to discharge into receiving environments at FDP locations. The mine water treatment systems may include coagulation, flocculation and precipitation. Moreover, further polishing of the effluent may be required. The maximum daily concentrations of PoPCs, that are expected to be achieved using water treatment were used in the ACS to determine the extent of the mixing zone under regulatory conditions. Target effluent objectives were used to quantify the extent of the mixing zone under normal conditions. Table 5.3 provides the proposed maximum daily, maximum monthly average and target objective concentration of PoPCs after treatment.

Table 5.3 Mine Water Effluent Treated Maximum Daily, Maximum Monthly Average and Target Objective Concentrations for PoPCs

Parameter	Unit	Maximum Daily Treatment Limit	Maximum Monthly Average Limit	Target Effluent Objective●
Nitrite (as N)	mg/L	1	0.75	0.5
Nitrate (as N)	mg/L	12	10	6
Fluoride	mg/L	0.36	0.24	0.18
Aluminum (Total)	mg/L	0.225	0.15	0.12
Aluminum (Dissolved)	mg/L	0.034[A]	0.023[A]	0.018[A]
Arsenic (Total)	mg/L	0.015	0.01	0.0075
Boron (Total)	mg/L	0.6	0.4	0.3
Cobalt (Total)	mg/L	0.0036	0.0027	0.0018
Chromium III	mg/L	0.027	0.018	0.013
Chromium VI	mg/L	0.003	0.002	0.0015
Copper (Total)	mg/L	0.015	0.01	0.0075
Iron (Total)	mg/L	0.9	0.6	0.5
Nickel (Total)	mg/L	0.075	0.05	0.0375
Selenium (Total)	mg/L	0.003	0.002	0.001
Uranium (Total)	mg/L	0.015	0.01	0.0075
Vanadium (Total)	mg/L	0.018	0.012	0.01
Zinc (Total)	mg/L	0.06	0.04	0.03

Parameter	Unit	Maximum Daily Treatment Limit	Maximum Monthly Average Limit	Target Effluent Objective●
Zinc (Dissolved)	mg/L	0.06[B]	0.04[B]	0.03[B]
Phosphorus	mg/L	0.09	0.06	0.05

Notes:

- An effluent objective is used by the treatment system operators as a threshold below an enforceable limit at which the system is capable of consistently meeting this concentration objective and the system is operating as expected. When effluent concentrations trend above effluent objectives, they act as triggers to indicate system anomalies, upsets or other system concerns that should be addressed before enforceable limits are reached.

A 15% of the value corresponding to total aluminum

B Equal to the value corresponding to total zinc

5.2.1.1.1 Sanitary Sewage

Treated sanitary discharge via a package plant will be either sent to FDP-TMF-SP or discharged to a collection pond and undergo additional treatment in the mine water treatment plant prior to discharge to a receiver via an FDP. Table 5.4 presents the proposed treatment objectives (maximum daily and mean monthly) for the sewage treatment system based on effluent treatment technology limits recommended by treatment technology suppliers.

Table 5.4 Sewage Maximum Daily Treatment Limit and Mean Monthly Limit

Parameter	Units	Maximum Daily Treatment Limit	Mean Monthly Limit
Biochemical Oxygen Demand (BOD)	mg/L	25	15
E. coli	coliform forming units (CFU)/100 mL	1,000	200
Total ammonia (as N)	mg/L	10	8
Total phosphorus	mg/L	0.1	0.08
Total suspended solids (TSS)	mg/L	30	15

5.2.2 Pit-Full

The GoldSim™ model was used to simulate the water quality of discharge from the pit lake when it is full in Mine Year 167 (Appendix K of the Impact Statement [Water Quality Assessment]). Concentrations reported for that year were used as the quality of water flowing from the pit lake into receiving waters. Parameters were assumed to be in dissolved form due to the extended detention/retention nature of the pit lake and its extensive water column depth. The pit lake was modeled conservatively to be fully mixed. Maximum and average concentrations were used in regulatory and normal conditions. Table B.2.2.1 in Appendix B of this report shows maximum and average parameter concentrations in pit lake discharge.

6 Mixing Zone Assessment for Ultimate Receivers

6.1 CORMIX

Near-field modelling of mixing in two receivers, the North Driftwood River and the West Buskegau River, was performed using CORMIX, Version 12.0. CORMIX is a United States Environmental Protection Agency supported mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones resulting from point source discharges (Doneker and Jirka 2017). The system can be used for the analysis, prediction, and design of aqueous toxic or conventional effluent discharges into diverse waterbodies. The major emphasis is on the geometry and dilution / assimilation characteristics of the initial mixing zone. The basic CORMIX methodology relies on the assumption of steady state ambient conditions, meaning CORMIX generates an instantaneous prediction of the effluent plume or mixing zone from the discharge point. The near-field CORMIX model incorporates effluent outfall design and provides a high resolution of effluent mixing. CORMIX was used to calculate the length to a point downstream of FDPs, at which full mixing occurs. Concentrations at such a point were calculated using the mass balance assessment explained in Section 6.2.

6.1.1 Model Inputs

The required model inputs for the receiving environment include water temperature, flow or velocity, and water depth. Flow in receivers was set either at 7Q20 (in regulatory conditions) or MAF (in climate change adjusted climate normal conditions). Water depth corresponding to a given volumetric flow in receivers was estimated based on available bathymetry information and rating curves.

Bottom roughness in CORMIX is expressed as Manning's "n" and converted internally to a friction factor based on average water depth. The friction factor has limited impact on modelling results and is important only for far-field diffusion. A Manning's n value of 0.035 was selected for use in the model based on available information about bottom sediments and roughness.

Wind is not a sensitive variable in near-field mixing modelling. Wind is non-directional in CORMIX and it is used for surface heat transfer and ambient mixing only. A mean annual wind speed of 3.5 m/s was used in the model and it was derived based on information on the website 'weatherstats.ca' for years 1999 to 2024 (Weatherstats 2024).

The receiving water and effluent were assumed to be freshwater with an average annual water temperature of 9 degrees Celsius (°C), based on data from 10 project deployed local water level and temperature data loggers obtained between 2021 and 2023.

The CORMIX methodology contains systems to model single-port discharge, multiport diffuser discharges, and surface discharge sources. The surface discharge option was selected for FDPs discharging to the ultimate receivers. Effluent flow rates from the sedimentation ponds in regulatory and climate normal conditions are shown in Table 5.1. CORMIX, as a near-field mixing zone model, works on the basis of the assumption that sufficient ambient water in the receiver is available to assimilate the effluent to levels that approach the baseline concentration in the receiver. This assumption requires the receiver flow to be higher than the effluent discharge. When this assumption is violated, CORMIX is not applicable. As a result, CORMIX was run only for cases where the effluent flow is smaller than receiver flow. When the effluent flow is higher than the receiver flow, mixing occurs almost instantaneously, i.e., in the immediate vicinity of the outfall. As a conservative estimate, for such cases, a distance of 30 m from the discharge point was assumed to be when the fully mixed condition occurred in the receiver.

CORMIX requires input parameters, which characterize the effluent, ambient environment, and outfall design. These parameters for the four FDP are summarized in Table 6.1.

Table 6.1 CORMIX Input Data

Parameter, units		**FDP-SP-03 (Upstream)**	**FDP-SP-01 (Downstream)**	**FDP-TMF-SP (Upstream)**	**FDP-SP-02 (Downstream)**	
Receiver		**West Buskegau River**		**North Driftwood River**		**Notes**
Regulatory Conditions	7Q20 Flow plus Seepage L/s	239	249	80	100	Regional Regression
	Effluent Discharge (L/s)	120	324	648	324	Maximum discharge during operations
	Receiver Depth at Discharge (m)	0.26	0.34	0.6	0.34	Water depth in the discharge channel
	Receiver Average Depth in Mixing Zone (m)	0.75	0.93	0.6	0.36	Water depth in the ambient
	CORMIX Applicable	Yes	No	No	No	
Normal Conditions	Mean Annual Flow plus Seepage (L/s)	2,036	2,140	308	471	Regional Regression
	Effluent Discharge (L/s)	40	316	421	191	Average discharge during operations (GoldSim Predictions)
	Receiver Depth at Discharge (m)	0.15	0.33	0.43	0.34	Flow depth in the discharge channel

Parameter, units		**FDP-SP-03 (Upstream)**	**FDP-SP-01 (Downstream)**	**FDP-TMF-SP (Upstream)**	**FDP-SP-02 (Downstream)**	
Receiver		**West Buskegau River**		**North Driftwood River**		**Notes**
Normal Conditions	Receiver Average Depth in Mixing Zone (m)	1.4	1.45	0.6	0.41	Water depth in the ambient
	CORMIX Available	Yes	Yes	No•	Yes	
Receiver Width (m)		8	8	3.5	3.5	Based on available cross-sectional information
Effluent and Receiver Water Temperature (˚C)		9	9	9	9	Average annual water temperature at 10 stations between 2021 and 2023
Manning's n		0.035	0.035	0.035	0.035	Assumed based on bottom roughness
Horizontal Angle (sigma)		90º	90º	90º	90º	Angle between the dominant ambient current direction to the plan projection of the outfall channel
Bottom slope at discharge (%)		3	2	2	2	Estimated slope at outfall
Average Wind Speed (m/s)		3.5	3.5	3.5	3.5	Based on weatherstats.ca
Discharge outlet width (m)		0.1	1.5	3	1	Width of the rectangular shape
Ambient Appearance		Slight Meander	Slight Meander	Slight Meander	Slight Meander	

Note:
• When CORMIX is not available, the length to the point of full mixing was set conservatively at 30 m

6.2 Mass Balance Assessment

Beyond the CORMIX near-mixing zone, a mass balance assessment was used to determine the concentrations of water quality parameters at the edge of full mixing and further downstream of each FDP. The mass balance analysis continued downstream to a point where concentrations meet regulatory objectives/guidelines defining the downstream edge of the mixing zone. The distance between the location of each FDP and the point where regulatory objectives/guideline or baseline concentrations are achieved represents the extent of the mixing zone for a given water quality parameter. The mixing zone of the effluent is defined by the PoPC that has the largest mixing zone.

6.2.1 Methodology

The mass balance analysis is based on the mixing of the effluent, seepage, and receiver water, and results in the concentration of a given parameter at the point of mixing under the assumption of steady-state conditions. Figure A.4 schematically shows the mass balance approach for a hypothetical constituent with concentration C_{FDP}, C_r, and C_g in the effluent, receiver, and groundwater seepage, respectively. When mixing occurs at the FDP (shown as o_1 in Figure A.4), which is also the outlet of watershed w_1, the resulting discharge and concentration (Q_{o_1}, and C_{o_1}) are calculated based on individual discharge and concentration terms (as shown with the equation in Figure A.4). Similarly, moving downstream to the outlet of the next watershed, w_2, with the outlet shown as o_2, new discharge (Q_{o_2}) and concentration (C_{o_2}) are calculated. Because the water produced by the downstream watershed area has baseline quality, it improves water quality conditions meaning that $C_{o_2} < C_{o_1}$. This process continues downstream until the resulting concentration meets regulatory objective/guideline or baseline conditions, indicating the downstream edge of the mixing zone.

The FDP associated with TMF ponds (FDP-SP-TMF) is located upstream of FDP-SP-02 on the North Driftwood River, and FDP-SP-03 is located upstream of FDP-SP-02 (see Figure A.1 in Appendix A of this report). The effluent discharge and concentrations at these upstream FDPs were used to calculate point loads at downstream FDPs in mass balance assessments. Accordingly, whenever results are shown for FDP-SP-01 and FDP-SP-02 (downstream FDPs), the impact of upstream FDPs are considered.

Mass balance was assessed at FDPs, as well as at the outlet of subwatersheds with their pourpoints located on the main channel of the receivers. Subwatershed delineation for the Project is detailed in the Surface Water Resources Baseline Report (2024). In the West Buskegau River, the subwatersheds selected for mass balance assessment were WB9, WB6, WB5, WB3 and WB1. The outlet of two FDPs, FDP-SP-01 and FDP-SP-03, are located in WB9. In the North Driftwood River, the selected subwatersheds were ND18, ND20, ND15, ND12, ND11, ND8, ND6, ND5, ND3 and ND1. The outlets of FDP-TMF-SP and FDP-SP-02 are located in ND18 and ND11, respectively. Figure A.5 shows the location of subwatersheds and the corresponding pourpoints considered in mass balance assessments related to the North Driftwood River and the West Buskegau River. In Jocko Creek, the selected subwatersheds were JC2, JC1, and JCDS. Each subwatershed is considered as a mass balance computational unit and AC results are provided at the subwatershed scale. The North Driftwood River Diversion Channel passes through subwatersheds ND20, ND15, ND11 and ND8.

A preliminary assessment indicated that the extent of the mixing zone was beyond the watershed limits presented in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement). Accordingly, further watershed delineation was conducted (using the Ontario Watershed Information Tool (OWIT)) downstream of model limits to the Frederick House River on the West Buskegau River and to the Abitibi River for the North Driftwood River. This watershed delineation was not required in Jocko Creek as concentrations were below regulatory objective/guideline in the corresponding subwatersheds (as shown in Sections 7.2.1.1.3 and 7.2.2. Table 6.2 provides information about downstream watershed pourpoints (for the West Buskegau River and the North Driftwood River receivers) that were considered in the mass balance assessment. These points are presented in Figure A.6 in Appendix A this report.

Table 6.2 Location of beyond-Model Limit Pourpoints Considered in Mass Balance Assessment

Point	Receiver	Lat/Lon	Description	Total Watershed Area (km^2)	Watershed Area beyond Previous Point (km^2)
WB1	West Buskegau River	48.96909° N, 81.24353° W	Hydrologic Model Limit	518.8	0
WB-A	West Buskegau River	49.04945° N, 81.24549° W	Downstream of Confluence with Fournier Creek	592.4	73.6
WB-B	West Buskegau River	49.07109° N, 81.23219° W	Downstream of Highway 11	604	11.6
WB-C	West Buskegau River	49.11505° N, 81.14250° W	Upstream of Confluence with the Frederick House River	645.5	41.5
WB-D	West Buskegau River	49.11400° N, 81.13787° W	Downstream of Confluence with the Frederick House River	4,185	3,539.5
ND1	North Driftwood River	49.08589° N, 81.43214° W	Hydrologic Model Limit	380.8	0
ND-A	North Driftwood River	49.22916° N, 81.39794° W	Upstream of Confluence with Calder Creek	494.8	114
ND-B	North Driftwood River	49.27623° N, 81.37048° W	Upstream of Confluence with Sheriff Creek	537.1	42.3
ND-C	North Driftwood River	49.39740° N, 81.30934° W	Upstream of Confluence with the Abitibi River	683.9	146.8
ND-D	North Driftwood River	49.40217° N, 81.31327° W	Downstream of Confluence with the Abitibi River	20683	19,999.1

7 Results and Discussion

7.1 CORMIX

CORMIX was run using the input parameters shown in Table 6.1 under both regulatory and normal conditions. Model outputs were used to determine the length between the FDP, where effluent and ambient flow start to mix, and the point where effluent is fully mixed across the width and depth of the receiver. This length is referred to as the distance to the point of full mixing. Table 7.1 shows the distances to the point of full mixing for the four FDPs under regulatory and normal conditions. Constituent concentrations at the edge of full mixing and further downstream at the outlet of subwatersheds are based on mass balance analysis and are presented in Section 7.2.

Table 7.1 Mixing zone characteristics at point of Full Mixing (CORMIX Outputs)

FDP		FDP-SP-03 (Upstream)	FDP-SP-01 (Downstream)	FDP-TMF-SP (Upstream)	FDP-SP-02 (Downstream)
Receiver		**West Buskegau River**		**North Driftwood River**	
Regulatory Conditions	Receiver Flow (7Q20+Seepage) (L/s)	239	249	80	100
	Distance to Full Mixing (m)	23	30•	30•	30•
	Dilution Ratio	2.99	n/a•	n/a	n/a
Normal Conditions	Receiver Flow (MAF+Seepage) L/s	2,036	2,140	308	471
	Distance to Full Mixing (m)	199	166	30•	185
	Dilution Ratio	51.9	7.8	n/a	3.5

Notes:
• 30 m was assumed as a conservative estimate for the length to the point of full mixing when CORMIX was not applicable
n/a: Not available because when the effluent flow is higher than the receiver flow, CORMIX is not applicable

7.2 Mass Balance Assessment

7.2.1 Construction/Operation Case

7.2.1.1 West Buskegau River and North Driftwood River

7.2.1.1.1 Regulatory Conditions

The focus of this ACS in the Construction/Operation case is to assess conditions when all FDPs discharge concurrently to receivers. FDP-SP-01 and its upstream FDP-SP-03 are located in the West Buskegau River, while FDP-SP-02 and its upstream FDP -TMF-SP discharge into the North Driftwood River. This case, as the most conservative case, is related to the operations phase 2 (Mine Year 4 to 23) and shown in Figure A.2 (c). The ACS results of PoPCs under regulatory conditions at the two most downstream FDPs, FDP-SP-01 (West Buskegau River) and FDP-SP-02 (North Driftwood River) in Table 7.2 and Table 7.3, respectively. The effects of upstream and downstream FDPs are accounted for in each of the AC assessment water quality results tables as well as concentrations at subwatershed convergence nodes and the nodes where parameter concentrations meet regulatory objectives/guidelines (Table 7.2 and Table 7.3). The distance between FDPs and the points where concentrations are predicted to meet regulatory objective/guideline represents the length of the mixing zone.

On the West Buskegau River under regulatory conditions (Table 7.2), parameters such as un-ionized ammonia (as N), dissolved aluminum (clay-free), chloride and dissolved zinc meet regulatory objective/guidelines either prior to or at the FDP-SP-01 end of pipe or within the receiver. The concentrations of nitrate, fluoride, total arsenic, total boron, total chromium(VI), total chromium(III), total cobalt, total copper, total nickel, total selenium, total uranium, total vanadium and total zinc decrease below objective/guideline values at the point WB-D. Point WB-D is the Buskegau River and Frederick House River confluence 40.2 km downstream of the most downstream FDP (FDP-SP-01) and is the edge of the mixing zone for those parameters. The nitrite concentration is predicted to be above regulatory objective/guidelines at WB-D. Parameter concentrations in the receiver as conservatively estimated to not react in the receiving environment in this ACS. Nitrite is rapidly oxidized to nitrate through nitrification when oxygen is available (Kendall 1998). Because the receivers are turbulent and oxygenated, nitrite concentrations are expected to decrease rapidly, therefore, the corresponding mixing zone will be shorter than what was estimated in this assessment. Total aluminum and iron, with iron being a Policy 2 parameter in the receiver, are above objective/guidelines within the mixing zone, but below baseline receiver concentrations. This indicates that effluent discharge at FDPs is better than receiver water quality for the regulatory condition for these two parameters and why concentrations in the mixing zone increase at each subsequent subwatershed node downstream of the FDP. Total phosphorus, as the other Policy 2 parameter, is above regulatory objective/guidelines within the watercourse and at WB-D. However, the effluent criteria are based on receiving water and reasonable and practical treatment, technology limits for total phosphorus define the effluent criteria. The technology limit applies as the regulatory discharge criteria even though the maximum water quality modeling predictions for total phosphorus concentrations in mine water are lower than the technology limits. As a result, the mixing zone for total phosphorus in the West Buskegau River is also expected to be much smaller than modeled under the regulatory condition case.

On the North Driftwood River under regulatory conditions (Table 7.3), the parameters un-ionized ammonia (as N), dissolved aluminum (clay-free), chloride and dissolved zinc are predicted to meet regulatory objective/guidelines at the upstream FDP-TMF-SP. For other Policy 1 parameters, the mixing zone extends to the confluence between the Abitibi River and the North Driftwood River 87.1 km downstream of the downstream FDP-SP-02. With the exception of nitrite, which is predicted to be above regulatory objective/guidelines at ND-D and are expected to decrease rapidly in the receiver by nitrification processes. The total aluminum concentration at each FDP is below baseline within the watercourse and converges to baseline downstream of ND-D. Total iron and phosphorus are above the regulatory objectives/guidelines and baseline concentrations, indicating that their mixing zones would be at the point of full mixing of the North Driftwood River in the Abitibi River within a short distance downstream of ND-D.

The extent of mixing zones under regulatory conditions was determined based on the assumption that the conservative worst case receiver quality and low flows occur simultaneously with peak effluent quality concentrations and discharge rates, representing the worst-case scenario for the effluent. This is a conservative and improbable case for the Project as the mine water management system is driven by climatic conditions meaning that when extended drought conditions drive low flows in the receiver, those same dry conditions also control effluent flows, resulting in lower discharge rates at the FDPs. Moreover, results shown in Table 7.2 and Table 7.3 demonstrate the combined effects of two FDPs on the West Buskegau River and North Driftwood River receivers, rather than isolated mixing zones associated with a single FDP. The cumulative effects of successive Project FDPs in each receiver contribute to the extension of mixing zones downstream of the PA.

Effluent concentrations at the point of discharge were determined based on geochemical predictions of raw dissolved and total constituents (total combining dissolved and particulate forms), sedimentation in sedimentation ponds, and reasonable and practical water treatment effluent limits provided by treatment technology suppliers. PoPC results indicate that effluent concentrations at the point of full mixing with the receiver flow are lower than concentrations at the point of discharge due to mixing processes within the West Buskegau River and North Driftwood River as presented in Table 7.2 and Table 7.3, respectively. A limited number of parameters at specific FDPs observe higher concentrations at points of full mixing, including un-ionized ammonia (as N) and dissolved aluminum at the four FDPs, total aluminum at FDP-SP03 and FDP-SP-01, chloride at FDP-TMF-SP, dissolved zinc at FDP-SP-02, and total iron at FDP-SP03 and FDP-SP-01. These trends are either attributed to the effects of groundwater seepage (un-ionized ammonia, chloride, and dissolved zinc) or are related to Policy 2 parameters with baseline concentrations being above PWQO (aluminum and iron). For Policy 2 parameters such as iron and aluminum, treatment criteria selected for controlling concentrations in the effluent improve the water quality of the receiver within the mixing zone. Concentrations of Policy 2 parameters converge to baseline downstream of the edge of the mixing zone.

The gradual improvement in water quality from the point of full mixing to the end of the mixing zone is due to the addition of new better quality ambient water from downstream subwatersheds. For instance, the last two columns in Table 7.2 imply that, concentrations at point WB-D are lower than those at point WB-C because of the flow difference (4.006 m^3/s minus 1.177 m^3/s) due to mixing with flows from the larger Frederick House River watershed. Upon the assimilation caused by additional discharge, the ultimate end of the mixing zone in regulatory conditions was predicted to be downstream of the West Buskegau River confluence with the Frederick House River and downstream of the North Driftwood River confluence with the Abitibi River. Nitrite (as N), total aluminum and Policy 2 parameters (total iron, and total phosphorus) define the extent of the ultimate mixing zone in receivers from Project Area effluent.

7.2.1.1.2 Normal Conditions

The mass balance assessments were conducted for PoPCs under normal conditions to identify changes in the extent of the mixing zones in comparison to those determined under regulatory conditions. Normal discharge conditions are generally representative of the long-term effects of the effluent on water quality, as opposed to the regulatory conditions that served as a representation of the short-term effects and worse-case conservative situation. Table 7.4 and Table 7.5 show AC results of PoPCs under normal discharge conditions for FDPs on the West Buskegau River and the North Driftwood River, respectively. Under normal conditions, concentrations at the point of full mixing are lower than those at FDPs, except for un-ionized ammonia at FDP-SP-02, dissolved and total aluminum at the four FDPs, chloride at FDP-TMF-SP, and iron at FDP-SP-03 and FDP-SP-01. These trends are also attributed to seepage and the fact that aluminum is a Policy 2 parameter. More importantly, the assimilation due to mixing is greater under normal conditions compared with regulatory conditions resulting in smaller mixing zones. On the West Buskegau River, the edge of the individual PoPC mixing zones for Policy 1 parameters was achieved prior to or at the point of full mixing associated with FDP-SP-01 (in 1.2 km, as shown in Table 7.4). Among Policy 2 parameters, aluminum and iron concentrations stayed below baseline, but above the regulatory objective/guidelines within the entire watercourse from the location of FDPs, converging to baseline at point WB-D, which is the Frederick House River confluence. Total phosphorus (another Policy 2 parameter) did not exceed the regulatory objective/guidelines at the FDPs and in the receivers. Therefore, the point of full mixing at FDP-SP-01 is the extent of the mixing zones on the West Buskegau River under normal conditions.

For the North Driftwood River, the assimilation due to mixing is greater under normal conditions compared to regulatory conditions, which reduced the length of the mixing zones. The edge of the mixing zone was achieved at the point of full mixing associated with FDP-SP-02 (as shown in Table 7.5) for 16 out of 17 Policy 1 parameters. The mixing zone for nitrate ended at the pourpoint of ND8 (3.6 km downstream of FDP-SP-02). Similar to the West Buskegau River, concentrations of total aluminum and iron were above guidelines, but below baseline concentrations within the watercourse to the most downstream point (ND-D) where convergence to baseline concentrations occurred. Total phosphorus did not exceed the regulatory objective. These results indicate that under normal conditions on the North Driftwood River, the ultimate mixing zones were achieved at ND8, 3.6 km downstream of FDP-SP-02.

Table 7.2 PoPC Concentrations at the Outlet of Mass Balance Subwatersheds for FDP-SP-03 and FDP-SP-01 on the West Buskegau River under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to FDP												
		Source [1]	Value		FDP-SP-03 (Treated End of Pipe)	Point of FDP-SP-03 Full Mixing	FDP-SP-01 (Treated End of Pipe)	Point of FDP-SP-01 Full Mixing	WB9 Pourpoint	WB6 Pourpoint	WB5 Pourpoint	WB3 Pourpoint	WB1 Pourpoint [B]	WB-A - Downstream of Fournier Creek Confluence	WB-B - Downstream of Highway 11	WB-C - Upstream of Frederick House River Confluence	WB-D - Downstream of Frederick House River Confluence
# of km downstream of the most upstream FDP [A]					0	0.033	1.1	1.13	3.50	9.10	10.10	14.30	21.70	26.90	33.20	41.20	41.30
# of km downstream of the most downstream FDP [A]					-	-	0	0.03	2.40	8.00	9.00	13.20	20.60	25.80	32.10	40.10	40.20
Total Flow Rate	m^3/s				0.116	0.355	0.689	0.689	0.692	0.704	0.730	0.940	1.052	1.125	1.136	1.177	4.006
							Concentration [2]										
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	1,000	347	1,000	650	647	636	614	479	429	402	398	385	120
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	12,000	4,286	12,000	7,857	7,822	7,721	7,474	5,806	5,191	4,856	4,808	4,643	1,378
Un-ionized Ammonia (as N)	µg/L	PWQO	20[3]	0.69	1.23	2.39	2.35	2.35	2.34	2.31	2.26	1.91	1.78	1.71	1.70	1.66	0.98
Fluoride	µg/L	CCME CWQG-FAL	120	50	360	150	360	247	246	243	236	194	179	171	170	165	84
Aluminum (Total)	µg/L	CCME CWQG-FAL	100[4,~]	598	225	439	225	340	341	345	354	409	429	440	441	447	554
Aluminum (Dissolved)	µg/L	PWQO	75[4*,~]	133	34	95	34	67	67	68	70	84	89	92	93	94	122
Arsenic (Total)	µg/L	Interim PWQO	5	1.1	15.0	5.6	15.0	10.0	9.9	9.8	9.5	7.6	6.9	6.6	6.5	6.3	2.6
Boron (Total)	µg/L	PWQO	200	2	600	216	600	394	392	385	372	289	259	242	239	231	69
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.4	3.6	1.5	3.6	2.5	2.5	2.4	2.4	1.9	1.8	1.7	1.7	1.6	0.8
Chloride	µg/L	CCME CWQG-FAL	120,000	400	51,980	36,603	109,200	70,264	69,952	68,833	66,525	51,722	46,270	43,296	42,866	41,410	12,446
Chromium III	µg/L	PWQO	8.9	1.5	27.0	9.7	27.0	18.0	18.0	17.0	17.0	13.0	12.0	11.0	11.0	11.0	4.3
Chromium VI	µg/L	PWQO	1	0	3.0	1.2	3.0	2.0	2.0	2.0	1.9	1.5	1.3	1.2	1.2	1.2	0.3
Copper (Total)	µg/L	Interim PWQO	5[5]	2.2	15.0	6.3	15.0	10.0	10.0	10.0	9.9	8.2	7.5	7.2	7.1	7.0	3.6
Iron (Total)	µg/L	PWQO	300[~]	1,075	900	944	900	925	926	927	932	964	976	982	983	986	1,049
Nickel (Total)	µg/L	PWQO	25	1.4	75.0	26.0	75.0	49.0	49.0	48.0	46.0	36.0	33.0	31.0	30.0	29.0	9.6
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.15	3.00	1.27	3.00	2.07	2.06	2.03	1.96	1.56	1.41	1.33	1.31	1.27	0.48
Uranium (Total)	µg/L	Interim PWQO	5	0.07	15.00	4.94	15.00	9.60	9.56	9.41	9.10	7.08	6.33	5.93	5.87	5.67	1.71
Vanadium (Total)	µg/L	Interim PWQO	6	1.6	18.0	6.9	18.0	12.0	12.0	12.0	11.0	9.3	8.5	8.0	7.9	7.7	3.4
Zinc (Total)	µg/L	Interim PWQO	20	8	60	25	60	41	41	40	39	32	30	28	28	27	14
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	95[6]	7	60	24	60	41	41	40	39	32	29	28	27	27	13
Phosphorus (Total)	µg/L	PWQO	30[7,~]	37	90	53	90	70	70	69	68	61	59	57	57	56	43

Notes:		
CCME CWQG-FAL	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term	
PWQO	Provincial Water Quality Objective	
(1)	PWQO or CCME CWQG-FAL	
(2)	Moving downstream from left to right	
(3)	Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 ºC	
(4)	CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5	
(4*)	PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9	
(5)	PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L	
(6)	CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L,	
	pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L	
	Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC	
(7)	PWQO: value of 30 ug/L when FDP drains into streams	
	2.0	First point where guidelines/objectives are met after a preceding exceedance
		Set equal to RDL as >50% of data are below detection limit.
		Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form
~	75th percentile receiver concentration is above PWQO value	
(A)	Distances were determined based on the length of the main channel from a given FDP to the outlet of downstream subwatersheds and not a straight connection line.	
(B)	Hydrologic model limit	

Table 7.3 PoPC Concentrations at the Outlet of Mass Balance Subwatersheds for FDP-TMF-SP and FDP-SP-02 on the North Driftwood River under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to FDP														
		Source [1]	Value		FDP-TMF-SP (Treated End of Pipe)	Point of FDP-TMF-SP Full Mixing	FDP-SP-02 (Treated End of Pipe)	Point of FDP-SP-02 Full Mixing	ND11 Pourpoint	ND8 Pourpoint	ND7 Pourpoint	ND6 Pourpoint	ND5 Pourpoint	ND3 Pourpoint	ND1 Pourpoint (B)	ND-A - Upstream of Calder Creek Confluence	ND-B - Upstream of Sheriff Creek Confluence	ND-C - Upstream of Abitibi Confluence	ND-D - Downstream of Abitibi Confluence
# of km downstream of the most upstream FDP (A)					0	0.03	5.825	5.855	6.73	9.43	11.13	14.23	19.93	36.23	44.03	63.93	72.325	92.925	92.925
# of km downstream of the most downstream FDP (A)					-	-	0	0.03	1.00	3.60	5.30	8.40	14.10	30.40	38.20	58.10	66.5	87.1	87.1
Flow Rate	m3/s				0.648	0.724	1.067	1.067	1.086	1.109	1.118	1.127	1.148	1.336	1.451	1.569	1.612	1.756	14.695
							Concentration (2)												
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	1,000	907	1,000	919	904	886	879	872	856	738	680	630	613	564	76
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	12,000	11,004	12,000	11,112	11,035	10,832	10,750	10,680	10,524	9,064	8,344	7,718	7,514	6,900	842
Un-ionized Ammonia (as N)	µg/L	PWQO	20(3)	0.48	6.83	7.27	4.69	6.36	6.27	6.15	6.10	6.10	6.00	5.29	4.90	4.57	4.46	4.14	0.92
Fluoride	µg/L	CCME CWQG-FAL	120	50	360	327	360	332	327	321	319	317	312	275	257	241	236	221	71
Aluminum (Total)	µg/L	CCME CWQG-FAL	100(4,~)	260	225	218	225	221	221	222	222	222	222	227	229	232	233	235	257
Aluminum (Dissolved)	µg/L	PWQO	75(4*,~)	86	34	37	34	37	38	39	39	39	40	46	50	52	53	56	80
Arsenic (Total)	µg/L	Interim PWQO	5	0.9	15.0	14.0	15.0	14.0	14.0	13.0	13.0	13.0	13.0	11.0	10.0	9.8	9.5	8.8	1.8
Boron (Total)	µg/L	PWQO	200	2	600	551	600	556	546	535	531	527	518	446	411	380	370	340	42
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.3	3.6	3.3	3.6	3.3	3.3	3.2	3.2	3.2	3.1	2.7	2.5	2.4	2.3	2.1	0.5
Chloride	µg/L	CCME CWQG-FAL	120,000	4,200	15,760	28,248	80,000	43,545	43,236	42,510	42,218	42,471	41,899	37,376	34,737	32,438	31,692	29,440	7,216
Chromium III	µg/L	PWQO	8.9	1.5	27.0	24.0	27.0	25.0	24.0	24.0	24.0	23.0	23.0	20.0	19.0	17.0	17.0	16.0	3.2
Chromium VI	µg/L	PWQO	1	0	3.0	2.8	3.0	2.8	2.8	2.7	2.7	2.7	2.7	2.3	2.1	2.0	1.9	1.7	0.2
Copper (Total)	µg/L	Interim PWQO	5(5)	1.5	15.0	14.0	15.0	14.0	14.0	13.0	13.0	13.0	13.0	11.0	11.0	9.9	9.7	9.0	2.4
Iron (Total)	µg/L	PWQO	300(~)	644	900	842	900	856	850	845	844	841	836	807	794	783	779	768	659
Nickel (Total)	µg/L	PWQO	25	0.9	75.0	68.0	75.0	69.0	68.0	66.0	66.0	65.0	64.0	55.0	51.0	47.0	46.0	42.0	5.9
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.15	3.00	2.84	3.00	2.84	2.80	2.74	2.72	2.71	2.66	2.32	2.15	2.00	1.95	1.80	0.35
Uranium (Total)	µg/L	Interim PWQO	5	0.04	15.00	13.00	15.00	14.00	13.00	13.00	13.00	13.00	13.00	11.00	10.00	9.38	9.13	8.38	1.04
Vanadium (Total)	µg/L	Interim PWQO	6	0.8	18.0	16.0	18.0	16.0	16.0	16.0	16.0	16.0	15.0	13.0	12.0	12.0	11.0	10.0	2.0
Zinc (Total)	µg/L	Interim PWQO	20	7	60	54	60	55	54	54	53	53	52	46	43	40	39	36	11
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	84(6)	6	60	54	60	55	54	53	53	53	52	45	42	40	39	36	9
Phosphorus (Total)	µg/L	PWQO	30(7,~)	27	90	83	90	84	83	82	81	81	80	73	69	66	65	62	31

Notes:	
CCME CWQG-FAL	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
PWQO	Provincial Water Quality Objective
(1)	PWQO or CCME CWQG-FAL
(2)	Moving downstream from left to right
(3)	Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 oC
(4)	CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5
(4*)	PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9
(5)	PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L
(6)	CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L
	Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC
(7)	PWQO: value of 30 ug/L when FDP drains into streams
	2.0 — First point where guidelines/objectives are met after a preceding exceedance
	Set equal to RDL as >50% of data are below detection limit.
	Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form
~	75th percentile receiver concentration is above PWQO value
(A)	Distances were determined based on the length of the main channel from a given FDP to the outlet of downstream subwatersheds and not a straight connection line.
(B)	Hydrologic model limit

Table 7.4 PoPC Concentrations at the Outlet of Mass Balance Subwatersheds for FDP-SP-03 and FDP-SP-01 on the West Buskegau River under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Stations in Relation to FDP												
		Source (1)	Value		FDP-SP-03 (Treated End of Pipe)	Point of FDP-SP-03 Full Mixing	FDP-SP-01 (Treated End of Pipe)	Point of FDP-SP-01 Full Mixing	WB9 Pourpoint	WB6 Pourpoint	WB5 Pourpoint	WB3 Pourpoint	WB1 Pourpoint (B)	WB-A - Downstream of Fournier Creek Confluence	WB-B - Downstream of Highway 11	WB-C - Upstream of Frederick House River Confluence	WB-D - Downstream of Frederick House River Confluence
# of km downstream of the most upstream FDP (A)					0	0.199	1.1	1.266	3.50	9.10	10.10	14.30	21.70	26.90	33.20	41.20	41.30
# of km downstream of the most downstream FDP (A)					-	-	0	0.166	2.40	8.00	9.00	13.20	20.60	25.80	32.10	40.10	40.20
Total Flow Rate	m^3/s				0.036	2.072	2.493	2.493	2.528	2.659	2.938	5.444	6.850	7.791	7.939	8.469	52.305
							Concentration (2)										
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	89	13	89	22	22	22	21	16	15	14	14	14	11
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	6,000	161	6,000	895	883	844	767	424	341	302	297	279	62
Un-ionized Ammonia (as N)	µg/L	PWQO	20(3)	0.60	0.77	0.76	0.95	0.77	0.77	0.76	0.75	0.68	0.66	0.66	0.66	0.65	0.61
Fluoride	µg/L	CCME CWQG-FAL	120	50	39	50	39	48	48	48	49	49	49	49	49	50	50
Aluminum (Total)	µg/L	CCME CWQG-FAL	100(4,~)	440	120	432	120	393	393	395	400	418	423	425	425	426	438
Aluminum (Dissolved)	µg/L	PWQO	75(4*,~)	107	18	105	18	94	94	95	96	101	102	103	103	103	106
Arsenic (Total)	µg/L	Interim PWQO	5	0.9	7.5	1.0	7.5	1.8	1.8	1.8	1.7	1.3	1.2	1.2	1.2	1.2	0.9
Boron (Total)	µg/L	PWQO	200	2	83	5	83	15	15	14	13	8.02	6.78	6.2	6.13	5.87	2.63
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.3	1.2	0.3	1.2	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3
Chloride	µg/L	CCME CWQG-FAL	120,000	300	34,042	2,848	47,402	8,390	8,282	7,895	7,178	4,019	3,255	2,897	2,849	2,689	686
Chromium III	µg/L	PWQO	8.9	1.3	8.9	1.4	8.9	2.4	2.4	2.3	2.2	1.8	1.7	1.6	1.6	1.6	1.4
Chromium VI	µg/L	PWQO	1	0	1.50	0.05	1.50	0.23	0.23	0.22	0.20	0.11	0.08	0.07	0.07	0.07	0.01
Copper (Total)	µg/L	Interim PWQO	5(5)	1.7	5.3	1.8	5.3	2.2	2.2	2.2	2.1	1.9	1.9	1.9	1.9	1.9	1.7
Iron (Total)	µg/L	PWQO	300(~)	823	500	812	500	773	773	776	780	800	805	807	807	808	821
Nickel (Total)	µg/L	PWQO	25	1.0	17.3	1.4	17.3	3.4	3.4	3.3	3.0	2.1	1.9	1.8	1.8	1.7	1.1
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.12	1.14	0.16	1.14	0.28	0.28	0.27	0.26	0.19	0.18	0.17	0.17	0.17	0.13
Uranium (Total)	µg/L	Interim PWQO	5	0.04	6.85	0.16	6.85	1.00	0.99	0.94	0.86	0.48	0.39	0.35	0.34	0.32	0.09
Vanadium (Total)	µg/L	Interim PWQO	6	1.1	9.9	1.2	9.9	2.3	2.3	2.3	2.1	1.7	1.5	1.5	1.5	1.5	1.2
Zinc (Total)	µg/L	Interim PWQO	20	7	20	7	20	9	9	9	9	8	8	8	8	8	7
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	88(6)	6	19	6	19	8	8	8	8	7	7	7	7	7	6
Phosphorus (Total)	µg/L	PWQO	30(7,~)	28	29	28	29	28	28	28	28	28	28	28	28	28	28

Notes:	
CCME CWQG-FAL	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
PWQO	PWQO or CCME CWQG-FAL
(1)	PWQO, BC-MECCS or CCME CWQG-FAL
(2)	Moving downstream from left to right
(3)	Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 ºC
(4)	CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5
(4*)	PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9
(5)	PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L
(6)	CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L,
	pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L
	Used pH of 7.5, hardness of 120 mg/L, and mean receiver DOC
(7)	PWQO: value of 30 ug/L when FDP drains into streams
	2.0 — First point where guidelines/objectives are met after a preceding exceedance
	Set equal to RDL as >50% of data are below detection limit.
	Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form
	FDP concentration is set at the highest predicted average concentration in the five sedimentation ponds
~	75th percentile receiver concentration is above PWQO value
(A)	Distances were determined based on the length of the main channel from a given FDP to the outlet of downstream subwatersheds and not a straight connection line.
(B)	Hydrologic model limit

Table 7.5 PoPC Concentrations at the Outlet of Mass Balance Subwatersheds for FDP-TMF-SP and FDP-SP-02 on the North Driftwood River under Normal Conditions

		Guideline			Stations in Relation to FDP														
Parameter	Unit	Source (1)	Value	Mean Receiver	FDP-TMF-SP (Treated End of Pipe)	Point of FDP-TMF-SP Full Mixing	FDP-SP-02 (Treated End of Pipe)	Point of FDP-SP-02 Full Mixing	ND11 Pourpoint	ND8 Pourpoint	ND7 Pourpoint	ND6 Pourpoint	ND5 Pourpoint	ND3 Pourpoint	ND1 Pourpoint (B)	ND-A - Upstream of Calder Creek Confluence	ND-B - Upstream of Sheriff Creek Confluence	ND-C - Upstream of Abitibi Confluence	ND-D - Downstream of Abitibi Confluence
# of km downstream of the most upstream FDP (A)					0	0.03	5.825	5.855	6.73	9.43	11.13	14.23	19.93	36.23	44.03	63.93	72.325	92.925	92.925
# of km downstream of the most downstream FDP (A)					-	-	0	0.185	1.00	3.60	5.30	8.40	14.10	30.40	38.20	58.10	66.5	87.1	87.1
Flow Rate	m^3/s				0.421	0.723	1.077	1.077	1.224	1.431	1.516	1.581	1.783	3.793	5.167	6.634	7.176	9.050	249.019
			Concentration (2)																
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	89	61	89	58	53	47	45	43	40	24	20	18	17	16	10
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	6,000	3,615	6,000	3,494	3,106	2,667	2,520	2,422	2,159	1,028	761	597	553	443	35
Un-ionized Ammonia (as N)	µg/L	PWQO	20(3)	0.38	5.31	3.84	2.36	3.06	2.74	2.40	2.29	2.22	2.02	1.16	0.95	0.83	0.79	0.71	0.39
Fluoride	µg/L	CCME CWQG-FAL	120	50	39	43	39	44	44	45	45	46	46	48	49	49	49	49	50
Aluminum (Total)	µg/L	CCME CWQG-FAL	100(4,~)	187	120	145	120	147	151	156	158	159	162	175	178	180	181	182	187
Aluminum (Dissolved)	µg/L	PWQO	75(4*,~)	56	18	34	18	34	37	40	41	41	43	50	51	52	53	53	56
Arsenic (Total)	µg/L	Interim PWQO	5	0.6	7.5	4.6	7.5	4.5	4.1	3.6	3.4	3.3	3.0	1.7	1.4	1.3	1.2	1.1	0.6
Boron (Total)	µg/L	PWQO	200	2	83	57	83	53	47	41	38	37	33	17	13	10	9.81	8.19	2.23
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.3	1.2	0.8	1.2	0.8	0.7	0.7	0.7	0.6	0.6	0.4	0.4	0.4	0.4	0.4	0.3
Chloride	µg/L	CCME CWQG-FAL	120,000	2,900	7,762	13,278	37,839	16,039	14,550	12,887	12,333	12,114	11,099	6,874	5,819	5,174	5,002	4,567	2,961
Chromium III	µg/L	PWQO	8.9	1.3	8.9	5.7	8.9	5.6	5.1	4.5	4.4	4.2	3.9	2.5	2.2	2.0	2.0	1.8	1.3
Chromium VI	µg/L	PWQO	1	0	1.50	0.95	1.50	0.91	0.80	0.68	0.65	0.62	0.55	0.26	0.19	0.15	0.14	0.11	0.004
Copper (Total)	µg/L	Interim PWQO	5(5)	1.2	5.3	3.6	5.3	3.5	3.3	3.0	2.9	2.8	2.6	1.9	1.7	1.6	1.6	1.5	1.2
Iron (Total)	µg/L	PWQO	300(~)	503	500	488	500	492	493	494	495	495	495	499	500	501	501	501	503
Nickel (Total)	µg/L	PWQO	25	0.8	17.3	11.0	17.3	10.0	9.3	8.1	7.7	7.4	6.7	3.6	2.8	2.4	2.3	2.0	0.8
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.13	1.14	0.79	1.14	0.75	0.68	0.60	0.58	0.56	0.51	0.31	0.26	0.23	0.23	0.21	0.13
Uranium (Total)	µg/L	Interim PWQO	5	0.03	6.85	3.97	6.85	3.88	3.44	2.95	2.79	2.68	2.38	1.14	0.84	0.66	0.62	0.49	0.05
Vanadium (Total)	µg/L	Interim PWQO	6	0.7	9.9	6.0	9.9	5.9	5.3	4.6	4.4	4.3	3.9	2.2	1.8	1.6	1.5	1.3	0.7
Zinc (Total)	µg/L	Interim PWQO	20	6	20	14	20	14	13	12	12	11	11	8	8	7	7	7	6
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	76(6)	5	19	13	19	13	12	11	11	11	10	7	7	6	6	6	5
Phosphorus (Total)	µg/L	PWQO	30(7,~)	23	29	26	29	26	26	25	25	25	25	24	24	23	23	23	23

Notes:		
CCME CWQG-FAL	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term	
PWQO	Provincial Water Quality Objective	
(1)	PWQO or CCME CWQG-FAL	
(2)	Moving downstream from left to right	
(3)	Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 ºC	
(4)	CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5	
(4*)	PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9	
(5)	PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L	
(6)	CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L	
	Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC	
(7)	PWQO: value of 30 ug/L when FDP drains into streams	
	2.0	First point where guidelines/objectives are met after a preceding exceedance
		Set equal to RDL as >50% of data are below detection limit.
		Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form
		FDP concentration is set at the highest predicted average concentration in the five sedimentation ponds
~	75th percentile receiver concentration is above PWQO value	
(A)	Distances were determined based on the length of the main channel from a given FDP to the outlet of downstream subwatersheds and not a straight connection line.	
(B)	Hydrologic model limit	

7.2.1.1.3 Sanitary Sewage

Sanitary sewage generated during the operations phase is planned to be treated in an onsite sanitary wastewater treatment system and discharged into one of two locations:

1. one of the large outflow rate sedimentation ponds (SP-01, SP-02, TMF NE or TMF NW Ponds) where it will subsequently be treated further prior to discharge at an FDP; or

2. immediately adjacent to the FDP discharge into the receiver (FDP-SP-01, SP-02 or FDP-SP-TMF).

Table 7.6 presents the total concentrations for treated sanitary sewage and FDP discharges to receivers for regulatory and normal conditions with the sanitary sewage discharge immediately adjacent to the FDP. The industry standard treatment objective concentrations of biochemical oxygen demand (BOD) and *E. coli* are associated with sanitary sewage and treated mine water is not expected to be a contaminant source, so total concentrations at the combined discharge are reduced below industry standards. The combined treated FDP and treated sanitary sewage discharge un-ionized ammonia concentration is slightly higher (<1 µg/L) than the FDP only discharge concentration with all discharge concentrations predicted below the PWQO value of 20 µg/L. The total phosphorus concentration is expected to slightly increase (0.1% or less) for the combined treated FDP and treated sanitary sewage discharge. The combined treated FDP and sanitary sewage TSS concentrations are the same and do not represent an increase in concentration. Based on these discharge quality results, releasing treated sanitary sewage adjacent to a treated mine water FDP will provide similar water quality as the FDP only discharge, and the treated sanitary sewage will not require additional treatment prior to release to the receiver.

Table 7.6 Regulatory and Normal Condition Combined Sanitary Sewage and FDP Parameter Discharge Concentrations

Parameter	Unit	Regulatory Condition				Normal Condition			
		Maximum Mine Water Single Pond FDP-SP Concentration *	Sanitary Wastewater Daily Maximum Concentration	Total Regulatory Condition Discharge Concentration	Percent difference from FDP-SP Only Concentration (%)	Average Mine Water Single Pond FDP-Concentration *	Sanitary Wastewater Mean Monthly Concentration	Total Normal Condition Discharge Concentration	Percent difference from FDP-SP Only Concentration (%)
Biochemical Oxygen Demand (BOD)	mg/L	0	25	0.2	100 **	0	15	0.1	100 **
E. Coli	CFU/ 100 mL	0	1,000	7	100 **	0	200	1	100 **
Unionized ammonia (as N) ***	ug/L	7	100	8	9.4	6	80	6	10.7
Total phosphorus	ug/L	90	100	90	0.1	50	80	50	0.0
TSS	mg/L	30	30	30	0.0	15	15	15	0.0

Notes:

* Single large collection pond with maximum outflow rate of 28,000 m^3/d and average 27,300 m^3/d
** Mine water is not expected to be a source for this parameter
*** Unionized ammonia concentration calculated based on pH 7.5 and water temperature of 17°C (MOEE 1994)

7.2.1.2 Jocko Creek

7.2.1.2.1 Regulatory and Normal Conditions

Jocko Creek has no FDPs but will receive mine sourced non-point seepage. The Jocko Creek AC results are shown in Tables C-1 and C-2 in Appendix C of this report for PoPCs under regulatory and normal conditions, respectively. Concentrations at the pourpoint of subwatersheds within Jocko Creek are driven by mine seepage (a non-point source) and receiver quality without any influence by point-source FDPs. The PoPCs were identified in seepage based on their comparison with the regulatory objective/guideline values. The AC results observe PoPC concentrations at the pourpoint of each subwatershed meeting the objective/guidelines. The total iron concentration, which is a Policy 2 parameter in the receiver, is above the regulatory objectives/guideline, but lower than the receiver concentration. Total aluminum also is above the CWQG-FAL value in the seepage, but lower than the receiver concentration. Therefore, in compliance with the PWQOs, water quality in Jocko Creek is not degraded further due to effects of seepage. The edge of the “seepage” mixing zones is between the seepage discharge point along the main channel of a given subwatershed and the pourpoint of that subwatershed. The seepage rates and quality are not available at smaller than subwatershed spatial scales and therefore the extent of seepage mixing zones cannot be estimated at a reduced scale. The channel length of subwatersheds JC2, JC1, and JCDS are 13 km, 5.5 km, and 5 km, respectively, and represent the zones where full mixing of seepage occurs within each subwatershed.

Further comparison between the regulatory and normal conditions AC results showed that, for 16 out of 21 PoPCs concentrations under regulatory conditions had higher concentrations than those observed in normal conditions. Figure A.7 shows the average difference (in percent) between regulatory and normal conditions concentrations in the three subwatersheds within Jocko Creek. Total copper observes the highest percent increase for the normal condition compared to the regulatory condition (26%) and total vanadium the lowest percent increase (0.53%). The five parameters with increased concentrations in the receiver during normal conditions in comparison to the regulatory condition are due to lower seepage rate contributions that in the regulatory condition effectively assimilate concentrations in the receiver water quality more than the normal condition. Overall, there is improved surface water quality in normal conditions compared to the regulatory condition, but both conditions observe PoPC concentrations at the pourpoint of each subwatershed meeting the objective/guidelines.

7.2.2 Pit-Full Case

In the Pit-Full case where the five sedimentation ponds are naturalized, the pit lake, once full, overflows to the North Driftwood River and West Buskegau River. The excess water will be diverted through spillways to the receiving environment. The east closure spillway will divert water to the West Buskegau River at the location of FDP-SP-01 and the west closure spillway will divert water to the North Driftwood River at the location of FDP-SP-02. The pit overflow POPC concentrations under regulatory and normal conditions are predicted to be below regulatory objectives/guidelines. For Policy 2 parameters, water quality in the receivers is not degraded further due to pit lake discharge or mine seepage as the predicted concentrations are below the receiver baseline concentrations. Therefore, for both the West Buskegau River and the North Driftwood River, no mixing zone analysis is required. Results for this case are provided in Appendix C this report. The Pit-Full AC results associated with PoPCs under regulatory conditions for FDP-SP-01 and FDP-SP-02 are shown in Table C-3 and Table C-4 (Appendix C of this report), respectively. The results for climate normal conditions are provided in Table C-5 (for FDP-SP-01) and Table C-6 (FDP-SP-02) in Appendix C of this report.

There will be no spillway or surface discharge to Jocko Creek in the Pit-Full case. However, seepage from the TMF into lake L1 may influence Jocko Creek. AC results for Jocko Creek in the Pit-Full case are shown in Appendix C of this report where regulatory and normal conditions results are shown in Table C-7 and Table C-8, respectively. No exceedances above regulatory objective/guidelines were observed under regulatory or normal discharge conditions. For Policy 2 parameters, water quality in the receivers is not degraded further as the predicted concentrations are below the receiver's baseline concentrations. Therefore, mixing zone analysis is not required in the Pit-Full case in Jocko Creek.

7.2.3 Non-PoPCs AC Results

ACS results for non-PoPCs were also obtained using the same AC assessment approach applied to PoPCs. Tables C9-C14 in Appendix C of this report provide non-PoPCs concentrations at FDPs and downstream subwatersheds in the Construction/Operation case and during regulatory conditions. Non-PoPCs concentrations were below the regulatory objective/guidelines at FDPs, indicating that no mixing zone analysis is required. Furthermore, no exceedances above the regulatory objective/guidelines were observed at downstream subwatersheds due to seepage loads along the main channel of the West Buskegau River, North Driftwood River and Jocko Creek. Therefore, no further assessment of non-PoPC parameter results is required.

Appendix C of this report also shows the Pit-Full AC results for Non-PoPCs in Table C-15 (the West Buskegau River, regulatory conditions), Table C-16 (the North Driftwood River, regulatory conditions), Table C-17 (Jocko Creek, regulatory conditions), Table C-18 (the West Buskegau River, normal conditions), Table C-19 (the North Driftwood River, normal conditions), and Table C-20 (Jocko Creek, normal conditions). The concentrations of Non-PoPCs were below guidelines in receivers in the Pit-Full case and no further analysis is required.

7.3 Recommended Effluent Criteria

Based on the AC assessment results, the recommended effluent criteria for the FDPs are presented in Table 7.7, which includes effluent concentration limits/objectives for PoPCs, including target effluent objectives, mean monthly limits and maximum daily limits. These limits are determined based on treatment technology and were used in this ACS to identify the extent of the mixing zones in the regulatory and normal conditions. Monthly average and daily maximum limits for total suspended solids are based on MDMER criteria. Table 7.8 provides the recommended maximum daily discharge rates from for FDPs in the Project Area to the receivers.

Table 7.7 Recommended Effluent Criteria

Parameter	MDMER		Regulatory Guidelines (mg/L) •	Target Effluent Objective (mg/L)	Monthly Mean Limit (mg/L)	Daily Maximum Limit (mg/L)
	Maximum Authorized Monthly Mean Concentration (mg/L)	Maximum Authorized Concentration in a Grab Sample (mg/L)				
Nitrite (as N)	-	-	0.06*	0.5	0.75	1
Nitrate (as N)	-	-	3*	6	10	12
Fluoride	-	-	0.12*	0.18	0.24	0.36
Aluminum (Total)	-	-	0.1*	0.12	0.15	0.225
Aluminum (Dissolved)	-	-	0.075	0.018	0.023	0.034
Arsenic (Total)	0.1	0.2	0.005	0.0075	0.01	0.015
Boron (Total)	-	-	0.2	0.3	0.4	0.6
Cobalt (Total)	-	-	0.0009	0.0018	0.0027	0.0036
Chromium III	-	-	0.0089	0.013	0.018	0.027
Chromium VI	-	-	0.001	0.0015	0.002	0.003
Copper (Total)	0.1	0.2	0.005	0.0075	0.01	0.015
Iron (Total)	-	-	0.3	0.5	0.6	0.9
Nickel (Total)	0.25	0.5	0.025	0.0375	0.05	0.075
Selenium (Total)	-	-	0.001*	0.001	0.002	0.003
Uranium (Total)	-	-	0.005	0.0075	0.01	0.015
Vanadium (Total)	-	-	0.006	0.01	0.012	0.018
Zinc (Total)	0.4	0.8	0.02	0.03	0.04	0.06
Zinc (Dissolved)	-	-	0.075-0.079*,A	0.03	0.04	0.06

Parameter	MDMER		Regulatory Guidelines (mg/L) •	Target Effluent Objective (mg/L)	Monthly Mean Limit (mg/L)	Daily Maximum Limit (mg/L)
	Maximum Authorized Monthly Mean Concentration (mg/L)	Maximum Authorized Concentration in a Grab Sample (mg/L)				
Phosphorus	-	-	0.03	0.05	0.06	0.09
Suspended Solids	15	30	Note *,C	-	15	30

• Notes:

PWQO or CWQG-FAL when PWQO is not available (shown with *)

A Varies across receivers based on pH, hardness, and dissolved organic carbon concentration

B Not above PWQO in the effluent. It is included in the list of PoPCs because is the concentration was above PWQO in the mine seepage

C 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).

Table 7.8 Recommended Maximum Daily Discharge at FDPs

FDP	Maximum Discharge (m^3/d)	Receiving Water
FDP-SP-03	10,000	West Buskegau River
FDP-SP-01	28,000	
FDP-TMF-SP	56,000	North Driftwood River
FDP-SP-02	28,000	

8 Summary

An ACS was completed for the construction, operations and decommissioning and closure phases of the Project. The ACS was completed for the two receivers that receive discharge via FDPs and seepage/ groundwater discharge due to mining activities, the West Buskegau River and the North Driftwood River, as well as Jocko Creek that receives only seepage. Four FDPs were considered, two on the West Buskegau River (FDP-SP-03 and FDP-SP-01) and the other two on the North Driftwood River (FDP-TMF-SP and FDP-SP-02). The cumulative effects of the two FDPs in each receiver were assessed with respect to downstream concentrations for PoPCs. The assessments were conducted using the near-field mixing CORMIX model in conjunction with mass balance analyses to determine PoPC concentrations at the point of full mixing and at the pourpoint (outlet) of subwatersheds downstream of the FDPs.

Water quality in the mixing zone in each receiver was assessed under regulatory (low flow) and normal conditions. Regulatory conditions were considered as a conservative worst case scenario, while normal conditions were considered representative of the expected average discharge conditions adjusted for climate change. These two discharge conditions were assessed in two life of mine cases, which were Construction/Operation when the four FDPs were discharging and Pit-Full when spillways from the filled Open Pit Lake discharged to the West Buskegau River and North Driftwood River. The Construction/Operations case represents life of mine discharge conditions between Mine Year 4 and 23 of operations phase 2 when the four FDPs will be discharging for full PA build-out. The regulatory and normal conditions considered discharge quality for the full operating life of each collection pond between Mine Year -3 and 41. The Pit-Full condition represents Mine Year 167 after the pit lake begins discharging to receivers.

Discharge quality from the FDPs and seepage quality from the Project is substantially below MDMER criteria values. The near-field mixing assessment estimated that the point of full mixing for the regulatory and normal conditions were less than 200 m downstream of each FDP within the West Buskegau River and North Driftwood River. Concentrations calculated at the point of full mixing and further downstream to the determine extent of the mixing zone were longest for the Construction/Operations case for the regulatory conditions (worst-case scenario) with the West Buskegau River reaching the confluence with the Frederick House River, and the North Driftwood River reaching the confluence with the Abitibi River. Nitrite, total iron and total phosphorus were the parameters under regulatory conditions that determined the extent of the mixing zone in each receiver. For the Construction/Operations case for normal conditions, the extent of the mixing zone was typically at the point of full mixing for the FDPs, except for nitrate in the North Driftwood River that reached 3.6 km downstream of FDP-SP-02.

In the Pit-Full case, representing the passive closure phase of the Project, concentrations in the pit lake discharge to West Buskegau River and North Driftwood River were below PWQO/CWQG-FAL objective/guideline values in both regulatory and normal conditions. Discharge quality below criteria values do not require a mixing zone and no passive closure phase treatment is predicted to be required for the Pit-Full case.

The Jocko Creek non-point source seepage AC results at the outlet of each hydrologic model subwatershed predict receiver water quality that is at or below objective/guideline values for both the regulatory and normal condition for the Construction/Operation case.

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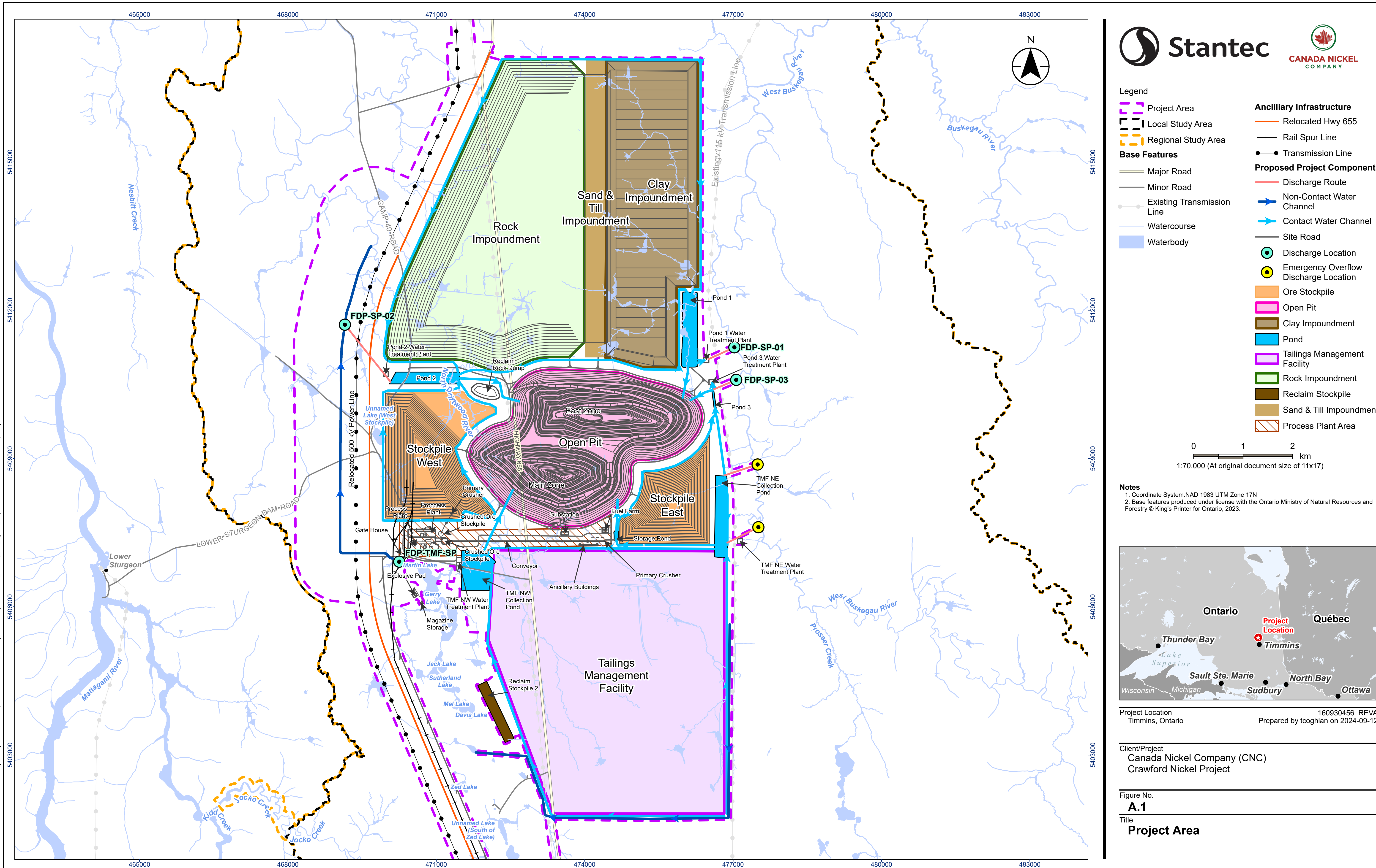
Appendices

Appendix A Figures



Stantec
CANADA NICKEL COMPANY
Legend
Project Area
Local Study Area
Regional Study Area
Base Features
Major Road
Minor Road
Existing Transmission Line
Watercourse
Waterbody
Ancilliary Infrastructure
Relocated Hwy 655
Rail Spur Line
Transmission Line
Proposed Project Components
Discharge Route
Non-Contact Water Channel
Contact Water Channel
Site Road
Discharge Location
Emergency Overflow Discharge Location
Ore Stockpile
Open Pit
Clay Impoundment
Pond
Tailings Management Facility
Rock Impoundment
Reclaim Stockpile
Sand & Till Impoundment
Process Plant Area
0 1 2 km
1:70,000 (At original document size of 11x17)
Notes
1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.
Ontario
Québec
Project Location
Thunder Bay
Timmins
Lake Superior
Sault Ste. Marie
North Bay
Sudbury
Ottawa
Wisconsin
Michigan
Project Location
Timmins, Ontario
160930456 REVA
Prepared by tcoghlan on 2024-09-12
Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project
Figure No.
A.1
Title
Project Area
Rock Impoundment
Sand & Till Impoundment
Clay Impoundment
Open Pit
East Zone
Main Zone
Stockpile West
Stockpile East
Tailings Management Facility
Pond 1
Pond 1 Water Treatment Plant
Pond 2
Pond 2 Water Treatment Plant
Pond 3
Pond 3 Water Treatment Plant
FDP-SP-01
FDP-SP-02
FDP-SP-03
FDP-TMF-SP
Reclaim Rock Dump
Primary Crusher
Process Plant
Crushed Ore Stockpile
Substation
Fuel Farm
Storage Pond
Gate House
Conveyor
Ancillary Buildings
Explosive Pad
Magazine Storage
TMF NW Water Treatment Plant
TMF NW Collection Pond
TMF NE Collection Pond
TMF NE Water Treatment Plant
Reclaim Stockpile 2
Relocated 500 kV Power Line
Existing 115 kV Transmission Line
CAMP-40-ROAD
LOWER-STURGEON-DAM-ROAD
HIGHWAY 655
Lower Sturgeon
North Driftwood River
West Buskegau River
Buskegau River
Prosser Creek
Nesbitt Creek
Mattagami River
Kidd Creek
Jocko Creek
Martin Lake
Gerry Lake
Jack Lake
Sutherland Lake
Mel Lake
Davis Lake
Zed Lake
Unnamed Lake (South of Zed Lake)
Unnamed Lake (West Stockpile)
465000
468000
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474000
477000
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483000
5403000
5406000
5409000
5412000
5415000
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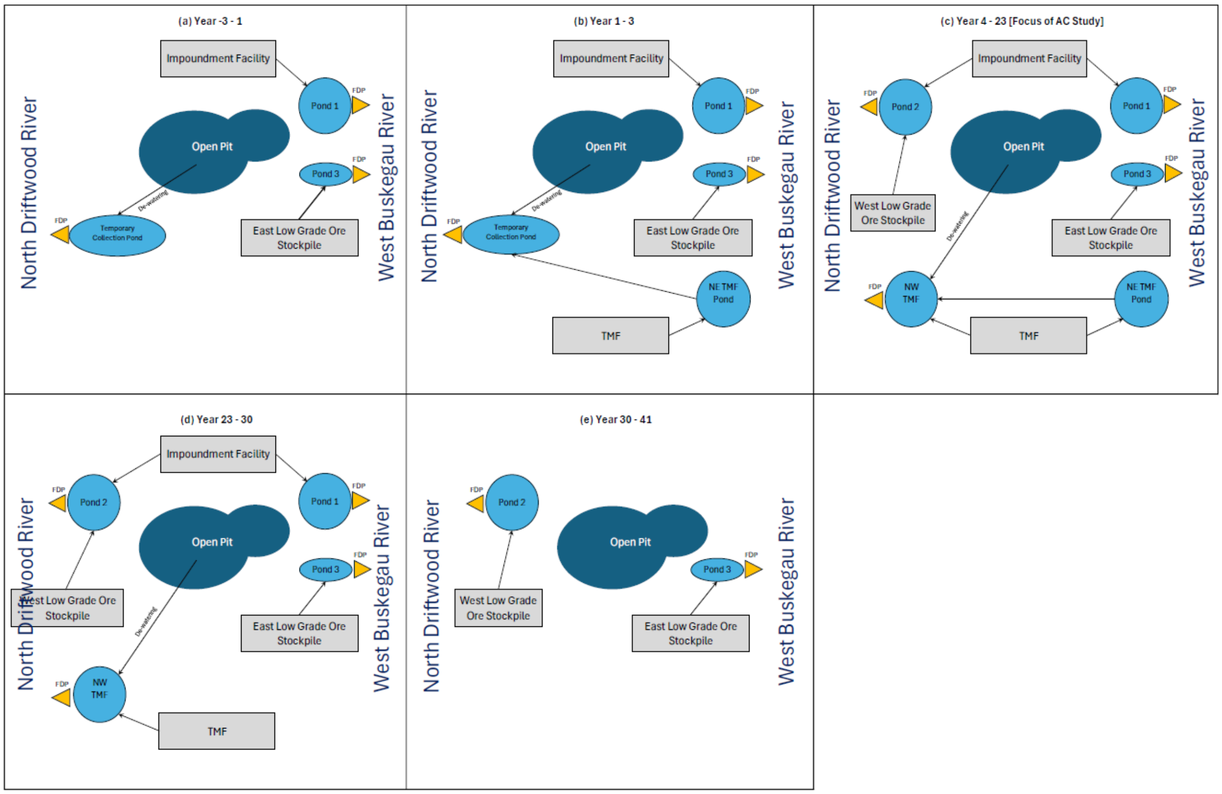
Figure A.2 Schematics of Water Management Plan Sequencing in Different Phases of the Project

Note:, focus of the Construction/Operation Case for the ACS is Panel (c).



Source: Based on Site-Wide Water Management Plan (Appendix J of the Impact Statement)

Figure A.3 Project Mine Effluent Flow Diagram for the Construction/Operation Case

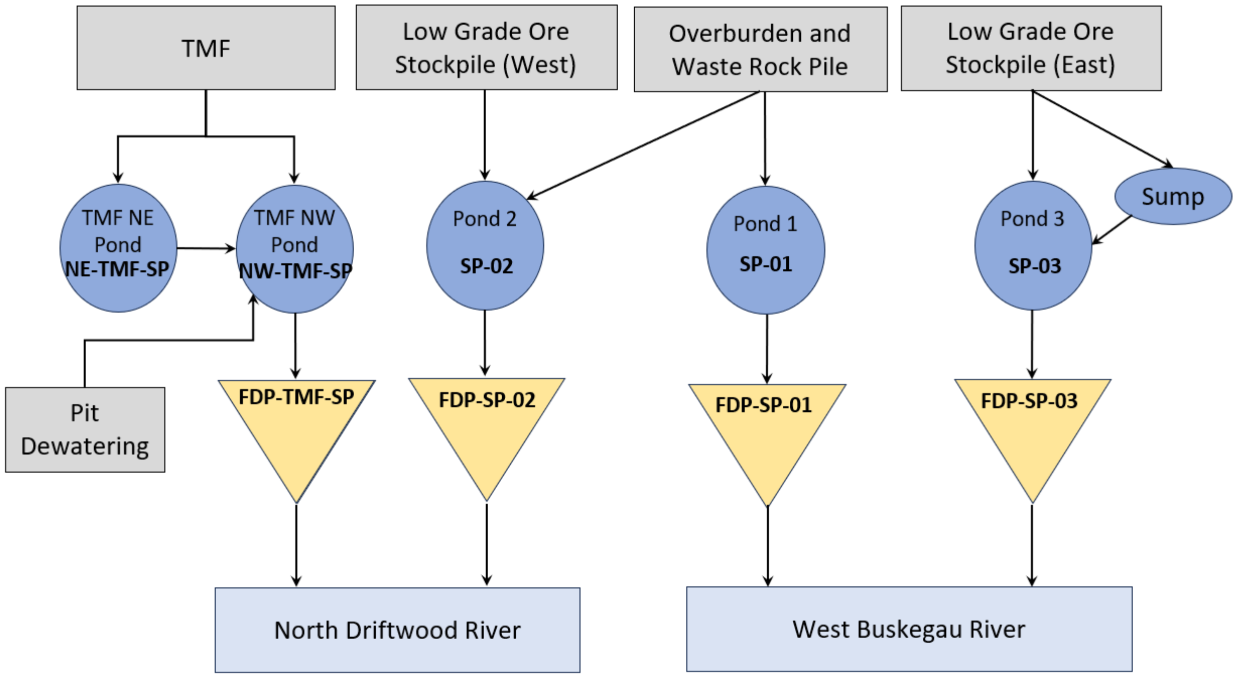
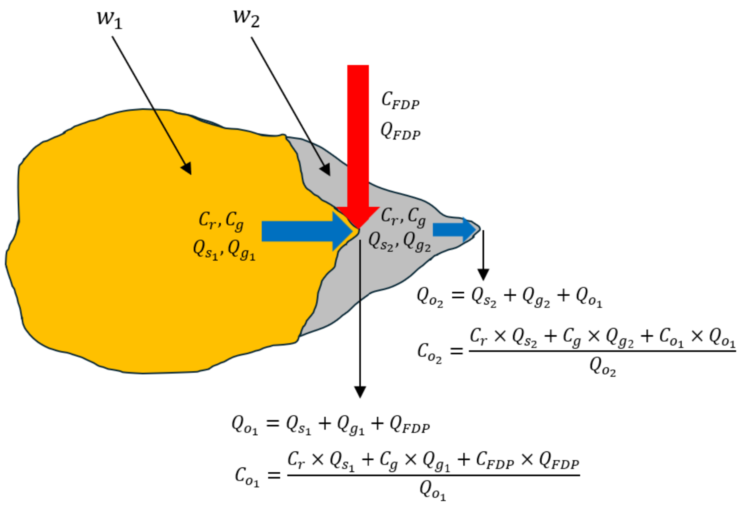
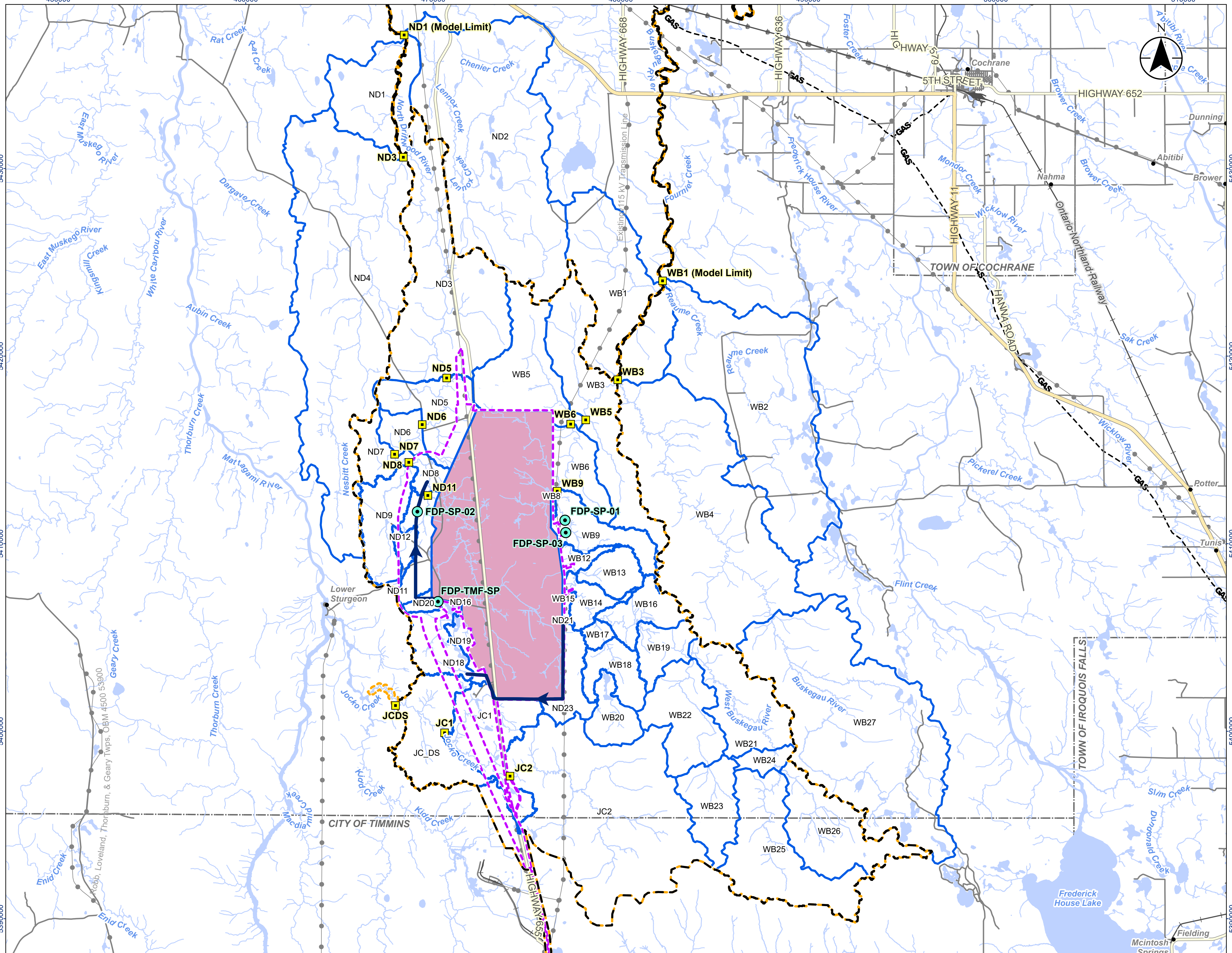


Figure A.4 Schematic of Mass Balance Assessment for the Determination of Concentrations at the Outlet of Nested Subwatersheds





Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local Study Area
- Regional Study Area
- Non-Contact Diversion Channel
- Existing Condition Subwatershed
- Subwatershed Reports to Mine Water Management System
- Discharge Location
- Subwatershed Outlet

Base Features

- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- GAS Natural Gas Pipeline
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody

0 2.5 5 km

1:210,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.

Project Location
Timmins, Ontario

160930456 REVA
Prepared by tcoghlan on 2024-09-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5

Title
Location of Subwatersheds within the Hydrologic Model Boundary Used in Mass Balance Analysis

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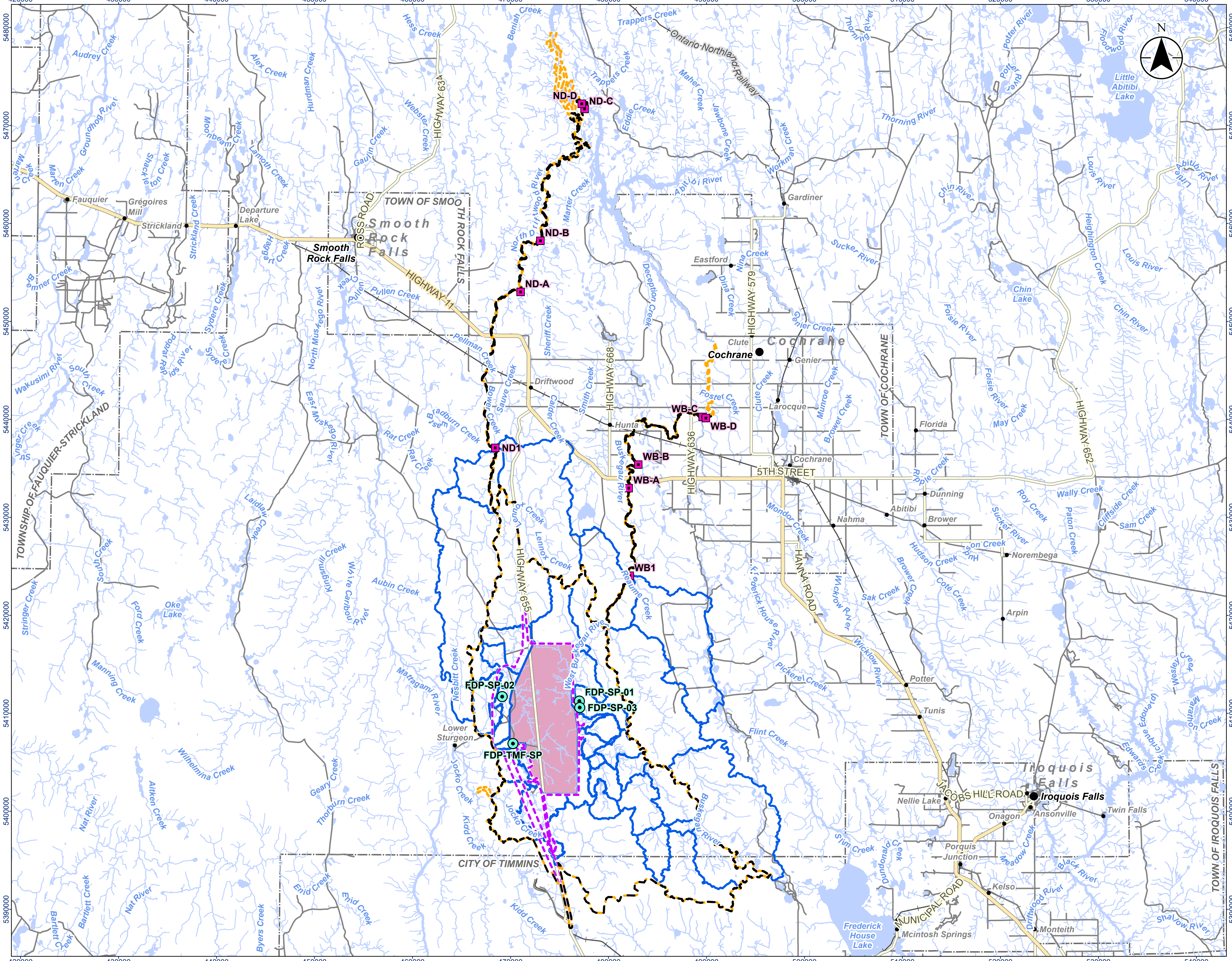
Revised: 2024-09-12 By: tcoghlan



Legend

- Project Area
- Local Study Area
- Regional Study Area

Base Features

- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody
- Existing Condition Subwatershed
- Subwatershed Reports to Mine Water Management System
- Discharge Location
- Subwatershed Outlet

0 5 10 km

1:400,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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Project Location
Timmins, Ontario

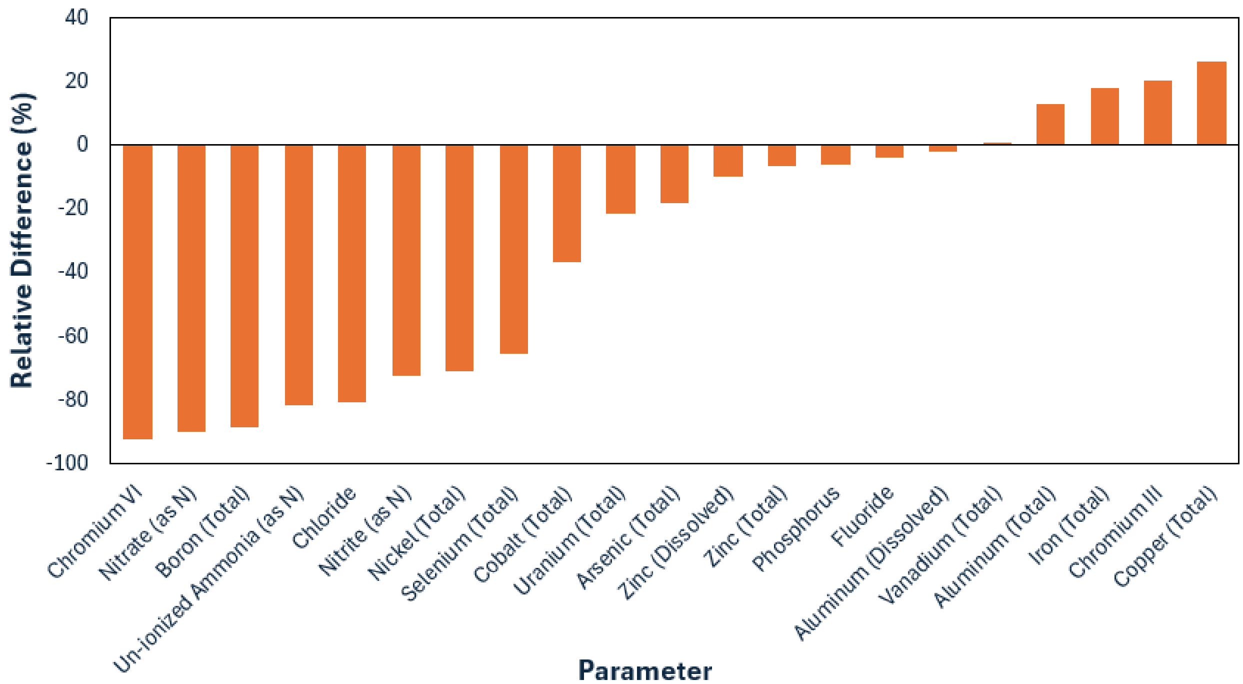
160930456 REVA
Prepared by tcoghlan on 2024-09-12

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6

Title
Location of Subwatersheds Outside of the Hydrologic Model Limit Used in Mass Balance Analysis

Figure A.7 Percent Difference between AC Results in the Two Discharge Conditions in Jocko Creek



Note:, Negative Numbers Indicate Lower Concentrations in Normal Conditions than Regulatory Conditions.

Appendix B Input Data Tables

B.1 Seepage

B.1.1 Seepage Quantity

Table B.1.1.1 Seepage Quantity at the Subwatershed Scale

Characteristics/Case			Sub-Watershed IDs																												
Subwatershed			JC2	JC1	JCDS	ND18	ND20	ND15	ND11	ND8	ND7	ND6	ND5	ND3	WB21	WB19	WB16	WB14	WB12	WB9	WB6	WB5	WB3	L1	L2	L3	L4	L5	L6	L7	L8
Drainage Area (ha)			7182.00	1945.00	1837.00	936.10	146.17	323.52	766.85	303.22	628.00	480.00	1500.54	5061.00	1887.00	723.00	851.00	480.70	251.80	1061.90	1001.40	2126.80	2871.00	-	-	-	-	-	-	-	766.85
Reach Length (km)			13.0	18.5	23.5	59.1	1175.5	2003.6	1700.0	2711.2	1716.8	3141.3	5691.0	16240.6	12966.6	5350.1	4394.8	4752.2	2285.3	4279.0	5649.1	1025.5	4175.2	-	-	-	-	-	-	-	-
Seepage Rate (m^3/d)	Operations, Regulatory	Tailing Management	1270.1	935.0	51.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	88.9	771.0	1243.8	0.0	0.0	0.0	0.0	0.0	1502.9	43.3	1099.5	154.8	58.4	1453.1	0.0	0.0
		Impoundment Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.0	8.1	13.6	124.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.4	36.6	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	324.0
		Low-Grade Stockpiles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Tailings	3.6	94.5	4.8	0.0	0.0	0.0	0.0	0.0	0.0	188.0	0.0	319.9	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	93.5	12.9	0.0	206.7	0.0	0.0
		Total	1273.7	1029.5	55.9	0.0	0.0	0.0	0.0	55.0	8.1	201.6	124.6	319.9	1.1	88.9	775.8	1246.2	0.0	0.0	67.4	36.6	1.4	1502.9	43.3	1193.0	167.8	58.4	1659.8	0.0	324.0
	Operations, Normal	Tailing Management	724.1	603.4	40.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	81.2	449.8	710.2	0.0	0.0	0.0	0.0	0.0	870.6	24.6	624.7	88.0	33.2	825.6	0.0	0.0
		Impoundment Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.2	3.5	11.0	70.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.3	20.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	139.9
		Low-Grade Stockpiles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Tailings	1.5	40.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0	81.2	0.0	138.2	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.4	5.6	0.0	89.3	0.0	0.0
		Total	725.6	644.3	42.3	0.0	0.0	0.0	0.0	33.2	3.5	92.2	70.8	138.2	0.5	81.2	451.9	711.2	0.0	0.0	38.3	20.8	0.8	870.6	24.6	665.1	93.6	33.2	914.9	0.0	139.9
	Pit-Full, Regulatory and Normal	Tailing Management	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	208.1	0.0	58.1	1.9	0.0	528.2	15.9	11.8
		Impoundment Facility	0.0	0.0	0.0	0.0	0.0	0.0	69.9	160.8	1.0	29.0	258.5	18.8	0.0	0.0	0.0	0.0	0.0	47.5	310.1	66.3	11.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.4
		Low-Grade Stockpiles	0.0	0.0	0.0	0.0	0.0	15.5	22.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	55.3	177.4
		Tailings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	6.5	22.3
		Total	0.0	0.0	0.0	0.0	0.0	15.5	91.9	160.8	1.0	29.0	258.5	18.8	0.0	0.0	0.0	0.0	0.0	47.5	310.1	66.3	11.6	208.1	0.0	58.1	1.9	0.0	535.0	77.8	216.9

B.1.2 Seepage Quality

Table B.1.2.1 Seepage Quality: Maximum Concentrations

Parameter(0)	Unit	Guideline		Seepage (Construction/Operation) (*)				Seepage (Pit-Full) (**)
		Source (1)	Value	West Stockpile	East Stockpile	Impoundment Facility	TMF	Impoundment Facility
Sulphate	µg/L	BC-MECCS	309,000(2)	122,381	146,842	244,474	282,317	325,958
Chloride	µg/L	CCME CWQG-FAL	120,000	62,160	74,572	120,963	282,339	715
Bromine	µg/L	-	N/A	13,687	16,714	8,399	1,496	11,199
Nitrite-N	µg/L	CCME CWQG-FAL	60	82	175	254	217	100
Nitrate-N	µg/L	CCME CWQG-FAL	3,000	20,303	24,790	35,860	5,198	4,908
Un-ionized Ammonia-N	µg/L	PWQO	20(3)	1.44	1.75	2.54	22.81	0.60
Fluoride	µg/L	CCME CWQG-FAL	120	30	30	30	30	30
Chromium III	µg/L	PWQO	8.9	0.1	0.1	0.1	0.1	0.0971
Chromium VI	µg/L	PWQO	1	12	14	0.6	3.2	0.6
Mercury	µg/L	CCME CWQG-FAL	0.026	0.005	0.005	0.005	0.005	0.005
Aluminum	µg/L	PWQO	75(4,~)	24	25	25	25	25
Silver	µg/L	PWQO	0.1	0.00025	0.00025	0.00025	0.00025	0.00025
Arsenic	µg/L	Interim PWQO	5	3.3	3.9	28	1.1	37
Barium	µg/L	-	N/A	301	177	82	8.7	17
Beryllium	µg/L	PWQO	1,100(5)	0.0035	0.0035	0.0035	0.0035	0.0035
Boron	µg/L	PWQO	200	1.2	1.5	9	282	12
Bismuth	µg/L	-	N/A	0.005	0.005	0.005	0.005	0.005
Calcium	µg/L	-	N/A	2,373	2,676	82,204	1,459	72,289
Cadmium	µg/L	Interim PWQO	0.5(6)	0.04	0.04	0.07	0.01	0.1
Cobalt	µg/L	Interim PWQO	0.9	0.62	0.75	0.91	0.92	1.2
Copper	µg/L	Interim PWQO	5(7)	6.9	8.3	11	1	15
Iron	µg/L	PWQO	300(~)	2.1	2.1	2.1	2.1	2.1
Potassium	µg/L	-	N/A	263	299	14,935	2,930	13,133
Lithium	µg/L	-	N/A	1.3	1.5	6.9	39	9.2
Magnesium	µg/L	-	N/A	82,695	93,516	71,362	181,631	62,756
Manganese	µg/L	-	N/A	14	17	141	70	189
Molybdenum	µg/L	Interim PWQO	40	4.7	5.6	17	28	23
Silicon	µg/L	-	N/A	0	0	0	0	0
Sodium	µg/L	-	N/A	212	241	21,515	26,480	18,920
Nickel	µg/L	PWQO	25	16	19	7.6	17	10
Lead	µg/L	Interim PWQO	5(8)	1.1	1.3	2.2	0.09	2.9
Antimony	µg/L	Interim PWQO	20	0.45	0.45	0.45	0.45	0.45

Parameter(0)	Unit	Guideline		Seepage (Construction/Operation) (*)				Seepage (Pit-Full) (**)
		Source (1)	Value	West Stockpile	East Stockpile	Impoundment Facility	TMF	Impoundment Facility
Selenium	µg/L	CCME CWQG-FAL	1	1.1	1.4	1.6	2.9	2.2
Tin	µg/L	-	N/A	0.94	1.1	2.9	1.4	3.9
Strontium	µg/L	-	N/A	100	121	323	9.6	431
Titanium	µg/L	-	N/A	0.9	1.1	4.9	0.1	6.5
Thallium	µg/L	Interim PWQO	0.3	0.0025	0.0025	0.0025	0.06	0.0025
Uranium	µg/L	Interim PWQO	5	9.3	11	18	0.01	23
Vanadium	µg/L	Interim PWQO	6	1	1.2	23	0.32	30
Tungsten	µg/L	PWQO	30	1.4	1.7	2.7	7.5	3.5
Yttrium	µg/L	-	N/A	0.24	0.29	0.48	0.07	0.64
Zinc	µg/L	Interim PWQO	20	24	29	48	2	64
Phosphorus	µg/L	PWQO	30(9,~)	42	42	2.1	20	0.53

Notes:
CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
PWQO Provincial Water Quality Objective
BC-MECCS British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life
(0) Same concentrations are considered for total and dissolved forms, if guideline values are available for both forms
(1) PWQO, BC-MECCS or CCME CWQG-FAL
(2) 128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L
(3) Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17°C
(4) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9
(5) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L
(6) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L
(7) PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L
(8) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L
(9) PWQO: value of 30 ug/L when FDP drains into streams
N/A Not applicable
* Parameters with above guideline concentrations are shown in bold red font.
** Concentrations for stockpiles are zero; Concentrations for TMF and tailings are similar to those of Construction/Operation; Above-guideline concentrations are not highlighted.
~ 75th percentile receiver concentration is above PWQO value

Table B.1.2.2 Seepage Quality: Average Concentrations

Parameter	Unit	Guideline		Seepage (Operating)				Seepage (Pit-Full) [*]
		Source [1]	Value	West Stockpile	East Stockpile	Impoundment Facility	TMF	Impoundment Facility
Sulphate	µg/L	BC-MECCS	309,000[2]	69,043	98,777	148,165	282,317	325,958
Chloride	µg/L	CCME CWQG-FAL	120,000	35,070	50,175	56,058	282,339	715
Bromine	µg/L	-	N/A	7,754	11,106	5,059	1,496	11,199
Nitrite-N	µg/L	CCME CWQG-FAL	60	39	109	132	217	100
Nitrate-N	µg/L	CCME CWQG-FAL	3,000	9,620	15,425	18,647	5,198	4,908
Un-ionized Ammonia-N	µg/L	PWQO	20[3]	0.68	1.1	1.3	23	0.60
Fluoride	µg/L	CCME CWQG-FAL	120	26	28	28	30	30
Chromium III	µg/L	PWQO	8.9	0.08	0.09	0.1	0.1	0.097
Chromium VI	µg/L	PWQO	1	6.5	9.4	0.6	3.2	0.6
Mercury	µg/L	CCME CWQG-FAL	0.026	0.004	0.005	0.005	0.005	0.005
Aluminum	µg/L	PWQO	75[4,~]	21	24	24	25	25
Silver	µg/L	PWQO	0.1	0.0002	0.0002	0.0002	0.0003	0.0003
Arsenic	µg/L	Interim PWQO	5	1.8	2.6	17	1.1	37
Barium	µg/L	-	N/A	56	55	36	8.7	17
Beryllium	µg/L	PWQO	1,100[5]	0.003	0.003	0.003	0.004	0.004
Boron	µg/L	PWQO	200	0.62	0.88	5.1	282	12
Bismuth	µg/L	-	N/A	0.004	0.004	0.005	0.005	0.005
Calcium	µg/L	-	N/A	1,567	2,046	54,259	1,459	72,280
Cadmium	µg/L	Interim PWQO	0.5[6]	0.02	0.03	0.04	0.01	0.1
Cobalt	µg/L	Interim PWQO	0.9	0.35	0.5	0.55	0.92	1.2
Copper	µg/L	Interim PWQO	5[7]	3.9	5.6	6.9	1	15
Iron	µg/L	PWQO	300[~]	1.8	2	2	2.1	2.1
Potassium	µg/L	-	N/A	174	228	9,880	2,930	13,133
Lithium	µg/L	-	N/A	0.73	1	4.2	39	9.2
Magnesium	µg/L	-	N/A	55,223	71,616	44,590	181,631	62,756
Manganese	µg/L	-	N/A	8.1	12	86	70	189
Molybdenum	µg/L	Interim PWQO	40	2.6	3.8	11	28	23
Silicon	µg/L	-	N/A	0	0	0	0	0
Sodium	µg/L	-	N/A	140	184	14,244	26,480	18,920
Nickel	µg/L	PWQO	25	9.1	13	4.6	17	10
Lead	µg/L	Interim PWQO	5[8]	0.62	0.89	1.3	0.09	2.9
Antimony	µg/L	Interim PWQO	20	0.4	0.4	0.4	3.9	0.4
Selenium	µg/L	CCME CWQG-FAL	1	0.64	0.92	0.98	2.9	2.2
Tin	µg/L	-	N/A	0.53	0.75	1.8	1.4	3.9

Parameter	Unit	Guideline		Seepage (Operating)				Seepage (Pit-Full) (*)
		Source (1)	Value	West Stockpile	East Stockpile	Impoundment Facility	TMF	Impoundment Facility
Strontium	µg/L	-	N/A	56	81	197	9.6	431
Titanium	µg/L	-	N/A	0.51	0.73	2.9	0.1	6.5
Thallium	µg/L	Interim PWQO	0.3	0.002	0.002	0.002	0.058	0.002
Uranium	µg/L	Interim PWQO	5	5.2	7.5	11	0.01	23
Vanadium	µg/L	Interim PWQO	6	0.56	0.8	14	0.32	30
Tungsten	µg/L	PWQO	30	0.78	1.1	1.6	7.5	3.5
Yttrium	µg/L	-	N/A	0.14	0.2	0.29	0.07	0.64
Zinc	µg/L	Interim PWQO	20	14	20	29	2	64
Phosphorus	µg/L	PWQO	30(9,~)	36	3*	0.68	20	0.53

Notes:

CCME CWQG-FAL	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
PWQO	Provincial Water Quality Objective
BC-MECCS	British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life
(1)	PWQO, BC-MECCS or CCME CWQG-FAL
(2)	128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L
(3)	Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17°C
(4)	PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9
(5)	PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L
(6)	PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L
(7)	PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L
(8)	PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L
(9)	PWQO: value of 30 ug/L when FDP drains into streams
N/A	Not applicable
*	Concentrations for stockpiles are zero; Concentrations for TMF and tailings are similar to those of Operating; Above-guideline concentrations are not highlighted.
~	75th percentile receiver concentration is above PWQO value

B.2 Effluent

B.2.1 Predicted Untreated Effluent Quality

Table B.2.1.1 Predicted Untreated Effluent Quality: Maximum Concentrations (Dissolved and 30 mg/L Total Suspended Solids)

Parameter	Unit	Guideline		Maximum Simulated Concentrations				
				Effluent				
		Source [1]	Value	SP-01	SP-02	SP-03	NE-TMF-SP	NW-TMF-SP
Sulphate	µg/L	BC-MECCS	309,000[2]	220,100	160,700	102,300	132,700	126,400
Chloride	µg/L	CCME CWQG-FAL	120,000	109,200	80,000	51,980	10,590	20,930
Bromine	µg/L	-	N/A	7,550	7,691	11,630	3,334	3,251
Nitrite-N	µg/L	CCME CWQG-FAL	60	**229**	**168**	**122**	**101**	**92**
Nitrate-N	µg/L	CCME CWQG-FAL	3,000	**32,340**	**24,460**	**17,260**	**8,089**	**7,905**
Un-ionized Ammonia-N	µg/L	PWQO	20[3]	2	5	1	7	7
Fluoride	µg/L	CCME CWQG-FAL	120	32	28	21	**139**	83
Chromium III	µg/L	PWQO	8.9	**26**	**26**	**27**	**27**	**26**
Chromium VI	µg/L	PWQO	1	0.64	**6.20**	**9.80**	**4.70**	**4.30**
Mercury (Trace)	µg/L	CCME CWQG-FAL	0.026	0.007	0.007	0.005	0.012	0.008
Total Aluminum	µg/L	PWQO	100[4,~]	**1,404**	**1,400**	**1,392**	**1,405**	**1,405**
Dissolved Aluminum (0.2 µm)	µg/L	PWQO	75[4*,~]	32	28	21	34	33
Total Silver	µg/L	PWQO	0.1	0.02	0.02	0.02	0.07	0.04
Total Arsenic	µg/L	Interim PWQO	5	**25**	**16**	3	**10**	**10**
Total Barium	µg/L	-	N/A	73	74	112	13	13
Total Beryllium	µg/L	PWQO	1,100[5]	0.01	0.01	0.01	7.74	1.77
Total Boron	µg/L	PWQO	200	8.40	5.70	1.60	109.00	102.00
Total Bismuth	µg/L	-	N/A	0.01	0.01	0.01	0.09	0.01
Calcium	µg/L	-	N/A	75,553	50,663	3,186	22,583	22,133
Total Cadmium	µg/L	Interim PWQO	0.5[6]	0.07	0.05	0.03	0.03	0.03
Total Cobalt	µg/L	Interim PWQO	0.9	**3.00**	**2.80**	**2.70**	**2.70**	**2.70**
Total Copper	µg/L	Interim PWQO	5[7]	**13**	**10**	**8**	**6**	**6**
Total Iron	µg/L	PWQO	300[~]	**1,832**	**1,830**	**1,905**	**1,889**	**1,884**
Potassium	µg/L	-	N/A	13,624	8,963	314	3,986	3,893
Total Lithium	µg/L	-	N/A	12	7	12	11	11
Total Magnesium	µg/L	-	N/A	67,593	62,153	68,503	58,423	53,473
Total Manganese	µg/L	-	N/A	163	113	43	82	81
Dissolved Manganese	µg/L	CCME CWQG-FAL	530[8]	133	82	13	51	50
Total Molybdenum	µg/L	Interim PWQO	40	16	11	4	8	7
Total Silicon	µg/L	-	N/A	616	609	946	984	1,676
Sodium	µg/L	-	N/A	19,685	12,955	374	5,794	6,019
Total Nickel	µg/L	PWQO	25	**32**	**34**	**39**	**32**	**31**

Parameter	Unit	Guideline		Maximum Simulated Concentrations				
				Effluent				
		Source [1]	Value	SP-01	SP-02	SP-03	NE-TMF-SP	NW-TMF-SP
Total Lead	µg/L	Interim PWQO	5[9]	2.0	1.5	1.0	0.9	0.9
Total Antimony	µg/L	Interim PWQO	20	0.50	0.45	0.34	0.99	0.52
Total Selenium	µg/L	CCME CWQG-FAL	1	**1.50**	**1.20**	0.98	**1.50**	**1.30**
Total Tin	µg/L	-	N/A	426	419	755	586	567
Total Strontium	µg/L	-	N/A	294	201	87	115	113
Total Titanium	µg/L	-	N/A	50	49	46	47	47
Total Thallium	µg/L	Interim PWQO	0.3	0.004	0.004	0.003	0.044	0.006
Total Uranium	µg/L	Interim PWQO	5	**16**	**12**	**8**	**7**	**6**
Total Vanadium	µg/L	Interim PWQO	6	**23**	**15**	3	**10**	**10**
Total Tungsten	µg/L	PWQO	30	3.10	2.10	1.60	2.00	1.90
Total Yttrium	µg/L	-	N/A	1.40	1.10	1.80	1.60	1.50
Total Zinc	µg/L	Interim PWQO	20	**45**	**33**	**22**	**21**	**21**
Dissolved Zinc	µg/L	CCME CWQG-FAL	see notes[10]	44	32	21	20	19
Total Phosphorus	µg/L	PWQO	30[11,~]	7	27	**34**	**39**	**36**

Notes:

CCME CWQG-FAL	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
PWQO	Provincial Water Quality Objective
BC-MECCS	British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life
(1)	PWQO, BC-MECCS or CCME CWQG-FAL
(2)	128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L
(3)	Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17°C
(4)	CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5
(4*)	PWQO (clay-free samples): 15 µg/L for 4.5<pH<5.5 and 75 µg/L for 6.5<pH<9
(5)	PWQO: 11 µg/L if hardness is less than 75 mg/L, and 1,100 µg/L if hardness is larger than 75 mg/L
(6)	PWQO Interim: 0.1 µg/L if hardness is less than 100 mg/L, and 0.5 µg/L if hardness is larger than 100 mg/L
(7)	PWQO Interim: 1 µg/L if hardness is between 0 and 20 mg/L, and 5 µg/L if hardness is larger than 20 mg/L
(8)	CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L
(9)	PWQO Interim: 1 µg/L if hardness is less than 30 mg/L, 3 µg/L if hardness is between 30 and 80 mg/L, and 5 µg/L if hardness is larger than 80 mg/L
(10)	CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L. Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC. West Buskegau River 95 µg/L, North Driftwood River 84 µg/L , Jocko Cree 85 µg/L
(11)	PWQO: value of 30 µg/L when FDP drains into streams
N/A	Not applicable
~	75th percentile receiver concentration is above PWQO value

Table B.2.1.2 Predicted Untreated Effluent Quality: Average Concentrations (Dissolved and 10 mg/L Total Suspended Solids)

				Average Simulated Concentrations				
		Guideline		Effluent				
Parameter	**Unit**	**Source [1]**	**Value**	**SP-01**	**SP-02**	**SP-03**	**NE-TMF-SP**	**NW-TMF-SP**
Sulphate	µg/L	BC-MECCS	309,000[2]	95,384	75,587	66,906	107,273	75,083
Chloride	µg/L	CCME CWQG-FAL	120,000	47,402	37,839	34,042	6,173	9,350
Bromine	µg/L	-	N/A	3,230	4,368	7,514	2,453	1,680
Nitrite-N	µg/L	CCME CWQG-FAL	60	**89**	**78**	**75**	**81**	58
Nitrate-N	µg/L	CCME CWQG-FAL	3,000	**12,592**	**10,754**	**10,604**	**6,169**	**5,119**
Un-ionized Ammonia-N	µg/L	PWQO	20[3]	1	2	1	6	5
Fluoride	µg/L	CCME CWQG-FAL	120	26	26	19	39	29
Chromium III	µg/L	PWQO	8.9	9	9	9	9	9
Chromium VI	µg/L	PWQO	1	0.52	**2.50**	**6.30**	**3.60**	**2.40**
Mercury (Trace)	µg/L	CCME CWQG-FAL	0.026	0.006	0.005	0.004	0.006	0.005
Total Aluminum	µg/L	PWQO	100[4,–]	**485**	**483**	**474**	**483**	**481**
Dissolved Aluminum (0.2 µm)	µg/L	PWQO	75[4*,–]	29	26	18	26	24
Total Silver	µg/L	PWQO	0.1	0.005	0.005	0.005	0.011	0.006
Total Arsenic	µg/L	Interim PWQO	5	**11**	**7**	2	7	5
Total Barium	µg/L	-	N/A	35	35	37	9	9
Total Beryllium	µg/L	PWQO	1,100[5]	0.005	0.005	0.005	0.861	0.339
Total Boron	µg/L	PWQO	200	3.30	2.10	0.77	83.00	59.00
Total Bismuth	µg/L	-	N/A	0.009	0.008	0.006	0.017	0.008
Calcium	µg/L	-	N/A	41,836	28,532	1,810	16,379	15,585
Total Cadmium	µg/L	Interim PWQO	0.5[6]	0.03	0.03	0.02	0.02	0.02
Total Cobalt	µg/L	Interim PWQO	0.9	**1.10**	**1.10**	**1.10**	**1.20**	**1.00**
Total Copper	µg/L	Interim PWQO	5[7]	**5.3**	4.6	4.6	3.8	2.7
Total Iron	µg/L	PWQO	300[–]	**646**	**624**	**598**	**624**	**648**
Potassium	µg/L	-	N/A	7,588	5,028	189	2,782	2,125
Total Lithium	µg/L	-	N/A	7	5	2	5	6
Total Magnesium	µg/L	-	N/A	34,095	37,553	49,215	45,195	36,992
Total Manganese	µg/L	-	N/A	70	46	19	48	39
Dissolved Manganese	µg/L	CCME CWQG-FAL	530[8]	60	36	9	37	29
Total Molybdenum	µg/L	Interim PWQO	40	7	5	3	6	4
Total Silicon	µg/L	-	N/A	359	261	151	302	657
Sodium	µg/L	-	N/A	10,961	7,264	193	4,370	4,665
Total Nickel	µg/L	PWQO	25	11	13	17	13	12
Total Lead	µg/L	Interim PWQO	5[9]	0.9	0.7	0.6	0.7	0.5
Total Antimony	µg/L	Interim PWQO	20	0.41	0.41	0.31	0.47	0.36

Parameter	Unit	Guideline		Average Simulated Concentrations				
				Effluent				
		Source [1]	Value	SP-01	SP-02	SP-03	NE-TMF-SP	NW-TMF-SP
Total Selenium	µg/L	CCME CWQG-FAL	1	0.65	0.58	0.63	**1.10**	0.73
Total Tin	µg/L	-	N/A	303	198	88	172	217
Total Strontium	µg/L	-	N/A	127	89	56	81	65
Total Titanium	µg/L	-	N/A	17	16	16	16	16
Total Thallium	µg/L	Interim PWQO	0.3	0.003	0.003	0.002	0.007	0.003
Total Uranium	µg/L	Interim PWQO	5	**6.8**	**5.5**	**5.1**	4.6	2.9
Total Vanadium	µg/L	Interim PWQO	6	**9.9**	6.0	1.4	**6.1**	4.2
Total Tungsten	µg/L	PWQO	30	1.70	1.30	0.94	1.10	0.94
Total Yttrium	µg/L	-	N/A	0.90	0.64	0.39	0.58	0.62
Total Zinc	µg/L	Interim PWQO	20	20	16	14	15	11
Dissolved Zinc	µg/L	CCME CWQG-FAL	see notes[10]	19	15	14	15	10
Phosphorus	µg/L	PWQO	30[11,~]	2	14	29	28	22

Notes:

CCME CWQG-FAL	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
PWQO	Provincial Water Quality Objective
BC-MECCS	British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life
(1)	PWQO, BC-MECCS or CCME CWQG-FAL
(2)	128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L
(3)	Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17°C
(4)	CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5
(4*)	PWQO (clay-free samples): 15 µg/L for 4.5<pH<5.5 and 75 µg/L for 6.5<pH<9
(5)	PWQO: 11 µg/L if hardness is less than 75 mg/L, and 1,100 µg/L if hardness is larger than 75 mg/L
(6)	PWQO Interim: 0.1 µg/L if hardness is less than 100 mg/L, and 0.5 µg/L if hardness is larger than 100 mg/L
(7)	PWQO Interim: 1 µg/L if hardness is between 0 and 20 mg/L, and 5 µg/L if hardness is larger than 20 mg/L
(8)	CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L
(9)	PWQO Interim: 1 µg/L if hardness is less than 30 mg/L, 3 µg/L if hardness is between 30 and 80 mg/L, and 5 µg/L if hardness is larger than 80 mg/L
(10)	CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L. Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC. West Buskegau River 95 µg/L, North Driftwood River 84 µg/L , Jocko Cree 85 µg/L
(11)	PWQO: value of 30 µg/L when FDP drains into streams
N/A	Not applicable
~	75th percentile receiver concentration is above PWQO value

B.2.2 Pit-Lake Quality

Table B.2.2.1 Pit Lake Quality: Maximum and Average Concentrations

Parameter	Unit	Guideline		Concentration (µg/L)	
		Source [1]	Value	Maximum	Average
Sulphate	µg/L	BC-MECCS	309,000[2]	68,730	67,652
Chloride	µg/L	CCME CWQG-FAL	120,000	59,300	58,310
Bromine	µg/L	-	N/A	691	682
Nitrite-N	µg/L	CCME CWQG-FAL	60	1.0	0.6
Nitrate-N	µg/L	CCME CWQG-FAL	3,000	2,249	2,227
Un-ionized Ammonia-N	µg/L	PWQO	20[3]	0.19	0.3
Fluoride	µg/L	CCME CWQG-FAL	120	28	28
Chromium III	µg/L	PWQO	8.9	0.1	0.1
Chromium VI	µg/L	PWQO	1	0.70	0.69
Mercury (Trace)	µg/L	CCME CWQG-FAL	0.026	0.002	0.002
Total Aluminum	µg/L	CCME CWQG-FAL	100[4,~]	15	14
Dissolved Aluminum (0.2 µm)	µg/L	PWQO	75[4*,~]	15	14
Total Silver	µg/L	PWQO	0.1	0.0001	0.0001
Total Arsenic	µg/L	Interim PWQO	5	2	2
Total Barium	µg/L	-	N/A	9	9
Total Beryllium	µg/L	PWQO	1,100[5]	2	2
Total Boron	µg/L	PWQO	200	63.88	62.83
Total Bismuth	µg/L	-	N/A	0.003	0.003
Calcium	µg/L	-	N/A	12,640	12,481
Total Cadmium	µg/L	Interim PWQO	0.5[6]	0.003	0.003
Total Cobalt	µg/L	Interim PWQO	0.9	0.17	0.17

Parameter	Unit	Guideline		Concentration (µg/L)	
		Source [1]	Value	Maximum	Average
Total Copper	µg/L	Interim PWQO	5[7]	0.3	0.3
Total Iron	µg/L	PWQO	300[~]	30	30
Potassium	µg/L	-	N/A	1,451	1,430
Total Lithium	µg/L	-	N/A	10	10
Total Magnesium	µg/L	-	N/A	47,730	46,942
Total Manganese	µg/L	-	N/A	29	29
Dissolved Manganese	µg/L	CCME CWQG-FAL	530[8]	29	29
Total Molybdenum	µg/L	Interim PWQO	40	7	7
Total Silicon	µg/L	-	N/A	1,206	1,194
Sodium	µg/L	-	N/A	9,760	9,621
Total Nickel	µg/L	PWQO	25	5	5
Total Lead	µg/L	Interim PWQO	5[9]	0.03	0.03
Total Antimony	µg/L	Interim PWQO	20	0.8	0.79
Total Selenium	µg/L	CCME CWQG-FAL	1	0.53	0.52
Total Tin	µg/L	-	N/A	110	108
Total Strontium	µg/L	-	N/A	52	51
Total Titanium	µg/L	-	N/A	0.03	0.03
Total Thallium	µg/L	Interim PWQO	0.3	0.01	0.01
Total Uranium	µg/L	Interim PWQO	5	0.03	0.03
Total Vanadium	µg/L	Interim PWQO	6	1	1
Total Tungsten	µg/L	PWQO	30	1.56	1.54
Total Yttrium	µg/L	-	N/A	0.25	0.25
Total Zinc	µg/L	Interim PWQO	20	3	3
Dissolved Zinc	µg/L	CCME CWQG-FAL	see notes[10]	3	3
Phosphorus	µg/L	PWQO	30[11,~]	16	16

Parameter	Unit	Guideline		Concentration (µg/L)	
		Source (1)	Value	Maximum	Average

Notes:

CCME CWQG-FAL	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
PWQO	Provincial Water Quality Objective
BC-MECCS	British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life
(1)	PWQO, BC-MECCS or CCME CWQG-FAL
(2)	128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L
(3)	Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17°C
(4)	CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5
(4*)	PWQO (clay-free samples): 15 µg/L for 4.5<pH<5.5 and 75 µg/L for 6.5<pH<9
(5)	PWQO: 11 µg/L if hardness is less than 75 mg/L, and 1,100 µg/L if hardness is larger than 75 mg/L
(6)	PWQO Interim: 0.1 µg/L if hardness is less than 100 mg/L, and 0.5 µg/L if hardness is larger than 100 mg/L
(7)	PWQO Interim: 1 µg/L if hardness is between 0 and 20 mg/L, and 5 µg/L if hardness is larger than 20 mg/L
(8)	CWQG-FAL: 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.
	Value was determined based on pH of 7.5 and hardness of 120 mg/L
(9)	PWQO Interim: 1 µg/L if hardness is less than 30 mg/L, 3 µg/L if hardness is between 30 and 80 mg/L, and 5 µg/L if hardness is larger than 80 mg/L
(10)	CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L,
	pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L. Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC.
	West Buskegau River 95 µg/L, North Driftwood River 84 µg/L , Jocko Cree 85 µg/L
(11)	PWQO: value of 30 µg/L when FDP drains into streams
N/A	Not applicable
~	75th percentile receiver concentration is above PWQO value

Appendix C Assessment Results

Table C-1 PoPC Concentrations at the Outlet of Mass Balance Subwatersheds on Jocko Creek under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Sub-watershed Pourpoints		
		Source (1)	Value		JC2 Pourpoint	JC1 Pourpoint	JCDS Pourpoint
# of km from upstream model limit (A)					13	18.5	23.5
Total Flow Rate	m^3/s				0.130	0.184	0.208
					Concentration (2)		
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	33	60	55
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	607	1,263	1,143
Un-ionized Ammonia (as N)	µg/L	PWQO	20(3)	0.57	3.09	5.91	5.39
Fluoride	µg/L	CCME CWQG-FAL	120	50	51	52	52
Aluminum (Total)	µg/L	CCME CWQG-FAL	100(4,~)	324	290	252	259
Aluminum (Dissolved)	µg/L	PWQO	75(48,~)	75	69	63	64
Arsenic (Total)	µg/L	Interim PWQO	5	0.8	0.8	0.9	0.9
Boron (Total)	µg/L	PWQO	200	2	34	69	63
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.2	0.3	0.4	0.4
Chloride	µg/L	CCME CWQG-FAL	120,000	4,600	36,067	71,247	64,840
Chromium III	µg/L	PWQO	8.9	1.5	1.2	1.0	1.0
Chromium VI	µg/L	PWQO	1	0	0.4	0.8	0.7
Copper (Total)	µg/L	Interim PWQO	5(5)	2.2	1.9	1.8	1.8
Iron (Total)	µg/L	PWQO	300(~)	580	515	441	455
Nickel (Total)	µg/L	PWQO	25	1	2.8	4.9	4.5
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.17	0.48	0.83	0.77
Uranium (Total)	µg/L	Interim PWQO	5	0.06	0.05	0.05	0.05
Vanadium (Total)	µg/L	Interim PWQO	6	0.9	0.8	0.8	0.8
Zinc (Total)	µg/L	Interim PWQO	20	10	9	8	8
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	85(6)	9	8	7	7
Phosphorus (Total)	µg/L	PWQO	30(7,~)	23	23	22	22

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

(1) PWQO or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 °C

(4) CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5

(4*) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(5) PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L

(6) CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L

Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC

(7) PWQO: value of 30 ug/L when FDP drains into streams

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form

~ 75th percentile receiver concentration is above PWQO value

(A) Distances were determined based on the length of the main channel within each subwatershed and not a straight connection line between upstream and downstream points.

Table C-2 PoPC Concentrations at the Outlet of Mass Balance Sub-watersheds on Jocko Creek under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Sub-watershed Pourpoints		
		Source (1)	Value		JC2 Pourpoint	JC1 Pourpoint	JCDS Pourpoint
# of km from upstream model limit (A)					13	18.5	23.5
Total Flow Rate	m^3/s				0.993	1.253	1.497
					Concentration (2)		
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	12	14	14
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	64	127	112
Un-ionized Ammonia (as N)	µg/L	PWQO	20(3)	0.5	0.69	0.96	0.90
Fluoride	µg/L	CCME CWQG-FAL	120	50	50	50	50
Aluminum (Total)	µg/L	CCME CWQG-FAL	100(4,~)	304	302	298	299
Aluminum (Dissolved)	µg/L	PWQO	75(4*,~)	65	65	64	64
Arsenic (Total)	µg/L	Interim PWQO	5	0.7	0.7	0.7	0.7
Boron (Total)	µg/L	PWQO	200	2	4	8	7
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.2	0.2	0.2	0.2
Chloride	µg/L	CCME CWQG-FAL	120,000	6,300	8,636	12,015	11,223
Chromium III	µg/L	PWQO	8.9	1.3	1.3	1.3	1.3
Chromium VI	µg/L	PWQO	1	0	0.03	0.07	0.06
Copper (Total)	µg/L	Interim PWQO	5(5)	2.3	2.3	2.3	2.3
Iron (Total)	µg/L	PWQO	300(~)	560	555	548	550
Nickel (Total)	µg/L	PWQO	25	0.9	1.0	1.2	1.2
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.19	0.21	0.25	0.24
Uranium (Total)	µg/L	Interim PWQO	5	0.04	0.04	0.04	0.04
Vanadium (Total)	µg/L	Interim PWQO	6	0.8	0.8	0.8	0.8
Zinc (Total)	µg/L	Interim PWQO	20	8	8	8	8
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	75(6)	7	7	7	7
Phosphorus (Total)	µg/L	PWQO	30(7,~)	21	21	21	21

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

(1) PWQO or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 °C

(4) CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5

(4*) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(5) PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L

(6) CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L
Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC

(7) PWQO: value of 30 ug/L when FDP drains into streams

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form

~ 75th percentile receiver concentration is above PWQO value

(A) Distances were determined based on the length of the main channel within each subwatershed and not a straight connection line between upstream and downstream points.

Table C-3 Pit-Full Case PoPC Concentrations on the West Buskegau River under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to Spillway										
		Source (1)	Value		Lake Spillway	At Full Mixing	WB9 Pourpoint	WB6 Pourpoint	WB5 Pourpoint	WB3 Pourpoint	WB1 Pourpoint (B)	WB-A - Downstream of Fournier Creek Confluence	WB-B - Downstream of Highway 11	WB-C - Upstream of Frederick House River Confluence	WB-D - Downstream of Frederick House River Confluence
# of km downstream of the point of mixing of lake water and receiver water (A)					0	-	2.4	8	9	13.2	20.6	25.8	32.1	40.1	40.2
Total Flow Rate	m^3/s				0.01	0.235	0.238	0.254	0.280	0.490	0.602	0.675	0.686	0.727	3.556
					Concentration (2)										
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	1	10	10	11	11	11	11	11	11	10	10
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	2,249	119	129	191	189	118	99	91	90	86	33
Un-ionized Ammonia (as N)	µg/L	PWQO	20(3)	0.69	0.20	0.67	0.67	0.67	0.67	0.68	0.68	0.68	0.68	0.68	0.69
Fluoride	µg/L	CCME CWQG-FAL	120	50	57	49	49	49	49	49	49	50	50	50	50
Aluminum (Total)	µg/L	CCME CWQG-FAL	100(4,~)	598	15	572	571	565	566	580	583	585	585	586	595
Aluminum (Dissolved)	µg/L	PWQO	75(4*,~)	133	15	128	128	126	127	129	130	130	130	131	132
Arsenic (Total)	µg/L	Interim PWQO	5	1.1	2.2	1.2	1.2	1.7	1.8	1.5	1.4	1.4	1.4	1.4	1.2
Boron (Total)	µg/L	PWQO	200	2.0	63.9	4.8	4.7	4.7	4.5	3.4	3.2	3.0	3.0	3.0	2.2
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.4	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Chloride	µg/L	CCME CWQG-FAL	120,000	400	59,300	3,013	2,981	2,872	2,654	1,687	1,448	1,334	1,319	1,268	577
Chromium III	µg/L	PWQO	8.9	1.5	0.1	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5
Chromium VI	µg/L	PWQO	1	0	0.70	0.03	0.03	0.04	0.04	0.02	0.02	0.02	0.02	0.01	0.003
Copper (Total)	µg/L	Interim PWQO	5(5)	2.2	0.3	2.1	2.2	2.3	2.4	2.3	2.3	2.3	2.3	2.3	2.2
Iron (Total)	µg/L	PWQO	300(~)	1,075	30	1029	1027	1015	1017	1042	1048	1051	1051	1053	1070
Nickel (Total)	µg/L	PWQO	25	1.4	5.0	1.6	1.6	1.7	1.7	1.6	1.5	1.5	1.5	1.5	1.4
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.15	0.53	0.17	0.17	0.20	0.20	0.18	0.17	0.17	0.17	0.17	0.15
Uranium (Total)	µg/L	Interim PWQO	5	0.07	0.03	0.07	0.12	0.45	0.48	0.31	0.27	0.24	0.24	0.23	0.10
Vanadium (Total)	µg/L	Interim PWQO	6	1.6	1.0	1.6	1.6	2.1	2.1	1.9	1.8	1.8	1.8	1.8	1.6
Zinc (Total)	µg/L	Interim PWQO	20	8	3	8	8	9	9	8	8	8	8	8	8
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	95(6)	7	3	7	7	8	8	7	7	7	7	7	7
Phosphorus (Total)	µg/L	PWQO	30(7,~)	37	16	36	36	36	36	36	36	36	36	36	37

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

(1) PWQO or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 °C

(4) CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5

(4*) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(5) PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L

(6) CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L
Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC

(7) PWQO: value of 30 ug/L when FDP drains into streams

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form

~ 75th percentile receiver concentration is above PWQO value

(A) Distances were determined based on the length of the main channel from where lake water and receiver are mixed to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-4 Pit-Full Case PoPC Concentrations on the North Driftwood River under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to Spillway												
		Source (1)	Value		Lake Spillway	At Full Mixing	ND11 Pourpoint	ND8 Pourpoint	ND7 Pourpoint	ND6 Pourpoint	ND5 Pourpoint	ND3 Pourpoint	ND1 Pourpoint (B)	ND-A - Upstream of Calder Creek Confluence	ND-B - Upstream of Sheriff Creek Confluence	ND-C - Upstream of Abitibi Confluence	ND-D - Downstream of Abitibi Confluence
# of km downstream of the point of mixing of lake water and receiver water (A)					0	-	0.9	3.6	5.3	8.4	14.1	30.4	38.2	58.1	66.5	87.1	87.1
Flow Rate	m^3/s				0.006	0.073	0.092	0.116	0.125	0.131	0.155	0.339	0.454	0.572	0.615	0.759	13.698
					Concentration (2)												
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	1	29	27	25	24	23	23	16	14	14	13	13	10
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	2,249	703	626	581	542	527	546	263	201	164	154	129	26
Un-ionized Ammonia (as N)	µg/L	PWQO	20(3)	0.48	0.20	2.63	2.26	1.90	1.80	1.73	1.54	0.97	0.84	0.77	0.75	0.70	0.49
Fluoride	µg/L	CCME CWQG-FAL	120	50	57	46	45	46	46	46	46	48	49	49	49	49	50
Aluminum (Total)	µg/L	CCME CWQG-FAL	100(4,~)	260	15	217	216	221	224	225	226	244	248	251	251	253	260
Aluminum (Dissolved)	µg/L	PWQO	75(4,~)	86	15	76	75	76	77	77	77	82	83	84	84	84	86
Arsenic (Total)	µg/L	Interim PWQO	5	0.9	2.2	1.0	1.3	1.8	1.8	1.8	2.4	1.6	1.4	1.3	1.3	1.2	0.9
Boron (Total)	µg/L	PWQO	200	2	64	34	29	23	22	21	18	9.41	7.53	6.38	6.08	5.31	2.18
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Chloride	µg/L	CCME CWQG-FAL	120,000	4,200	59,300	35698	30116	24794	23350	22342	19621	11239	9449	8366	8077	7342	4374
Chromium III	µg/L	PWQO	8.9	1.5	0.1	1.2	1.2	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.5
Chromium VI	µg/L	PWQO	1	0	0.70	0.37	0.31	0.26	0.24	0.23	0.21	0.09	0.07	0.06	0.05	0.04	0.002
Copper (Total)	µg/L	Interim PWQO	5(5)	1.5	0.3	1.3	1.5	1.7	1.7	1.7	1.9	1.7	1.7	1.6	1.6	1.6	1.5
Iron (Total)	µg/L	PWQO	300(~)	644	30	525	525	539	546	550	551	601	612	619	621	625	643
Nickel (Total)	µg/L	PWQO	25	0.9	5.0	2.8	2.5	2.4	2.3	2.2	2.2	1.5	1.3	1.3	1.2	1.2	0.9
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.15	0.53	0.45	0.41	0.39	0.38	0.37	0.38	0.25	0.23	0.21	0.21	0.20	0.15
Uranium (Total)	µg/L	Interim PWQO	5	0.04	0.03	0.04	0.26	0.59	0.55	0.58	0.96	0.47	0.36	0.30	0.28	0.23	0.05
Vanadium (Total)	µg/L	Interim PWQO	6	0.8	1.0	0.8	1.0	1.5	1.4	1.5	1.9	1.3	1.2	1.1	1.1	1.0	0.8
Zinc (Total)	µg/L	Interim PWQO	20	7	3	6	7	8	8	8	9	8	8	8	7	7	7
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	84(6)	6	3	5	6	7	7	7	8	7	7	7	7	6	6
Phosphorus (Total)	µg/L	PWQO	30(7,~)	27	16	25	25	25	25	25	25	26	26	26	26	27	27

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

(1) PWQO or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 °C

(4) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(4*) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(5) PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L

(6) CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L
Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC

(7) PWQO: value of 30 ug/L when FDP drains into streams

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form

~ 75th percentile receiver concentration is above PWQO value

(A) Distances were determined based on the length of the main channel from where lake water and receiver are mixed to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-5 Pit-Full Case PoPC Concentrations on the West Buskegau River under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Stations in Relation to Spillway										
		Source [1]	Value		Lake Spillway	At Full Mixing	WB9 Pourpoint	WB6 Pourpoint	WB5 Pourpoint	WB3 Pourpoint	WB1 Pourpoint [B]	WB-A - Downstream of Fournier Creek Confluence	WB-B - Downstream of Highway 11	WB-C - Upstream of Frederick House River Confluence	WB-D - Downstream of Frederick House River Confluence
# of km downstream of the point of mixing of lake water and receiver water [A]					0	-	2.4	8	9	13.2	20.6	25.8	32.1	40.1	40.2
Total Flow Rate	m^3/s				0.029	2.156	2.190	2.325	2.605	5.101	6.506	7.448	7.596	8.125	51.961
					Concentration [2]										
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	1	10	10	10	10	10	10	10	10	10	10
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	2,227	50	51	56	54	37	34	32	32	31	22
Un-ionized Ammonia (as N)	µg/L	PWQO	20[3]	0.6	0.03	0.59	0.59	0.59	0.59	0.60	0.60	0.60	0.60	0.60	0.60
Fluoride	µg/L	CCME CWQG-FAL	120	50	56	50	50	50	50	50	50	50	50	50	50
Aluminum (Total)	µg/L	CCME CWQG-FAL	100[4,~]	440	14	434	434	434	434	437	438	438	438	438	440
Aluminum (Dissolved)	µg/L	PWQO	75[4*,~]	107	14	106	106	106	106	106	107	107	107	107	107
Arsenic (Total)	µg/L	Interim PWQO	5	0.9	2.1	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9
Boron (Total)	µg/L	PWQO	200	2.0	62.8	2.8	2.8	2.8	2.7	2.4	2.3	2.3	2.2	2.2	2.0
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Chloride	µg/L	CCME CWQG-FAL	120,000	300	58,310	1,087	1,075	1,036	958	636	563	530	526	511	333
Chromium III	µg/L	PWQO	8.9	1.3	0.1	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Chromium VI	µg/L	PWQO	1	0	0.69	0.01	0.01	0.01	0.01	0.01	0.004	0.003	0.003	0.003	0.000
Copper (Total)	µg/L	Interim PWQO	5[5]	1.7	0.3	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Iron (Total)	µg/L	PWQO	300[~]	823	30	812	812	812	813	818	819	819	819	820	822
Nickel (Total)	µg/L	PWQO	25	1.0	4.9	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.12	0.52	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12
Uranium (Total)	µg/L	Interim PWQO	5	0.04	0.03	0.04	0.05	0.08	0.08	0.06	0.06	0.06	0.06	0.05	0.04
Vanadium (Total)	µg/L	Interim PWQO	6	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Zinc (Total)	µg/L	Interim PWQO	20	7	3	7	7	7	7	7	7	7	7	7	7
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	88[6]	6	3	6	6	6	6	6	6	6	6	6	6
Phosphorus (Total)	µg/L	PWQO	30[7,~]	28	16	28	28	28	28	28	28	28	28	28	28

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

(1) PWQO or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 °C

(4) CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5

(4*) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(5) PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L

(6) CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L

Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC

(7) PWQO: value of 30 ug/L when FDP drains into streams

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form

~ 75th percentile receiver concentration is above PWQO value

(A) Distances were determined based on the length of the main channel from where lake water and receiver are mixed to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-6 Pit-Full Case PoPC Concentrations on the North Driftwood River under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Stations in Relation to Spillway												
		Source [1]	Value		Lake Spillway	At Full Mixing	ND11 Pourpoint	ND8 Pourpoint	ND7 Pourpoint	ND6 Pourpoint	ND5 Pourpoint	ND3 Pourpoint	ND1 Pourpoint [B]	ND-A - Upstream of Calder Creek Confluence	ND-B - Upstream of Sheriff Creek Confluence	ND-C - Upstream of Abitibi Confluence	ND-D - Downstream of Abitibi Confluence
# of km downstream of the point of mixing of lake water and receiver water [A]					0	-	0.9	3.6	5.3	8.4	14.1	30.4	38.2	58.1	66.5	87.1	87.1
Flow Rate	m^3/s				0.038	0.497	0.645	0.853	0.937	1.002	1.205	3.215	4.589	6.056	6.598	8.472	248.442
					Concentration [2]												
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	1	12	12	12	12	11	11	11	10	10	10	10	10
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	2,227	262	216	179	165	157	146	68	53	45	43	38	21
Un-ionized Ammonia (as N)	µg/L	PWQO	20[3]	0.38	0.03	0.67	0.62	0.56	0.54	0.53	0.51	0.43	0.41	0.41	0.40	0.40	0.38
Fluoride	µg/L	CCME CWQG-FAL	120	50	56	48	48	49	49	49	49	50	50	50	50	50	50
Aluminum (Total)	µg/L	CCME CWQG-FAL	100[4,~]	187	14	172	174	177	178	178	179	184	185	185	186	186	187
Aluminum (Dissolved)	µg/L	PWQO	75[4,~]	56	14	53	53	54	54	54	54	55	56	56	56	56	56
Arsenic (Total)	µg/L	Interim PWQO	5	0.6	2.1	0.7	0.7	0.8	0.8	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.6
Boron (Total)	µg/L	PWQO	200	2	63	11	8.82	7.18	6.71	6.41	5.69	3.38	2.97	2.74	2.67	2.53	2.02
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Chloride	µg/L	CCME CWQG-FAL	120,000	2,900	58,310	11099	9382	7802	7361	7073	6370	4201	3812	3591	3534	3394	2917
Chromium III	µg/L	PWQO	8.9	1.3	0.1	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Chromium VI	µg/L	PWQO	1	0	0.69	0.10	0.08	0.06	0.06	0.05	0.05	0.02	0.01	0.01	0.01	0.01	0.00
Copper (Total)	µg/L	Interim PWQO	5[5]	1.2	0.3	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Iron (Total)	µg/L	PWQO	300[~]	503	30	459	466	474	477	478	481	495	497	499	499	500	503
Nickel (Total)	µg/L	PWQO	25	0.8	4.9	1.4	1.2	1.2	1.1	1.1	1.1	0.9	0.9	0.9	0.9	0.8	0.8
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.13	0.52	0.20	0.19	0.18	0.17	0.17	0.17	0.15	0.14	0.14	0.14	0.14	0.13
Uranium (Total)	µg/L	Interim PWQO	5	0.03	0.03	0.03	0.06	0.10	0.10	0.10	0.15	0.08	0.06	0.05	0.05	0.05	0.03
Vanadium (Total)	µg/L	Interim PWQO	6	0.7	1.0	0.7	0.8	0.8	0.8	0.8	0.9	0.8	0.7	0.7	0.7	0.7	0.7
Zinc (Total)	µg/L	Interim PWQO	20	6	3	6	6	6	6	6	6	6	6	6	6	6	6
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	76[6]	5	3	5	5	5	5	5	5	5	5	5	5	5	5
Phosphorus (Total)	µg/L	PWQO	30[7,~]	23	16	22	22	23	23	23	23	23	23	23	23	23	23

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

(1) PWQO or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 °C

(4) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(4*) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(5) PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L

(6) CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L
Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC

(7) PWQO: value of 30 ug/L when FDP drains into streams

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form

~ 75th percentile receiver concentration is above PWQO value

(A) Distances were determined based on the length of the main channel from where lake water and receiver are mixed to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-7 Pit-Full Case PoPC Concentrations on Jocko Creek under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Sub-watershed Pourpoints		
		Source [1]	Value		JC2 Pourpoint	JC1 Pourpoint	JCDS Pourpoint
# of km from upstream model limit [A]					13	18.5	23.5
Total Flow Rate	m^3/s				0.115	0.142	0.166
					Concentration [2]		
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	10	14	13
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	20	108	95
Un-ionized Ammonia (as N)	µg/L	PWQO	20[3]	0.50	0.57	0.95	0.89
Fluoride	µg/L	CCME CWQG-FAL	120	50	50	50	50
Aluminum (Total)	µg/L	CCME CWQG-FAL	100[4,~]	324	324	319	320
Aluminum (Dissolved)	µg/L	PWQO	75[4*,~]	75	75	74	74
Arsenic (Total)	µg/L	Interim PWQO	5	0.8	0.8	0.8	0.8
Boron (Total)	µg/L	PWQO	200	2	2	7	6
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.2	0.2	0.2	0.2
Chloride	µg/L	CCME CWQG-FAL	120,000	4600	4,600	9,312	8,638
Chromium III	µg/L	PWQO	8.9	1.5	1.3	1.3	1.3
Chromium VI	µg/L	PWQO	1	0	0	0.05	0.05
Copper (Total)	µg/L	Interim PWQO	5[5]	2.2	2.0	2.0	2.0
Iron (Total)	µg/L	PWQO	300[~]	580	580	570	572
Nickel (Total)	µg/L	PWQO	25	1.0	1.0	1.3	1.2
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.17	0.17	0.22	0.21
Uranium (Total)	µg/L	Interim PWQO	5	0.06	0.06	0.06	0.06
Vanadium (Total)	µg/L	Interim PWQO	6	0.9	0.9	0.9	0.9
Zinc (Total)	µg/L	Interim PWQO	20	10	10	10	10
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	85[6]	9	9	9	9
Phosphorus (Total)	µg/L	PWQO	30[7,~]	23	23	23	23

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

(1) PWQO or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 °C

(4) CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5

(4*) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(5) PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L

(6) CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L, pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L
Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC

(7) PWQO: value of 30 ug/L when FDP drains into streams

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form

~ 75th percentile receiver concentration is above PWQO value

(A) Distances were determined based on the length of the main channel within each subwatershed and not a straight connection line between upstream and downstream points.

Table C-8 Pit-Full Case PoPC Concentrations on Jocko Creek under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Sub-watershed Pourpoints		
		Source [1]	Value		JC2 Pourpoint	JC1 Pourpoint	JCDS Pourpoint
# of km from upstream model limit [A]					13	18.5	23.5
Total Flow Rate	m^3/s				0.984	1.230	1.474
					Concentration [2]		
Nitrite (as N)	µg/L	CCME CWQG-FAL	60	10	10	10	10
Nitrate (as N)	µg/L	CCME CWQG-FAL	3,000	20	20	30	28
Un-ionized Ammonia (as N)	µg/L	PWQO	20[3]	0.50	0.50	0.54	0.54
Fluoride	µg/L	CCME CWQG-FAL	120	50	50	50	50
Aluminum (Total)	µg/L	CCME CWQG-FAL	100[4,~]	304	304	303	304
Aluminum (Dissolved)	µg/L	PWQO	75[4*,~]	65	65	65	65
Arsenic (Total)	µg/L	Interim PWQO	5	0.7	0.7	0.7	0.7
Boron (Total)	µg/L	PWQO	200	2	2	3	2
Cobalt (Total)	µg/L	Interim PWQO	0.9	0.2	0.2	0.2	0.2
Chloride	µg/L	CCME CWQG-FAL	120,000	6300	6,300	6,841	6,751
Chromium III	µg/L	PWQO	8.9	1.3	1.3	1.3	1.3
Chromium VI	µg/L	PWQO	1	0	0.00	0.01	0.01
Copper (Total)	µg/L	Interim PWQO	5[5]	2.3	2.3	2.3	2.3
Iron (Total)	µg/L	PWQO	300[~]	560	560	559	559
Nickel (Total)	µg/L	PWQO	25	1.0	0.9	0.9	0.9
Selenium (Total)	µg/L	CCME CWQG-FAL	1	0.19	0.19	0.20	0.19
Uranium (Total)	µg/L	Interim PWQO	5	0.04	0.04	0.04	0.04
Vanadium (Total)	µg/L	Interim PWQO	6	0.8	0.8	0.8	0.8
Zinc (Total)	µg/L	Interim PWQO	20	8	8	8	8
Zinc (Dissolved)	µg/L	CCME CWQG-FAL	75[6]	7	7	7	7
Phosphorus (Total)	µg/L	PWQO	30[7,~]	21	21	21	21

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

(1) PWQO or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) Un-ionized ammonia was estimated based on total ammonia and assumed pH of 7.5 and temperature of 17 °C

(4) CCME CWQG-FAL: 5 µg/L if pH <6.5, 100 µg/L if pH ≥6.5

(4*) PWQO (clay-free samples): 15 ug/L for 4.5<pH<5.5 and 75 ug/L for 6.5<pH<9

(5) PWQO Interim: 1 ug/L if hardness is between 0 and 20 mg/L, and 5 ug/L if hardness is larger than 20 mg/L

(6) CCME CWQG-FAL: calculated using the equation exp(0.947[ln(hardness mg·L-1)]-0.815[pH]+0.398[ln(DOC mg·L-1)]+4.625) for hardness between 23.4 and 399 mg/L,
pH between 6.5 and 8.13, and DOC (dissolved organic carbon) between 0.3 and 22.9 mg/L
Used pH of 7.5, hardness of 120 mg/L, and 75th percentile receiver DOC

(7) PWQO: value of 30 ug/L when FDP drains into streams

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

Based on recently collected data. Previously collected total chromium data have been assumed to be entirely in Cr(III) form

~ 75th percentile receiver concentration is above PWQO value

(A) Distances were determined based on the length of the main channel within each subwatershed and not a straight connection line between upstream and downstream points.

Table C-9 Non-PoPC Concentrations for FDP-SP-03 and FDP-SP-01 on the West Buskegau River under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to FDP												
		Source [1]	Value		FDP-SP-03 (Treated End of Pipe)	Point of FDP-SP-03 Full Mixing	FDP-SP-01 (Treated End of Pipe)	Point of FDP-SP-01 Full Mixing	WB9 Pourpoint	WB6 Pourpoint	WB5 Pourpoint	WB3 Pourpoint	WB1 Pourpoint [B]	WB-A - Downstream of Fournier Creek Confluence	WB-B - Downstream of Highway 11	WB-C - Upstream of Frederick House River Confluence	WB-D - Downstream of Frederick House River Confluence
# of km downstream of most upstream FDP [A]					0	0.033	1.1	1.13	3.50	9.10	10.10	14.30	21.70	26.90	33.20	41.20	41.30
# of km downstream of most downstream FDP [B]					-	-	0	0.03	2.40	8.00	9.00	13.20	20.60	25.80	32.10	40.10	40.20
Total Flow Rate	m^3/s				0.355	0.368	0.689	0.689	0.692	0.704	0.730	0.940	1.052	1.125	1.136	1.177	4.006
					Concentration [2]												
Sulphate	µg/L	BC-MECCS	309,000[3]	900	102,300	53,324	220,100	131,080	130,499	128,435	124,144	96,556	86,394	80,851	80,049	77,336	23,352
Bromine	µg/L	-	N/A	100	11,630	3,958	7,550	5,595	5,570	5,481	5,299	4,135	3,706	3,472	3,439	3,324	1,047
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	6.45	5.16	5.93	7.11	6.49	6.49	6.49	6.49	6.48	6.48	6.47	6.47	6.47	6.46
Silver	µg/L	PWQO	0.1	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	9.3	112.3	42.9	73.0	56.6	56.4	55.6	54.0	44.0	40.3	38.3	38.0	37.0	17.5
Beryllium	µg/L	PWQO	1,100[4]	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Bismuth	µg/L	-	N/A	0.05	0.01	0.03	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.05
Calcium	µg/L	-	N/A	15,700	3,186	10,639	75,553	41,259	41,145	40,760	39,928	34,505	32,507	31,417	31,260	30,726	20,114
Cadmium	µg/L	Interim PWQO	0.5[5]	0.050	0.034	0.042	0.072	0.056	0.056	0.056	0.056	0.055	0.054	0.054	0.054	0.054	0.051
Potassium	µg/L	-	N/A	438	314	569	13,624	6,711	6,683	6,587	6,381	5,051	4,561	4,294	4,255	4,124	1,521
Lithium	µg/L	-	N/A	1	12	7	12	9	9	9	9	7	6	6	6	6	2
Magnesium	µg/L	-	N/A	3,590	68,503	37,004	67,593	50,934	50,723	49,949	48,377	38,351	34,658	32,644	32,353	31,367	11,749
Manganese (Total)	µg/L	-	N/A	75.7	43.3	69.5	163.0	113.6	113.4	112.8	111.6	103.5	100.6	99.0	98.7	98.0	82.2
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530[6]	59.2	12.9	49.6	132.6	88.8	88.7	88.2	87.3	81.0	78.7	77.4	77.2	76.6	64.3
Molybdenum	µg/L	Interim PWQO	40	0.05	3.91	3.26	15.77	9.10	9.06	8.92	8.62	6.70	5.99	5.61	5.55	5.36	1.61
Silicon	µg/L	-	N/A	2,685	946	1,933	616	1,324	1,330	1,351	1,396	1,685	1,791	1,849	1,857	1,886	2,450
Sodium	µg/L	-	N/A	1,565	374	2,888	19,685	10,775	10,734	10,591	10,288	8,336	7,616	7,224	7,167	6,975	3,154
Lead	µg/L	Interim PWQO	5[7]	0.59	0.97	0.68	2.04	1.32	1.31	1.30	1.28	1.13	1.07	1.04	1.03	1.02	0.72
Antimony	µg/L	Interim PWQO	20	0.1	0.3	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.2
Tin	µg/L	-	N/A	0.1	755.4	246.5	426.5	327.8	326.3	320.4	309.3	240.1	214.6	200.7	198.7	191.8	56.4
Strontium	µg/L	-	N/A	29.6	87	47	294	163	162	160	156	128	117	111	111	108	53
Titanium	µg/L	-	N/A	21.0	46.4	27.8	50.0	38.2	38.1	37.8	37.2	33.6	32.2	31.5	31.4	31.0	24.0
Thallium	µg/L	Interim PWQO	0.3	0.01	0.003	0.01	0.004	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	1.6	1.1	3.1	2.1	2.0	2.0	1.9	1.5	1.4	1.3	1.3	1.2	0.4
Yttrium	µg/L	-	N/A	1	2	1	1	1	1	1	1	1	1	1	1	1	1

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

BC-MECCS British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life

(1) PWQO, BC-MECCS or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) 128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L

(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where objective/guidelines are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel from a given FDP to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-10 Non-PoPC Concentrations for FDP-TMF-SP and FDP-SP-02 on the North Driftwood River under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to FDP														
		Source [1]	Value		FDP-TMF-SP (Treated End of Pipe)	Point of FDP-TMF-SP Full Mixing	FDP-SP-02 (Treated End of Pipe)	Point of FDP-SP-02 Full Mixing	ND11 Pourpoint	ND8 Pourpoint	ND7 Pourpoint	ND6 Pourpoint	ND5 Pourpoint	ND3 Pourpoint	ND1 Pourpoint [B]	ND-A - Upstream of Calder Creek Confluence	ND-B - Upstream of Sheriff Creek Confluence	ND-C - Upstream of Abitibi Confluence	ND-D - Downstream of Abitibi Confluence
# of km downstream of most upstream FDP [A]					0	0.03	5.825	5.855	6.73	9.43	11.13	14.23	19.93	36.23	44.03	63.93	72.325	92.925	92.925
# of km downstream of most downstream FDP [A]					-	-	0	0.03	1.00	3.60	5.30	8.40	14.10	30.40	38.20	58.10	66.5	87.1	87.1
Flow Rate	m^3/s				0.648	0.724	1.067	1.067	1.086	1.109	1.118	1.127	1.148	1.336	1.451	1.569	1.612	1.756	14.695
					Concentration [2]														
Sulphate	µg/L	BC-MECCS	309,000[3]	1,000	129,550	129,976	160,700	137,028	135,407	132,816	131,796	131,339	129,196	111,975	103,146	95,457	92,960	85,429	11,088
Bromine	µg/L	-	N/A	100	3,293	3,028	7,691	4,393	4,344	4,262	4,230	4,201	4,135	3,572	3,296	3,055	2,977	2,741	416
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	3.45	10.04	9.42	6.67	8.48	8.39	8.30	8.26	8.22	8.13	7.48	7.16	6.88	6.79	6.52	3.82
Silver	µg/L	PWQO	0.1	0.01	0.06	0.05	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.01
Barium	µg/L	-	N/A	9.5	12.9	12.5	73.7	31.0	30.9	30.5	30.3	30.2	29.9	27.0	25.6	24.4	24.0	22.8	11.1
Beryllium	µg/L	PWQO	1,100[4]	0.02	4.76	4.26	0.01	2.89	2.84	2.79	2.76	2.74	2.69	2.32	2.13	1.97	1.92	1.77	0.23
Bismuth	µg/L	-	N/A	0.05	0.05	0.05	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05
Calcium	µg/L	-	N/A	24,500	22,358	21,447	50,663	30,378	30,470	30,382	30,341	30,258	30,222	29,355	28,969	28,632	28,523	28,194	24,941
Cadmium	µg/L	Interim PWQO	0.5[5]	0.030	0.032	0.031	0.052	0.037	0.037	0.037	0.037	0.037	0.037	0.036	0.036	0.035	0.035	0.035	0.031
Potassium	µg/L	-	N/A	700	3,940	3,711	8,963	5,254	5,220	5,137	5,103	5,074	5,010	4,411	4,116	3,859	3,775	3,523	1,037
Lithium	µg/L	-	N/A	1	11	12	7	10	10	10	10	10	9	8	8	7	7	7	2
Magnesium	µg/L	-	N/A	5,300	55,948	59,341	62,153	59,239	58,491	57,448	57,042	56,983	56,095	49,451	45,938	42,880	41,886	38,890	9,313
Manganese (Total)	µg/L	-	N/A	83.3	81.1	84.1	112.6	92.7	92.8	92.6	92.5	92.4	92.3	91.0	90.4	89.9	89.7	89.2	84.0
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530[6]	51.1	50.6	55.0	82.2	63.2	63.3	63.1	63.0	63.0	62.9	61.3	60.5	59.7	59.5	58.8	52.0
Molybdenum	µg/L	Interim PWQO	40	0.05	7.4	8.1	10.6	8.7	8.6	8.4	8.4	8.4	8.2	7.2	6.6	6.1	5.9	5.5	0.7
Silicon	µg/L	-	N/A	2,190	1,330	1,312	609	1,114	1,126	1,146	1,155	1,158	1,175	1,311	1,381	1,442	1,462	1,521	2,110
Sodium	µg/L	-	N/A	2,860	5,907	6,751	12,955	8,567	8,528	8,424	8,382	8,386	8,306	7,607	7,229	6,900	6,793	6,471	3,291
Lead	µg/L	Interim PWQO	5[7]	0.33	0.9	0.9	1.5	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.4
Antimony	µg/L	Interim PWQO	20	0.10	0.76	0.88	0.45	0.73	0.72	0.71	0.71	0.71	0.70	0.62	0.58	0.55	0.53	0.50	0.15
Tin	µg/L	-	N/A	0.10	576.48	516.35	419.38	477.75	469.12	459.59	455.97	452.36	443.87	381.56	351.21	324.78	316.20	290.31	34.77
Strontium	µg/L	-	N/A	33	114	104	201	132	132	130	129	128	127	114	107	101	100	94	40
Titanium	µg/L	-	N/A	8.00	47.37	42.87	48.51	43.97	43.30	42.59	42.31	42.03	41.38	36.67	34.39	32.41	31.76	29.81	10.61
Thallium	µg/L	Interim PWQO	0.3	0.01	0.03	0.03	0.004	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
Tungsten	µg/L	PWQO	30	0.1	2.0	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	1.7	1.6	1.5	1.5	1.3	0.2
Yttrium	µg/L	-	N/A	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

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(1) PWQO, BC-MECCS or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) 128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L

(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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.
Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where objective/guidelines are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel from a given FDP to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-11 Non-PoPC Concentrations for FDP-SP-03 and FDP-SP-01 on the West Buskegau River under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Stations in Relation to FDP												
		Source (1)	Value		FDP-SP-03 (Treated End of Pipe)	Point of FDP-SP-03 Full Mixing	FDP-SP-01 (Treated End of Pipe)	Point of FDP-SP-01 Full Mixing	WB9 Pourpoint	WB6 Pourpoint	WB5 Pourpoint	WB3 Pourpoint	WB1 Pourpoint (B)	WB-A - Downstream of Fournier Creek Confluence	WB-B - Downstream of Highway 11	WB-C - Upstream of Frederick House River Confluence	WB-D - Downstream of Frederick House River Confluence
# of km downstream of most upstream FDP (A)					0	0.199	1.1	1.266	3.50	9.1	10.1	14.3	21.7	26.9	33.2	41.2	41.3
# of km downstream of most downstream FDP (B)					-	-	0	0.166	2.40	8	9	13.2	20.6	25.8	32.1	40.1	40.2
Total Flow Rate	m^3/s				0.036	2.072	2.493	2.493	2.528	2.659	2.938	5.444	6.850	7.791	7.939	8.469	52.305
					Concentration (2)												
Sulphate	µg/L	BC-MECCS	309,000(3)	800	66,906	3,911	95,384	15,378	15,183	14,494	13,205	7,507	6,129	5,484	5,397	5,109	1,497
Bromine	µg/L	-	N/A	100	7,514	239	3,230	613	606	582	536	336	287	265	262	252	125
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	4.77	4.01	4.76	5.71	4.88	4.88	4.87	4.86	4.82	4.81	4.81	4.80	4.80	4.78
Silver	µg/L	PWQO	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	7.5	36.8	8.0	35.2	11.4	11.4	11.2	10.9	9.3	8.9	8.8	8.7	8.7	7.7
Beryllium	µg/L	PWQO	1,100(4)	0.02	0.005	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Bismuth	µg/L	-	N/A	0.05	0.01	0.05	0.01	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05
Calcium	µg/L	-	N/A	10,606	1,810	10,389	41,836	14,385	14,334	14,157	13,823	12,345	11,988	11,821	11,798	11,724	10,787
Cadmium	µg/L	Interim PWQO	0.5(5)	0.039	0.022	0.038	0.033	0.038	0.038	0.038	0.038	0.038	0.039	0.039	0.039	0.039	0.039
Potassium	µg/L	-	N/A	315	189	331	7,588	1,250	1,238	1,194	1,111	745	657	616	610	591	360
Lithium	µg/L	-	N/A	1	2	1	7	2	2	2	2	1	1	1	1	1	1
Magnesium	µg/L	-	N/A	2,668	49,215	4,725	34,095	8,362	8,286	8,014	7,510	5,286	4,748	4,496	4,462	4,350	2,940
Manganese (Total)	µg/L	-	N/A	68.2	19.3	67.8	70.1	68.1	68.1	68.1	68.1	68.2	68.2	68.2	68.2	68.2	68.2
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530(6)	50.8	9.1	50.7	60.0	51.9	51.9	51.8	51.7	51.3	51.2	51.1	51.1	51.1	50.9
Molybdenum	µg/L	Interim PWQO	40	0.05	2.55	0.29	6.86	1.11	1.10	1.05	0.95	0.54	0.44	0.39	0.39	0.36	0.10
Silicon	µg/L	-	N/A	2,129	151	2,080	359	1,863	1,867	1,880	1,903	2,007	2,032	2,044	2,045	2,051	2,116
Sodium	µg/L	-	N/A	1,078	193	1,239	10,961	2,465	2,446	2,380	2,258	1,716	1,585	1,524	1,515	1,488	1,144
Lead	µg/L	Interim PWQO	5(7)	0.47	0.63	0.47	0.90	0.52	0.52	0.52	0.52	0.50	0.49	0.49	0.49	0.49	0.47
Antimony	µg/L	Interim PWQO	20	0.1	0.3	0.1	0.4	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Tin	µg/L	-	N/A	0.1	88.1	1.6	302.6	39.7	39.2	37.3	33.7	18.3	14.5	12.8	12.6	11.8	2.0
Strontium	µg/L	-	N/A	21	56	22	127	35	35	34	33	27	26	25	25	25	22
Titanium	µg/L	-	N/A	14.4	15.7	14.3	17.1	14.7	14.7	14.7	14.6	14.5	14.5	14.5	14.5	14.5	14.4
Thallium	µg/L	Interim PWQO	0.3	0.01	0.002	0.01	0.003	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	0.9	0.2	1.7	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1
Yttrium	µg/L	-	N/A	1	0	1	1	1	1	1	1	1	1	1	1	1	1

Notes:

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(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where objective/guidelines are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel from a given FDP to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-12 Non-PoPC Concentrations for FDP-TMF-SP and FDP-SP-02 on the North Driftwood River under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Stations in Relation to FDP														
		Source (1)	Value		FDP-TMF-SP (Treated End of Pipe)	Point of FDP-TMF-SP Full Mixing	FDP-SP-02 (Treated End of Pipe)	Point of FDP-SP-02 Full Mixing	ND11 Pourpoint	ND8 Pourpoint	ND7 Pourpoint	ND6 Pourpoint	ND5 Pourpoint	ND3 Pourpoint	ND1 Pourpoint (B)	ND-A - Upstream of Calder Creek Confluence	ND-B - Upstream of Sheriff Creek Confluence	ND-C - Upstream of Abitibi Confluence	ND-D - Downstream of Abitibi Confluence
# of km downstream of most upstream FDP (A)					0	0.03	5.825	5.855	6.73	9.43	11.13	14.23	19.93	36.23	44.03	63.93	72.325	92.925	92.925
# of km downstream of most downstream FDP (A)					-	-	0	0.185	1.00	3.60	5.30	8.40	14.10	30.40	38.20	58.10	66.5	87.1	87.1
Flow Rate	m^3/s				0.421	0.723	1.077	1.077	1.224	1.431	1.516	1.581	1.783	3.793	5.167	6.634	7.176	9.050	249.019
					Concentration (2)														
Sulphate	µg/L	BC-MECCS	309,000 (3)	800	91,178	60,643	75,587	54,266	48,118	41,344	39,095	37,693	33,600	16,347	12,219	9,695	9,023	7,321	1,037
Bromine	µg/L	-	N/A	100	2,066	1,274	4,368	1,642	1,465	1,270	1,205	1,161	1,044	544	426	354	335	286	107
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	2.47	5.49	4.28	5.43	4.21	4.01	3.79	3.72	3.67	3.53	2.97	2.84	2.76	2.73	2.68	2.48
Silver	µg/L	PWQO	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	8.3	8.9	8.6	35.2	13.3	12.7	12.1	11.9	11.7	11.4	9.7	9.4	9.1	9.1	8.9	8.3
Beryllium	µg/L	PWQO	1,100 (4)	0.02	0.60	0.35	0.01	0.24	0.23	0.20	0.19	0.18	0.17	0.09	0.07	0.06	0.06	0.05	0.02
Bismuth	µg/L	-	N/A	0.05	0.01	0.03	0.01	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.05	0.05
Calcium	µg/L	-	N/A	17,751	15,982	16,288	28,532	18,663	18,603	18,490	18,450	18,414	18,356	18,029	17,955	17,910	17,898	17,868	17,755
Cadmium	µg/L	Interim PWQO	0.5 (5)	0.020	0.021	0.020	0.026	0.021	0.021	0.021	0.021	0.021	0.021	0.020	0.020	0.020	0.020	0.020	0.020
Potassium	µg/L	-	N/A	488	2,453	1,690	5,028	2,096	1,918	1,715	1,647	1,601	1,480	956	831	756	735	684	495
Lithium	µg/L	-	N/A	1	5	4	5	4	4	3	3	3	3	2	2	1	1	1	1
Magnesium	µg/L	-	N/A	4,526	41,093	30,451	37,553	27,799	25,091	22,140	21,163	20,584	18,792	11,311	9,509	8,408	8,115	7,372	4,629
Manganese (Total)	µg/L	-	N/A	66.6	43.2	55.1	46.3	55.3	56.6	58.1	58.5	58.9	59.8	63.4	64.2	64.8	64.9	65.3	66.6
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530 (6)	46.4	33.1	41.2	36.2	41.1	41.8	42.5	42.7	42.9	43.3	44.9	45.3	45.6	45.6	45.8	46.4
Molybdenum	µg/L	Interim PWQO	40	0.05	5.0	3.7	4.7	3.3	2.9	2.5	2.4	2.3	2.1	1.0	0.8	0.6	0.6	0.5	0.1
Silicon	µg/L	-	N/A	1,712	479	953	261	946	1,034	1,131	1,164	1,185	1,244	1,491	1,550	1,586	1,595	1,619	1,709
Sodium	µg/L	-	N/A	1,817	4,518	4,045	7,264	4,276	4,001	3,690	3,586	3,529	3,341	2,544	2,351	2,233	2,202	2,122	1,828
Lead	µg/L	Interim PWQO	5 (7)	0.28	0.6	0.4	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Antimony	µg/L	Interim PWQO	20	0.10	0.41	0.39	0.41	0.35	0.32	0.29	0.28	0.27	0.25	0.17	0.15	0.14	0.14	0.13	0.10
Tin	µg/L	-	N/A	0.10	194.26	112.31	198.15	110.53	97.43	83.42	78.79	75.54	67.03	31.58	23.22	18.11	16.75	13.31	0.58
Strontium	µg/L	-	N/A	28	73	53	89	56	53	49	48	47	45	36	34	32	32	31	28
Titanium	µg/L	-	N/A	6.20	16.21	11.82	16.44	11.78	11.12	10.41	10.17	10.01	9.58	7.79	7.36	7.11	7.04	6.87	6.22
Thallium	µg/L	Interim PWQO	0.3	0.01	0.005	0.01	0.003	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	1.0	0.8	1.3	0.8	0.7	0.6	0.6	0.6	0.5	0.3	0.3	0.2	0.2	0.2	0.1
Yttrium	µg/L	-	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Notes:

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Value was determined based on pH of 7.5 and hardness of 120 mg/L

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2.0 First point where objective/guidelines are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel from a given FDP to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-13 Non-PoPC Concentrations on Jocko Creek under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to FDP		
		Source (1)	Value		JC2 Pourpoint	JC1 Pourpoint	JCDS Pourpoint
# of km downstream of model limit (A)					13	18.5	23.5
Total Flow Rate	m^3/s				0.130	0.184	0.208
					Concentration (2)		
Sulphate	µg/L	BC-MECCS	309,000(3)	3700	35,267	70,558	64,130
Bromine	µg/L	-	N/A	100	258	435	403
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	4.91	4.92	4.93	4.93
Silver	µg/L	PWQO	0.1	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	7.6	7.7	7.9	7.8
Beryllium	µg/L	PWQO	1,100(4)	0.02	0.02	0.02	0.02
Bismuth	µg/L	-	N/A	0.05	0.04	0.04	0.04
Calcium	µg/L	-	N/A	15,500	13,909	12,131	12,455
Cadmium	µg/L	Interim PWQO	0.5(5)	0.050	0.045	0.040	0.041
Potassium	µg/L	-	N/A	490	766	1,076	1,019
Lithium	µg/L	-	N/A	1	5	10	9
Magnesium	µg/L	-	N/A	3,630	23,797	46,344	42,238
Manganese (Total)	µg/L	-	N/A	52.3	54.3	56.4	56.0
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530(6)	38.1	41.7	45.6	44.9
Molybdenum	µg/L	Interim PWQO	40	0.05	3.27	6.86	6.21
Silicon	µg/L	-	N/A	2,970	2,634	2,257	2,326
Sodium	µg/L	-	N/A	4,220	6,742	9,562	9,048
Lead	µg/L	Interim PWQO	5(7)	0.50	0.45	0.40	0.41
Antimony	µg/L	Interim PWQO	20	0.1	0.5	1.0	0.9
Tin	µg/L	-	N/A	0.1	0.2	0.4	0.4
Strontium	µg/L	-	N/A	24	22	20	21
Titanium	µg/L	-	N/A	10.9	9.7	8.3	8.6
Thallium	µg/L	Interim PWQO	0.3	0.01	0.02	0.02	0.02
Tungsten	µg/L	PWQO	30	0.1	0.9	1.9	1.7
Yttrium	µg/L	-	N/A	1	1	1	1

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(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where objective/guidelines are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel within each subwatershed and not a straight connection line between upstream and downstream points.

Table C-14 Non-PoPC Concentrations on Jocko Creek under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Stations in Relation to FDP		
		Source (1)	Value		JC2 Pourpoint	JC1 Pourpoint	JCDS Pourpoint
# of km downstream of model limit (A)					13	18.5	23.5
Total Flow Rate	m^3/s				0.993	1.253	1.497
					Concentration (2)		
Sulphate	µg/L	BC-MECCS	309,000(3)	6900	9,230	12,602	11,812
Bromine	µg/L	-	N/A	100	112	129	125
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	3.86	3.87	3.88	3.88
Silver	µg/L	PWQO	0.1	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	7.3	7.3	7.3	7.3
Beryllium	µg/L	PWQO	1,100(4)	0.02	0.02	0.02	0.02
Bismuth	µg/L	-	N/A	0.05	0.05	0.05	0.05
Calcium	µg/L	-	N/A	13,569	13,467	13,318	13,353
Cadmium	µg/L	Interim PWQO	0.5(5)	0.042	0.042	0.041	0.041
Potassium	µg/L	-	N/A	447	468	498	491
Lithium	µg/L	-	N/A	1	1	2	2
Magnesium	µg/L	-	N/A	3,109	4,619	6,805	6,293
Manganese (Total)	µg/L	-	N/A	39.5	39.8	40.1	40.0
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530(6)	25.8	26.2	26.7	26.6
Molybdenum	µg/L	Interim PWQO	40	0.05	0.29	0.64	0.56
Silicon	µg/L	-	N/A	2,412	2,392	2,362	2,369
Sodium	µg/L	-	N/A	4,359	4,546	4,817	4,754
Lead	µg/L	Interim PWQO	5(7)	0.41	0.41	0.40	0.40
Antimony	µg/L	Interim PWQO	20	0.1	0.1	0.2	0.2
Tin	µg/L	-	N/A	0.1	0.1	0.1	0.1
Strontium	µg/L	-	N/A	25	25	25	25
Titanium	µg/L	-	N/A	10.7	10.6	10.5	10.5
Thallium	µg/L	Interim PWQO	0.3	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	0.2	0.3	0.2
Yttrium	µg/L	-	N/A	1	1	1	1

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

BC-MECCS British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life

(1) PWQO, BC-MECCS or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) 128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L

(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where objective/guidelines are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel within each subwatershed and not a straight connection line between upstream and downstream points.

Table C-15 Pit-Full Case non-PoPC Concentrations on the West Buskegau River under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to spillway										
		Source [1]	Value		Lake Spillway	At Full Mixing	WB9 Pourpoint	WB6 Pourpoint	WB5 Pourpoint	WB3 Pourpoint	WB1 Pourpoint [B]	WB-A - Downstream of Fournier Creek Confluence	WB-B - Downstream of Highway 11	WB-C - Upstream of Frederick House River Confluence	WB-D - Downstream of Frederick House River Confluence
# of km downstream of spillway and receiver confluence [A]					0	-	2.4	8	9	13.2	20.6	25.8	32.1	40.1	40.2
Total Flow Rate	m^3/s				0.01	0.235	0.238	0.254	0.280	0.490	0.602	0.675	0.686	0.727	3.556
					Concentration [2]										
Sulphate	µg/L	BC-MECCS	309,000[3]	900	68,730	3,909	4,613	8,982	9,130	5,683	4,795	4,374	4,316	4,127	1,559
Bromine	µg/L	-	N/A	100	691	126	151	305	317	227	203	192	190	185	117
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	6.45	4.40	6.27	6.27	6.26	6.27	6.35	6.37	6.38	6.38	6.38	6.44
Silver	µg/L	PWQO	0.1	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	9.3	9.0	9.3	9.3	9.4	9.4	9.4	9.4	9.4	9.3	9.3	9.3
Beryllium	µg/L	PWQO	1,100[4]	0.02	1.95	0.10	0.10	0.10	0.09	0.06	0.05	0.05	0.05	0.05	0.03
Bismuth	µg/L	-	N/A	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Calcium	µg/L	-	N/A	15,700	12,640	15,564	15,697	16,497	16,579	16,217	16,121	16,075	16,069	16,049	15,771
Cadmium	µg/L	Interim PWQO	0.5[5]	0.050	0.003	0.048	0.048	0.049	0.049	0.049	0.050	0.050	0.050	0.050	0.050
Potassium	µg/L	-	N/A	438	1,451	483	512	687	698	590	562	548	547	541	459
Lithium	µg/L	-	N/A	1	10	1	1	2	1	1	1	1	1	1	1
Magnesium	µg/L	-	N/A	3,590	47,730	5,548	5,655	6,365	6,273	5,136	4,849	4,713	4,694	4,633	3,803
Manganese (Total)	µg/L	-	N/A	75.7	29.0	73.6	73.9	75.6	75.9	75.9	75.8	75.8	75.8	75.8	75.7
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530[6]	59.2	29.0	57.9	58.2	60.1	60.3	59.9	59.8	59.7	59.7	59.7	59.3
Molybdenum	µg/L	Interim PWQO	40	0.05	6.95	0.36	0.40	0.71	0.71	0.44	0.36	0.33	0.33	0.31	0.10
Silicon	µg/L	-	N/A	2,685	1,206	2,619	2,614	2,581	2,583	2,626	2,637	2,642	2,643	2,645	2,677
Sodium	µg/L	-	N/A	1,565	9,760	1,929	1,963	2,184	2,175	1,918	1,852	1,821	1,817	1,803	1,614
Lead	µg/L	Interim PWQO	5[7]	0.59	0.03	0.57	0.57	0.60	0.61	0.60	0.60	0.60	0.60	0.60	0.59
Antimony	µg/L	Interim PWQO	20	0.1	0.9	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Tin	µg/L	-	N/A	0.1	109.8	5.0	4.9	4.7	4.3	2.5	2.0	1.8	1.8	1.7	0.4
Strontium	µg/L	-	N/A	30	52	31	31	37	37	34	33	33	33	33	30
Titanium	µg/L	-	N/A	21.0	0.0	20.1	20.1	19.9	20.0	20.4	20.5	20.6	20.6	20.6	20.9
Thallium	µg/L	Interim PWQO	0.3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	1.6	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Yttrium	µg/L	-	N/A	1	0	1	1	1	1	1	1	1	1	1	1

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

BC-MECCS British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life

(1) PWQO, BC-MECCS or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) 128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L

(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel from where lake water and receiver are mixed to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-16 Pit-Full Case non-PoPC Concentrations on the North Driftwood River under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to spillway												
		Source [1]	Value		Lake Spillway	At Full Mixing	ND11 Pourpoint	ND8 Pourpoint	ND7 Pourpoint	ND6 Pourpoint	ND5 Pourpoint	ND3 Pourpoint	ND1 Pourpoint [B]	ND-A - Upstream of Calder Creek Confluence	ND-B - Upstream of Sheriff Creek Confluence	ND-C - Upstream of Abitibi Confluence	ND-D - Downstream of Abitibi Confluence
# of km downstream of spillway and receiver confluence [A]					0	-	0.9	3.6	5.3	8.4	14.1	30.4	38.2	58.1	66.5	87.1	87.1
Flow Rate	m^3/s				0.006	0.073	0.092	0.116	0.125	0.131	0.155	0.339	0.454	0.572	0.615	0.759	13.698
					Concentration [2]												
Sulphate	µg/L	BC-MECCS	309,000[3]	1,000	68,730	37,922	40,914	37,736	35,022	34,003	35,429	16,489	12,483	10,080	9,442	7,826	1,374
Bromine	µg/L	-	N/A	100	691	316	421	542	510	517	678	364	295	255	244	216	106
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	3.45	4.40	3.89	3.84	3.78	3.76	3.74	3.73	3.57	3.54	3.52	3.52	3.50	3.45
Silver	µg/L	PWQO	0.1	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	9.5	9.0	10.4	10.2	10.2	10.1	10.1	10.2	9.8	9.7	9.7	9.7	9.6	9.5
Beryllium	µg/L	PWQO	1,100[4]	0.02	1.95	0.19	0.15	0.12	0.11	0.11	0.09	0.05	0.04	0.04	0.04	0.03	0.02
Bismuth	µg/L	-	N/A	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Calcium	µg/L	-	N/A	24,500	12,640	23,532	23,507	24,549	24,550	24,677	25,623	25,030	24,893	24,811	24,789	24,733	24,513
Cadmium	µg/L	Interim PWQO	0.5[5]	0.030	0.003	0.029	0.029	0.030	0.030	0.030	0.032	0.031	0.031	0.030	0.030	0.030	0.030
Potassium	µg/L	-	N/A	700	1,451	1,086	1,188	1,295	1,251	1,254	1,421	1,028	943	892	879	844	708
Lithium	µg/L	-	N/A	1	10	6	6	5	5	5	4	2	2	2	2	2	1
Magnesium	µg/L	-	N/A	5,300	47,730	28,939	29,173	24,914	23,453	22,594	21,042	12,322	10,506	9,416	9,127	8,394	5,470
Manganese (Total)	µg/L	-	N/A	83.3	29.0	93.4	91.5	91.5	90.9	90.8	91.8	87.1	86.1	85.5	85.4	85.0	83.4
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530[6]	51.1	29.0	64.2	63.0	62.7	61.9	61.6	62.8	56.4	55.0	54.2	54.0	53.4	51.2
Molybdenum	µg/L	Interim PWQO	40	0.05	6.95	3.78	3.98	3.52	3.26	3.14	3.13	1.43	1.07	0.86	0.80	0.66	0.08
Silicon	µg/L	-	N/A	2,190	1,206	2,096	2,025	2,023	2,036	2,038	2,018	2,112	2,132	2,144	2,148	2,156	2,188
Sodium	µg/L	-	N/A	2,860	9,760	6,364	6,398	5,896	5,671	5,557	5,460	4,024	3,723	3,542	3,494	3,373	2,888
Lead	µg/L	Interim PWQO	5[7]	0.33	0.03	0.31	0.33	0.38	0.37	0.38	0.42	0.37	0.36	0.36	0.35	0.35	0.33
Antimony	µg/L	Interim PWQO	20	0.1	0.9	0.6	0.6	0.5	0.5	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.1
Tin	µg/L	-	N/A	0.1	109.8	10.0	7.8	6.2	5.7	5.4	4.7	2.1	1.6	1.3	1.2	1.0	0.1
Strontium	µg/L	-	N/A	33	52	35	38	44	43	43	50	40	38	37	37	36	33
Titanium	µg/L	-	N/A	8.0	0.0	7.3	7.2	7.3	7.4	7.4	7.5	7.8	7.8	7.9	7.9	7.9	8.0
Thallium	µg/L	Interim PWQO	0.3	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	1.6	1.1	1.1	0.9	0.9	0.8	0.8	0.4	0.3	0.3	0.3	0.2	0.1
Yttrium	µg/L	-	N/A	1	0	1	1	1	1	1	1	1	1	1	1	1	1

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

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(1) PWQO, BC-MECCS or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) 128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L

(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel from where lake water and receiver are mixed to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-17 Pit-Full Case non-PoPC Concentrations on Jocko Creek under Regulatory Conditions

Parameter	Unit	Guideline		75th Percentile Receiver	Stations in Relation to FDP		
		Source (1)	Value		JC2 Pourpoint	JC1 Pourpoint	JCDS Pourpoint
# of km downstream of upstream model limit (A)					13	18.5	23.5
Total Flow Rate	m^3/s				0.115	0.142	0.166
					Concentration (2)		
Sulphate	µg/L	BC-MECCS	309,000(3)	3700	3,700	8,427	7,751
Bromine	µg/L	-	N/A	100	100	124	120
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	4.91	4.91	4.91	4.91
Silver	µg/L	PWQO	0.1	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	7.6	7.6	7.6	7.6
Beryllium	µg/L	PWQO	1,100(4)	0.02	0.02	0.02	0.02
Bismuth	µg/L	-	N/A	0.05	0.05	0.05	0.05
Calcium	µg/L	-	N/A	15,500	15,500	15,262	15,296
Cadmium	µg/L	Interim PWQO	0.5(5)	0.050	0.050	0.049	0.049
Potassium	µg/L	-	N/A	490	490	531	525
Lithium	µg/L	-	N/A	1	1	2	2
Magnesium	µg/L	-	N/A	3,630	3,630	6,650	6,218
Manganese (Total)	µg/L	-	N/A	52.3	52.3	52.6	52.6
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530(6)	38.1	38.1	38.6	38.6
Molybdenum	µg/L	Interim PWQO	40	0.05	0.05	0.53	0.46
Silicon	µg/L	-	N/A	2,970	2,970	2,920	2,927
Sodium	µg/L	-	N/A	4,220	4,220	4,598	4,544
Lead	µg/L	Interim PWQO	5(7)	0.50	0.50	0.49	0.49
Antimony	µg/L	Interim PWQO	20	0.1	0.1	0.2	0.2
Tin	µg/L	-	N/A	0.1	0.1	0.1	0.1
Strontium	µg/L	-	N/A	24	24	24	24
Titanium	µg/L	-	N/A	10.9	10.9	10.7	10.7
Thallium	µg/L	Interim PWQO	0.3	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	0.10	0.23	0.21
Yttrium	µg/L	-	N/A	1	1	1	1

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

PWQO Provincial Water Quality Objective

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(2) Moving downstream from left to right

(3) 128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L

(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel within each subwatershed and not a straight connection line between upstream and downstream points.

Table C-18 Pit-Full Case non-PoPC Concentrations on the West Buskegau River under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Stations in Relation to spillway										
		Source (1)	Value		Lake Spillway	At Full Mixing	WB9 Pourpoint	WB6 Pourpoint	WB5 Pourpoint	WB3 Pourpoint	WB1 Pourpoint (B)	WB-A - Downstream of Fournier Creek Confluence	WB-B - Downstream of Highway 11	WB-C - Upstream of Frederick House River Confluence	WB-D - Downstream of Frederick House River Confluence
# of km downstream of spillway and receiver confluence (A)					0	-	2.4	8	9	13.2	20.6	25.8	32.1	40.1	40.2
Total Flow Rate	m^3/s				0.029	2.156	2.190	2.325	2.605	5.101	6.506	7.448	7.596	8.125	51.961
					Concentration (2)										
Sulphate	µg/L	BC-MECCS	309,000(3)	800	67,652	1,707	1,774	2,219	2,163	1,504	1,352	1,282	1,273	1,242	869
Bromine	µg/L	-	N/A	100	682	108	111	127	127	114	111	110	110	109	101
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	4.77	4.30	4.74	4.74	4.74	4.74	4.76	4.76	4.76	4.76	4.76	4.77
Silver	µg/L	PWQO	0.1	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	7.5	8.9	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Beryllium	µg/L	PWQO	1,100(4)	0.02	1.93	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.02
Bismuth	µg/L	-	N/A	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Calcium	µg/L	-	N/A	10,606	12,481	10,631	10,647	10,739	10,743	10,678	10,662	10,655	10,654	10,651	10,613
Cadmium	µg/L	Interim PWQO	0.5(5)	0.039	0.003	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
Potassium	µg/L	-	N/A	315	1,430	330	333	352	352	334	330	328	328	327	317
Lithium	µg/L	-	N/A	1	10	1	1	1	1	1	1	1	1	1	1
Magnesium	µg/L	-	N/A	2,668	46,942	3,268	3,274	3,332	3,278	2,981	2,913	2,882	2,878	2,865	2,699
Manganese (Total)	µg/L	-	N/A	68.2	28.7	67.7	67.7	67.9	68.0	68.1	68.1	68.1	68.1	68.1	68.2
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530(6)	50.8	28.7	50.5	50.5	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8
Molybdenum	µg/L	Interim PWQO	40	0.05	6.83	0.14	0.15	0.18	0.17	0.11	0.10	0.09	0.09	0.09	0.06
Silicon	µg/L	-	N/A	2,129	1,194	2,116	2,116	2,113	2,114	2,122	2,123	2,124	2,124	2,124	2,128
Sodium	µg/L	-	N/A	1,078	9,621	1,194	1,197	1,217	1,207	1,145	1,130	1,124	1,123	1,120	1,085
Lead	µg/L	Interim PWQO	5(7)	0.47	0.03	0.46	0.46	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Antimony	µg/L	Interim PWQO	20	0.1	0.9	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Tin	µg/L	-	N/A	0.1	108.4	1.6	1.5	1.5	1.3	0.7	0.6	0.5	0.5	0.5	0.2
Strontium	µg/L	-	N/A	21	51	21	22	22	22	22	21	21	21	21	21
Titanium	µg/L	-	N/A	14.4	0.0	14.2	14.2	14.2	14.2	14.3	14.3	14.3	14.3	14.3	14.4
Thallium	µg/L	Interim PWQO	0.3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	1.5	0.12	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Yttrium	µg/L	-	N/A	1	0	1	1	1	1	1	1	1	1	1	1

Notes:

CCME CWQG-FAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term

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(1) PWQO, BC-MECCS or CCME CWQG-FAL

(2) Moving downstream from left to right

(3) 128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L

(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel from where lake water and receiver are mixed to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-19 Pit-Full Case non-PoPC Concentrations on the North Driftwood River under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Stations in Relation to spillway												
		Source [1]	Value		Lake Spillway	At Full Mixing	ND11 Pourpoint	ND8 Pourpoint	ND7 Pourpoint	ND6 Pourpoint	ND5 Pourpoint	ND3 Pourpoint	ND1 Pourpoint [B]	ND-A - Upstream of Calder Creek Confluence	ND-B - Upstream of Sheriff Creek Confluence	ND-C - Upstream of Abitibi Confluence	ND-D - Downstream of Abitibi Confluence
# of km downstream of spillway and receiver confluence [A]					0	-	0.9	3.6	5.3	8.4	14.1	30.4	38.2	58.1	66.5	87.1	87.1
Flow Rate	m^3/s				0.038	0.497	0.645	0.853	0.937	1.002	1.205	3.216	4.589	6.056	6.598	8.472	248.442
					Concentration [2]												
Sulphate	µg/L	BC-MECCS	309,000[3]	800	67,652	10,061	9,440	8,028	7,376	7,058	6,806	3,065	2,386	2,001	1,902	1,658	829
Bromine	µg/L	-	N/A	100	682	167	172	178	172	171	186	133	123	117	116	113	100
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	2.47	4.30	2.53	2.53	2.52	2.52	2.51	2.51	2.49	2.48	2.48	2.48	2.48	2.47
Silver	µg/L	PWQO	0.1	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	8.3	8.9	8.5	8.4	8.4	8.4	8.4	8.4	8.3	8.3	8.3	8.3	8.3	8.3
Beryllium	µg/L	PWQO	1,100[4]	0.02	1.93	0.16	0.13	0.10	0.10	0.09	0.08	0.04	0.04	0.03	0.03	0.03	0.02
Bismuth	µg/L	-	N/A	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Calcium	µg/L	-	N/A	17,751	12,481	17,358	17,454	17,647	17,657	17,682	17,830	17,784	17,774	17,769	17,767	17,764	17,751
Cadmium	µg/L	Interim PWQO	0.5[5]	0.020	0.003	0.019	0.019	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Potassium	µg/L	-	N/A	488	1,430	603	603	602	592	590	604	532	519	511	510	505	489
Lithium	µg/L	-	N/A	1	10	2	2	2	2	2	2	1	1	1	1	1	1
Magnesium	µg/L	-	N/A	4,526	46,942	10,437	9,825	8,648	8,274	8,050	7,596	5,676	5,331	5,136	5,086	4,962	4,541
Manganese (Total)	µg/L	-	N/A	66.6	28.7	65.7	66.0	66.4	66.5	66.5	66.8	66.7	66.7	66.6	66.6	66.6	66.6
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530[6]	46.4	28.7	47.0	47.1	47.3	47.2	47.2	47.4	46.8	46.7	46.6	46.6	46.5	46.4
Molybdenum	µg/L	Interim PWQO	40	0.05	6.83	0.99	0.91	0.75	0.69	0.65	0.61	0.26	0.20	0.16	0.15	0.13	0.05
Silicon	µg/L	-	N/A	1,712	1,194	1,671	1,671	1,677	1,681	1,682	1,683	1,701	1,704	1,706	1,707	1,708	1,712
Sodium	µg/L	-	N/A	1,817	9,621	2,804	2,692	2,514	2,451	2,416	2,357	2,020	1,959	1,924	1,916	1,894	1,820
Lead	µg/L	Interim PWQO	5[7]	0.28	0.03	0.26	0.27	0.28	0.28	0.28	0.29	0.28	0.28	0.28	0.28	0.28	0.28
Antimony	µg/L	Interim PWQO	20	0.1	0.9	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Tin	µg/L	-	N/A	0.1	108.4	8.5	6.6	5.0	4.5	4.2	3.6	1.4	1.0	0.8	0.7	0.6	0.1
Strontium	µg/L	-	N/A	28	51	30	30	30	30	30	30	29	28	28	28	28	28
Titanium	µg/L	-	N/A	6.2	0.0	5.7	5.8	5.9	5.9	5.9	6.0	6.1	6.1	6.2	6.2	6.2	6.2
Thallium	µg/L	Interim PWQO	0.3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	1.5	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Yttrium	µg/L	-	N/A	1	0	1	1	1	1	1	1	1	1	1	1	1	1

Notes:

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(3) 128 mg/L if hardness is less than 30 mg/L, 218 mg/L if hardness is between 31 and 75 mg/L, 309 mg/L if hardness is between 76 and 180 mg/L, and 429 mg/L if hardness is larger than 181 mg/L

(4) PWQO: 11 ug/L if hardness is less than 75 mg/L, and 1,100 ug/L if hardness is larger than 75 mg/L

(5) PWQO Interim: 0.1 ug/L if hardness is less than 100 mg/L, and 0.5 ug/L if hardness is larger than 100 mg/L

(6) CWQG-FAL: 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. Value was determined based on pH of 7.5 and hardness of 120 mg/L

(7) PWQO Interim: 1 ug/L if hardness is less than 30 mg/L, 3 ug/L if hardness is between 30 and 80 mg/L, and 5 ug/L if hardness is larger than 80 mg/L

2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel from where lake water and receiver are mixed to the outlet of downstream subwatersheds and not a straight connection line.

(B) Hydrologic model limit

Table C-20 Pit-Full Case non-PoPC Concentrations on Jocko Creek under Normal Conditions

Parameter	Unit	Guideline		Mean Receiver	Stations in Relation to FDP		
		Source (1)	Value		JC2 Pourpoint	JC1 Pourpoint	JCDS Pourpoint
# of km downstream of upstream model limit (A)					13	18.5	23.5
Total Flow Rate	m^3/s				0.984	1.229	1.473
					Concentration (2)		
Sulphate	µg/L	BC-MECCS	309,000(3)	6900	6,900	7,440	7,350
Bromine	µg/L	-	N/A	100	100	103	102
Mercury (Trace)	ng/L	CCME CWQG-FAL	26	3.86	3.86	3.86	3.86
Silver	µg/L	PWQO	0.1	0.01	0.01	0.01	0.01
Barium	µg/L	-	N/A	7.3	7.3	7.3	7.3
Beryllium	µg/L	PWQO	1,100(4)	0.02	0.02	0.02	0.02
Bismuth	µg/L	-	N/A	0.05	0.05	0.05	0.05
Calcium	µg/L	-	N/A	13,569	13,569	13,545	13,549
Cadmium	µg/L	Interim PWQO	0.5(5)	0.042	0.042	0.042	0.042
Potassium	µg/L	-	N/A	447	447	452	451
Lithium	µg/L	-	N/A	1	1	1	1
Magnesium	µg/L	-	N/A	3,109	3,109	3,459	3,401
Manganese (Total)	µg/L	-	N/A	39.5	39.5	39.6	39.5
Manganese (Dissolved)	µg/L	CCME CWQG-FAL	530(6)	25.8	25.8	25.9	25.9
Molybdenum	µg/L	Interim PWQO	40	0.05	0.05	0.11	0.10
Silicon	µg/L	-	N/A	2,412	2,412	2,407	2,408
Sodium	µg/L	-	N/A	4,359	4,359	4,402	4,395
Lead	µg/L	Interim PWQO	5(7)	0.41	0.41	0.41	0.41
Antimony	µg/L	Interim PWQO	20	0.1	0.1	0.1	0.1
Tin	µg/L	-	N/A	0.1	0.1	0.1	0.1
Strontium	µg/L	-	N/A	25	25	25	25
Titanium	µg/L	-	N/A	10.7	10.7	10.7	10.7
Thallium	µg/L	Interim PWQO	0.3	0.01	0.01	0.01	0.01
Tungsten	µg/L	PWQO	30	0.1	0.10	0.11	0.11
Yttrium	µg/L	-	N/A	1	1	1	1

Notes:

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2.0 First point where guidelines/objectives are met

Set equal to RDL as >50% of data are below detection limit.

N/A Non-applicable

(A) Distances were determined based on the length of the main channel within each subwatershed and not a straight connection line between upstream and downstream points.