WATER MANAGEMENT PLAN - CONSTRUCTION
Woodfibre LNG Project

WLNG-W0001-EV-EMP-0012.REV 7

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PREAMBLE

The Woodfibre Liquified Natural Gas Project (the Project) is a liquefied natural gas export facility being constructed on the former Woodfibre Pulp and Paper Mill site (the Project) in Nexwnéwu7ts Átlk̲'a7tsem (Howe Sound), approximately seven kilometres south of Sk̲wx̲wú7mesh (Squamish). The Project is on the historical location of a Sk̲wx̲wú7mesh Úxwumixw (Squamish Nation) village known as Swiy̓át. Swiy̓át and Nexwnéwu7ts Átlk̲'a7tsem (Howe Sound) are tied to the cultural well-being of Sk̲wx̲wú7mesh Úxwumixw (Squamish Nation) members, their ancestors, and their descendants, and to other Indigenous groups as defined in the Project's Environmental Assessment Certificates. Woodfibre LNG Limited recognizes the importance of these areas to the Sk̲wx̲wú7mesh stélmexw (Squamish People), and other Indigenous groups. Woodfibre LNG Limited seeks to construct and operate the Project in a manner that is respectful of Indigenous values. This Water Management Plan is primarily written in English with important place names, species, phrases, and passages provided in the Sk̲wx̲wú7mesh Sníchim (Squamish language).

Temíxwiy̓ik̲w chet wa naantem chet ti temíxw Swiy̓át
Chet wa sméṅhemswit kwis ns7éyx̲nitas chet ti temíxw
We7ú chet kwis t'ích̓imwit iy íẇas chet ek̲' I tti.

Our ancient ancestors named this place Swiy̓át
We, as their descendants safeguard these lands
We will continue to swim and fish in these clear waters.

REVISION HISTORY

Version	Date Issued	Distribution	Comments
1	October 2018	Sḵwx̱wú7mesh Úxwumixw (Squamish Nation)	Preliminary Draft
2	June 2019	Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) Oil and Gas Commission Ministry of Forests, Lands, Natural Resource Operations and Rural Development	Draft
3	August 2019	Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) Oil and Gas Commission Ministry of Forests, Lands, Natural Resource Operations and Rural Development	Draft
4	October 2019	Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) Oil and Gas Commission Ministry of Forests, Lands, Natural Resource Operations and Rural Development	Draft
5	December 2020	Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) Oil and Gas Commission Ministry of Forests, Lands, Natural Resource Operations and Rural Development Tsleil-Waututh Nation	Draft
6	November 2022	Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) Oil and Gas Commission Ministry of Forests Tsleil-Waututh Nation	Draft
7	June 2023	Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) Oil and Gas Commission Ministry of Forests Tsleil-Waututh Nation	Draft

ACRONYMS AND ABBREVIATIONS

Acronym	Definition
BC	British Columbia
BCER	BC Energy Regulator (formerly Oil and Gas Commission)
CSFP	critical stream flow period
EAC	Environmental Assessment Certificate
EAO	Environmental Assessment Office
EFN	Environmental flow needs
EM	Environmental Monitor
ENV	Ministry of Environment and Climate Change Strategy
EPPs	Environmental Protection Plans
FDS	Federal Decision Statement
FLNRORD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
IFR	instream flow requirement
KP	Knight Piésold Ltd.
LNG	liquefied natural gas
MAD	mean annual discharge
MOF	Ministry of Forests
OGC	Oil and Gas Commission (now BC Energy Regulator)
PoD	point of diversion
Project	Woodfibre LNG Project
QEP	qualified environmental professional
SNEAA	Squamish Nation Environmental Assessment Agreement
TWN	Tsleil-Waututh Nation
Woodfibre LNG	Woodfibre LNG Limited
Working Group	Squamish Nation–Woodfibre LNG Environmental Working Group
WMP	Water Management Plan
WMP-C	Water Management Plan for Construction
WSA	Water Sustainability Act

SYMBOLS AND UNITS OF MEASUREMENT

Unit of Measurement	Definition
%	Percent
cm/hr	centimetres per hour
m	metres
m^3/s	cubic metres per second

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1.0 PROJECT DESCRIPTION

Woodfibre LNG Limited Partnership (Woodfibre LNG) will construct and operate the Woodfibre Liquefied Natural Gas Project (the Project), which is located on the former Woodfibre Pulp Mill site approximately seven kilometres southwest of Sḵwx̱wú7mesh (Squamish), British Columbia (BC) (Figure 1). The Project will have the capacity to liquefy up to 2.1 million tonnes per year of liquefied natural gas (LNG), have a storage capacity of 250,000 cubic metres (m^3), and export the LNG via tankers. The Project underwent a comprehensive environmental assessment process from 2013 to 2015, and Woodfibre LNG received the following approvals:

- An environmental assessment certificate (EAC) for the Certified Project Area (CPA) under the British Columbia *Environmental Assessment Act* (EAC #E15-02) in 2015;
- An environmental assessment approval from Skwxwú7mesh Úxwumixw (Squamish Nation) through the Squamish Nation Environmental Assessment Agreement (SNEAA) in 2015, and;
- A positive federal Decision Statement (FDS) under the *Canadian Environmental Assessment Act*, *2012* in 2016.

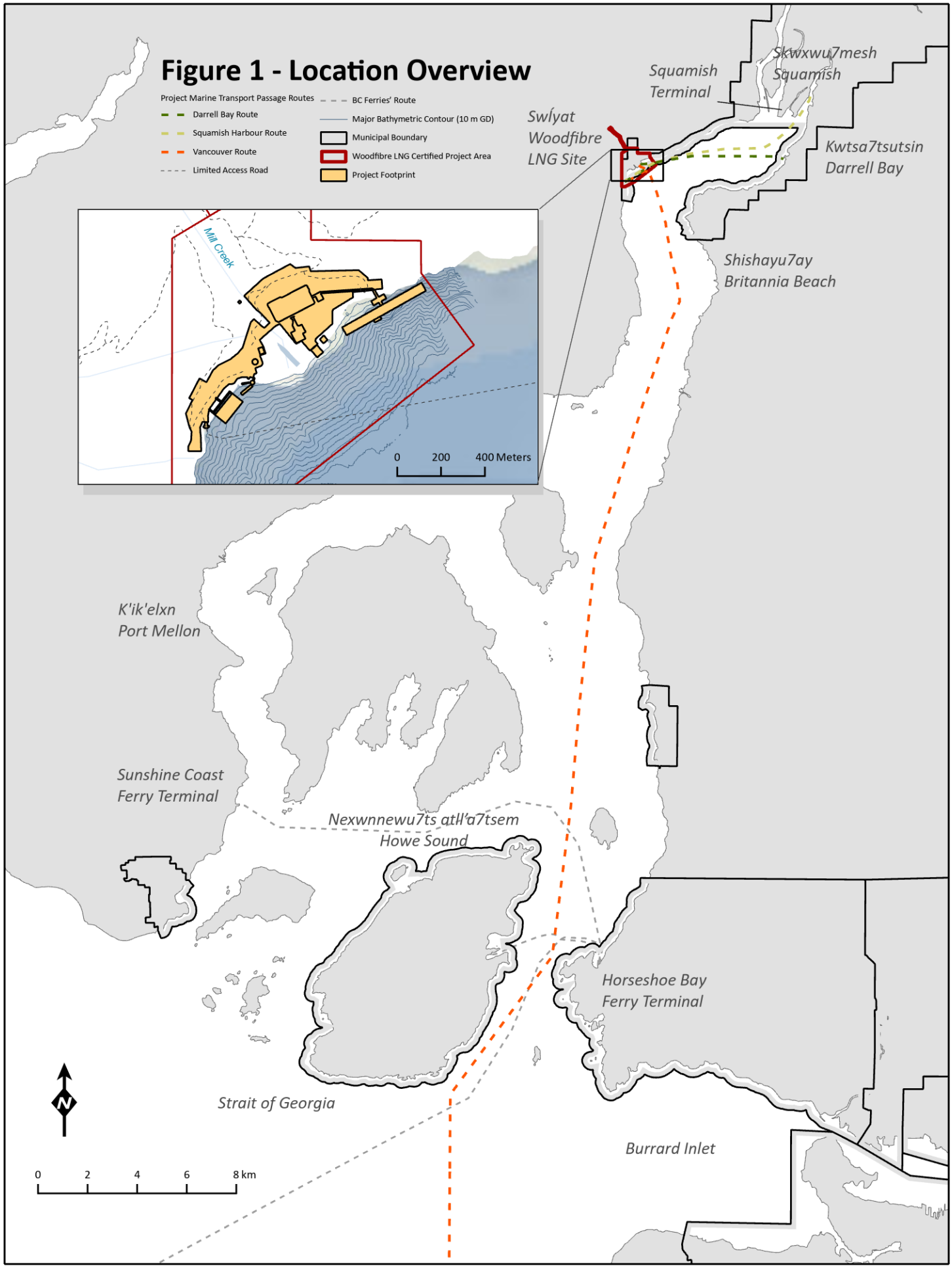
Two EAC amendments were granted by the BC Environmental Assessment Office (EAO) in 2017 and 2019, and the FDS was reissued in 2018 in response to changes to the Designated Project. Woodfibre LNG also received an extension on EAC#15-02 from the BC EAO in October 2020. The provincial, Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), and federal environmental assessment processes have each yielded conditions of approval that Woodfibre LNG must address.

The certified project description is outlined in EAC #15-02 Schedule A. Most of the Project is on fee simple, industrially zoned, brownfield lands with more than 100 years of industrial use. There is no road access to the CPA, and all personnel, equipment, and supplies for the Project will be brought in by vessel via Nexwnnewu7ts atll'a7tsem (Howe Sound). The Project will use electrical power sourced from BC Hydro, and gas will be supplied by Fortis BC to the facility for export.

The CPA and key project components are illustrated in Figure 2. Key project components are:

- Land-based natural gas processing and liquefaction facilities
- Floating storage and offloading unit
- Construction worker accommodation (pending approval of EAC Application amendment 3)
- Supporting infrastructure

The supporting infrastructure includes such things as buildings (e.g., administration, control rooms, maintenance, dry storage and chemical, fire house, first aid, safety and guardhouse), fencing (temporary and permanent), material storage and laydown areas, utility and loading lines, and boil off gas vapour lines.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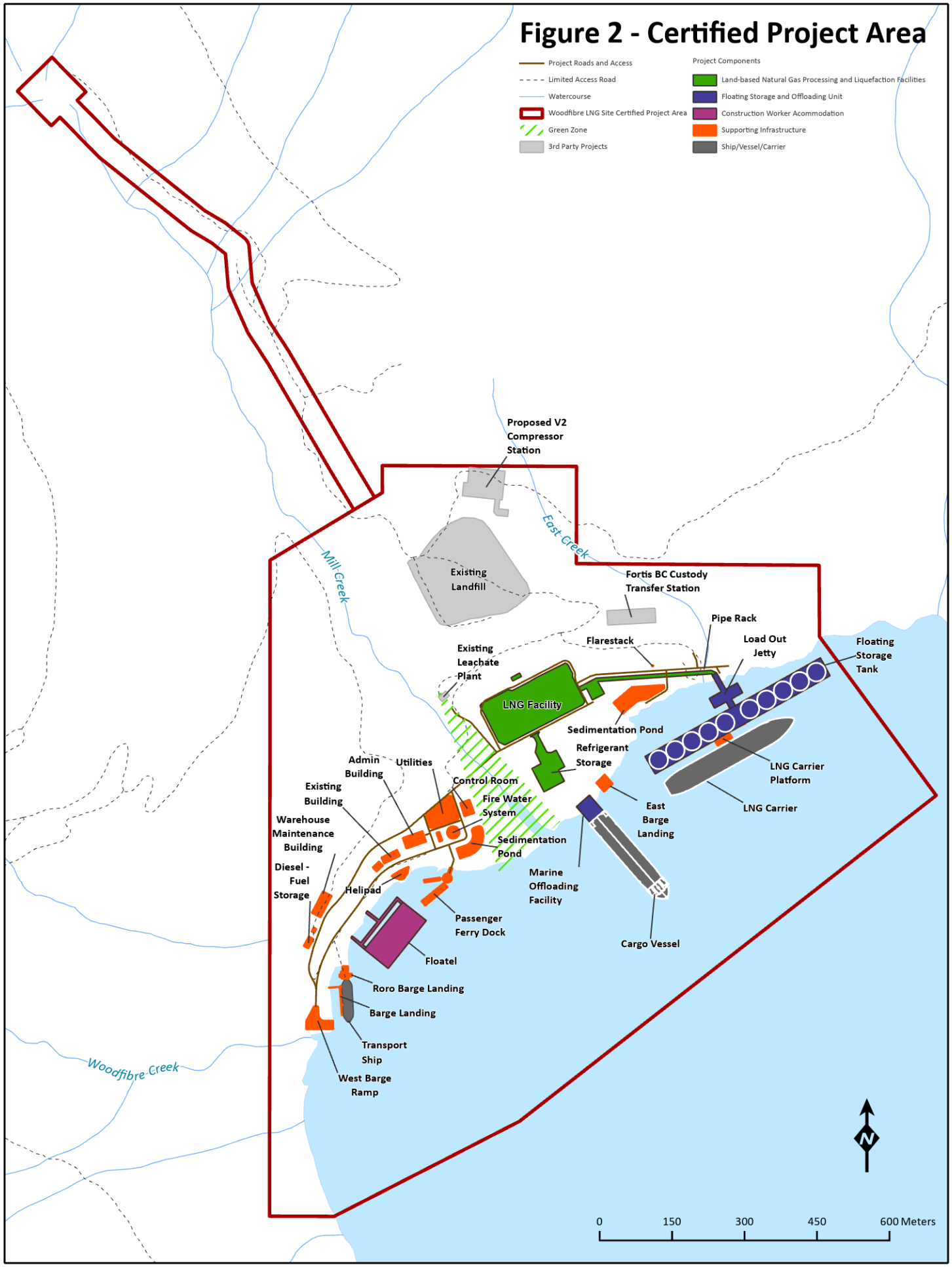
0 200 400 Meters
K'ik'elxn Port Mellon
Sunshine Coast Ferry Terminal
Nexwnnewu7ts atll'a7tsem Howe Sound
Horseshoe Bay Ferry Terminal
Strait of Georgia
Burrard Inlet
N
0 2 4 6 8 km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Refrigerant Storage
LNG Carrier Platform
LNG Carrier
East Barge Landing
Admin Building
Utilities
Control Room
Fire Water System
Existing Building
Warehouse Maintenance Building
Sedimentation Pond
Diesel - Fuel Storage
Helipad
Marine Offloading Facility
Passenger Ferry Dock
Cargo Vessel
Floatel
Roro Barge Landing
Barge Landing
Transport Ship
West Barge Ramp
Woodfibre Creek
N
0
150
300
450
600 Meters

The works and activities that will occur as part of construction include, but are not limited to:

- Marine early works (e.g., shoreline improvements, dock replacement or repairs), including improvements to the existing in-service (east) barge landing
- Clearing vegetation and grubbing
- Stripping and grading
- Demolition
- Drilling and blasting, including excavation, crushing, screening, and hauling
- Grouting and rock stabilization
- Road, culvert, and bridge works
- Construction of land-based natural gas processing and liquefaction facility
- Construction support structures, services, and equipment
- Construction of the floating storage and offloading unit
- Marine early works including dock replacement, south barge landing improvements, shoreline armoring, and placement of riprap, cobble, or sand in the intertidal and shallow subtidal marine environment
- Marine facility construction of mooring dolphin supports and connecting trestles, and gangways dredging if required

Woodfibre LNG will obtain water required for construction and operation activities for the Project from two streams in the Project area, Mill Creek and Woodfibre Creek, and is required to present a withdrawal regime and monitoring program for each of the creeks that will be protective of Environmental Flow Needs (EFN) in both creeks. This Water Management Plan for construction (WMP-C) presents the interim minimum Instream Flow Requirements (IFR) for the creeks during the construction phase; presents the regulatory framework that enables water withdrawals; outlines the roles and responsibilities for developing and implementing this plan; and presents the process to update the WMP for the operations phase.

Water use for Project construction includes sanitary purposes, concrete mixing, dust suppression, vehicle washing, lubrication, or other as required. Consistent with Amendment 2 to EAC #15-02, construction includes physical activities in connection with preparation, building, or installation of the components of the Project but excludes:

- Activities conducted solely for investigative purposes under a valid permit or authorization
- Demolition and removal or on-site remediation of existing terrestrial structures and facilities associated with the former Woodfibre Pulp Mill
- Closure of the existing pulp mill landfill
- On-going maintenance work or upgrades to existing infrastructure to maintain safety, environment, or regulatory compliance

Project Construction is scheduled to commence September 2023 with commissioning scheduled to commence in 2026. This WMP-C will be updated to present a long-term minimum IFR for the Operations phase and will be prepared in consultation with the Ministry of Forests (MOF), the BC Energy Regulator (BCER) (formerly BC Oil and Gas Commission (OGC)), Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and Tsleil-Waututh Nation. The Operations WMP will be completed consistent with the EAC approval.

2.0 CONSULTATION AND PLAN DEVELOPMENT

The WMP-C has been developed by Qualified Professionals and updated based on input from Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), OGC (now BCER), FLNRORD (now Ministry of Forests (MOF)), and Tsleil-Waututh Nation. Draft versions of the plan were provided to these parties for review in 2018, 2019, 2020, and 2022.

Per EAC #15-02 Condition 5 (as amended by Amendment 1 (air cooling)), the draft WMP-C was submitted to the EAO no less than 60 days prior to the start of construction; and was submitted to the MOF and BCER for review prior to submitting to the EAO. A copy of the WMP-C, containing the IFR reports for each of the creeks, will be provided to Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and Tsleil-Waututh Nation within seven days of the report being approved by the EAO.

The WMP-C is considered a Regulated Plan under the SNEAA and must also be approved by the Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) representative prior to the start of construction. Versions, parties consulted, and dates of review are summarized in the Revision History table (p. ii) and each successive revision of WLNG-W0001-EV-EMP-0012 incorporates edits and addresses comments received from stakeholders regarding the previous version.

The WMP-C is a living document and revisions will be made as relevant new information becomes available through the progression of the detailed engineering design of the Project, changes in legislation, if performance objectives are not met, or as required by other regulatory approvals. In the event that the WMP-C requires updates, Woodfibre LNG will prepare an updated version of the document identifying the changes that were made. The updated version will be issued to Sḵwx̱wú7mesh (Squamish Nation), Tsleil-Waututh Nation, and regulatory agencies for a 30-day (excluding statutory holidays) review and comment period. After comments are received, the document will be updated and issued as a clean final revision for approval by the BC EAO.

3.0 REGULATORY FRAMEWORK

The Project is to be designed, constructed, and operated in alignment with the requirements of the provincial, federal, and Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) environmental assessment processes, including:

- EAC #15-02 issued on October 26, 2015 as updated from time to time including amendments issued on July 12, 2017 and July 19, 2019
- FDS issued under Section 54 of the *Canadian Environmental Assessment Act, 2012* on March 18, 2016 as updated from time to time including a revised FDS on March 7, 2018
- Skwxwú7mesh Úxwumixw (Squamish Nation) Environmental Assessment Agreement certificate issued on October 14, 2015 as updated from time to time including a Clarifying Interpretation on July 8, 2019 and Clarifying Interpretation #3 on June 24, 2020
- Permits, licenses, and authorizations issued for the Project
- Regulatory requirements of federal and provincial legislation and regulations
- Squamish Lillooet Regional District bylaws
- District of Squamish bylaws
- Guidance documents as applicable to the WMP-C.

Information that is applicable to this WMP-C is provided in the following sections.

3.1 ENVIRONMENTAL ASSESSMENT CONDITIONS AND COMMITMENTS

The sections of the WMP-C where the conditions of the EAC #15-02, FDS, and the Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) Environmental Assessment Agreement (SNEAA) are addressed are cross-referenced in Table 3.1.

Table 3.1 Table of Concordance for EA Conditions and Application Mitigations

Condition Number	Condition	WMP Reference
EAC Amendment # 1 Condition 5 – Instream Flow Requirements	The Holder must require a Qualified Professional to prepare an instream flow requirements (IFR) report for Mill Creek and Woodfibre Creek, in consultation with FLNRO and BCER. The IFR report must be completed at least 60 days prior to the commencement of Construction.	This WMP-C, which includes IFR reports for Mill Creek (Appendix A) and Woodfibre Creek (Appendix B), has been prepared by a Qualified Professional and has been reviewed by MOF and BCER. The IFR reports propose stepped thresholds to reduce water diversions for Project construction to keep withdrawals in the low risk management category (level 1, BC EFN Policy, 2022), and recommend that when EFNs cannot be met, water diversions be reduced or halted based on real time hydrometric monitoring on each creek. The proposed flow regime has been superseded by the BCER short-term use approval requirement and MOF recommendation to cease withdrawal at 20% MAD in both creeks.

Condition Number	Condition	WMP Reference
	The IFR report must include an interim IFR regime and a procedure for establishing a long-term IFR regime for Mill Creek.	An interim IFR was determined for Mill Creek (Appendix A). The proposed flow regime has been superseded by the short-term use approval requirement and MOF recommendation to cease withdrawal if flows fall below 20% MAD. A long-term IFR regime will be determined to meet the operations water requirements.
	The IFR report must include an IFR regime for Woodfibre Creek for the duration of anticipated water withdrawal for Woodfibre Creek;	An interim IFR has been determined for Woodfibre Creek (Appendix B). The proposed flow regime has been superseded by the BCER short-term use approval requirement and MOF recommendation to cease withdrawal if flows fall below 20% MAD.
	The IFR report must include a record of the data utilized to support the IFR regimes for Mill Creek and Woodfibre Creek;	Hydrology data to support the proposed interim IFRs are presented in Appendices A and B. The proposed flow regime has been superseded by the BCER short-term use approval requirement and MOF recommendation to cease withdrawal if flows fall below 20% MAD. Data utilized to support the long-term IFR will be presented at the time of development.
	The IFR report must include monitoring locations, methods and procedures for the IFR regimes for Mill Creek and Woodfibre Creek;	Included in Sections 6 and 7 of this WMP-C. Monitoring locations, methods, and procedures to support the long-term IFR will be presented at the time of development.
	The IFR report must include the content and frequency for monitoring reports on the implementation of the IFR program and a list of the agencies, including, but not limited to, FLNRO, BCER and Aboriginal Groups, that will receive copies of the reports; and	The content of monitoring reports is described in Section 6 of this WMP-C. Copies of the annual monitoring reports will be delivered to MOF, BCER, Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and Tsleil-Waututh Nation.
	The IFR report must include the process by which the Holder can revise the IFR, including any consultation with BCER, FLNRO and EAO that would occur in connection with any such revisions.	The long-term IFR will be presented in an Operations Water IFR report and WMP, prepared in consultation with MOF, BCER, Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and Tsleil-Waututh Nation. The process for revising the IFR is described in Section 6.3 of this WMP-C.

Condition Number	Condition	WMP Reference
	The Holder must monitor and report on instream flow in Mill Creek during Construction and Operations phases of the Project provided that water withdrawals continue. The Holder must also monitor and report on instream flow in Woodfibre Creek during the Construction phase or, if water withdrawals from Woodfibre Creek extend beyond the Construction period, for the duration of water withdrawal from Woodfibre Creek. Monitoring and reporting for both Creeks must be done in accordance with the IFR report for Mill Creek and Woodfibre Creek required by this condition.	Construction period monitoring is described in Section 6 (Monitoring) and Section 7 (Reporting) of this WMP-C. Operations monitoring will be described in the Operations WMP.
	The Holder must obtain approval from the EAO for the IFR report prior to implementing the IFR regimes.	To be completed following MOF, BCER and Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and Tsleil-Waututh Nation review.
	The Holder must provide a copy of the IFR report to Aboriginal Groups within seven days of the report being approved by the EAO.	To be completed following EAO approval.
Application Mitigations	M5.9-1 Minimum Instream Flow Releases: Woodfibre LNG limited will ensure that the minimum instream flow releases (IFRs) will be established by a qualified professional. When required, the water diversions will be interrupted or reduced as required to maintain minimum or higher instream flows.	The IFR reports for Mill Creek (Appendix A) and Woodfibre Creek (Appendix B) were prepared by qualified professionals. The IFR reports propose stepped thresholds to reduce water diversions for Project construction to keep withdrawals in the low risk management category (level 1, BC EFN Policy, 2022), and recommend that when EFNs cannot be met, water diversions be reduced or halted based on real time hydrometric monitoring on each creek. The proposed flow regime has been superseded by the BCER short-term use approval requirement and MOF recommendation to cease withdrawal if flows fall below 20% MAD in both creeks.

Condition Number	Condition	WMP Reference
Application Mitigations	M5.15-2 Water Management Plan. Instream flow releases specific to the existing flow regime and geomorphology of Mill Creek will be developed in general accordance with Assessment Methods for Aquatic Habitat and Instream Flow Characteristics in Support of Application to Dam, Divert, or Extract Water from Streams in British Columbia (Lewis et a. 2004) and consultation with MFLNRO. The information requirements for determining IFRs include the fish-bearing status of the stream, historic flow records, and any recently collected data. This current and historical information will allow for the establishment of seasonally adjusted instream flow thresholds calculated as percentiles of natural mean daily flows each month. Until such time as the Mill Creek-specific IFRs can be developed, the Project will adhere to IFRs calculated in accordance with the methods outlined in Development of Instream Flow Thresholds as Guidelines for Reviewing Proposed Water Uses (Hatfield et al. 2003). Monitoring will be a requirement of the Water Management Plan to confirm that the plan is effective in protecting fish and fish habitat. Effective monitoring will include a combination of compliance monitoring and biotic response monitoring and the definition of program objectives, scope of effort, timing, and duration. Typical designs include, though are not limited to, the following: Continuous streamflow monitoring downstream of point of withdrawal Intermittent monitoring of biotic variables (e.g., fish abundance or density) Random IFR compliance audits	As agreed with the Working Group, Woodfibre LNG applied the framework in the Environmental Flow Needs Policy (FLNRORD and Ministry of Environment and Climate Change Strategy (ENV) 2014, updated 2022) in lieu of Hatfield et al. (2003) to establish the minimum IFRs. This document considers fish presence / absence, baseline hydrologic regime, and stream size. These values were superseded by the BCER short-term use approval requirement and MOF recommendation to cease withdrawal if flows fall below 20% MAD. Monitoring is described in Section 6 of this WMP-C.
FDS Condition 3.3	The Proponent shall implement measures to mitigate adverse environmental effects of the Designated Project on fish, including mortality, physical injury and behavioral change, during all phases of the Designated Project. The mitigation measures shall include: 3.3.3 maintaining minimum flow in Mill Creek and Woodfibre Creek to support fish and fish habitat	Appendix A Appendix B

Condition Number	Condition	WMP Reference
	3.3.4 designing, installing and operating a water intake structure to avoid or reduce the risk of injury and mortality to fish in Mill Creek and Woodfibre Creek	
FDS Condition 3.14	The Proponent shall, in consultation with Fisheries and Oceans Canada and Aboriginal groups, develop, prior to construction, and implement, during all phases of the Designated Project, a follow-up program to verify the accuracy of the environmental assessment and to determine the effectiveness of the mitigation measures identified under conditions 3.1 to 3.10	Section 6 of this WMP-C.
SNEAA 4.3	Prior to commencing construction, Woodfibre LNG will develop a water management plan for Mill Creek and will develop interim minimum instream flow releases ("IFR"s) on Mill Creek to protect aquatic life as well as the procedure for establishing long-term IFRs, if required in accordance with 4.3(c).	This WMP-C and Appendix A, which proposes an interim IFR regime for construction based on the risk level as defined by the BC EFN Policy (FLNRORD and ENV, 2022). The proposed flow regime has been superseded by the BCER short-term use approval requirement and MOF recommendation to maintain a minimum flow of 20% MAD in both creeks. Section 6.2 of this WMP-C - A long-term IFR regime will be determined to meet the operations water requirements, prepared in consultation with MOF, BCER and Sḵwx̱wú7mesh Úxwumixw (Squamish Nation).
	Woodfibre LNG will engage with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) through the Environmental Working Group in establishing the minimum IFRs, which will be initially determined based on the standard-setting guidelines defined by Instream Flow Thresholds for Fish and Fish Habitat as Guidelines for Reviewing Proposed Water Uses (Hatfield et al. 2003).	As agreed with the Working Group, Woodfibre LNG applied FLNRORD and ENV (2022) in lieu of the standard-setting guidelines in Hatfield et al. (2003) to establish the minimum IFRs. The proposed flow regime presented in the IFRs report has been superseded by the BCER short-term use approval requirement and MOF recommendation to maintain a minimum flow of 20% MAD in both creeks.
	Woodfibre LNG will not change the IFR regime in Mill Creek during the critical stream flow periods ("CSFP") prior to completion of a detailed study, based on Lewis et al. (2004), and will review the results of any associated studies with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) through the Woodfibre Environmental Working Group.	A final IFR will be determined prior to operations, in consultation with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), Tsleil-Waututh Nation, MOF and BCER. Any revisions to the WMP during construction will follow the procedure defined in Section 6.3.

Condition Number	Condition	WMP Reference
	If minimum instream flow is not available on Mill Creek during CSFP for both fish habitat and Project needs, Woodfibre LNG will identify alternative water sources to meet its requirements subject to emergency provisions for fire suppression. For clarity, unless otherwise shown through site-specific studies, the CSFP will be from August 1 through October 31.	Woodfibre Creek will be used as a water source and on-site storage is anticipated to provide capacity during low flow periods. The CSFP will be from August 1 through October 31.
	Any on-site hydrometric data collection and long-term compliance monitoring shall be undertaken in accordance with the Manual of British Columbia Hydrometric Standards (RISC 2009).	Section 3.3 of this WMP-C Appendix A Appendix B

3.2 LEGISLATIVE REQUIREMENTS AND CRITERIA

The diversion and use of water throughout BC is mandated through the *Water Sustainability Act* (WSA), SBC 2014, c. 15, specifically to ensure the beneficial use, management, and protection of water in an efficient way. The *WSA* and Water Sustainability Regulation legislate the diversion and use of water through licences (long-term) or use approvals (use of water for a period of up to 24 months), as well as changes in and about a stream, EFN, and for the introduction of foreign matter into a stream.

The harmful alteration, disruption or destruction of fish habitat is prohibited without prior authorization, under section 35 of the *Fisheries Act*, RSC 1985, c. F-14. This legislation also provides for the protection of fish under Section 34, and from the introduction of deleterious substances or the harmful alteration, disruption or destruction of fish habitat, under Sections 36 and 37.

The regulatory framework for the WMP-C is summarized in Table 3.2.

Table 3.2 Regulatory Framework for the Water Management Plan

Name	Jurisdiction	Description
Fisheries Act, RSC 1985, c. F-14	Federal	Protects Canada's fisheries as a natural resource by safeguarding both fish and fish habitat. It is also an offence for anyone to deposit or permit the deposit of any type of deleterious substance in water frequented by fish without a permit or under a regulation.
Water Sustainability Act, SBC 2014, c. 15	Provincial	The Act and associated regulations and operational policies are intended to ensure sustainable supply of fresh, clean water that meets the needs of BC residents today and in the future. Sections 9 and 11 of the Act allow for water licensing and water use approvals respectively.

3.3 BEST MANAGEMENT PRACTICES AND STANDARDS

Data collection and assessment methods were developed based on the guidelines and methods outlined in the following documents:

- Manual of British Columbia Hydrometric Standards, prepared by Ministry of Environment for Resources Information Standards Committee (RISC 2009, updated 2018)
- British Columbia Environmental Flow Needs Policy (FLNRORD and ENV, 2022)
- Assessment Methods for Aquatic Habitat and Instream Flow Characteristics in Support of Applications to Dam, Divert, or Extract Water from Streams in BC (Lewis et. al. 2004)
- Guidelines for the Collection and Analysis of Fish and Fish Habitat Data for the Purpose of Assessing Impacts from Small Hydropower Projects in British Columbia (Hatfield et. al., 2007)
- Fish Collection Methods and Standards. Version 4. (Ministry of Environment, 1997).

3.4 WATER SUSTAINABILITY ACT APPROVALS

Woodfibre LNG received approval from the BCER under Section 10 of the WSA, allowing short term use of water (Determination of Application Number 100117204) from Mill Creek and Woodfibre Creek, and Section 11 of the WSA, allowing changes in and about a stream in Woodfibre Creek (Determination of Application Number 100117209).

The Section 10 permit allows for the diversion, storage, and use of water from Mill Creek and Woodfibre Creek at the established points of diversion from April 12, 2023 to April 11, 2025. Water withdrawn under this authorization may not be used to operate worker accommodations.

The Section 11 permit allows removal of some large boulders and stream bed in order to install a sump for an instream intake structure in Woodfibre Creek within the Woodfibre LNG CPA.

4.0 ROLES AND RESPONSIBILITIES

This section outlines the roles and responsibilities of Woodfibre LNG, Woodfibre LNG's Environmental Representative, the Contractor(s), and Environmental Monitor(s) for updating, implementing, inspecting, and reporting on the effectiveness of environmental protection and mitigation measures (Table 4.1). This section will focus on the roles and responsibilities for the WMP-C.

Table 4.1 Summary of Roles and Responsibilities for the Water Management Plan

Entity	Role and Responsibility

Woodfibre LNG Environmental Representative	• Responsible for overall compliance with regulatory permits, and approvals, including EAC conditions, FDS conditions, and SNEAA environmental assessment certificate conditions.
	• The Woodfibre LNG Environmental Representative will appoint an environmental team which will be accountable for the following activities relevant to the WMP-C during construction of the Project.
	  ○ Retain the Environmental Monitor (EM) and Qualified Professionals as necessary to implement the WMP-C
	  ○ Review and approve Contractor Environmental Protection Plans (EPPs) for compliance with the WMP-C
	  ○ Verify Contractor compliance with the WMP-C
	• Communicate monitoring results externally and other information in accordance with the WMP-C

Contractor	• Undertake work in compliance with management plans, EPPs, environmental approvals, permits, and authorizations. • Withdraw water from Mill and Woodfibre creeks in accordance with permits/approval and this WMP-C • Install structures consistent with this WMP-C
Environmental Monitor	• Monitor and review compliance of construction activities with management plans, EPPs, permits, approvals, and other environmental requirements. • Attend Project planning and tailgate meetings to communicate potential environmental concerns and requirements. • Maintain monitoring records regarding implementation of management plans, EPPs, permits, and approvals. This will include any measurements taken (e.g. streamflow), sampling conducted, field notes, photographs, and environmental incident reports. • Monitor streamflow data and inform the Contractor of streamflow conditions • Verify the effectiveness of mitigation measures • Prepare and submit reports, at least monthly, on environmental monitoring to Woodfibre LNG for relevant management plans and EPPs. • Stop or modify site activities if environmental mitigation measures are not considered to be effective, if there is an imminent risk to the environment, or if work does not comply with the terms and conditions of the WMP-C.

Entity	Role and Responsibility
Qualified Environmental Professional (QEP)	• Prepare the WMP-C including the IFR reports • Provide discipline-specific expertise (e.g., hydrology monitoring, biotic sampling, and IFR audits). • Establish and maintain hydrometric stations. • Oversee surveys / monitoring associated with the implementation of the WMP-C • Prepare annual reports as outlined in this WMP-C
Aboriginal Monitors	• Condition 23 of the EAC requires that Woodfibre LNG seek to provide opportunities for members of Aboriginal Groups to participate in monitoring activities that are occurring within their asserted traditional territory

5.0 INSTREAM FLOW REQUIREMENT

5.1 WATER NEEDS

The water diversion rate proposed in the environmental assessment application was estimated as 0.07 m^3/s for the construction phase. Advancement of Project design and refinement of information on construction activities now indicates that the Project requires up to 0.10 m^3/s of water year-round for construction of the LNG facility and ancillary works. The water will be sourced from Mill Creek and/or Woodfibre Creek. This quantity may not be required continuously but may be required at any time during the construction phase, depending on the evolution of the construction schedule. Approximately 0.005 m^3/s of this total diversion (0.10 m^3/s) is proposed to be withdrawn for Woodfibre Creek during construction to supply water to the floating worker accommodations, pending approval of the associated EAC amendment application and request for amendment to the WSA permit (Application Determination Number: 100117204).

Water diversions during the operations phase are estimated as 0.007 m^3/s for regular use and additional requirements for fire fighting water. In the event that water diversions would be needed for firefighting, the anticipated withdrawal rate would be 0.03 m^3/s. Water will be diverted from Mill Creek and/or Woodfibre to the LNG facility area. The design and location of the intake structures for operations will be determined as part of detailed design of the Project, and this WMP-C will be updated in consultation with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), Tsleil-Waututh Nation, MOF, and the BCER. The operations WMP will be submitted to the EAO prior to commencement of LNG facility operations.

5.2 ALLOWABLE DIVERSION RATES

Water diversions for use during construction are proposed at a maximum instantaneous diversion limit of 0.10 m^3/s. This may be achieved from either Woodfibre Creek or Mill Creek or any combination thereof, provided the diversion rate from each stream does not exceed 0.10 m^3/s. The BC EFN Policy (FLNRORD and ENV, 2022) presents a risk-based assessment approach that considers fish presence/absence, baseline hydrologic regime, and stream size. The policy was used to quantify the risk level of withdrawals from Mill Creek and Woodfibre Creek based on the proposed construction water requirement – the detailed methodology and results of the risk assessment can be found in Appendices A and B, for Mill Creek and Woodfibre Creek, respectively.

The proposed flow regimes in Appendices A and B have been superseded by the BCER short-term use approval (Determination of Application Number 100117204) issued on April 12, 2023, and the MOF recommendation to maintain a minimum flow of 20% MAD in both creeks (MOF Personal Communication, 2023).

The permitted allowable maximum diversion limit from both creeks is 0.10 m^3/s, a total daily withdrawal of 3,600 m^3/day (based on a 10-hour construction day), and a total annual withdrawal of 1,314,000 m^3. Flows will only be diverted when streamflows at the hydrometric gauging stations are greater than or equal to 20% MAD, which equate to:

- Mill Creek: no water withdrawals are authorized if the discharge measured at the hydrometric gauging station is less than 0.81 m^3/s.
- Woodfibre Creek: no water withdrawals are authorized if the discharge measured at the hydrometric gauging station is less than 0.47 m^3/s

This regime applies year round.

The permitted diversion rate and flow restrictions supersede the IFR regime proposed in the IFR reports for Mill Creek (Appendix A) and Woodfibre Creek (Appendix B). These reports are included for information only – water will be diverted in accordance with the WSA approval rather than following the flow regime presented in these reports.

A long-term IFR regime will be determined to meet the operations water requirements, prepared in consultation with MOF, BCER and Skwxwú7mesh Úxwumixw (Squamish Nation).

6.0 MONITORING AND FOLLOW UP PLANS

6.1 OVERVIEW

Monitoring for the IFR regime includes hydrology compliance monitoring (IFR audits), fish habitat and fish passage monitoring, and ramping rate assessment. Additional monitoring as part of a freshwater Fisheries and Aquatic Life Monitoring Program to be included within the Construction Environmental Management Plan will further supplement the monitoring outlined herein. As determined by the QEP, data from other studies will be used to inform the IFR, as the data become available.

6.2 MONITORING

6.2.1 Hydrology Compliance Monitoring

Streamflow data collection will continue on both Mill and Woodfibre creeks for the duration of water withdrawals. If water diversion is discontinued, gauging may also be discontinued on that creek at Woodfibre LNG's discretion.

Woodfibre LNG, under direction of the QEP, will maintain active telemetered gauging stations on Mill Creek and Woodfibre Creek, currently located upstream of the historic hydropower intakes, for the duration of water withdrawals. In accordance with SNEAA 4.3, all on-site hydrometric data collection and long-term compliance monitoring will be undertaken following the most recent version of the Manual of British Columbia Hydrometric Standards (RISC 2009, updated in 2018).

The EM will monitor Mill Creek and Woodfibre Creek flows at the active gauging stations and communicate available flows to the Contractor, who is responsible for complying with approved diversion quantities.

The EM will review streamflow conditions at the gauging station daily via the telemetry software, prior to any water diversion, and inform the Contractor if flows are dropping and approaching the flow diversion threshold of 20% MAD. Alarms will be set on the telemetry and email and/or text notifications will be sent to the EM when flows are 10% higher than the diversion threshold:

1. In Mill Creek the EM will notify the Contractor that the diversion rate may have to be reduced when the instantaneous flow is 0.89 m^3/s
2. In Woodfibre Creek the EM will notify the Contractor that the diversion rate may have to be reduced when the instantaneous flow is 0.57 m^3/s.

The EM will continue to monitor the gauging stations and inform the contractor to cease diverting water from the intakes when the instantaneous flow in Mill Creek is 0.81 m^3/s and the instantaneous flow in Woodfibre Creek is 0.47 m^3/s.

An inline flow meter has been installed on the Mill Creek intake pipeline to monitor the quantity of flow withdrawn at the point of diversion (PoD). Flows pumped from Woodfibre Creek will be monitored. Woodfibre LNG will maintain accurate records of all water withdrawal quantities for each PoD throughout the term authorized and document compliance with the allowable diversion rates (Section 5.2).

6.2.2 Fish Habitat Monitoring

A QEP will conduct at least three fish habitat assessments during low flow periods (less than 30% MAD), focussing on the CSFP, to document changes in habitat (wetted width, depth, velocity) in the sections of Mill Creek and Woodfibre Creek impacted by flow reductions, with and without diversion occurring. Methodology will be adapted from the BC Instream Flow Methodology standardized approach to the collection of instream flow information in relation to fish and fish habitat (Lewis et al., 2004).

The BC Instream Flow Methodology recommends that transect sites be located in habitats important to the fish stock(s) of interest (Lewis et al., 2004); transects will therefore be established in monitoring sites in Mill Creek downstream of the anadromous barrier, to focus on pink salmon spawning habitat, and upstream of the anadromous barrier to focus on rainbow trout and Dolly Varden rearing habitat. Transects will be established in Woodfibre Creek downstream of the diversion, which will be located downstream of the anadromous barrier.

Monitoring will occur at two locations in Mill Creek and one location in Woodfibre Creek downstream of the intakes – approximate locations are shown on Figure 3:

- MT-04: In Mill Creek approximately 300 metres from the mouth of the creek in step-pool habitat, upstream of tidal influence and downstream of the anadromous barrier.
- MT-06: In Mill Creek approximately 1000 metres from the mouth of the creek in pool-cascade habitat; upstream of the anadromous barrier.
- WT-01: located in Woodfibre Creek approximately 50 metres from the mouth of the creek in pool-cascade habitat; within tidal influence and downstream of the anadromous barrier.

Transects will be established perpendicular to flow and marked using rock bolts drilled into large boulders along each bank so that water level measurements can be referenced to the same fixed location for each site visit. Each transect will be geo-referenced using a handheld GPS unit using the NAD83 map datum and marked with flagging tape to allow easy identification in the field. Two habitat monitoring transects will be established at each site – transects will be established in areas that will show the greatest change in depth and velocity with changes in discharge (e.g., in a wide, shallow section with sloping banks rather than in a confined bedrock pool, as pools often show limited change in wetted width, depth, or velocity with flow change (Lewis et al., 2004).

LEGEND:

- CPA
- WATER DIVERSION
- FISH HABITAT MONITORING SITE
- TRIBUTARY STREAM CONNECTIVITY MONITORING SITE
- RAMPING SITE
- STREAM

HABITAT UNIT

- POOL CASCADE
- TIDALLY INFLUENCED
- STEP POOL

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	7JUN'23	ISSUED WITH TRANSMITTAL	TJP	KK	TJP

100 50 0 100 200 Meters

NOTES:

1. BASE MAP: ESRI ONLINE WORLD IMAGERY.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:10,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

MONITORING LOCATIONS

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-494/28	VA23-01004

FIGURE 3 REV 0

SAVED: \\KPL\VA-Prj$\11\03\00494\28\A\GIS\Figs\VA23-00784\Fig3_MonitoringLocations_r0.mxd, Jun 07, 2023 11:08 AM, dalexander

During each monitoring event at each transect the QEP will:

- Install a tag line (meter tape) on the rock bolt hangers on the left and right banks
- Record the time at the start of the survey
- Record the wetted width of the transect in meters (m) to the nearest centimeter (0.01 m)
- Measure depth, velocity, and dominant substrate at 20 evenly-spaced verticals ("cells") measured from the established bolt anchors. As the purpose of the monitoring program is to document change in depth and velocity with change in flow, the verticals will be repeated in the same locations during each monitoring event. To facilitate this, the left bank pin will be assigned as the horizontal datum (distance = 0 m) and verticals will be referenced to this datum:
- Measure the depth of the water using the metering rod, recording the depth in metres to the nearest 0.01 m
- Measure the water velocity at each vertical using a meter: velocity measurements will be taken at 0.4 x depth if the water depth is ≤1 m, and at 0.2 and 0.8 x depth if the water depth is >1 m
- Visually estimate and record dominant substrate based on the categories presented in Lewis et al. (2004)
- Record the time at the end of the survey
- Take photographs (view upstream at the transect, view downstream at the transect, view from left bank to right bank along the transect, view from right bank to left bank along the transect)
- Record instantaneous streamflow data from telemetered gauging stations on Mill Creek and Woodfibre Creek at the start and end of each transect measurement.

Weighted usable width will be calculated at each transect using the following equation (Lewis et al., 2004):

$$WUWdvs = \sum_{i}^{n} (Wi \times Di \times Vi \times Si)$$

Where:

- Wi *is the width of cell "i" on the transect*
- Di *is the suitability of depth at cell "i" on the transect*
- Vi *is the suitability of velocity at cell "i" on the transect*
- Si *is the suitability of substrate at cell "I" on the transect*.

Suitability parameters will be based on the Habitat Suitability Index curves developed by the BC Ministry of Environment for rainbow trout juvenile rearing and pink salmon spawning (Ptolemy, 2001).

6.2.3 Ramping Rate Monitoring

When water diversion commences, streamflow will decrease, and water level will drop. The purpose of ramping rate monitoring is to determine if the rate of flow withdrawal will result in fish stranding downstream of the intakes. Fish stranding is any event where fish become trapped in pools and isolated from a main body of water or are beached due to rapid fluctuations in flow regime Fisheries and Oceans Canada (2017).

River stage, shoreline slopes less than 6%, heavily structured littoral zones, cooler water temperatures and abrupt water levels changes increase the likelihood of fish stranding events (Fisheries and Oceans Canada, 2017).

Ramping rate is defined by Fisheries and Oceans Canada (2012) as the rate of change in discharge measured as a flow per unit time (i.e., m^3/s per second) or as the rate of change in stage and measured as vertical change in water surface per unit time (i.e., centimetres per hour (cm/hr)). The ramping rate monitoring protocol has been adapted from Fisheries and Oceans Canada (2012) - the components involved in determining the impacts of flow ramping are included below:

- Sample Area: monitoring sites will be established in sensitive habitats downstream of the intakes. Sensitive habitats (areas with a high risk of fish stranding) in Mill Creek will be identified; monitoring sites will be established in locations that exhibit large changes in wetted area as stage or discharge change (e.g., broad active channel sections and shallow sloping banks). It is expected that monitoring sites in Mill Creek will be limited, as the diversion reach has primarily step-pool morphology and/or is incised within a bedrock canyon, often with near vertical walls exceeding 10 m in height. Therefore, an initial monitoring site has been identified in the tidally influenced zone for each creek (see Figure 3).
- Method: Water level transducers will be installed at each monitoring site to record continuous stage during the CSFP. water will be diverted at the intakes at the maximum withdrawal rate (0.1 m^3/s) and the resulting stage change will be recorded at each monitoring area. Data will be retrieved from the water level transducers and stage change rates (in cm/hour) will be calculated for a pre-determined period prior to, during, and following the start of water diversion, accounting for lag time. Rates will be compared to the DFO criteria rates of 2.5 cm/h when fry are present, and 5.0 cm/h at all other times, as well as to background stage change rates.
    - Biotic monitoring: following the initiation of water withdrawal, a QEP will conduct a visual survey of sensitive habitats for fish stranding. The number and location of any stranded fish will be recorded. Fish will be returned to the wetted portion of the streams.
    - Operational Monitoring: the ability of the contractor to accurately and precisely start, stop, and ramp flow diversion will be assessed. Specifically, at Mill Creek where diversion will be controlled by regulation at the LNG facility, 2 km downstream of the intake.
- Frequency:
    - Water level transducers will record continuous stage during the CSFP.
    - Biotic and operational monitoring will be conducted three times during low flows, targeting the range of 10% to 30% MAD, to assess variability.
    - Ramping rate monitoring will occur in August or September, during the CSFP, when the withdrawal ratio is greatest (6% and 5%, respectively, of the natural monthly flows in Mill Creek and 8% for both months in Woodfibre Creek).

6.2.4 Tributary Streams Connectivity

Three first-order streams are mapped flowing into Mill Creek from the northeast downstream of the intake site. These streams will be visually assessed where they cross the access road to the intake to document flow (monitoring sites TS-1, TS-2, TS-3 on Figure 3), and if they are flowing and if safe to do so, the confluence of the tributaries with Mill Creek will be assessed to document surface connectivity (wetted width, depth) to determine if fish passage is maintained when water is being diverted from Mill Creek.

No streams flow into Woodfibre Creek between the intake site and the mouth of the creek.

6.3 ADAPTIVE MANAGEMENT

A QEP will review the hydrology and fisheries data collected. If the QEP determines that adjustments to the WMP or IFR are required based on the additional data collected, this WMP-C will be updated. Updates to the plan and IFR will follow the approach outlined in Section 2. The QEP may increase the IFR flow diversion threshold above 20% MAD for the purposes of protection of aquatic life.

The QEP will verify effectiveness of new/revised mitigations and will provide a monitoring report based on these assessments and any adaptive management recommendations.

7.0 REPORTING AND COMMUNICATIONS

7.1 MONITORING REPORTS

Reporting will occur for the duration over which water is being withdrawn from Mill or Woodfibre creeks as authorized by environmental assessment approvals. Flow and/or water level measurements and observations related to water quantity, work activities, and employed actions taken will be recorded by the EM and will form the basis of environmental monitoring reports.

A monthly report will be prepared by the EM during construction that will include a summary of actions completed related to this plan.

Water withdrawal records will be submitted to the BCER on a quarterly basis: reports are due on or before April 25, July 25, October 25, and January 25.

An annual report will be prepared by the QEP to present streamflow data and diverted flow quantities, along with documentation of actions completed if the maximum diversion limits at the gauging station did not meet the streamflow triggers. Documentation to be included in the report is listed as follows:

1. Stage-discharge measurements and gauging station maintenance records
2. Hydrograph showing flow upstream of the PoD
3. Quantity of flow diverted, recorded at the inline flow meter or pumped
4. Summary of any environmental incident reports (Section 7.2)

The annual monitoring report will also include fish habitat, ramping rate, and tributary streams connectivity in the years that this work is completed. The annual report will be shared with MOF, BCER, Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), and Tsleil-Waututh Nation.

7.2 ENVIRONMENTAL INCIDENT REPORTS

An Environmental Incident with respect to surface water quantity is one that has caused, or has the potential for causing, one or more of the following:

- Exceedance of approved maximum diversion limits (0.1 m^3/s).
- Adverse alteration of habitat (e.g., dewatering) following water withdrawal at the approved maximum diversion limits.
- Fish stranding following water withdrawal at the approved maximum diversion limits.
- Water withdrawal if the discharge measured at the hydrometric monitoring stations is less than 0.81 m^3/s in Mill Creek and less than 0.47 m^3/s in Woodfibre Creek

The Environmental Incident Report will characterize and document the:

- Cause and nature of the incident.
- Approximate magnitude (area or habitat affected) and duration.
- Actions taken to control or limit the activity causing the incident, and

- Proposed remedial or corrective actions to prevent recurrence of the incident.

Incident reporting will be included in monthly and annual reports, however, where permit requirements establish that an incident report is to be submitted, these will be prepared and submitted consistent with permit requirements and shared with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and Tsleil-Waututh Nation.

8.0 REFERENCES

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9.0 PROFESSIONAL STATEMENT

Knight Piésold Ltd. confirms that this report, titled Water Management Plan-Construction, has been prepared in general conformance with the *Water Sustainability Act*.

Report authors Toby Perkins and Stephanie Eagen of Knight Piésold Ltd. have demonstrable experience in the preparation of water management plans and are familiar with the investigation carried out at the Site.

Table 9.1 lists the Qualified Professionals and designations who prepared the Project's WMP.

Table 9.1 Qualified Professionals

Name	Qualifications
Toby Perkins	P.Eng.
Stephanie Eagen	R.P.Bio.

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APPENDIX A

Mill Creek Instream Flow Requirement, Construction Water Study (Rev 6)

Prepared for
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Prepared by
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VA103-494/24-2

MILL CREEK INSTREAM FLOW REQUIREMENT
CONSTRUCTION WATER STUDY

Rev	Description	Date
0	Issued in Final	July 20, 2018
1	Revised Point of Diversion and Diversion Rate	February 26, 2019
2	Revised Hydrology and Monitoring Plan	May 21, 2019
3	Updated to Address Agency Review Comments	August 30, 2019
4	Updated to Include Revised Point of Diversion Location	December 11, 2020
5	Updated to Address Review Comments. Updated Hydrology. Updated Maximum Diversion Rate.	August 16, 2022
6	Updated to Address Client Comments	September 23, 2022

Knight Piésold CONSULTING

Management System Certified by: bsi ISO 9001 ISO 14001 ISO 45001 CERTIFIED

EXECUTIVE SUMMARY

Woodfibre LNG Ltd. (Woodfibre LNG) will construct and operate the Woodfibre Liquefied Natural Gas (LNG) Project (the Project), which is located on the former Woodfibre Pulp Mill site approximately seven kilometres (km) southwest of Skwxwú7mesh (Squamish), British Columbia. The Project will have capacity to liquefy up to 2.1 million tonnes per year of natural gas, have a storage capacity of 250,000 cubic metres (m^3), and export the LNG via tankers. The Project underwent a comprehensive environmental assessment process from 2013 to 2015 and Woodfibre LNG received:

- An environmental assessment certificate (EAC) for the Certified Project Area (CPA) under the British Columbia *Environmental Assessment Act* (BCEAA; EAC #E15-02) in 2015
- An environmental assessment approval from Squamish Nation through the Squamish Nation Environmental Assessment Agreement (SNEAA) in 2015
- A positive federal Decision Statement under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) in 2016

Two EAC amendments were granted by the British Columbia Environmental Assessment Office (EAO) in 2017 and 2019, and the federal Decision Statement was reissued in 2018 in response to changes to the Designated Project. Woodfibre LNG also received an extension on EAC#15-02 from the BC EAO in October 2020. The provincial, Skwxwú7mesh Úxwumixw (Squamish Nation), and federal environmental assessment processes have each yielded conditions of approval that Woodfibre LNG must address, including that Woodfibre LNG undertake an instream flow requirements (IFR) study to assess the potential effects of diverting water for construction and operation from Mill Creek and Woodfibre Creek.

Water is required for construction of the facility and will be sourced from Mill Creek or Woodfibre Creek. The proposed Mill Creek construction water source point of diversion (PoD) is located approximately 2 km upstream from the mouth of the Creek at Howe Sound. This IFR report is intended to support assessment of construction water diversion from Mill Creek and presents:

- A description of watershed, hydrological and fisheries baseline studies
- A summary of proposed Project water use and current water infrastructure
- A risk assessment of the proposed withdrawals following the BC Environmental Flow Needs Policy
- Supplementary measures to mitigate any residual risk

This report is intended to meet Condition 5 of the Project's provincial Environmental Assessment Certificate for instream flow requirements. Specifically, this report supports the construction water requirements for the Project, and for use in the Project's Water Management Plan. This report only addresses Woodfibre Creek.

Physical Setting, Hydrology and Fisheries Studies

Mill Creek is a tributary of Howe Sound, located in the southern Coast Mountains approximately 7 km southwest of Squamish and 45 km north of Vancouver in BC. The Mill Creek watershed area is approximately 41 km^2 at the mouth and ranges in elevation from over 2,000 meters above sea level (masl) at the peak of Mount Sedgewick to sea level at the mouth, where the stream discharges into Howe Sound.

Fish and aquatic habitat information for Mill Creek are based on publicly available datasets, sampling and interpretation completed previously as part of the Project environmental assessment, and sampling and

interpretation completed by Knight Piésold Ltd. (KP) during 2017 and 2018. Anadromous fish are present in Mill Creek from Howe Sound to approximately 600 m upstream, where the gradient increase and large cascades and waterfalls prevent access. Several species of salmon, trout, char and sculpin were documented below the barrier. Above the barrier, only Dolly Varden and rainbow trout were documented; fish densities are very low.

Woodfibre LNG operates an active streamflow gauging station, located just upstream of the historic hydropower intake site, at an elevation of approximately 200 masl and 2 km from the mouth. This station was established in April 2017 and remains active to support instream flow monitoring and management.

Long-term hydrologic conditions in Mill Creek were assessed based on over four years of measured streamflow records collected at the Mill Creek gauging station. These data were correlated with streamflow data collected by Water Survey of Canada (WSC) on the Capilano River to produce a long-term synthetic daily flow series for the gauging station. This synthetic daily flow series was used as the basis of assessing baseline and Project affected flow conditions. The mean annual discharge (MAD) for Mill Creek at the gauging station was estimated to be 4.05 m^3/s (1960 to 2020 period), which equates to a mean annual unit runoff of 107 $L/s/km^2$ for the 38 km^2 watershed. The gauging station is located approximately 100 m upstream of the PoD and flow conditions are equivalent at the two locations.

Proposed Construction Water Use and Water Infrastructure

Woodfibre LNG will require up to 0.10 m^3/s of fresh water year-round during the construction phase of the Project, which will be used for sanitary purposes, concrete mixing, dust suppression, vehicle washing, lubrication or other, as required. Woodfibre LNG currently holds three water licences for water use on Mill Creek; however, these licences are for power generation and pulp mill purposes and cannot be used prior to a change in use. Woodfibre LNG will request approval for construction water use pursuant to the *Water Sustainability Act* (WSA). Any amendments to Woodfibre LNG's existing Mill Creek water licences would occur later when the permanent water requirements are known.

Woodfibre LNG is proposing to use the existing intake and flume on Mill Creek to divert water for construction. The intake will be upgraded to include fish screening and diverted to a holding tank for subsequent construction use. A flow meter will be installed on the pipeline to measure the diverted water quantity.

Construction Water Withdrawal Risk Assessment

The Environmental Flow Needs (*EFN) Implementation Guidance for British Columbia* and BC EFN Policy were used to assess the proposed construction water need of 0.10 m^3/s (maximum withdrawal rate). No other water is currently permitted for withdrawal. Based on the BC EFN Policy criteria, the Mill Creek construction withdrawal is considered low risk.

Supplementary Measures

The risk to fish from the proposed construction water withdrawal is considered low, overall. However, during late summer there are periods when baseline streamflow can be low and water withdrawal could represent a substantial portion of the available water. Supplementary measures to avoid impacting the lowest flows are proposed, which would limit construction water withdrawal if streamflow falls below 0.81 m^3/s at the PoD, such that the proportion of flow withdrawn remains low (<15% of streamflow). As streamflow reduces further, the allowable diversion rate as a proportion of real-time flow reduces to 10% then 5% to reduce risk to fish. Between August 1 and October 31, a minimum instream flow requirement of 0.81 m^3/s (20% MAD)

has been set to maintain pink salmon migration and spawning habitat. If flows fall below 0.81 m^3/s, no water will be diverted.

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APPENDICES

Appendix A Mill Creek Hydrologic Analysis and Synthetic Flow Record (VA22-01362)
Appendix B Mill Creek Synthetic Flow Duration Curves

ABBREVIATIONS

BC ..... British Columbia
CPUE ..... Catch Per Unit Effort
EAC ..... Environmental Assessment Certificate
EAO ..... Environmental Assessment Office
EFN ..... Environmental Flow Needs
ENV ..... British Columbia Ministry of Environment and Climate Change Strategy
FIDQ ..... Fish Inventories Data Queries
FLNRORD ..... Ministry of Forests, Lands, Natural Resource Operations and Rural Development
IFR ..... Instream Flow Requirements
JTH ..... J.Termuende Hydrological
km ..... kilometers
KP ..... Knight Piésold Ltd.
LNG ..... liquefied natural gas
m ..... meters
MAD ..... Mean Annual Discharge
masl ..... meters above sea level
OGC ..... BC Oil and Gas Commission
Project ..... the Woodfibre LNG Project
PoD ..... Point of Diversion
SN ..... Squamish Nation
Woodfibre LNG ..... Woodfibre LNG Limited
WSA ..... Water Sustainability Act
WSC ..... Water Survey of Canada

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

Woodfibre LNG Ltd. (Woodfibre LNG) will construct and operate the Woodfibre Liquefied Natural Gas (LNG) Project (the Project), which is located on the former Woodfibre Pulp Mill site approximately seven kilometres (km) southwest of Skwxwú7mesh (Squamish), British Columbia. The Project will have capacity to liquefy up to 2.1 million tonnes per year of natural gas, have a storage capacity of 250,000 cubic metres (m^3), and export the LNG via tankers. The Project underwent a comprehensive environmental assessment process from 2013 to 2015 and Woodfibre LNG received:

- An environmental assessment certificate (EAC) for the Certified Project Area (CPA) under the British Columbia *Environmental Assessment Act* (BCEAA; EAC #E15-02) in 2015
- An environmental assessment approval from Squamish Nation through the Squamish Nation Environmental Assessment Agreement (SNEAA) in 2015
- A positive federal Decision Statement under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) in 2016

Two EAC amendments were granted by the British Columbia Environmental Assessment Office (EAO) in 2017 and 2019, and the federal Decision Statement was reissued in 2018 in response to changes to the Designated Project. Woodfibre LNG also received an extension on EAC#15-02 from the BC EAO in October 2020. The provincial, Skwxwú7mesh Úxwumixw (Squamish Nation), and federal environmental assessment processes have each yielded conditions of approval that Woodfibre LNG must address, including that Woodfibre LNG undertake an instream flow requirements (IFR) study to assess the potential effects of diverting water for construction and operation from Mill Creek and Woodfibre Creek.

1.2 SCOPE OF REPORT

Knight Piésold Ltd (KP) has been retained by Woodfibre LNG to conduct an instream flow requirement (IFR) study for Mill Creek to assess the effects of the proposed water withdrawals of construction and operations water. This report has been prepared to support Woodfibre LNG's application for approval for construction water use pursuant to the *Water Sustainability Act* (WSA) and Condition 5 of the Project's provincial Environmental Assessment Certificate for instream flow requirements. Some of the conditions placed on Woodfibre LNG by Squamish Nation (SN), the federal Minister of Environment and Climate Change, and the BC EAO are addressed in this report. However, a subsequent detailed IFR study that assesses the proposed water withdrawals for operation of the Woodfibre LNG facilities will be presented in an Operational Water Study report to address any outstanding water related conditions.

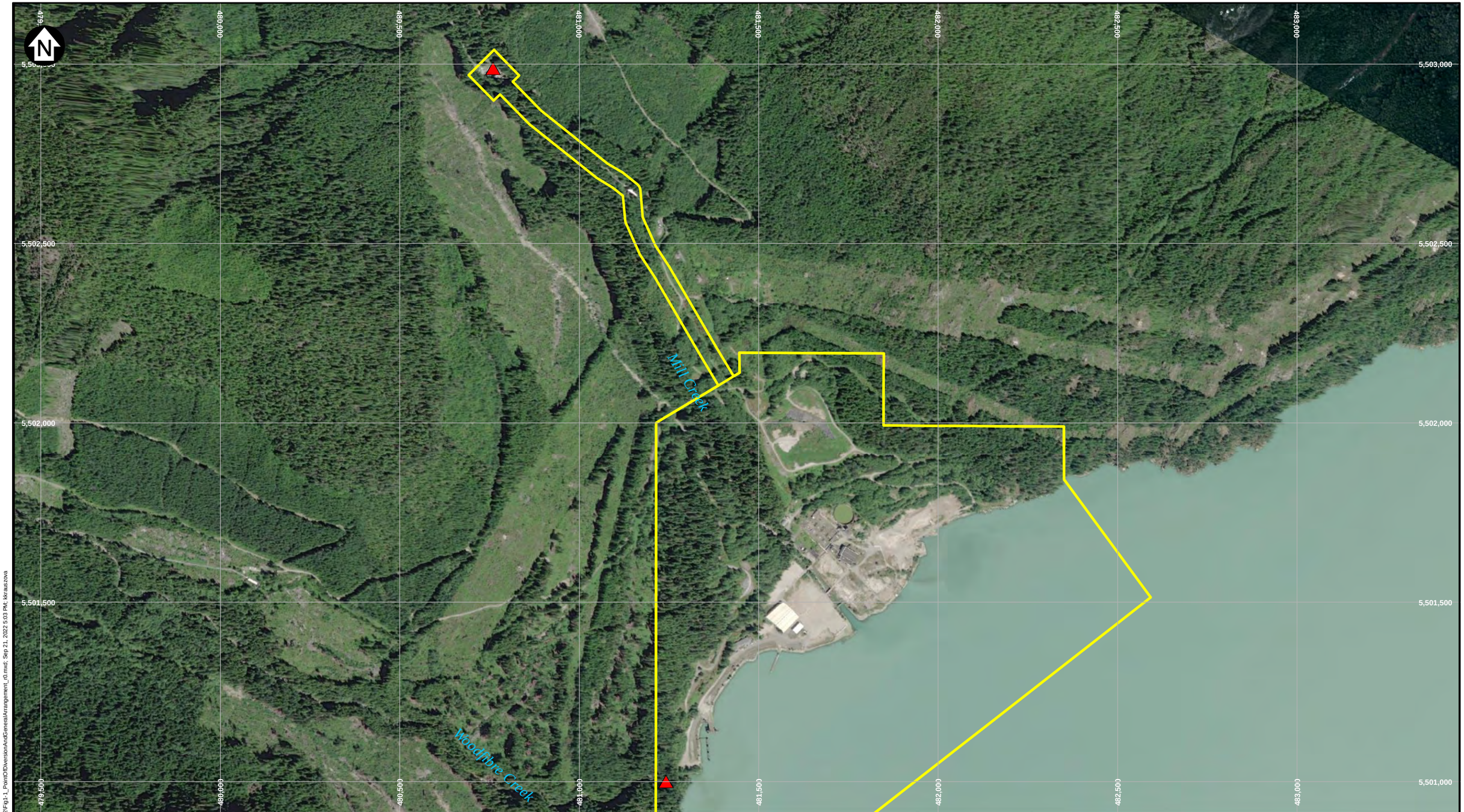
This IFR report presents:

1. A comprehensive description of the physical characteristics of Mill Creek including watershed, channel morphology and hydrological conditions.
2. A fisheries baseline description, providing a summary of fish presence, distribution, periodicity, and habitat requirements.
3. A summary of proposed Project construction water use and water infrastructure.
4. Proposed allowable diversion rates and supplementary measured to mitigate any residual risk.

1.3 CONSTRUCTION WATER REQUIREMENTS

The Project requires up to 0.10 m^3/s of water, year-round, to provide water for construction of the LNG facility and ancillary facilities, to be sourced from Mill Creek or Woodfibre Creek. Water will be diverted from either stream, depending on construction requirements, but the maximum diversion rate from Mill Creek shall not exceed 0.10 m^3/s. Water use for construction of the project includes sanitary purposes, concrete mixing, dust suppression, vehicle washing, lubrication or other as required. The duration and quantity of the water withdrawals (up to the permitted limit) will be dependent upon the construction schedule and Project logistics. For the purpose of this assessment, it is assumed that the maximum water requirement is diverted continuously, to provide a conservative assessment of potential effects.

Water will be diverted from the existing Mill Creek intake, located approximately 2 km upstream from the mouth of the creek. The intake is currently only partially functional but will be upgraded for construction water use to provide diversion rate control, flow measurement and fish screening, to meet Fisheries and Oceans Canada interim code of practice for end-of-pipe fish protection screens (Fisheries and Oceans Canada, 2020). Water will be directed to the construction site via the existing penstock infrastructure and stored in a holding tank for subsequent use at the Project. The point of diversion is shown on Figure 1.1.



LEGEND:

- CPA
- PROPOSED WATER DIVERSION

100 50 0 100 200 Meters

NOTES:

1. BASE MAP: ESRI ONLINE WORLD IMAGERY.
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:10,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
1	10AUG'22	ISSUED WITH REPORT	TJP	KK	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

POINT OF DIVERSION

Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF NO. 2

FIGURE 1.1

REV 0

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2.0 PHYSICAL SETTING

2.1.1 MILL CREEK WATERSHED

Mill Creek is a tributary of Howe Sound, as shown on Figure 2.1, located in the southern Coast Mountains approximately 7 km southwest of Squamish and 45 km north of Vancouver, BC. The Mill Creek watershed and Howe Sound have physiographic characteristics that are typical of the Coast Mountains, a mountain range created by tectonic uplift and intense glacial erosion. These characteristics include high mountain peaks composed of plutonic bedrock, active glaciers in high-elevation headwater areas, U-shaped valleys that were intensely scoured by much larger glaciers during the Ice Age and discordant valley bottom elevations between tributary and main valleys due to variable degrees of glacial scour. Howe Sound is one of many fjords along the British Columbia coast, where a glacially scoured valley was flooded by the sea following deglaciation at the end of the Pleistocene Epoch around 10,000 years ago. Mill Creek flows into Howe Sound near the head of the fjord. Howe Sound is essentially the flooded lower section of the Squamish River valley.

The Canadian Hydrographic Service publishes tidal information for a station located near Squamish. The typical diurnal tidal range is 3 m to 4 m, and the extreme range is over 5 m.

The Mill Creek watershed is approximately 41 km^2 at the mouth and ranges in elevation from over 2,000 meters above sea level (masl) at the peak of Mount Sedgewick to sea level at the mouth, where the stream discharges into Howe Sound. In the upper watershed, the stream channel is largely confined by a series of colluvial/alluvial fans and coupled with hillslope processes.

Mill Creek flows in a southeasterly direction into Howe Sound, roughly through the middle of the Woodfibre LNG property. Mill Creek has a densely vegetated but previously logged watershed with a mean basin elevation of 975 masl. The Mill Creek watershed contains one lake, Scott Lake, located at 1,300 masl. Glaciers cover a negligible area of the watershed.

2.1.2 MILL CREEK CHANNEL MORPHOLOGY

Mill Creek has a mainstem length of approximately 9 km from its source near Mount Sedgwick to its mouth at sea level and an average gradient of approximately 7.5%. As is typical of glaciated valleys of the Coast mountains, channel gradient is steepest in the upper headwaters, moderate in the mid reaches, then steepening again in the lower reaches as the watershed meets the parent valley. Woodfibre LNG operates an active hydrometric gauging station just upstream of the historic Mill Creek intake location at an elevation of approximately 200 masl and 2 km from the mouth. The median watershed elevation above the gauge is 1,050 masl. The reach from the gauge to the mouth has an average gradient of 10%. Channel gradient decreases near the mouth as the channel flows over the historic fan deposits and channel gradient reduces to approximately 4%. The channel on the fan has been confined by the historic pulp mill infrastructure.

Between the mouth of Mill Creek and the proposed intake site, the channel was divided into three reaches. These reaches are shown on Figure 2.2 to Figure 2.3 and described in the following sections.

MILL CREEK WATERSHED

LOCATION TO:	DRAINAGE AREA (km²)
Mill Creek Mouth	41
Point of Diversion	38
Mill Creek Gauge	38

LEGEND:

- PROPOSED WATER DIVERSION
- ACTIVE WOODFIBRE LNG HYDROLOGY GAUGE
- WATERSHED BOUNDARY

1 0.5 0 1 2 3 4 5 Km

NOTES:

1. BASE MAP: ESRI WORLD TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:50,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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WOODFIBRE LNG LIMITED

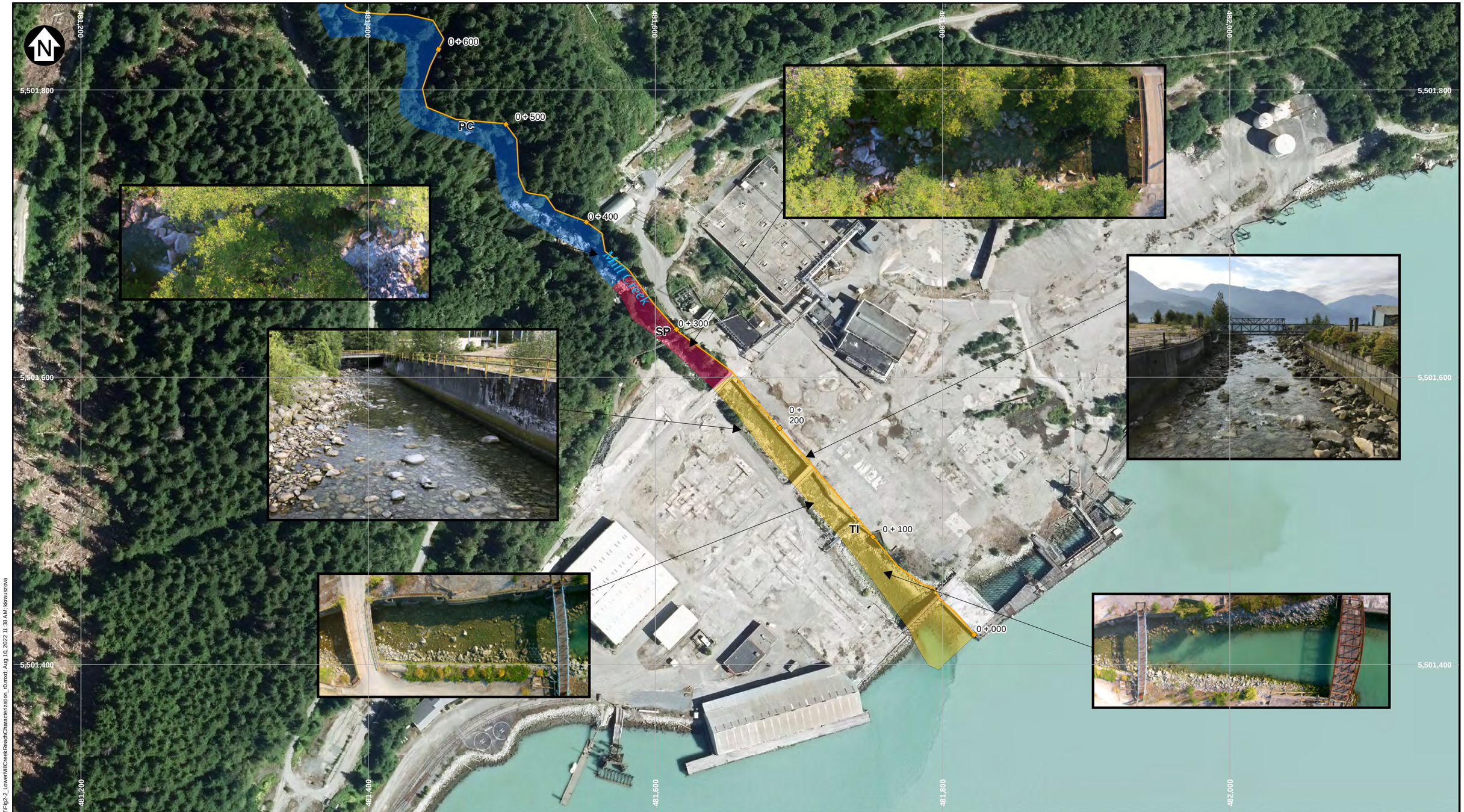
WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

MILL CREEK WATERSHED

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-00494/24	2

FIGURE 2.1 REV 0



LEGEND:

GENERAL

- FISH HABITAT TRANSECT
- CREEK CHAINAGE (METERS)
- PROPOSED WATER DIVERSION

HABITAT UNIT

- TI TIDALLY INFLUENCED
- SP STEP POOL
- PC POOL CASCADE

100 50 0 100 200 Meters

NOTES:

1. BASE MAP: PROJECT IMAGERY.
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:2,500 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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WOODFIBRE LNG LIMITED

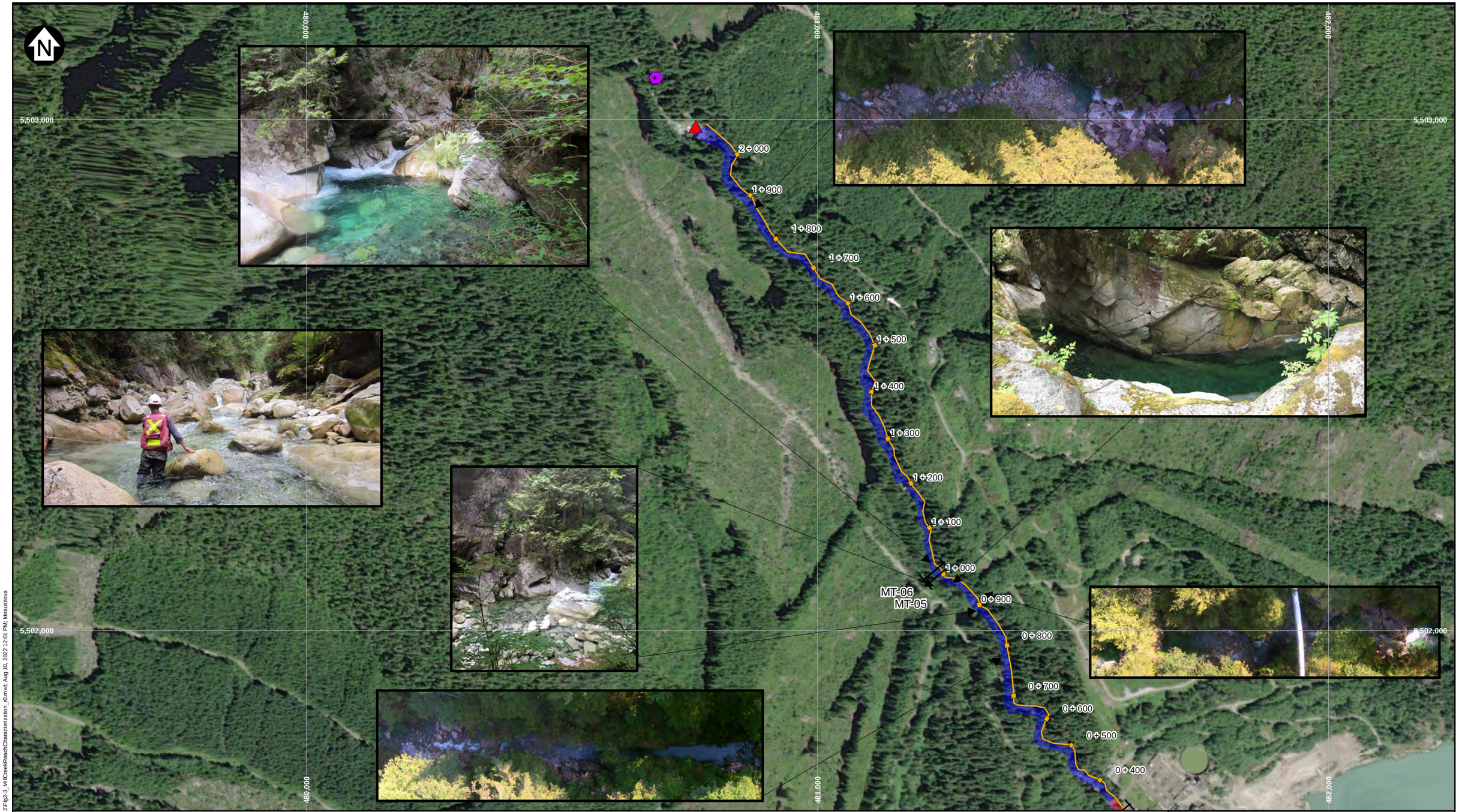
WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

LOWER MILL CREEK REACH CHARACTERIZATION

Knight Piésold CONSULTING

PIA NO.	REF NO.
VA103-494/24	2

FIGURE 2.2 REV 0



LEGEND:

- FISH HABITAT TRANSECT
- CREEK CHAINAGE (METERS)
- PROPOSED WATER DIVERSION
- ACTIVE WOODFIBRE LNG HYDROLOGY GAUGE

HABITAT UNIT

- SP — STEP POOL
- PC — POOL CASCADE

100 50 0 100 200 300 400 500 Meters

NOTES:

1. BASE MAP: ESRI ONLINE.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:7,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	10AUG'22	ISSUED WITH REPORT	ELK	KK	TJP

WOODFIBRE LNG LIMITED

MILL CREEK INSTREAM FLOW STUDY

MILL CREEK REACH CHARACTERIZATION

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-494/24	2

FIGURE 2.3 REV 0

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Reach 1

Starting from the mouth, between chainage 0+000 to 0+250 m of Mill Creek, the channel is tidally influenced, and water levels fall and rise with the tides. At low tide, this reach is classified as plane bed morphology and glide habitat (following the classifications in Montgomery and Buffington, 1997). This reach is also confined by fill placed for the historic pulp mill site. Riparian conditions are vertical concrete walls on the left bank and riprap on the right bank (Photos 2.1 and 2.2).

Photo 2.1 Reach 1 at low tide, showing riparian conditions on the left and right banks

Photo 2.2 Reach 1 at low tide looking downstream to the mouth

The channel is confined by vertical concrete walls on the left bank and both rip rap and concrete walls on the right bank.

Reach 2

Between chainage 0+250 and 0+350, the gradient increases slightly and channel morphology and habitat are classified as step-pool. Bed material is dominated by cobbles and boulders, as shown in Photos 2.3 and 2.4. Photo 2.4 was taken on August 29, 2017 when pink salmon spawners were seen holding in the pool downstream. The upstream limit of anadromous fish is a barrier at chainage 0+600 (in Reach 3).

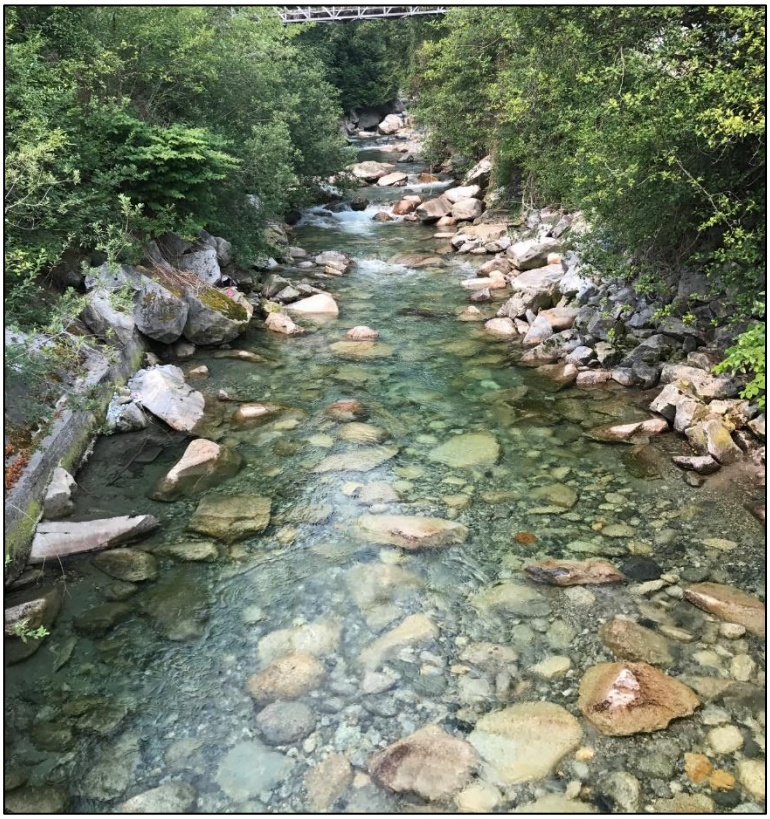


Photo 2.3 **Reach 2 showing an increase in channel gradient compared to Reach 1, and step-pool morphology**

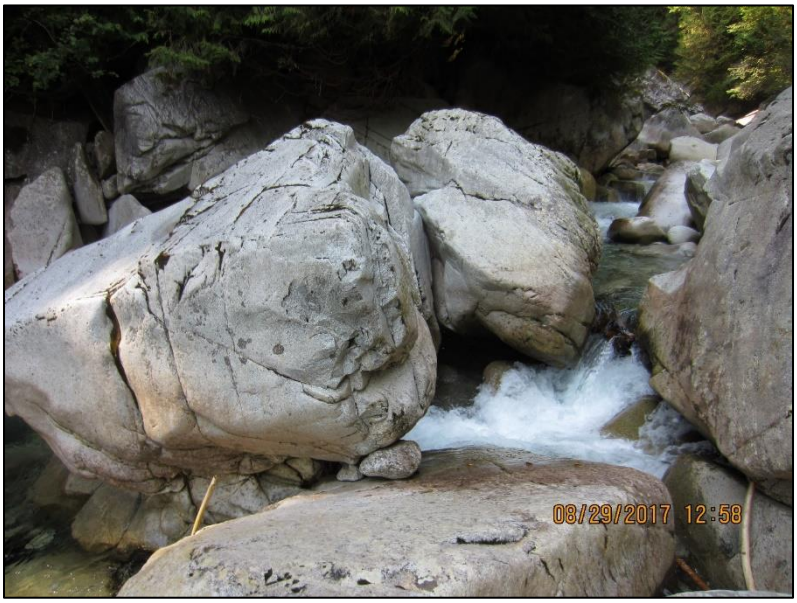


Photo 2.4 **Upstream boundary of Reach 2 (0+350) showing the partial fish barrier at low flows**

Reach 3

Above chainage 0+350 to the PoD at chainage 2+090, the channel gradient increases to an average gradient of approximately 10%. The channel is incised within a bedrock canyon, often with near vertical walls exceeding 10 m in height, as shown on Photo 2.5. Access to the channel on foot is difficult and is only possible in a small number of locations. Channel morphology is characterized as cascade (following the classifications in Montgomery and Buffington, 1997), with frequent bedrock outcrops and large non-alluvial boulders dominating the channel form. Water tumbles off these steps, creating barriers (permanent or flow dependent) to upstream fish migration (see Photo 2.6). Between these falls are short reaches with semi-alluvial step-pool morphology. At approximately chainage 0+415 there is a 4 m high falls that limits upstream migration of most Pacific salmon species at some flows, and at chainage 0+600 there is a 15 m high waterfall representing an absolute anadromous fish barrier (Golder, 2014). Fish habitat in this reach is characterized as pool-cascade.

Photo 2.5 **Downstream boundary of Reach 3 showing difficult access as a result of vertical bedrock walls, and deep pools interspersed with cascades**

Photo 2.6 Aerial view of stream channel of Reach 3 showing falls and cascade barriers to upstream migrating fish

3.0 FISHERIES AND AQUATIC HABITAT BASELINE

3.1 HISTORICAL INFORMATION

Fish and aquatic habitat information for Mill Creek presented in this section is based on publicly available data, sampling and interpretation completed previously as part of the Project environmental assessment, and sampling and interpretation completed by KP during 2017 and 2018.

Limited publicly available historical fish and aquatic information exists for Mill Creek, and fisheries information in the provincial database (Fish Inventories Data Queries, FIDQ) is sparse and outdated (Ministry of Environment and Climate Change Strategy, 2022). Fish observations recorded in the provincial database are from 1979 and 1980, and are restricted to Dolly Varden char, steelhead trout, and coho salmon. Escapement data are provided for chum salmon and coho salmon but is limited to one year of data (1985), with the maximum escapement recorded as eight chum salmon and one coho salmon (Ministry of Environment and Climate Change Strategy, 2022).

Golder Associates prepared a Freshwater Fish Baseline Study for the Project environmental assessment (Golder, 2014). Golder described the Mill Creek aquatic habitat in the channelized section of the Woodfibre property as glide-riffle habitat, ranging in width from 4 m to 31 m, with substrates predominantly boulder and cobble (Golder, 2014). Extending from the mouth of the creek, this 250 m reach of channel is tidally influenced, and water levels rise and fall with the tides. Gradient is moderate within the channelized section (4%) and increases to 15% or more, in some sections, upstream of the property. Instream cover for fish was estimated as 8% of the total creek in the lower channelized section, comprised of cobbles and boulders. Riparian vegetation, and hence the overstream canopy, is sparse as a result of the riprap and concrete walls. Golder identified several barriers to upstream fish passage: a 4 m high falls located 415 m from the mouth of the creek, and two 15 m high falls located approximately 600 m upstream from the mouth.

Golder conducted fish sampling at two sites in Mill Creek in the Project area and at one site upstream of the intake on several dates in 2013 and 2014, and conducted an adult salmon count on September 10, 2013. Golder recorded 1,860 live pink salmon and 219 dead fish on the one-day survey in September 2013, with the majority of live salmon observed between 210 m to 285 m and 385 m to 415 m from the mouth in riffle-glide and cascade-pool habitat, respectively. Golder surmised that the cascade-pool habitat was being used for holding, prior to fish returning downstream to select areas for spawning. Golder noted that the pink salmon were exhibiting redd guarding and spawning behaviour in the creek upstream of tidal influence, although the area and distribution of spawning habitat was limited. Golder concluded that the fish production potential from Mill Creek was habitat-limited.

Minnow trapping by Golder at two sites in lower Mill Creek over three sampling events yielded coho salmon, rainbow trout, and sculpins, as well as gunnel fish. Sculpin were the predominant species: only one coho was captured, in the July 2014 survey, and the gunnel fish was/were not included in the sample summary. The Catch Per Unit Effort (CPUE) in the lower creek ranged from a high of 1.98 fish/24 hours in July 2014 at Site 3 (from the mouth of the creek to approximately chainage 0+150) to a low of 0.13 fish/24 hours in April 2014 at Site 4 (between chainage 0+150 and the cascades, above tidal influence). Rainbow trout were predominantly captured at Site 4. No fish were captured in minnow traps at Site 5 (immediately upstream of the historic hydropower intake located at chainage 0+2000) in July 2014; however, fishing effort was low, and 10 traps were set for approximately 2 hours each.

Coho salmon, rainbow trout, and sculpins were also the only species captured by Golder while electrofishing in lower Mill Creek, with sculpin comprising the majority of the catch. The CPUE ranged from a high of 4.29 fish/minute at Site 3 in July 2014 (36 fish captured in 574 seconds of electrofishing) to a low of zero fish in April 2014 (no fish captured in 574 seconds of electrofishing). Only one rainbow trout was captured at Site 5 by electrofishing in July 2014 in 280 seconds of electrofishing, for a CPUE of 0.21 fish/min.

Hemmera conducted minnow trapping in spring 2016 in Mill Creek between the third and fourth bridge (chainage 0+150 and 0+250) as part of a study to assess pink salmon fry outmigration (Hemmera, 2016). The Hemmera catch information is summarized in Table 3.1.

Table 3.1 Fish Species Capture Data, Hemmera (2016)

Date	# Fish Captured	CPUE (fish/24 hours)	Species
March 23	10	1	Pink salmon fry, Chinook salmon juvenile Unidentified char
March 30	3	0.3	Rainbow trout, Coastrange sculpin
April 4	6	0.35	Rainbow trout Sculpin general
April 13	6	0.3	Rainbow trout, Sculpin general

In addition, two chum salmon were observed (one each in March and April of 2016), but no information on size or life stage was reported.

3.2 IFR STUDY -SPECIFIC SURVEYS

KP conducted fish sampling in support of the IFR assessment in 2017 and 2018 (KP, 2018). Fish sampling methods included electrofishing upstream of the barriers to anadromous salmonids (in accordance with the federal fish collection permit) and minnow trapping in the channelized section near the mouth of the creek as well as upstream of the falls. A snorkel survey was also conducted in the channelized section near the mouth of the creek in February 2018 to assess overwinter use of the habitat. Aerial drone photography was used to map habitat at a high level in August and October 2017 (Figure 2.2), and channel characteristics were recorded at the fish sampling sites in April 2018 at moderate flows.

Coho salmon, rainbow trout, and sculpins were captured by minnow trapping in Mill Creek below the partial cascades barrier at chainage 0+415. A single Dolly Varden was captured at a site upstream of the set of 15 m falls (chainage 0+600), and rainbow trout was the only fish species captured upstream of the historic intake: the minnow trapping CPUE for these sampling events is provided in Table 3.2. The two coho salmon fry captured downstream of the cascade on August 9, 2017 had fork lengths of 46 mm and 74 mm: the presence of the 46 mm fry could indicate that some coho spawn in Mill Creek. The rainbow trout fry captured upstream of the historic intake had a fork length of 62 mm. Numerous adult pink salmon were incidentally observed during low flows on August 28 and 29, 2017 holding in a pool at the base of the cascade downstream of the first falls.

Five rainbow trout fry were captured by electrofishing upstream of the historic intake in August 2017 (for a CPUE of 0.28 fish/minute), and two rainbow trout and two sculpins were captured by electrofishing upstream of the first cascade below the barrier falls in April 2018 (for a CPUE of 1.21 fish/minute). No fish were captured by electrofishing upstream of the set of 15 m falls or upstream of the intake in April 2018.

No fish were observed during the snorkel survey conducted by KP from the mouth of the creek to the top of the pool above the first cascade in February 2018.

Table 3.2 Fish Species Capture Data, Knight Piésold Ltd. (2017-2018)

Date	Site	# Fish Captured	CPUE (fish/24 hours)	Species
August 9, 2017	MC-01 (Below falls)	3	0.62	Sculpin
August 9, 2017	MC-02 (Below falls)	7	1.45	Sculpin Coho salmon
August 9, 2017	MC-10 (Above intake)	1	0.24	Rainbow trout
August 30, 2017	MC-03 (Below falls)	7	1.22	Rainbow trout Coho salmon
August 30, 2017	MC-06 (Above falls)	1	0.17	Dolly Varden char

3.3 POST-EA MONITORING

Keystone Environmental (2021) conducted fish sampling downstream of the barrier falls in Mill Creek in 2020: six baited minnow traps were set for approximately 46 hours each on May 12, 2020 and eight baited minnow traps were set for approximately 22 hours each on September 30, 2020. Six sculpin were the only fish captured in the minnow traps in May. One Chinook salmon, two rainbow, and 14 sculpin were captured in October.

3.4 SUMMARY

A summary of the fish capture data to date is provided in Table 3.3.

Table 3.3 Mill Creek Fish Presence Summary

Reach	Fish Species Present	Life Stage	Reference
Downstream of Barrier Falls	Dolly Varden, steelhead	n/a	FIDQ
	Coho salmon, chum salmon	adult	FIDQ
	Pink salmon	adult	Golder
	Coho salmon, rainbow trout, sculpin, gunnel fish	n/a	Golder
	Pink salmon	fry	Hemmera
	Chinook salmon	juvenile	Hemmera
	Unidentified char, Rainbow trout, Coastrange sculpin, sculpin general, chum salmon	n/a	Hemmera
	Pink salmon	adult	Knight Piésold Ltd.
	Coho salmon	parr	Knight Piésold Ltd.
	Rainbow trout	juvenile	Knight Piésold Ltd.
	Sculpin	n/a	Knight Piésold Ltd.
	Sculpin	n/a	Keystone Environmental
	Chinook salmon	juvenile	Keystone Environmental
	Rainbow trout	juvenile	Keystone Environmental
Between Falls and Historic Intake	Dolly Varden	adult	Knight Piésold Ltd.
Upstream of Intake	Rainbow trout	n/a	Golder
	Dolly Varden	n/a	Fish Inventories Data Queries
	Rainbow trout	juvenile	Knight Piésold Ltd.

The rainbow trout captured by KP ranged from 51 mm to 62 mm fork length, while the Dolly Varden captured upstream of the falls had a fork length of 185 mm. The single rainbow trout captured by Golder at the site upstream of the historic intake in 2014 had a fork length of approximately 50 mm. The sculpin captured by Keystone Environmental ranged in size from 41 mm to 95 mm in May 2020 and 10 mm to 140 mm in October. The Chinook salmon captured by Keystone Environmental in October 2020 had a fork length of 103 mm, while the two rainbow trout had fork lengths of 120 mm and 151 mm.

Although only one Dolly Varden adult has been captured upstream of the falls in Mill Creek, it is likely that the resident rainbow trout and Dolly Varden populations are small-bodied, similar to other high-gradient streams confluent with Howe Sound. Adult rainbow trout captured upstream of impassable barriers on Woodfibre Creek ranged from 136 mm to 209 mm fork length (FSCI Biological Consultants, 2010). In the McNab Creek watershed, cutthroat trout aged 2+ had fork lengths ranging from 151 mm to 179 mm, while Dolly Varden char aged 3+ in the Potlatch Creek watershed had fork lengths ranging from 133 mm to 179 mm (M.A. Whelen and Associates Ltd., 1999). The largest rainbow trout captured in Rainy River by Hatfield Consulting Ltd. (2013) had a fork length of 304 mm. Fish sampling by Hatfield Consultants Ltd. in 1998 in Rainy River found rainbow trout ranging in size from 102 mm to 195 mm, with fish aged as 2+ ranging in size from 126 mm to 132 mm. Rainbow trout ranged from 112 mm to 235 mm in McNair Creek and 112 mm to 197 mm in Dakota Creek, while Dolly Varden char ranged from 157 mm to 194 mm (Hatfield Consultants Ltd., 1998).

In contrast, rainbow trout from larger systems such as the Babine River can attain sizes of 308 mm by age 3 and 531 mm by age 5 (Narver, 1975), and 600 mm rainbow trout have been recorded in the Salmo River (Baxter Environmental, 2002).

Species habitat use for key life history timing events can be shown graphically on Species Periodicity Charts. General species periodicity charts for pink salmon, Dolly Varden char, and rainbow trout are shown in Tables 3.4, 3.5, and 3.6 respectively, and are based on available species life history information for creeks in the Howe Sound region (Ministry of Environment and Climate Change Strategy, 2022).

Table 3.4 Pink Salmon Periodicity Chart

Species	Phase	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Pink salmon	migration																								
	spawning																								
	incubation/emergence																								
	rearing																								

Table 3.5 Dolly Varden Char Periodicity Chart

Species	Phase	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Dolly Varden char	migration																								
	spawning																								
	incubation/emergence																								
	rearing																								

Table 3.6 Rainbow Trout Periodicity Chart

Species	Phase	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Rainbow trout	migration																								
	spawning																								
	incubation/emergence																								
	rearing																								

4.0 HYDROLOGY

The Project area is located within Hydrologic Zone 27 (Western South Coast Mountains), on the boundary with Zone 26, as delineated by Obedkoff (2003). In this zone, Pacific frontal systems encounter the abruptly rising terrain of the Coast Mountains and produce large quantities of precipitation as they are forced upward. Spatial variability in annual precipitation is extensive due to orographic enhancement on windward slopes and rain shadow effects in leeward areas. The proportion of precipitation falling as snow varies with elevation, with little snow falling at sea level and large snowpacks accumulating on upper mountain slopes. Even at high elevations, however, winter rainfall and snowmelt are common, leading to a complex hydrologic regime.

Hydrologic conditions in Mill Creek were assessed based on over two years of measured streamflow records collected on Mill Creek near the historic hydropower intake location. These data were correlated with streamflow data collected by Water Survey of Canada (WSC) on the Capilano River to produce a long-term synthetic daily flow series. This synthetic daily flow series was used for the basis of assessing baseline and project affected (construction) flow conditions.

4.1 MILL CREEK BASELINE HYDROLOGY

4.1.1 MEASURED STREAMFLOW DATA

The measured hydrologic record on Mill Creek consists of both historical data collected by J.Termuende Hydrological (JTH) from 2009 to 2010, and measured data collected by KP since April 2017. Both JTH and KP operated streamflow gauging stations located just upstream of the historic hydropower intake location. KP operates two active streamflow gauging stations on Mill Creek, referred to as MILL and MILL-R2. The current rating curves for each active streamflow gauging station on Mill Creek, are shown on Figure 4.1 and Figure 4.2.

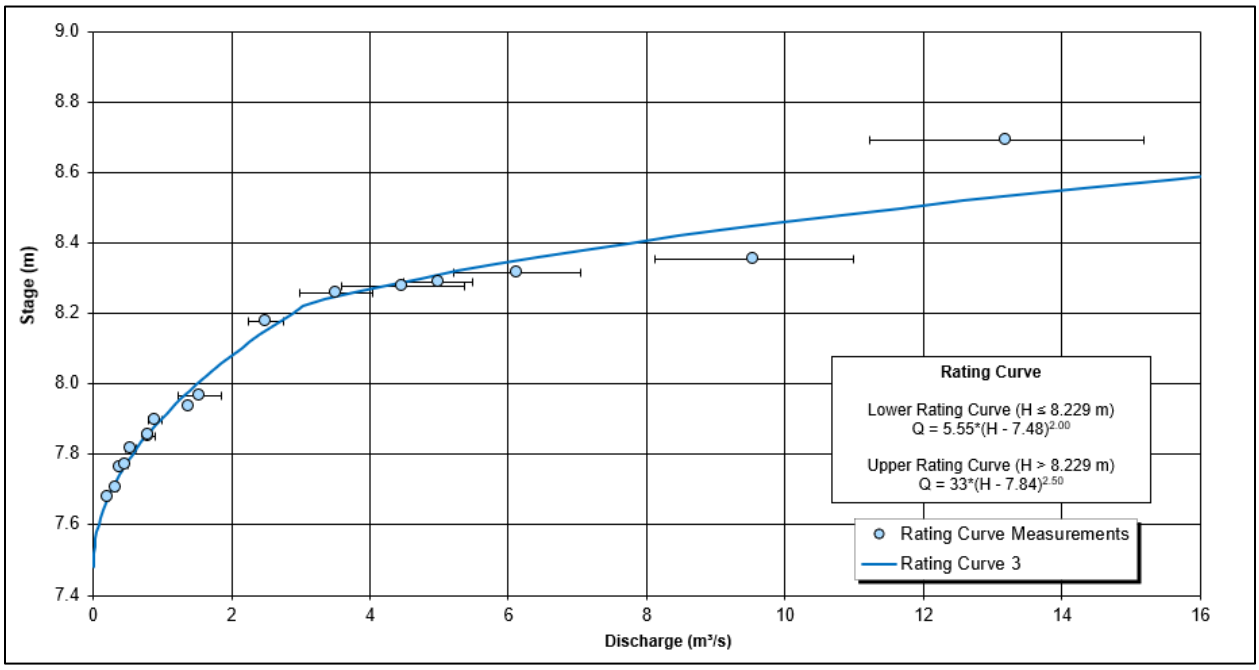


Figure 4.1 Mill Creek (MILL) Rating Curve

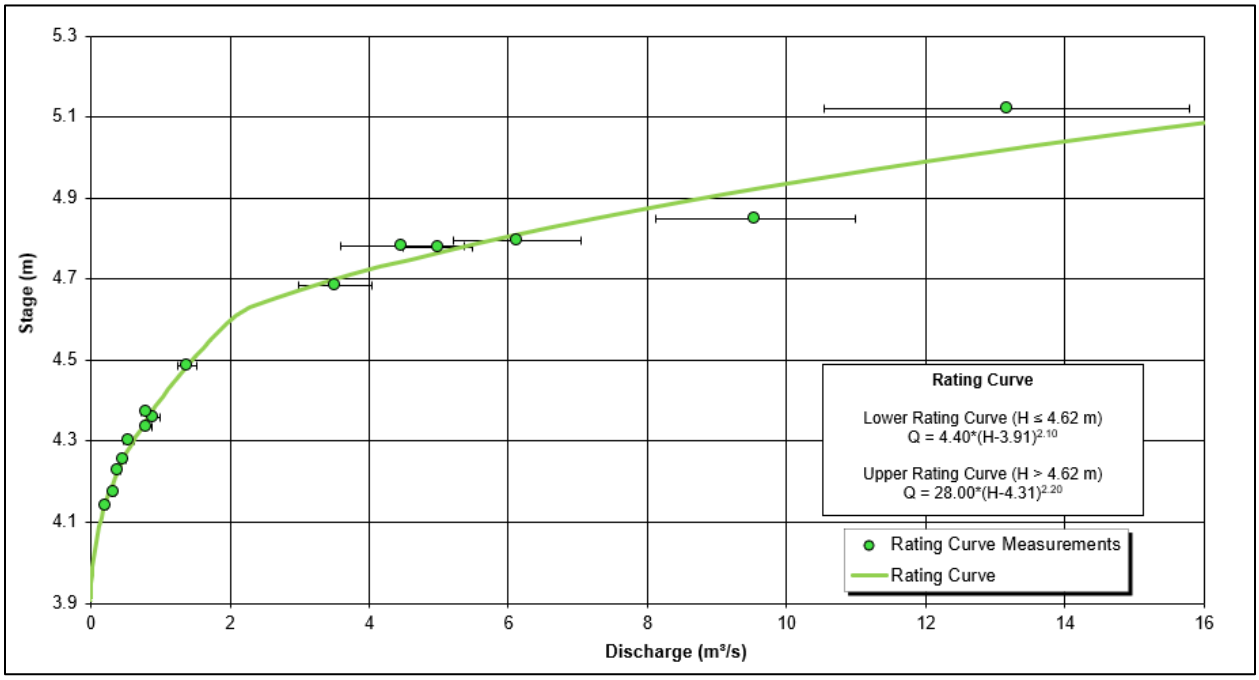


Figure 4.2 Mill Creek (MILL-R2) Rating Curve

The daily average discharge hydrograph for the MILL streamflow gauging station is presented on Figure 4.3.

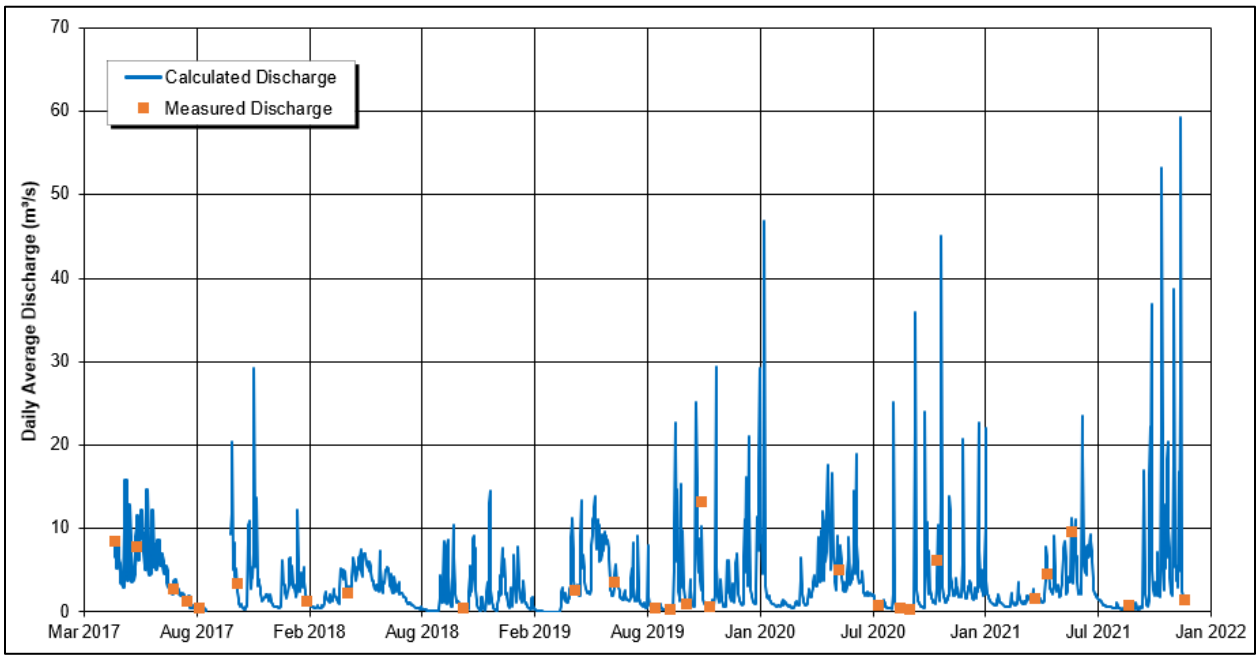


Figure 4.3 Mill Creek (MILL) Daily Average Discharge Hydrograph

Details of the hydrology data collection and processing are discussed in the *Mill Creek Hydrologic Analysis and Synthetic Flow Record* (KP, 2022), provided in Appendix A.

4.1.2 MILL CREEK LONG TERM SYNTHETIC HYDROLOGY

As part of a baseline hydrology characterization of Mill Creek, a synthetic long-term flow record using site-specific and regional measured streamflow records was developed. Fifty-five complete years of record are available from the WSC station “Capilano River above Intake” (08GA010), which, in conjunction with discharge data from Palisade Lake provided by Metro Vancouver, were used in an empirical frequency pairing analysis. Capilano River is a regulated system due to summer releases from Palisades Lake reservoir, which are managed by Metro Vancouver. Details on regulated flows are not consistently available; however, a naturalized streamflow record for Capilano has previously been developed for the Project for the period of record between 1960 and early 2018 using records of release rates from Metro Vancouver or by comparison of unit runoff between regulated and unregulated rivers.

Periods with regulation were also removed from the Capilano River dataset for April 1, 2019 to May 28, 2021 by removal of periods with sudden, steady increases in Capilano River flow that are not reflected in the Mill Creek data, which is an unregulated system. The naturalized flow record for Capilano River therefore includes 55 complete years of record and six years with incomplete records.

The mean annual discharge (MAD) for Mill Creek at the KP hydrology gauge was estimated to be 4.05 m^3/s (1960 to 2021 period), which equates to a mean annual unit runoff of 107 $L/s/km^2$ for the 38 km^2 watershed. At the time of this analysis, more than four years of data are available at Mill Creek, and the synthetic flow record is considered to be of good quality. Further data collection may reduce uncertainty in the long-term synthetic record, as discussed in Appendix A.

Streamflow at the proposed PoD is equivalent to the hydrology gauge data and the mean monthly hydrograph is relatively uniform with sustained flows though the fall and winter, and a modest nival freshet in spring, indicating that a substantial proportion of winter precipitation falls as rain (rather than snow). Flows decrease through June, July and August as snowmelt and precipitation decrease.

The mean monthly hydrograph is relatively uniform with sustained flows though the fall and winter, and a modest nival freshet in spring, indicating that a substantial proportion of winter precipitation falls as rain (rather than snow). Flows decrease through June, July and August as snowmelt and precipitation decrease. The mean monthly hydrograph is shown on Figure 4.4. Average, minimum and maximum monthly mean flow conditions for the synthetic 1960 to 2021 dataset are presented in Table 4.1. Daily flow conditions tend to be more variable than monthly flow conditions, with the watershed responding rapidly to intense rainfall events. Synthetic daily flows during 2009, a year where the annual average discharge was close to the long-term MAD, are shown on Figure 4.5.

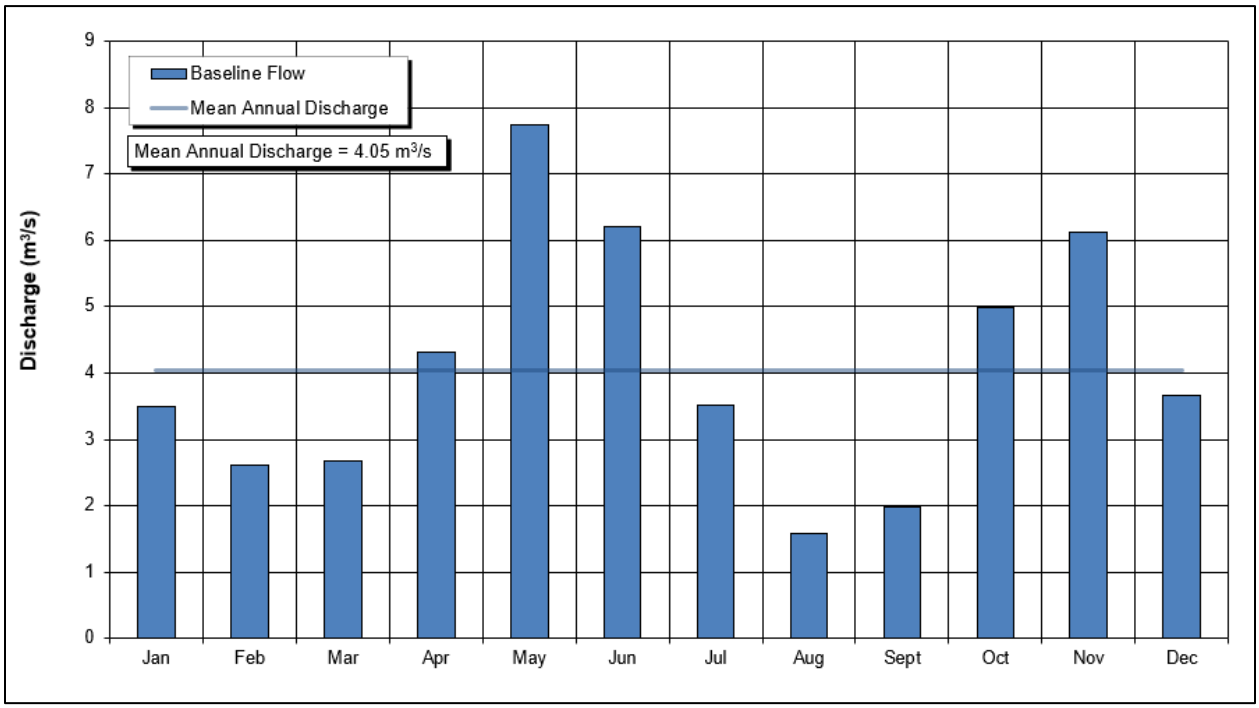


Figure 4.4 Mean Monthly Hydrograph – Mill Creek at the PoD

Table 4.1 Average, Minimum and Maximum Monthly Flows - Mill Creek at the PoD

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average (m^3/s)	3.49	2.62	2.67	4.32	7.74	6.21	3.51	1.58	1.97	4.98	6.13	3.66	**4.05**
Maximum (m^3/s)	9.68	8.73	7.32	7.64	12.26	11.33	9.46	6.82	6.81	13.00	13.68	10.42	**5.51**
Minimum (m^3/s)	0.35	0.71	0.78	1.79	1.13	1.16	0.35	0.37	0.28	0.23	1.87	0.63	**2.82**

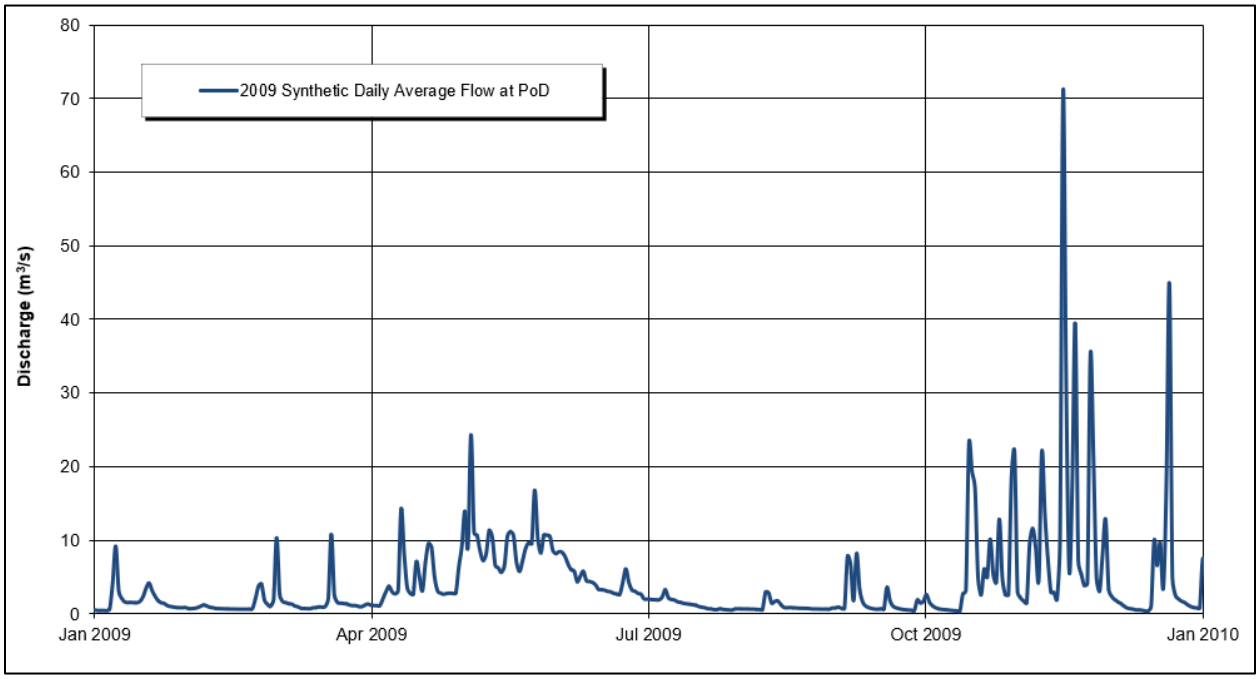


Figure 4.5 2009 Daily Hydrograph – Mill Creek at the PoD Synthetic Daily Flow Series

5.0 CONSTRUCTION ENVIRONMENTAL FLOW NEEDS

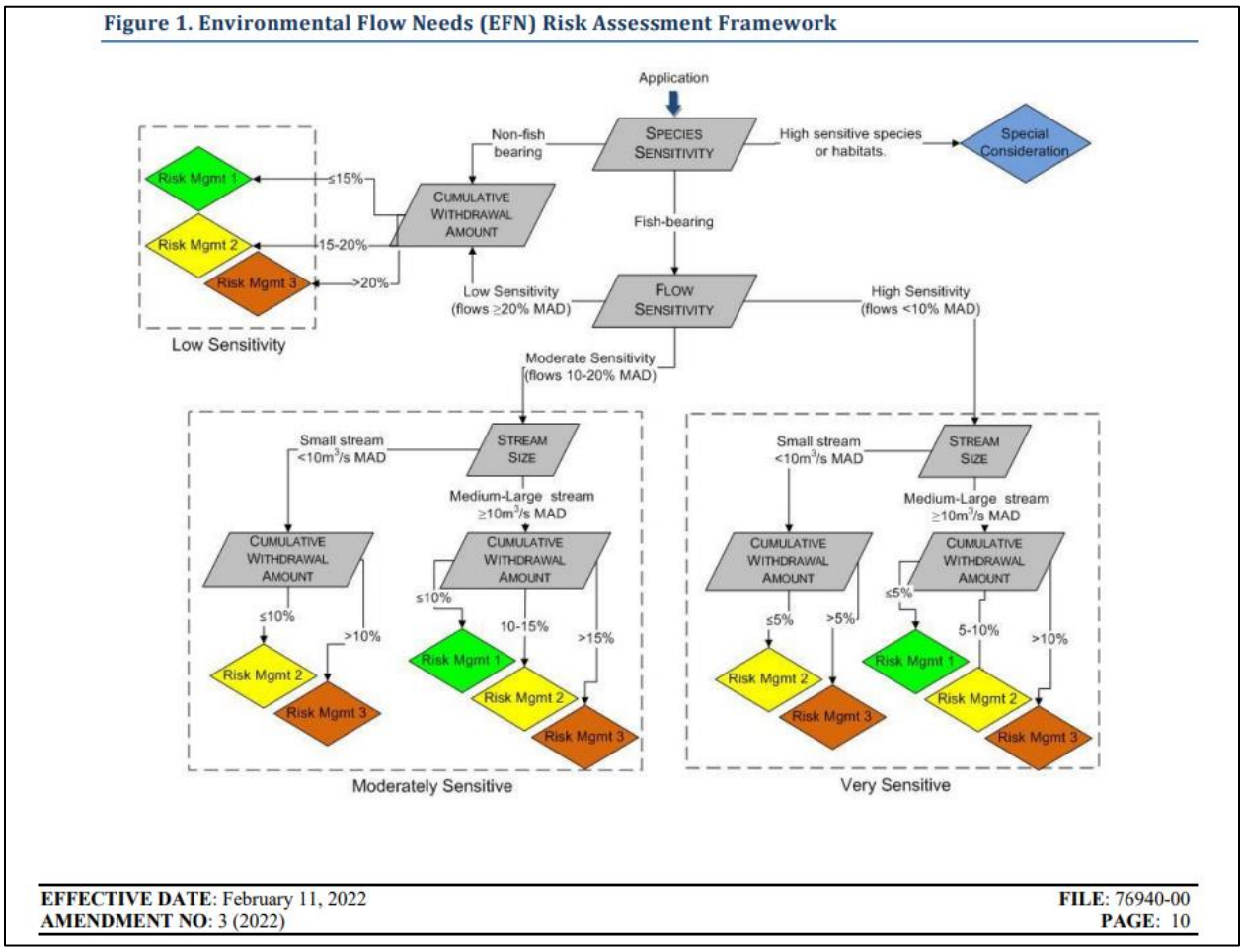
5.1 CONSTRUCTION ENVIRONMENTAL FLOW NEEDS ASSESSMENT METHODOLOGY

The BC EFN Policy (FLNRORD and ENV, 2016 and updated in 2022) presents a risk-based assessment approach that considers fish presence/absence, baseline hydrologic regime and stream size. KP has used this guidance document to assess the proposed construction water requirement and quantify the risk level of withdrawals from Mill Creek.

The BC EFN policy presents an “Environmental Flow Needs Risk Assessment Framework” for applications for water licences and use approvals under the Water Sustainability Act (*WSA)*. This framework includes the following steps:

1. Determine the Area of Influence
2. Application Risk Screening
3. Screen for Fish Bearing Status and High Sensitivity Species
4. Determine Flow Sensitivity
5. Determine Stream Size
6. Determine Cumulative Withdrawal within the Area of Influence
7. Assign Preliminary Risk Rating

A flowchart, reproduced from the policy and presented on Figure 5.1 for reference.



Note(s):

1. Source: FLNRORD and ENV (2022)

Figure 5.1 Risk Management Decision-Making Process for Consideration of Environmental Flow Needs within the BC EFN Policy

5.2 CONSTRUCTION IFR FOR MILL CREEK

5.2.1 AREA OF INFLUENCE

The point of diversion considered in this assessment is the existing Mill Creek intake, located approximately 2 km from the mouth. There is only a small difference in watershed area between the intake (38 km^2) and the mouth of Mill Creek (41 km^2). The area of influence for this flow reduction is the lower 2 km of Mill Creek to the confluence with Howe Sound.

5.2.2 APPLICATION RISK SCREENING

Woodfibre LNG currently holds water licences for power generation and pulp mill operation from Mill Creek; however, no water is currently being diverted or used under these licences. Details of these licences are presented in Table 5.1. No other users have active licences to divert water in Mill Creek.

Table 5.1 Existing Mill Creek Water Licences

Licensee	Number	Purpose	POD	Priority Date	Quantity (m^3/s)
Woodfibre LNG Limited	F007219	Power: Commercial	PD44666	25/6/1909	0.63
			PD44669		
Woodfibre LNG Limited	F017347	Pulp Mill	PD44666	1/10/1959	0.63
			PD44669		
Woodfibre LNG Limited	F044330	Pulp Mill	PD44666	25/6/1909	0.106
			PD44669		

5.2.3 SCREEN FOR FISH BEARING STATUS AND HIGH SENSITIVITY SPECIES

Mill Creek is fish bearing as discussed in Section 3. There are no federal *Species at Risk Act* listed or provincially listed fish species documented in Mill Creek. The EFN Guideline allows for cultural sensitivities under Special Considerations. The importance of restoring salmon productivity (all anadromous species) is a high cultural priority for Squamish Nation (Squamish Nation, 2001).

5.2.4 FLOW SENSITIVITY

Flow sensitivity refers to whether flow withdrawal is expected to cause a negative effect, with less tolerance for flow withdrawal from “high” sensitivity streams. High sensitivity is defined as a month where the ratio of mean monthly flow to mean annual flow is less than 10%, indicating that flows are low in that month compared to normal conditions and there is little tolerance for additional withdrawal. Flow sensitivity in Mill Creek is classified as “Low” year-round, meaning that the ratio of mean monthly flow to mean annual flow is greater than 20%. The flow sensitivity for Mill Creek is shown in Table 5.2.

Table 5.2 Mill Creek Flow Sensitivity at the PoD

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Discharge (m^3/s)	3.49	2.62	2.67	4.32	7.74	6.21	3.51	1.58	1.97	4.98	6.13	3.66
Ratio Monthly/Annual (%MAD)	86%	65%	66%	107%	191%	154%	87%	39%	49%	123%	152%	90%
Sensitivity	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low

5.2.5 STREAM SIZE

Small streams, defined as streams with a MAD less than 10 m^3/s, (and streams that freeze over in winter) are considered more ecologically sensitive to water withdrawals. The estimated MAD in Mill Creek at the PoD location is 4.05 m^3/s. Using the metrics in the EFN policy, this creek is classified as “Small”.

5.2.6 CUMULATIVE WITHDRAWAL

Although Woodfibre LNG holds active licenses on Mill Creek, they cannot currently be used, as their purpose is for power and pulp mill. The licences will require an amendment for a change in works (maintenance or updating) and change in purpose prior to being used to support the LNG Project, or abandonment and removal of works.

During construction, the only water diversion will be for the proposed construction water requirement.

5.2.7 RISK RATING

The risk rating, based on the BC EFN Policy (FLNRORD and ENV, 2022) is presented in Table 5.3 based on the proposed construction withdrawal.

Table 5.3 Risk Assessment for Cumulative Withdrawals in Mill Creek near the Mouth

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flow (m^3/s)	3.49	2.62	2.67	4.32	7.74	6.21	3.51	1.58	1.97	4.98	6.13	3.66
Cumulative Withdrawal Amount (m^3/s)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Withdrawal Ratio (%)	3%	4%	4%	2%	1%	2%	3%	6%	5%	2%	2%	3%
Risk Management Level	1	1	1	1	1	1	1	1	1	1	1	1

Note(s):

1. The actual diversion will be less than 0.1 m^3/s because this quantity is not required continuously and may be sourced from mill creek rather than Woodfibre Creek.

Because the stream is classified as low sensitivity and cumulative withdrawals are less than 15% of the mean monthly flow, the risk rating is Risk Level 1 across all months indicating a low level of risk.

5.2.8 RESULTS

This assessment indicates there is sufficient water in Mill Creek to meet construction water needs of 0.10 m^3/s while fulfilling environmental needs. Any residual risk can be addressed through monitoring and supplemental measures.

5.2.8.1 CONSTRUCTION FLOW CONDITIONS

Allowing for the continuous diversion of 0.10 m^3/s (subject to the supplemental measures described in Section 6.2) during Project construction, mean monthly baseline and operational flows are summarized on Figure 5.2 and in Table 5.4, which show that the proposed reduction in MAD is 2% on an average annual basis. It is noted that the percentage flow reductions in Table 5.4 are less than Table 5.3, due to the diversion restrictions imposed by the supplemental measures (Section 6.2). Flow duration curves of daily flow, presented on a monthly basis, showing baseline and construction flow conditions are included in Appendix B.

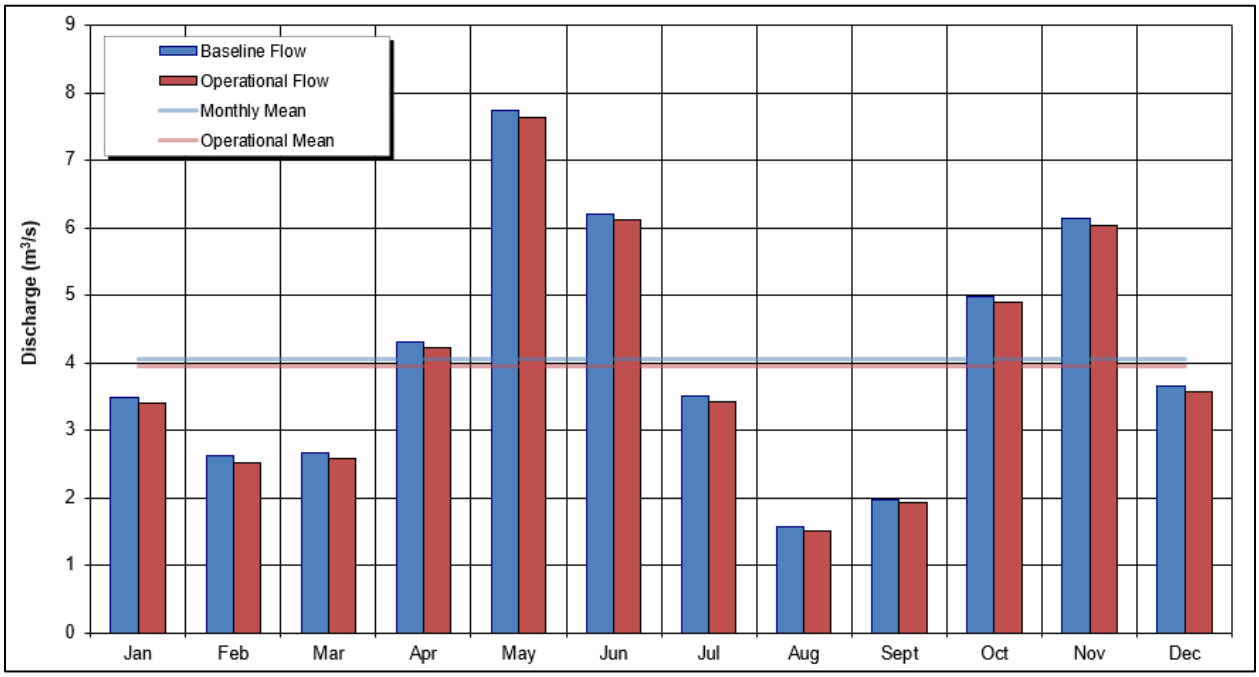


Figure 5.2 Baseline and Construction Mean Monthly Flows – Mill Creek at the PoD

Table 5.4 Baseline and Construction Mean Monthly Flows – Mill Creek at the PoD

Month	Baseline Flows	Operational Instream Flows	
	Q (m^3/s)	Q (m^3/s)	% Reduction
Jan	3.49	3.40	3%
Feb	2.62	2.53	3%
Mar	2.67	2.57	4%
Apr	4.32	4.22	2%
May	7.74	7.64	1%
Jun	6.21	6.11	2%
Jul	3.51	3.41	3%
Aug	1.58	1.51	3%
Sep	1.97	1.92	3%
Oct	4.98	4.90	1%
Nov	6.13	6.03	2%
Dec	3.66	3.57	2%
Annual	**4.05**	**3.96**	**2%**

6.0 SUMMARY AND RECOMMENDATIONS

6.1 SUMMARY

Woodfibre LNG is proposing the development and operation of a LNG processing and export facility on the previous Woodfibre pulp and paper mill site near Squamish, BC. Water is required for construction of the facility, a portion of which may be sourced from Mill Creek. The proposed water source is a gravity intake with fish screening, located approximately 2 km upstream from the mouth of Mill Creek.

The conclusion of this study is that the proposed flow withdrawals are small (approximately 2% of streamflow on average) and the risk to fish from the proposed short-term construction water withdrawal is considered low, overall. However, there are times of the year (particularly during July, August, and September) when baseline streamflow can be low and water withdrawal could represent a large portion of the available water. It is proposed that supplementary measures be incorporated into the water management plan to mitigate risk to fish during low-flow periods.

6.2 SUPPLEMENTARY MEASURES

Stated objectives of the BC EFN Policy include avoiding fish-flow conflicts and being scientifically-defensible; the policy was derived in part from methods currently used in B.C., scientific literature, and expert opinion (FLNRORD and ENV 2022). As noted in Section 3, pink salmon are the predominant species found in Mill Creek, with low densities of other salmon species (chinook, chum, coho), rainbow trout, and Dolly Varden char. The canyonised reach is not considered sensitive to flow reductions due to the channel morphology (cascade and step-pool). The key species and life stage of interest were therefore identified as pink salmon spawning and migration. The pink salmon migration period, based on site observations and regional data, is identified as the months of August and September, while the spawning period is identified as August through October.

As shown on Figure 5.2 and detailed in Table 5.4, the instream flow with the withdrawal of construction water of 0.10 m^3/s equates to a reduction in baseline monthly flows of 1% - 4% throughout the year. Although these construction flow withdrawals are expected to have minimal impact of fish habitat, consistent with Risk Management Level 1, supplementary measures suggested for Risk Management Level 2 have been or will be implemented, including:

1. Establish adequate baseline hydrology data
2. Collection of site-specific fisheries information
3. Real-time streamflow monitoring during construction
4. Real-time monitoring of diverted flows
5. Flow diversion restrictions.

The allowable flow diversion rate (diversion limit) will be reduced as instream flow falls to reduce risk during higher habitat stress conditions. Water withdrawal will be limited to:

- Less than 15% of total streamflow, up to a maximum of 0.10 m^3/s when instantaneous flows are more than 20% MAD (low sensitivity conditions)
- 10% of total streamflow when instantaneous flow is between 10 - 20% MAD (moderate sensitivity conditions)

- 5% of total streamflow when instantaneous flow is < 10% MAD (high flow sensitivity)

Additionally, between August 1 and October 31 (the critical stream flow periods, CSFP, as defined by Squamish Nation) if flows fall below 0.81 m^3/s (20% MAD), no water will be diverted.

Allowable flow diversion rates are shown in Table 6.1. Although the diversion rate could be adjusted continuously to meet the percentage withdrawal limits, a look-up table with discrete steps has been proposed to provide a an easy-to-understand and practical protocol that the Environmental Monitor and Contractor can follow.

Table 6.1 Construction Management Plan Flow Diversion Limits

Streamflow at Gauging Station/PoD (m^3/s)	% MAD	November 1 to July 31		August 1 to October 31	
		Maximum Diversion Limit (m^3/s)	% Diverted	Maximum Diversion Limit (m^3/s)	% Diverted
≥0.81	>20%	0.10	<12%	0.10	<12%
≥0.70	17%	0.07	10%	0.00	0%
≥0.61	15%	0.06	10%	0.0	0%
≥0.50	12%	0.05	10%	0.0	0%
≥0.41	10%	0.04	10%	0.0	0%
≥0.30	7%	0.02	5%	0.0	0%
≥0.20	5%	0.01	5%	0.0	0%
<0.20	5%	5% of measured flow	5%	0.0	0%

In order to manage construction water requirements during restricted diversion periods, the following will be conducted:

1. Schedule high water demand activities outside the low flow period, to the extent practical
2. Provide water storage to accommodate short term flow restrictions
3. Use Woodfibre Creek to supplement Mill Creek withdrawals to meet construction water requirements

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KNIGHT PIÉSOLD LTD.
PERMIT NUMBER
1001011
EGBC PERMIT TO PRACTICE

8.0 CERTIFICATION

This report was prepared and reviewed by the undersigned.

Prepared:

Sarah Chang, M.A.Sc., EIT
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Prepared:

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Reviewed:

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Approval that this document adheres to the Knight Piésold Quality System: SRM

APPENDIX A

Mill Creek Hydrologic Analysis and Synthetic Flow Record (VA22-01362)

(Pages A-1 to A-31)

Knight Piésold CONSULTING

Management System Certified by: bsi ISO 9001 ISO 14001 ISO 45001 CERTIFIED

September 23, 2022

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Dear Darren,

RE: Mill Creek Hydrologic Analysis and Synthetic Flow Record

Woodfibre LNG Limited (Woodfibre LNG) is proposing the development and operation of a liquefied natural gas (LNG) processing and export facility (the Project) on the previous Woodfibre Pulp and Paper Mill site located approximately 7 km west-southwest of Squamish, British Columbia (BC). Water is required for construction and operation of the facility, which will be sourced from Mill Creek or Woodfibre Creek. Knight Piésold Ltd. (KP) has been retained by Woodfibre LNG to assist with hydrology studies for the Project, and as part of this work KP has installed and operated streamflow gauging stations on Mill Creek since April 2017.

A regional hydrologic analysis was completed to identify trends and characteristics in precipitation and runoff, then the short-term measured data were correlated with data collected by Water Survey of Canada (WSC) at a suitable surrogate station to develop a long-term synthetic daily streamflow series for Mill Creek. A hydrologic analysis of Mill Creek was conducted previously (KP, 2018). However, since completion of the previous analysis, over 2.5 years of additional data have been collected in Mill Creek. This letter presents the synthetic flow series development, based on data measured between April 2017 and May 2021.

1.0 HYDROLOGIC SETTING

The Project area is located within Hydrologic Zone 27 (Western South Coast Mountains) as delineated by Ahmed (2017). In this zone, Pacific frontal systems encounter the abruptly rising terrain of the Coast Mountains and produce large quantities of precipitation as they are forced upward. Spatial variability in annual precipitation is extensive due to orographic enhancement on windward slopes and rain shadow effects in leeward areas. The proportion of precipitation falling as snow varies with elevation, with little snow falling at sea level and large snowpacks accumulating on upper mountain slopes. Even at high elevations, however, winter rainfall and snowmelt are common, leading to a complex hydrologic regime. In general, streamflow in South Coast watersheds like Mill Creek (i.e., coastal, but also with high-elevation mountainous terrain) are highest in autumn due to frontal rainstorm activity, with a secondary peak in spring due to snowmelt. Flows are lowest in late summer when precipitation is low. Winter flows tend to be moderate as much of the precipitation falls as snow but can be punctuated by warm rainfall events and rainfall at lower elevation.

Mean annual precipitation varies dramatically from only 1,490 mm at Gibsons, located approximately 35 km southwest of the Project, to 3,320 mm at Port Mellon, located 25 km southwest of the Project and then to 2,230 mm in Squamish. This is indicative of topographic convergence of frontal systems in Howe Sound, and extreme orographic enhancement of precipitation due to rapid uplift. Similarly, mean annual unit runoff

varies dramatically from 125 L/s/km^2 (or 4,000 mm) in Rainy River and 118 L/s/km^2 (or 3,660 mm) in Capilano River, located close to the Project area, to only 32 L/s/km^2 (or 1,000 mm) in Roberts Creek, located 20 km to the southwest and with a lower elevation basin.

2.0 STREAMFLOW DATA COLLECTION

A synthetic daily streamflow series was developed by correlation of measured streamflow data at the Mill Creek gauging station, MILL, with concurrent data from a streamflow gauging station operated by WSC with the intent of assessing long-term streamflow conditions in Mill Creek. A secondary station on Mill Creek (MILL-R2) is not used in this analysis, but is operated as backup and validation of the MILL station.

2.1 MILL STATION

KP installed a hydrometric station in April 2017 (MILL) on Mill Creek, approximately 2 km upstream from the mouth of the Creek and near the inactive hydropower intake. The site was selected primarily due to accessibility and gauging characteristics with the objective of collecting high-quality streamflow data, but also considering potential water diversion locations. Mill Creek downstream of the gauging location is more canyon-like, with steep or vertical bedrock banks, and safe access year-round is challenging. Additionally, locations that allow high-quality streamflow measurements at a range of flow conditions are limited. Near the mouth of Mill Creek, much of the accessible reach is backwatered by tides and therefore not suitable for stream gauging.

The station is located on the left bank of a pool, downstream of a cascade, as shown on Photo 1a. The gauge is approximately 100 meters upstream of the historic Mill Creek hydropower intake. Water level is hydraulically controlled by a cascade at the outlet of the pool, shown on Photo 1b. The low-flow control section consists of cobbles and boulders, while the high-flow control also includes the bedrock banks. The hydrometric station consists of a pressure transducer connected to a datalogger that records stage at fifteen-minute intervals. The Mill Creek gauging location and watershed is shown on Figure 1.

Photo 1 MILL Station – Apr 18, 2018

Photo 2 Hydraulic Control at MILL Aug 29, 2017

2.2 MILL RATING CURVE AND DISCHARGE HYDROGRAPH

A total of 26 stage/discharge measurements have been made at MILL. The discharge measurements were conducted using area-velocity and Rhodamine dye dilution measurements, depending on flow conditions at the time of each site visit.

The station includes three benchmarks, located in bedrock above the normal high-water level, as well as a staff gauge and a reference mark for determining stage. Benchmark 1 was assigned an elevation of 10 m and this datum is used for converting water level to gauge height (stage). These stage-discharge measurements were used to develop rating curves for the gauge.

A high flow event on November 22, 2017 was identified as causing a change in the hydraulic control, due to deposition of material at the control section, which required a new stage-discharge rating curve. Rating Curve 1 is applied from April 18, 2017 to November 22, 2017. A second rating curve (Rating Curve 2) was developed, but only three stage-discharge measurements were collected before another shift was detected. This change in the hydraulic control appears to have occurred between the October 17, 2018 and April 10, 2019 site visits, possibly due to high flow events that caused scouring of material deposited during the November 22, 2017 event within the control section. It is unknown what date this change occurred, or whether it was gradual during the time interval between site visits. The new rating curve (Rating Curve 3), developed for flows after the second hydraulic control change, results in a higher discharge for a given stage. Data collected since November 2021 (following the atmospheric river event that caused widespread flooding in southwest British Columbia) indicate that a further control shift may have occurred. Data collection and rating curve adjustment is ongoing. Details of the field data collection and rating curve development to the end of 2021 are presented in Appendix A.

Rating Curve 1 was plotted through the six available stage-discharge points collected prior to the first rating curve shift using the standard form for a rating curve equation (power function) with the constant, offset, and exponent constrained within expected values based on hydraulic theory (Maidment, 1993) and experience with similar conditions in mountainous streams. Rating Curve 2 is based on the shape of Rating Curve 1, as the three available stage-discharge measurements are insufficient to independently delineate a new rating curve. Rating Curve 3 is based on the 15 stage-discharge measurements collected since the April 2019 shift. Due to the limited number of measurements available to develop Rating Curve 1 and Rating Curve 2, and a data gap from September 6, 2017 to October 17, 2017, only streamflow data developed from Rating Curve 3 (April 2019 to July 2021) were used in this hydrologic analysis.

A high flow measurement was collected in May 2021, and Rating Curve 3 was updated to include this point. The current rating curve has two segments, as shown on Figure 2. The first is applied up to a stage of 8.229 m. The second segment is extrapolated to the maximum recorded stage-discharge measurement collected during its period of application.

The daily average discharge hydrograph for MILL is presented on Figure 3 and was developed by applying Rating Curve 3 to the relevant period of stage record and then averaging the fifteen-minute streamflow record over a calendar day.

3.0 LONG-TERM SYNTHETIC FLOW SERIES

A synthetic daily streamflow series was developed to assess long-term streamflow conditions in Mill Creek by correlating Mill Creek measured streamflow data with concurrent data from a streamflow gauging station operated by WSC.

3.1 HYDROGRAPH COMPARISON

The median watershed elevation above the Mill Creek gauge is 1,050 meters above sea level and glaciers cover a negligible area in the watershed. Several WSC stations were reviewed to determine an appropriate surrogate station, as shown on Figure 4. A suitable site should be close in proximity and have similar watershed characteristics to Mill Creek and have available concurrent data. Roberts Creek at Roberts Creek (08GA047) was excluded due to differences in watershed characteristics and flow regulation. Clowhom River near Clowhom Lake (08GB013) was considered, but correlation of concurrent daily flows found that the stations had differences in timing and magnitude of response to precipitation events. Seymour River Below Orchid Creek (08GA077) was also considered and although not noted as regulated by WSC, summer regulation was evident in the flow record (visually and by chronological correlation of concurrent flows) and Metro Vancouver records note regulation of Loch Lemond. Capilano River Above Intake (08GA010) was identified as the most representative long-term WSC station due to availability of concurrent data, its proximity to the Project and similarity of drainage area and basin characteristics such as median drainage elevation and negligible glacial cover. Daily discharge records are available at Capilano River between 1914 and 2021, except 1972,1973, and portions of 2007 and 2017. A summary of the regional WSC gauging stations, along with the Mill Creek station, is presented in Table 1.

Table 1 Regional WSC Gauging Station Summary

Station Name	Station ID	Gauge Elevation (masl)	Years of Record	Years of Complete Record	Start Year	End Year	Drainage Area (km^2)	Mean Annual Discharge (m^3/s)	Average Annual Unit Runoff ($L/s/km^2$)
Clowhom River Near Clowhom Lake	08GB013	60	30	28	1993	2022	147	15.6	106
Seymour River below Orchid Creek	08GA077	290	31	29	1992	2022	63	6.5	103
Capilano River above the Intake	08GA010	160	92	108	1914	2022	173	20.3	118
Mill Creek	MILL	208	6	4	2017	2022	38	4.1	106

Capilano River is a regulated system due to summer releases from Palisades Lake reservoir, which are managed by Metro Vancouver. Details on flow regulation are not consistently available; however, a naturalized streamflow record for Capilano River Above Intake (08GA010) has previously been developed for the Project for the period of record between 1960 and early 2018 using records of release rates from Metro Vancouver. Periods with regulation were also removed from the Capilano River Above Intake (08GA010) and Mill Creek records for the April 1, 2019 to May 28, 2021 concurrent period of record, conducted by visual comparison of the two datasets and removal of periods with sudden, steady increases in Capilano River Above Intake (08GA010) flow that are not reflected in the Mill Creek data. The naturalized flow record for Capilano River Above Intake (08GA010) therefore includes 55 complete years of record (i.e. 1960 – 1971, 1974 – 2006, 2008 – 2016) and six years with incomplete records (2007 and 2017 – 2021). This station has a watershed area of 173 km^2 and a mean annual unit runoff or 118 $L/s/km^2$.

A comparison of concurrent records between Mill Creek and Capilano River for April 1, 2019 to May 28, 2021 are presented on Figure 5. Mill Creek data prior to April 1, 2019 were removed due to the data quality concerns for this period discussed above. The two streams have similar runoff and seasonal flow patterns for the measured concurrent period, as shown on Figure 5. Unit runoff in Mill Creek appears to be lower than the Capilano River flows in the fall and winter, potentially due to Mill Creek's slightly higher median watershed elevation and less exposed location, which may result in increased winter snow storage at Mill Creek and decreased precipitation from incoming rainstorms off the coast, when compared to the

Capilano River drainage. Unit runoff in Mill Creek is higher than at Capilano River through the summer, potentially due to snowmelt from a larger snowpack. Fall peak flows also tend to be higher in Mill Creek due to its smaller and higher elevation watershed producing a flashier response.

3.2 EMPIRICAL FREQUENCY PAIRING ANALYSIS

Monthly discharge relationships were developed by correlating the frequency distributions of concurrent daily flows for Mill Creek versus Capilano River. The discharge relationships were developed using an analytical technique known as Empirical Frequency Pairing (EFP) (Butt, 2013). EFP requires that daily flows for the concurrent period of record for two datasets be ranked in descending order of magnitude. When comparing these sets of data, each flow value of equal rank has an equal probability of exceedance within its respective dataset (since the datasets are of equal length). A comparison of ranked daily flows therefore amounts to a comparison of flow frequency distributions. The EFP technique assumes that the correlation of the flow frequency relationship developed from the sample (concurrent record) is generally representative of the correlation that would exist between concurrent long-term records. Butt (2013) demonstrated the general validity of this assumption for watershed pairs that are located in regional proximity to one another and have similar hydrologic regimes.

The frequency pairing approach, rather than the more common chronological pairing approach, overcomes the often substantial differences in the timing and magnitude of rainstorm or snowmelt events between watersheds and differences in storage and attenuation, and has been shown to be a more accurate and precise model for synthetically generating long-term flow patterns (Butt, 2013). The objective of the EFP analysis is not necessarily to reproduce exact historical flow patterns at the point of interest, so that one can determine what the flow was on any given day, but rather to generate a dataset that provides a representation of the expected long-term mean annual discharge and associated variability of flows.

EFP relationships were developed for the available data and an example correlation for May is shown on Figure 6. The line of equivalent unit runoff was also plotted to assess whether the trends in proportional flow are consistent with the expected hydrologic characteristics of the respective watersheds, and to guide the extrapolation of the EFP relationships to highest recorded flows at the WSC station. The seasonal EFP relationships were applied to the corresponding long-term Capilano River records to produce a long-term synthetic discharge series for the Mill Creek gauge.

3.3 RESULTS

The estimated long-term monthly and annual flows at the intake location are summarized in Table 2. The corresponding annual hydrograph of mean monthly discharge at the Mill Creek gauge is shown on Figure 7. The flow duration curve for the long-term synthetic series at the gauge is shown on Figure 8. The mean annual discharge (MAD) is estimated to be 4.05 m^3/s (1960 to 2020 period), which equates to a mean annual unit runoff of 106 $L/s/km^2$ for the 38 km^2 watershed.

4.0 DISCUSSION

Mill Creek gauge measured streamflow between April 2019 and May 2021 were correlated with WSC data from Capilano River to produce a long-term synthetic streamflow timeseries that is of sufficient length for the purpose of assessing “normal” streamflow conditions, where “normal” includes flows between approximately 5% and 200% MAD.

The continued field data collection at the MILL and MILL-R2 gauges is recommended in order to:

- Increase the quality of the stage/discharge rating curves for the purpose of improving the quality of the streamflow records.
- Increase the length of the streamflow records concurrent with regional stations to improve calibration regressions for the purpose of generating a reliable long-term synthetic streamflow series.
- Support permitting and monitoring of water withdrawals.

If you have any questions or comments, please contact the undersigned.

Yours truly,
Knight Piésold Ltd.

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KNIGHT PIÉSOLD LTD.
PERMIT NUMBER
1001011
EGBC PERMIT TO PRACTICE

Approval that this document adheres to the Knight Piésold Quality System: SRM

Attachments:

Table 2 Rev 0	Long-Term Synthetic Discharge at Mill Creek (MILL) Gauge
Figure 1 Rev 0	Mill Creek Watershed
Figure 2 Rev 0	Mill Creek (MILL) – Rating Curve 3 – Extrapolated to Maximum Recorded Stage
Figure 3 Rev 0	Mill Creek (MILL) Gauge – Daily Average Discharge Hydrograph
Figure 4 Rev 0	Hydrologic Zones and Regional Hydrology Stations
Figure 5 Rev 0	Mill Creek and Capilano River – Concurrent Unit Runoff
Figure 6 Rev 0	Mill Creek and Capilano River – Frequency Paired Relationship: May
Figure 7 Rev 0	Mill Creek – Mean Monthly Hydrograph
Figure 8 Rev 0	Mill Creek Synthetic Series - Flow Duration Curves
Appendix A	Mill Creek Hydrologic Analysis

References:

Ahmed, A., 2017. "Inventory of Streamflow in the South Coast and West Coast Regions", October 2017, Knowledge Management Branch, British Columbia Ministry of Environment and Climate Change Strategy, Victoria, B.C.

Butt, C., (2013). Evaluation of the Performance of Frequency and Chronological Pairing Techniques in Synthesizing Long-Term Streamflow. Master's Thesis, Dept. of Civil Engineering, Faculty of Applied Science, University of British Columbia, Vancouver, BC, Canada.

Knight Piésold Ltd. (KP), 2018. Mill Creek Hydrologic Analysis. KP Ref. VA18-01049. Vancouver, BC.

Maidment, D.R., 1993. Handbook of Hydrology. McGraw-Hill, Inc., New York, New York.

/skc

Knight Piésold CONSULTING

TABLE 2

WOODFIBRE LNG LTD.
WOODFIBRE LNG PROJECT

LONG-TERM SYNTHETIC DISCHARGE AT MILL CREEK (MILL) GAUGE
(m^3/s)

Print: Aug/31/21 09:27:22

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1960	2.36	1.66	1.58	4.47	6.86	5.24	2.40	2.08	1.29	6.16	2.95	3.27	3.36
1961	7.16	6.28	2.64	4.04	10.39	7.08	2.63	1.68	1.58	5.17	5.22	3.28	4.76
1962	2.82	2.46	0.78	4.57	5.45	6.56	2.95	3.71	2.20	6.20	6.91	5.72	4.20
1963	1.73	4.93	1.91	3.63	4.70	3.46	3.43	1.28	0.85	7.34	7.69	3.98	3.74
1964	2.33	1.31	1.11	2.97	8.97	11.33	8.68	3.03	3.45	3.17	4.54	1.92	4.40
1965	1.35	1.65	1.28	4.36	7.22	5.26	2.28	0.98	0.44	7.37	6.65	3.76	3.55
1966	2.76	1.58	2.64	4.50	8.85	8.19	4.98	1.60	1.46	4.49	5.88	10.42	4.78
1967	3.87	2.24	2.76	2.58	10.65	10.77	4.32	1.45	1.16	13.00	3.47	3.33	4.97
1968	6.37	4.42	3.74	2.25	8.46	7.85	4.79	1.56	2.47	8.80	4.93	3.86	4.96
1969	2.00	1.33	1.81	6.64	11.23	7.84	3.14	2.00	5.85	3.60	2.99	3.02	4.29
1970	2.25	1.55	2.05	5.08	4.17	4.03	1.91	1.44	3.28	3.83	4.61	2.65	3.07
1971	2.51	3.60	1.48	2.86	8.83	8.29	6.34	1.84	2.17	4.31	4.59	0.86	3.97
1974	3.73	1.79	3.99	4.06	9.46	9.55	8.68	2.76	1.79	1.20	5.94	3.18	4.68
1975	1.09	0.77	1.97	2.00	10.09	8.41	4.63	3.65	1.00	10.65	9.30	5.30	4.91
1976	1.85	1.10	1.10	3.43	11.39	8.21	7.49	3.47	2.39	2.07	2.05	3.75	4.03
1977	1.59	2.29	1.53	4.25	5.38	4.72	1.99	1.31	3.55	5.41	6.40	4.13	3.55
1978	2.30	1.96	2.75	2.69	6.33	4.70	1.63	2.17	5.20	1.21	2.26	0.63	2.82
1979	0.35	1.99	3.21	3.34	7.69	5.02	2.90	0.51	2.98	4.84	1.87	7.53	3.52
1980	1.28	6.19	1.36	5.48	5.34	4.52	3.74	0.89	2.45	1.07	10.80	7.16	4.19
1981	1.59	3.81	1.39	5.20	5.57	6.36	1.88	0.53	3.78	9.69	6.21	3.60	4.13
1982	1.33	4.18	1.56	3.40	9.59	10.28	4.44	1.31	0.58	7.71	4.09	3.82	4.36
1983	4.13	8.59	4.31	3.10	7.94	6.91	7.12	1.72	1.81	2.71	12.98	0.72	5.17
1984	3.93	3.70	3.01	3.82	8.52	7.90	4.88	1.13	1.14	6.11	6.53	1.19	4.32
1985	0.98	0.71	0.82	4.83	7.62	6.10	2.27	0.73	0.69	7.16	2.45	1.22	2.96
1986	4.84	3.43	4.31	2.43	9.59	4.57	2.56	0.44	0.78	1.32	4.59	4.48	3.61
1987	4.02	2.15	5.40	3.81	9.73	4.96	2.48	0.48	0.48	0.47	4.62	3.55	3.51
1988	2.01	1.54	1.69	5.37	10.02	6.21	3.38	0.97	1.61	2.44	8.23	2.41	3.82
1989	2.18	1.55	1.90	5.85	7.89	6.37	3.70	1.26	0.37	5.30	6.07	2.63	3.76
1990	2.29	1.27	1.78	5.44	6.08	6.59	1.84	1.34	0.91	4.05	13.14	2.16	3.91
1991	2.54	8.73	0.93	4.58	6.19	4.66	2.36	6.82	0.92	0.25	6.66	3.57	4.02
1992	9.68	3.33	1.61	6.52	2.82	2.93	1.79	0.90	2.04	6.86	4.93	1.19	3.72
1993	1.58	1.23	3.96	7.20	8.20	4.05	1.89	0.90	0.34	2.00	2.89	5.75	3.33
1994	4.84	3.56	6.27	4.67	5.33	5.22	2.70	0.54	0.67	2.97	3.28	7.71	3.98
1995	5.10	4.97	3.99	3.37	7.74	4.96	2.44	1.93	0.67	7.27	13.68	6.55	5.22
1996	4.98	3.23	1.92	6.78	4.79	3.12	1.84	0.57	0.84	6.01	4.47	2.36	3.41
1997	5.27	1.09	5.29	6.53	11.24	7.54	5.07	0.97	4.49	9.52	6.33	2.75	5.51
1998	4.84	3.61	1.90	1.98	7.09	4.31	2.74	0.60	0.28	3.65	10.77	5.32	3.92
1999	3.57	2.13	2.26	3.76	8.78	10.74	9.46	4.59	1.10	3.70	9.08	3.75	5.24
2000	1.28	1.44	1.53	3.97	9.42	9.18	4.34	1.07	1.29	4.62	1.91	1.70	3.48
2001	2.23	0.81	1.87	3.63	7.34	4.68	1.82	4.66	1.06	3.31	7.34	3.15	3.49
2002	5.15	1.96	1.11	6.47	9.55	8.78	3.03	0.93	1.37	0.23	7.77	3.05	4.12
2003	5.08	1.06	5.63	4.48	3.82	3.76	1.68	0.37	0.74	9.83	3.00	3.05	3.54
2004	4.00	1.53	2.02	3.23	5.13	4.29	1.35	1.24	3.04	4.10	5.28	3.87	3.26
2005	7.64	0.88	2.66	6.09	6.10	2.98	3.24	0.38	0.91	6.09	4.08	6.37	3.95
2006	4.40	1.50	1.76	3.39	8.29	7.17	2.29	0.61	0.50	1.23	10.87	3.45	3.79
2007	3.10	2.15	7.32	5.18	9.18	8.21			1.72	7.64	5.10	4.58	
2008	1.52	0.97	1.50	1.93	12.26	7.37	4.09	2.90	0.75	4.37	6.18	1.10	3.74
2009	1.84	1.08	1.85	4.00	9.75	4.74	1.33	0.93	1.74	5.76	12.52	4.06	4.13
2010	8.06	3.21	1.72	4.45	5.60	6.71	3.01	0.74	3.12	5.85	3.52	6.05	4.34
2011	3.52	1.74	2.94	2.75	9.30	9.45	7.11	3.26	2.98	4.14	4.24	1.86	4.44
2012	3.85	1.49	1.60	5.91	8.85	8.95	5.27	0.89	0.34	5.79	8.37	3.37	4.56
2013	1.05	1.12	5.70	6.72	9.72	5.46	1.70	1.32	5.16	2.00	2.31	1.01	3.61
2014	2.38	0.94	4.52	4.73	7.50	3.20	1.64	0.62	1.53	9.69	8.94	7.63	4.44
2015	3.59	5.81	4.02	1.79	1.13	1.16	0.35	1.45	3.56	2.17	6.24	7.19	3.20
2016	7.90	3.80	5.28	4.27	3.46	3.88	2.42	0.49	0.88	10.31	10.93	0.82	4.54
2017	3.15	3.43	3.81	7.64	12.17	8.08	2.91	0.57			10.35	1.54	
2018	5.79												
2019				4.88	4.57	2.31	1.62	0.54	5.85	4.04	2.09	2.18	
2020	7.58	2.48	1.22	3.01	9.29	5.16	2.30	1.82	6.81	3.72	4.53	3.55	4.29
2021	5.07	1.13	1.51	3.26	7.04	7.60	1.50						
Average	**3.52**	**2.59**	**2.65**	**4.30**	**7.72**	**6.24**	**3.39**	**1.58**	**1.97**	**4.98**	**6.13**	**3.66**	**4.05**
Maximum	**9.68**	**8.73**	**7.32**	**7.64**	**12.26**	**11.33**	**9.46**	**6.82**	**6.81**	**13.00**	**13.68**	**10.42**	**5.51**
Minimum	**0.35**	**0.71**	**0.78**	**1.79**	**1.13**	**1.16**	**0.35**	**0.37**	**0.28**	**0.23**	**1.87**	**0.63**	**2.82**

\\KPL\VA-Prj$\1\03\00494\19\A\Data\Hydrology\Synthetic Flow Development\Mill\EFP Analysis\[MILL-Capilano EFP Analysis.xlsb]TABLE 2

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER VA22-01362	SKC	TJP

MILL CREEK WATERSHED

LOCATION TO:	DRAINAGE AREA (km²)
Mill Creek Mouth	41
Mill Creek Gauge	38

LEGEND:

- ACTIVE WOODFIBRE LNG HYDROLOGY GAUGE
- WATERSHED BOUNDARY

1 0.5 0 1 2 3 4 5 Km

NOTES:

1. BASE MAP: ESRI WORLD TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:50,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	23SEP'22	ISSUED WITH LETTER	ELK	KK	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

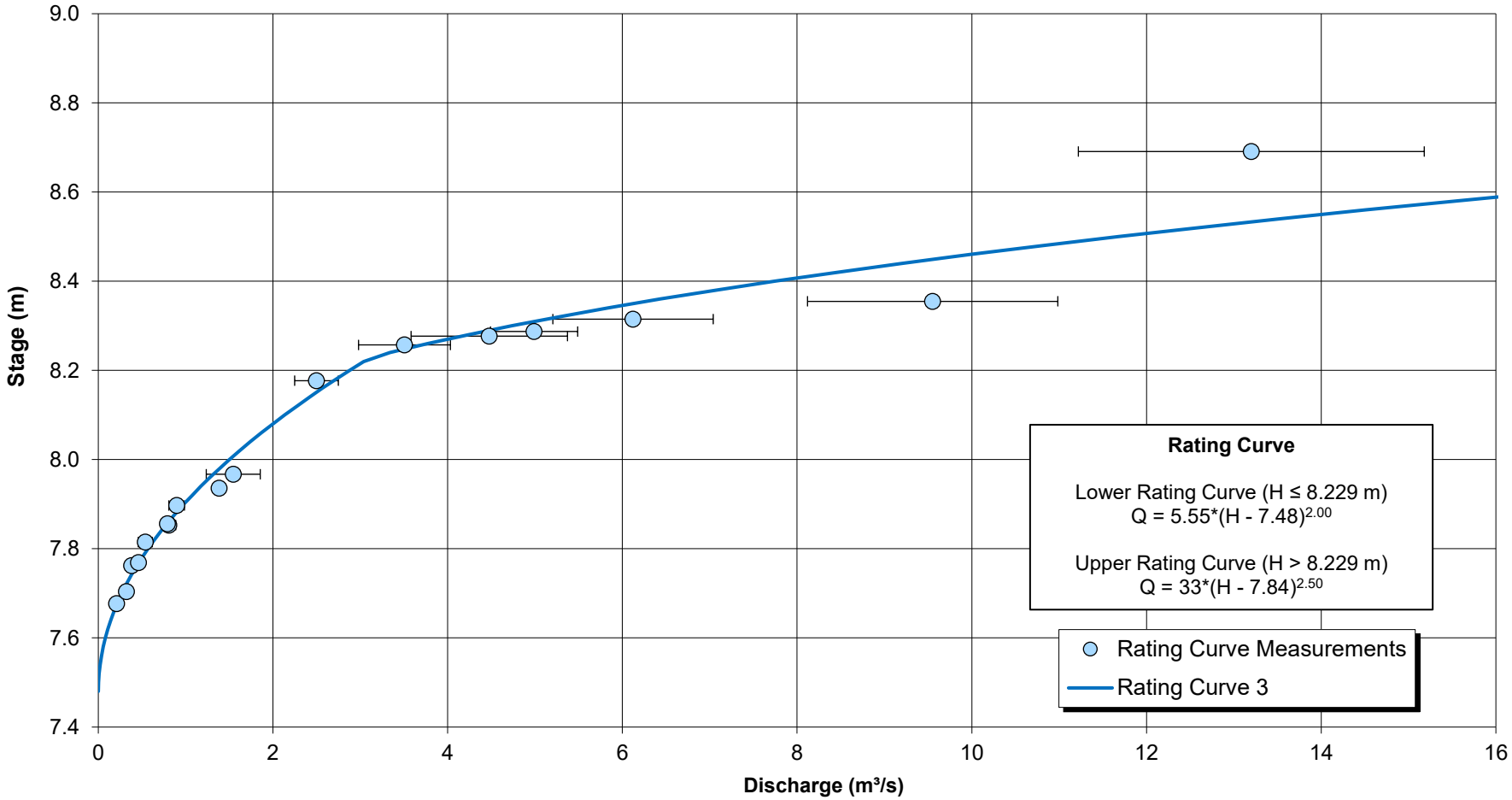
MILL CREEK WATERSHED

Knight Piésold CONSULTING

P/A NO. VA103-00494/24 | REF NO. VA22-01362

FIGURE 1 | REV 0

SAVED: M:\1\03\00494\24\A\GIS\Figs\VA22-01362\Fig1_MillCreekWatershed_r0.mxd; Sep 23, 2022 9:39 AM; kkrauszova



REV	DATE	DESCRIPTION	PREP'D	RVW'D
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WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK (MILL)
RATING CURVE 3
EXTRAPOLATED TO MAXIMUM RECORDED STAGE

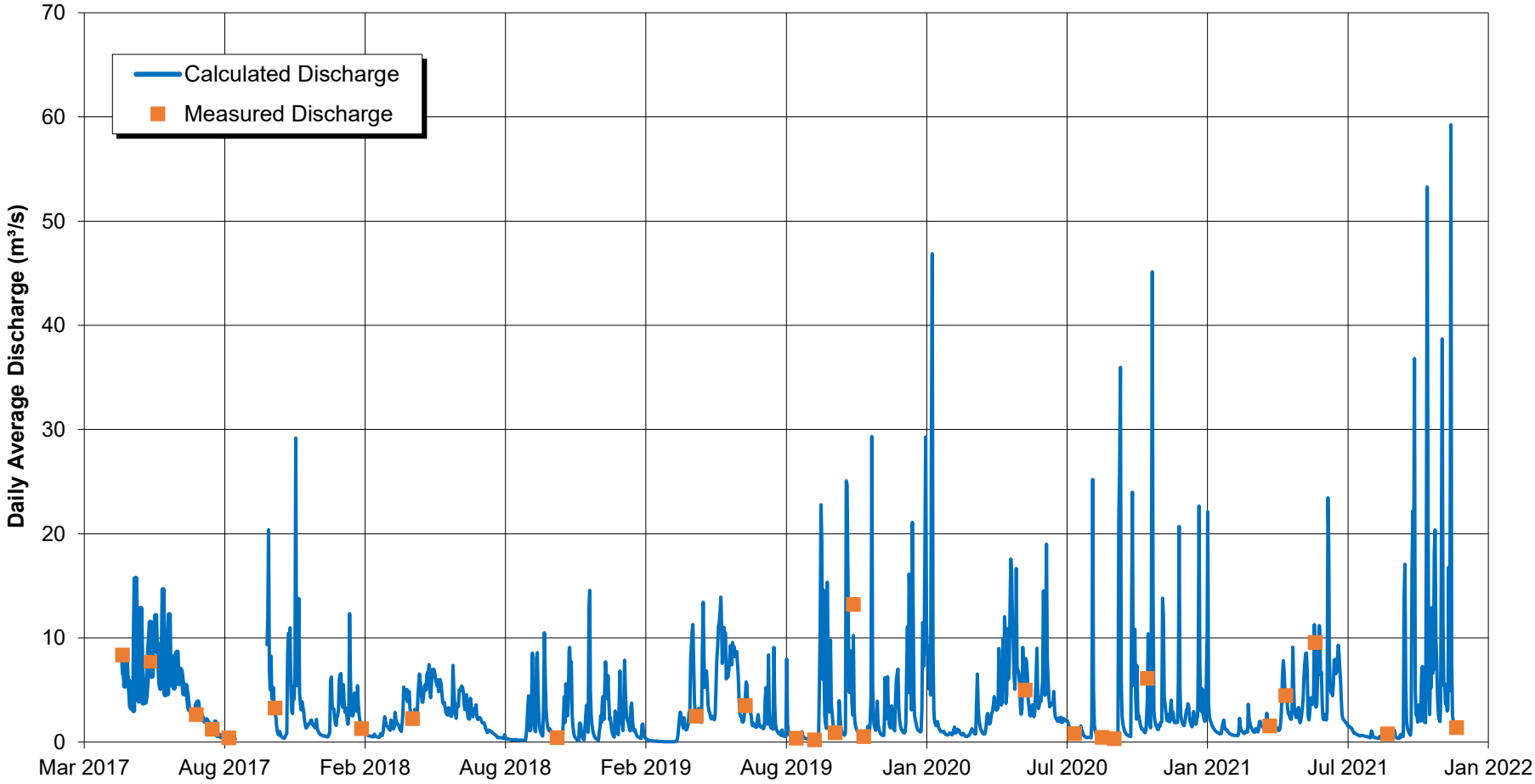
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01362

FIGURE 2

REV 0



NOTE:
1. MANUAL MEASUREMENTS OF INSTANTANEOUS DISCHARGE DO NOT NECESSARILY MATCH DAILY AVERAGE DISCHARGE ON THE SAME DATE DUE TO DAILY FLUCTUATIONS IN DISCHARGE.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK (MILL) GAUGE
DAILY AVERAGE DISCHARGE HYDROGRAPH

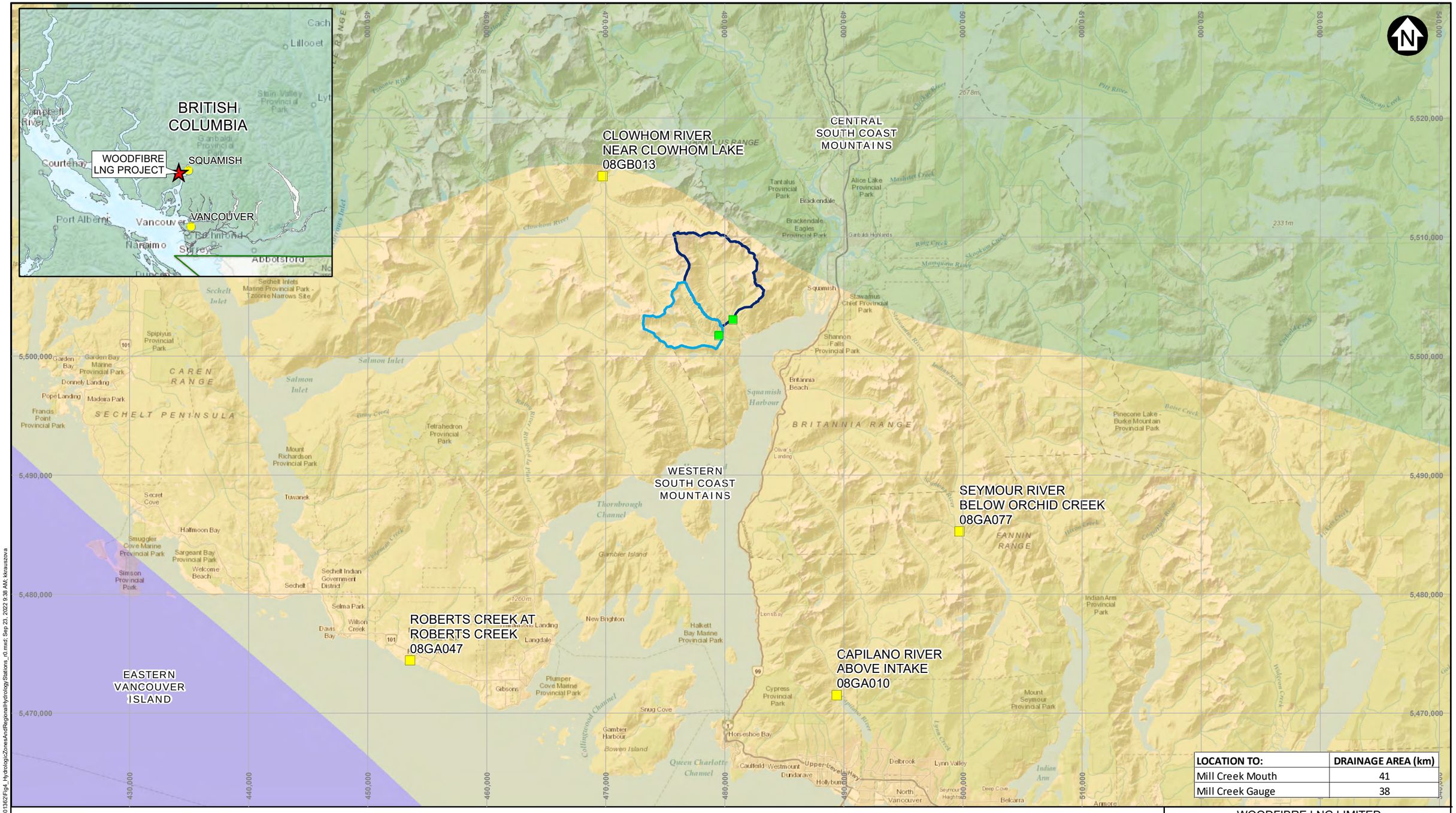
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01362

FIGURE 3

REV 0



LOCATION TO:	DRAINAGE AREA (km)
Mill Creek Mouth	41
Mill Creek Gauge	38

LEGEND:

- WSC STATION
- ACTIVE WOODFIBRE LNG HYDROLOGY GAUGE
- WOODFIBRE CREEK WATERSHED BOUNDARY
- MILL CREEK WATERSHED BOUNDARY

HYDROLOGIC ZONE

- CENTRAL SOUTH COAST MOUNTAINS (ZONE 26)
- EASTERN VANCOUVER ISLAND (ZONE 28)
- WESTERN SOUTH COAST MOUNTAINS (ZONE 27)

0 3.75 7.5 15 22.5 30 Km

NOTES:

1. BASE MAP: ESRI WORLD TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:300,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	23SEP'22	ISSUED WITH LETTER	TJP	KK	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

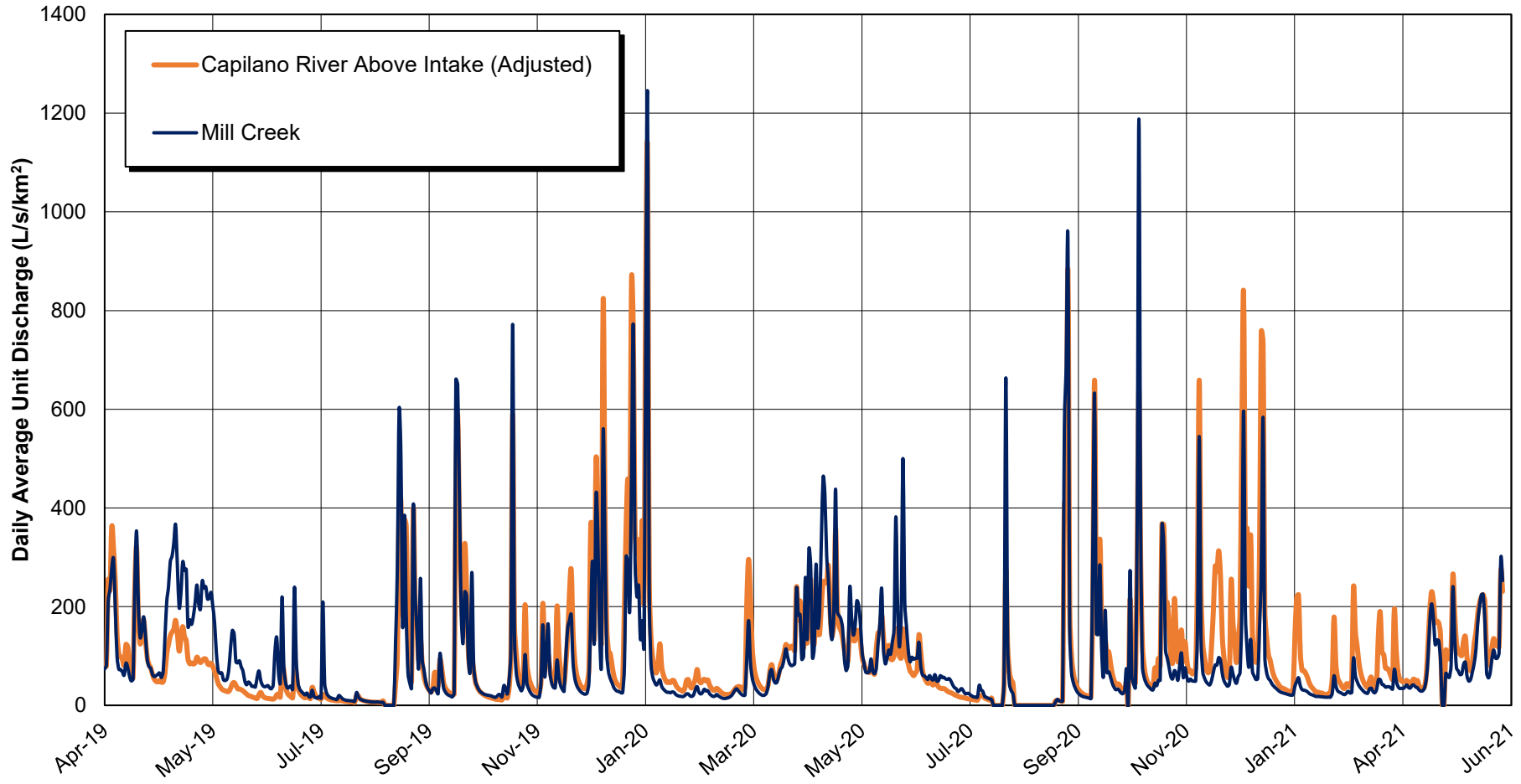
HYDROLOGIC ZONES AND REGIONAL HYDROLOGY STATIONS

Knight Piésold CONSULTING

P/A NO. VA103-00494/24 | REF NO. VA21-01362

FIGURE 4 REV 0

SAVED: M:\103\00494\24\A\GIS\Figs\VA22-01362\Fig4_HydrologicZonesAndRegionalHydrologyStations_r0.mxd: Sep 23, 2022 9:38 AM: kkrauszova



NOTES:
1. PERIOD OF RECORD USED FOR CONCURRENT PROJECT AND WSC STATION DISCHARGE IS APRIL 1, 2019 TO MAY 28, 2021

REV	DATE	DESCRIPTION	PREP'D	RVW'D
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WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK AND CAPILANO RIVER CONCURRENT UNIT RUNOFF

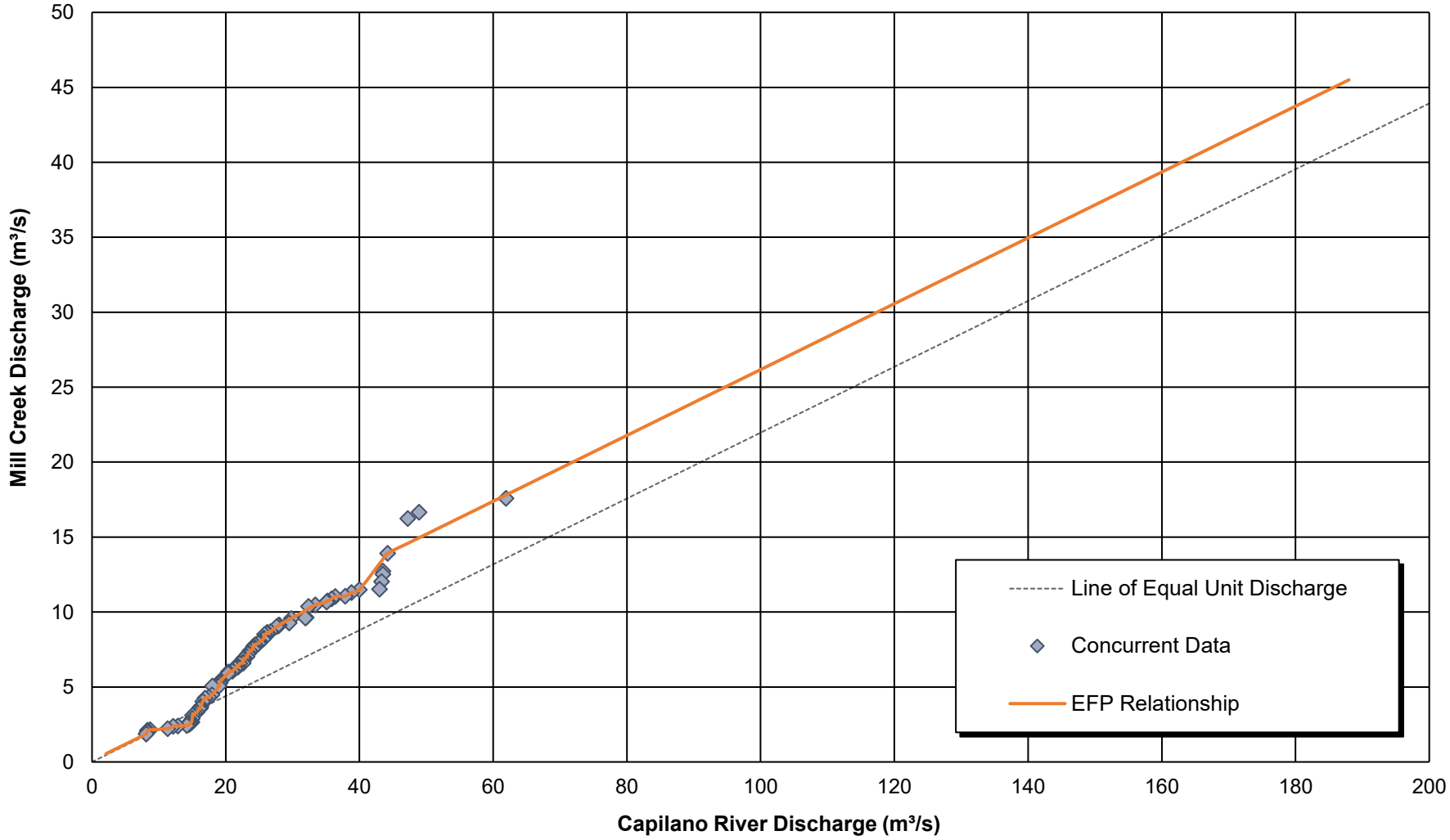
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01362

FIGURE 5

REV 0



NOTES:
1. PERIOD OF RECORD USED FOR CONCURRENT PROJECT AND WSC STATION DISCHARGE IS APRIL 1, 2019 TO MAY 28, 2021

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK AND CAPILANO RIVER FREQUENCY PAIRED RELATIONSHIP: MAY

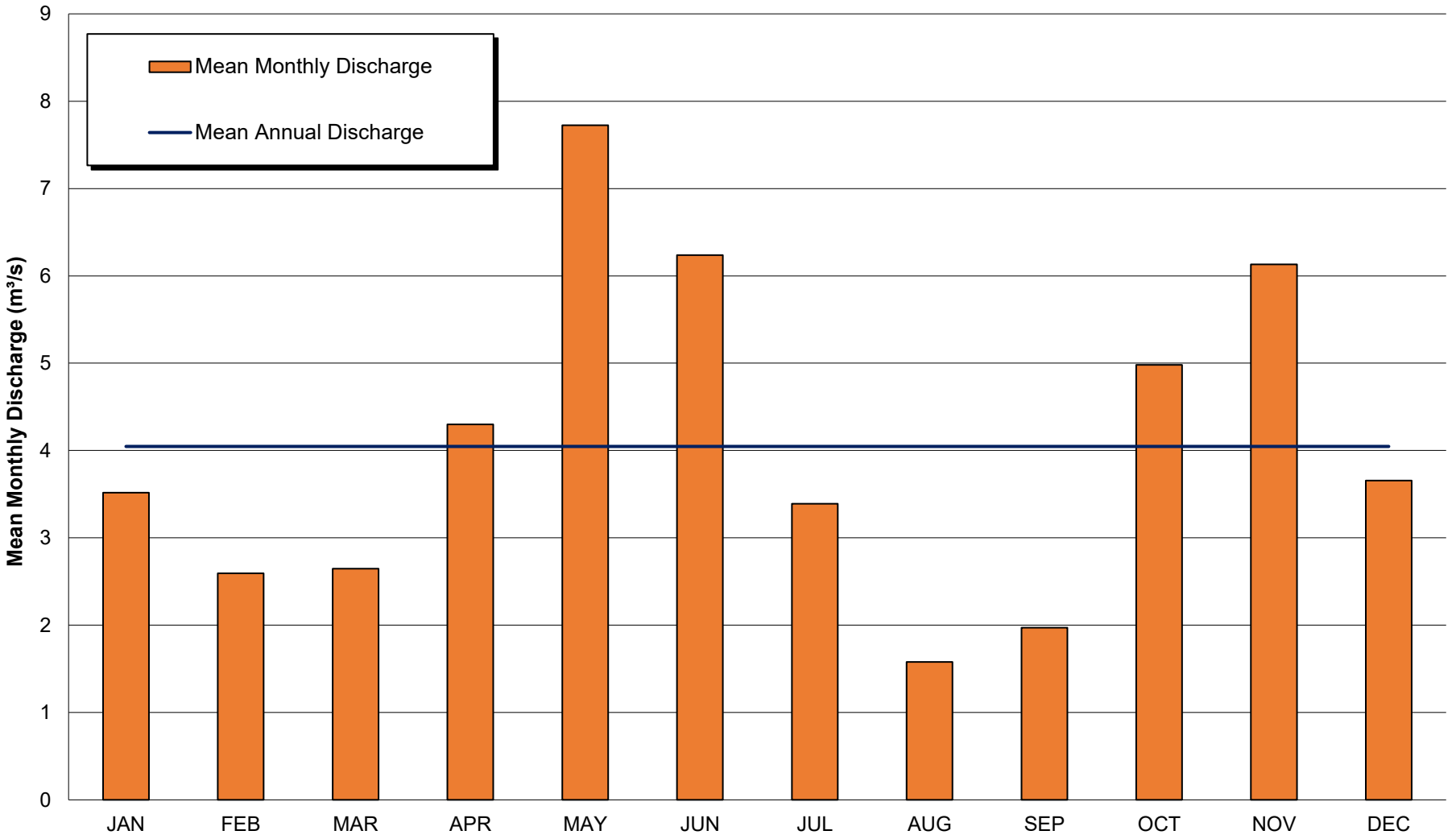
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01362

FIGURE 6

REV 0



NOTES:
1. MEAN MONTHLY FLOWS ESTIMATED FROM LONG-TERM SYNTHETIC SERIES (1960 - 2021).
2. MEAN ANNUAL DISCHARGE IS 4.06 m³/s

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK
MEAN MONTHLY HYDROGRAPH

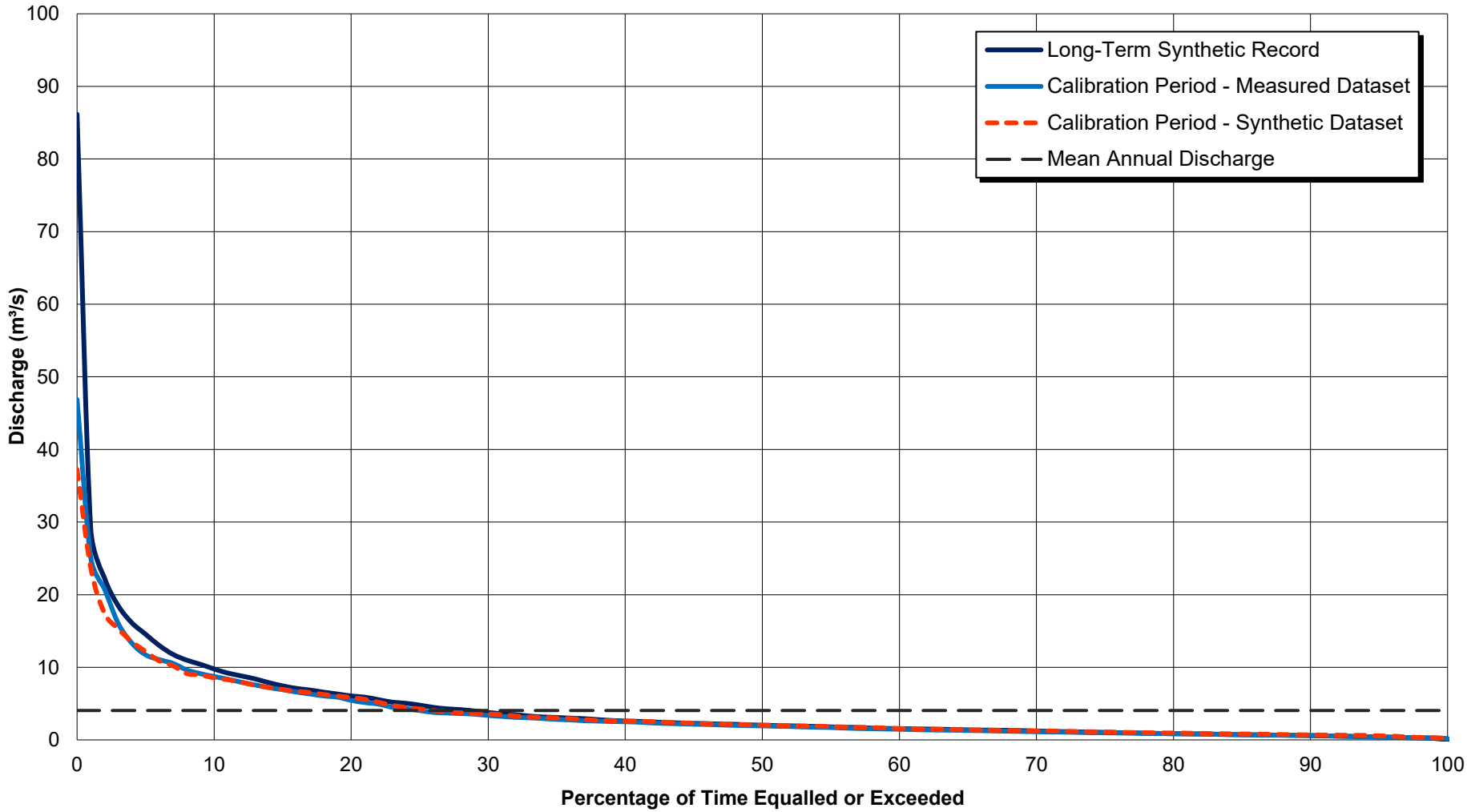
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01362

FIGURE 7

REV 0



NOTES:
1. THE PERIOD OF RECORD FOR THE CONCURRENT MEASURED AND SYNTHETIC FLOWS IS APRIL 1, 2019 TO MAY 28, 2021.
2. THE PERIOD OF RECORD FOR THE LONG-TERM SYNTHETIC SERIES IS JAN 1, 1960 TO MAY 28, 2021, WITH GAPS IN THE RECORD IN 1972 - 1973 AND 2017 - 2021.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK SYNTHETIC SERIES FLOW DURATION CURVES

Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01362

FIGURE 8

REV 0

APPENDIX A

Mill Creek Hydrologic Analysis

(Pages A-1 to A-14)

Knight Piésold CONSULTING

Management System Certified by: bsi ISO 9001 ISO 14001 ISO 45001 CERTIFIED

February 22, 2022

Darren Cowan
Permitting Manager
Woodfibre LNG Limited
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Canada, V6E 4E6

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Dear Darren,

RE: Mill Creek Hydrologic Analysis

Woodfibre LNG Limited (Woodfibre LNG) is developing a liquefied natural gas (LNG) export facility (the Project) on the former Woodfibre Pulp and Paper Mill site, located near Squamish, British Columbia (BC). Knight Piésold Ltd. (KP) has been retained by WLNG to assist with the hydrometric monitoring of Mill Creek, in support of instream flow studies and Project permitting. As part of this work, KP has installed and operated streamflow gauging stations on Mill Creek and Woodfibre Creek. Two gauging stations are operated on Mill Creek and referred to as MILL and MILL-R2. This letter presents the details of the Mill Creek field data collection by KP and the available measured record, covering April 2017 to November 2021.

1.0 HYDROLOGIC SETTING

The Project area is located within Hydrologic Zone 27 (Western South Coast Mountains), on the boundary with Zone 26, as presented by Ahmed (2017). In this zone, Pacific frontal systems encounter the abruptly rising terrain of the Coast Mountains and produce large quantities of precipitation as they are forced upward. Spatial variability in annual precipitation is extensive due to orographic enhancement on windward slopes and rain shadow effects in leeward areas. The proportion of precipitation falling as snow varies with elevation, with little snow falling at sea level and large snowpacks accumulating on upper mountain slopes. Even at high elevations, however, winter rainfall and snowmelt are common, leading to a complex hydrologic regime. In general, streamflow in South Coast watersheds like Mill Creek (i.e. coastal, but also with high elevation mountainous terrain) is highest in autumn due to frontal rainstorm activity, with a secondary peak in spring due to snowmelt. Flows are lowest in late summer when precipitation is low. Winter flows tend to be moderate as much of the precipitation falls as snow but can be punctuated by warm rainfall events and rainfall at lower elevation.

Mean annual precipitation varies from only 1,490 mm at Gibsons, located approximately 35 km southwest of the Project, to 3,322 mm at Port Mellon, located 25 km southwest of the Project and then to 2,230 mm in Squamish. This is indicative of topographic convergence of frontal systems in Howe Sound, and extreme orographic enhancement of precipitation due to rapid uplift. Similarly, mean annual unit runoff varies dramatically from 125 l/s/km^2 (or 4,000 mm) in Rainy River, located near Port Mellon, and 116 l/s/km^2 (or 3,660 mm) in Capilano River, located close to the Project area, to only 32 l/s/km^2 (or 1,000 mm) in Roberts Creek, located 40 km to the southwest and with a lower elevation basin.

The Mill Creek watershed is shown on Figure 1.

2.0 STREAMFLOW DATA COLLECTION

2.1 MILL STATION

KP installed a hydrometric station (MILL) on Mill Creek in April 2017. The station is approximately 2 km upstream from the mouth of the Creek, as shown on Figure 1, and approximately 100 meters upstream of the historic hydropower intake. The site was selected primarily due to accessibility and gauging characteristics with the objective of collecting accurate and reliable streamflow data, but also considering potential future and existing water diversion locations. Mill Creek downstream of the gauging location lies in a canyon with steep or vertical bedrock banks, and safe access year-round is challenging. Additionally, locations that allow high quality streamflow measurements at a range of flow conditions are limited. Near the mouth of Mill Creek, much of the accessible reach is backwatered by tides and therefore not suitable for stream gauging.

The station is located on the left bank of a pool, downstream of a cascade, as shown on Photo 1a. Water level is hydraulically controlled by a cascade at the outlet of the pool, shown on Photo 1b. The low-flow control section consists of cobbles and boulders, while the high-flow control also includes the bedrock banks. The hydrometric station consists of a pressure transducer connected to a datalogger that records stage at fifteen-minute intervals.

(a) (b)

Photo 1 – (a) MILL Station looking upstream at the pressure transducer and staff gauge (Apr 10, 2019), and (b) looking downstream at the hydraulic control section (Aug 29, 2017)

2.1.1 MILL RATING CURVE AND DISCHARGE HYDROGRAPH

A total of 26 stage/discharge measurements have been collected at MILL, as summarized in Table 1. The discharge measurements were conducted using area-velocity or Rhodamine dye dilution measurements, depending on flow conditions at the time of each site visit. The station includes three benchmarks located in bedrock above the normal high-water level, a staff gauge, and three reference marks for determining stage. Benchmark 1 was assigned an elevation of 10 m and this datum is used for converting water level to gauge height (stage). These stage-discharge measurements were used to develop a rating curve for the gauge.

A high flow event on November 22, 2017, resulting in a deposition of gravel and cobbles at the control section, was identified as causing a change in the hydraulic control, which required a new stage-discharge rating curve. Rating Curve 1 is applied from April 18, 2017 to November 22, 2017.

Another change in the hydraulic control appears to have occurred between the October 17, 2018 and April 10, 2019 site visits, possibly due to high flow events that caused scouring of material deposited during the November 22, 2017 event within the control section. It is unknown when the exact date of this change occurred or if it was gradual during the time interval between site visits. A second rating curve (Rating Curve 2) was developed, but only three stage-discharge measurements were collected before another shift was detected. Rating Curve 3 is applied from April 1, 2019 to the most recent site visit on November 22, 2021. All three rating curves are shown on Figure 2.

Rating Curve 1 was plotted through the six available stage-discharge points using the standard form for a rating curve equation (power function) with the constant, offset, and exponent constrained within expected values based on hydraulic theory (Maidment, 1993) and experience with similar conditions in mountainous streams. Rating Curve 2 is based on the shape of Rating Curve 1 as the three available stage-discharge measurements are insufficient to independently delineate a new rating curve. Rating Curve 3 is based on the 17 stage-discharge measurements collected since the April 2019 shift. The latest measurement (recorded November 22, 2021) falls on Rating Curve 3. As data collection continues, the need to create a new rating curve will be assessed.

The most recent rating curve (Rating Curve 3) is shown on Figure 3. The rating curve meets the number and distribution of stage-discharge measurements compared to RISC (2018) recommendations over the range of "normal" flows and, in particular, over the range of flows most relevant for the instream flow studies and Project permitting. Rating Curve 1 also meets the RISC (2018) recommendations over the range of measured flows. Rating Curve 2 does not meet the RISC (2018) recommendations over the range of measured flows due to a lack of discharge measurements collected to delineate this rating curve. Based on the B.C. Hydrometric standards (RISC, 2018) the data collected at MILL is considered to meet Grade A standards for the period of record, with the following exceptions: during the period when Rating Curve 2 is applied (November 22, 2017 to April 01, 2019) due to insufficient stage-discharge measurements, and RISC (2018) notes that rating curves developed from dilution methods should be graded as "BP" (i.e., Best Practice) due to lack of Provincial guidelines on the method.

The daily average discharge hydrograph for MILL is presented on Figure 4 and was developed by applying the rating curves to their respective periods of stage record and then averaging the fifteen-minute streamflow record over a calendar day. The MILL hydrograph has one gap from September 6, 2017 to October 17, 2017 (dates are inclusive) due to depleted logger battery.

As evidenced above, the hydraulic control at the MILL station is not stable and the rating curve has shifted twice since the installation of the station in April 2017. Given the reliance on the Mill Creek station for low flow mitigation, a new sensor was installed near the current MILL station. The new station location, MILL-R2, is considered more stable than the previous MILL station location and conditions are considered suitable for telemetry, if required in the future. Both MILL and MILL-R2 are operated concurrently to provide redundancy and improved accuracy.

2.2 MILL-R2 STATION

KP installed an additional hydrometric station (MILL-R2) in June 2019. The gauge. is approximately 50 meters upstream of the historic Mill Creek hydropower intake and 50 meters downstream from the original

MILL station. The station is located on the left bank of a pool, downstream of a cascade, as shown on Photo 3a. Water level is hydraulically controlled by a constriction of the bedrock banks, as shown on Photo 3b. The low-flow control section consists of cobbles and boulders, while the high-flow control also includes the bedrock banks. The hydrometric station consists of a pressure transducer connected to a datalogger that records stage at fifteen-minute intervals.

(a) (b)

Photo 3 – (a) MILL-R2 Station looking upstream at the pressure transducer (October 2, 2019), and (b) looking upstream showing the Hydraulic Control (Aug 14, 2019). The gauge location is identified by the red dot.

2.2.1 MILL-R2 RATING CURVE AND DISCHARGE HYDROGRAPH

A total of 15 stage/discharge measurements have been made at MILL-R2, as summarized in Table 2. The discharge measurements were conducted using area-velocity and Rhodamine dye dilution methods depending on flow conditions at the time of each site visit. The station includes three benchmarks, located in bedrock above the normal high-water level and one reference mark for determining stage. Benchmark 1 was assigned an elevation of 5 m and this datum is used for converting water level to gauge height (stage). On two occasions this year, high flow events have damaged the station and the benchmarks. On April 1, 2021, KP staff arrived on site to a damaged sensor with the protective aluminum housing pipe missing. The sensor was replaced during the April 21, 2021 site visit. KP staff returned for the final site visit of the year on November 22, 2021 to again find the new sensor was missing along with the protective aluminum pipe. All dipping points and one benchmark need to be re-established in 2022.

One rating curve was plotted through the 15 available stage-discharge points using the standard form for a rating curve equation (power function) with the constant, offset, and exponent constrained within expected values based on hydraulic theory (Maidment, 1993) and experience with similar conditions in mountainous streams. The rating curve, showing up to the maximum recorded stage-discharge measurement collected over the monitored time period, is shown on Figure 5. The rating curve was adjusted based on additional stage-discharge measurements collected during the 2021 monitoring program to better delineate the curve. The May 28, 2021 measurement was a high flow rating curve point that fell to the right of the previously established rating curve. The upper portion of the old curve was driven by a high flow measurement taken on October 25, 2019. The new rating curve takes both of these high flow measurements into account as there is no certainty on whether there has been a control shift at the site. Future high flow measurements

will determine if there has been a control shift or if one of these points are simply anomalous. The rating curve meets the RISC (2018) recommendations over the range of measured flows, including over the range of flows most relevant to the instream flows studies and Project permitting, due to the number and distribution of discharge measurements delineating the curve. Based on the B.C. Hydrometric standards (RISC, 2018) the data collected at MILL-R2 is considered to meet Grade A standards for the period of record, except RISC (2018) notes that rating curves developed from dilution methods should be graded as "BP" (i.e., Best Practice) due to lack of Provincial guidelines on the method.

The daily average discharge hydrograph for MILL-R2 is presented on Figure 6 and was developed by applying the rating curve to the available stage record and then averaging the fifteen-minute streamflow record over a calendar day. The MILL-R2 hydrograph has three gaps:

- May 28, 2020 to July 29, 2020 – due to depleted logger battery.
- October 29, 2020 to April 21, 2021 – due to station damage.
- September 29, 2021 to next station installation – due to station damage, station needs to be replaced and is currently not logging.

Although these data are missing at MILL-R2, stage data are available from the MILL gauging station during these time periods.

3.0 DISCUSSION

Streamflow gauging will continue on Mill Creek to support instream flow studies and Project permitting. The rating curves at MILL and MILL-R2 are believed to accurately calculate streamflow over the range of conditions most relevant for the instream flow studies and Project permitting. It is recommended that both the MILL and MILL-R2 gauges continue to be operated to provide improved accuracy and redundancy. MILL-R2 is the better candidate for telemetry, if required, as the rating curve appears to be more stable than MILL. Despite the station being damaged on two occasions this year, it is believed that with the addition of more clamps the station will become more robust. At least five site visits covering an adequate range of streamflows should be conducted annually at the Mill Creek gauging stations to increase the accuracy and confirm stability of the stage-discharge rating curves and meet the Grade A standard for data collection guidelines outlined in RISC (2018). It is also recommended that the instrumentation (pressure transducer and data logger) at the MILL station be replaced during 2022 as part of routine maintenance to maintain data accuracy.

Yours truly,
Knight Piésold Ltd.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
T. J. PERKINS
32079
2022-02-22

Prepared: Kaelan Hagen, GIT
Project Scientist

Reviewed: Toby Perkins, M.A.Sc., P.Eng.
Senior Engineer

Approval that this document adheres to the Knight Piésold Quality System: SRM

Attachments:

Table 1 Rev 0	Summary of Discharge Measurements
Table 2 Rev 0	Summary of Discharge Measurements
Figure 1 Rev 0	Mill Creek Watershed
Figure 2 Rev 0	Mill Creek (MILL) Rating Curves - Measured Range
Figure 3 Rev 0	Mill Creek (MILL) Rating Curve 3 - Extrapolated to Maximum Recorded Stage-Discharge Measurement
Figure 4 Rev 0	Mill Creek (MILL) Daily Average Discharge Hydrograph
Figure 5 Rev 0	Mill Creek (MILL-R2) Rating Curve - Extrapolated to Maximum Recorded Stage-Discharge Measurement
Figure 6 Rev 0	Mill Creek (MILL-R2) Daily Average Discharge Hydrograph

References

Ahmed, A. (2017). “Inventory of Streamflow in the South Coast and West Coast Regions”, October 2017, Knowledge Management Branch, British Columbia Ministry of Environment and Climate Change Strategy, Victoria, B.C.

Maidment, David R. (1993). Handbook of hydrology. Vol. 9780070. McGraw-Hill, New York.

Resources Information Standards Committee (RISC). 2018. Manual of British Columbia Hydrometric Standards, Version 2.0, December 2018. Knowledge Management Branch, B.C. Ministry of Environment and Climate Change Strategy, Victoria, B.C.

/krh

Knight Piésold CONSULTING

TABLE 1

WOODFIBRE LNG LTD.
WOODFIBRE LNG PROJECT

MILL CREEK (MILL)
SUMMARY OF DISCHARGE MEASUREMENTS

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Date	Number of Gaugings	Method	Stage [m]	Stage +/- [m]	Discharge [m^3/s]	Discharge Error
4/18/2017	4	Dye Dilution	8.30	0.010	8.36	10%
5/24/2017	3	Dye Dilution	8.26	0.010	7.74	10%
7/20/2017	2	Area-Velocity	7.90	0.002	2.65	5%
8/9/2017	2	Area-Velocity	7.74	0.010	1.23	5%
8/30/2017	2	Area-Velocity	7.52	0.002	0.39	5%
10/27/2017	3	Dye Dilution	7.94	0.005	3.27	10%
2/13/2018	3	Dye Dilution	8.15	0.005	1.28	10%
4/18/2018	3	Dye Dilution	8.26	0.010	2.25	10%
10/17/2018	2	Area-Velocity	7.94	0.010	0.44	10%
4/10/2019	4	Dye Dilution	8.18	0.020	2.50	10%
6/11/2019	3	Dye Dilution	8.26	0.020	3.51	15%
8/14/2019	2	Area-Velocity	7.76	0.005	0.38	10%
9/6/2019	2	Area-Velocity	7.68	0.005	0.21	10%
10/2/2019	2	Area-Velocity	7.90	0.002	0.90	10%
10/25/2019	4	Dye Dilution	8.69	0.030	13.20	15%
11/7/2019	1	Area-Velocity	7.82	0.005	0.54	15%
5/28/2020	3	Dye Dilution	8.29	0.020	4.99	10%
7/29/2020	2	Dye Dilution	7.85	0.010	0.81	10%
9/2/2020	2	Dye Dilution	7.77	0.010	0.46	10%
9/17/2020	2	Dye Dilution	7.70	0.005	0.32	10%
10/29/2020	2	Dye Dilution	8.32	0.030	6.12	15%
4/1/2021	2	Dye Dilution	7.97	0.020	1.55	20%
4/21/2021	2	Dye Dilution	8.28	0.020	4.48	20%
5/28/2021	2	Dye Dilution	8.36	0.020	9.55	15%
8/27/2021	2	Dye Dilution	7.86	0.010	0.79	10%
11/22/2021	2	Area-Velocity	7.94	0.020	1.38	15%

\\KPL\VA-Prj$\1\03\00494\18\A\Data\Hydrology\End of Year 2021 QAQC\MILL\[MILL_QAQC 2021_NEW.xlsm]Q Table

NOTES:

1) NUMBER OF GAUGINGS REFERS TO THE NUMBER OF GAUGINGS AVERAGED TO PRODUCE ONE RATING POINT.
2) STAGE ERROR IS BASED ON A VISUAL ASSESSMENT OF THE WAVE AMPLITUDE IN THE GAUGE POOL.
3) DISCHARGE ERROR REFERS TO THE IN-SITU MEASUREMENT ERROR ESTIMATED BY THE FIELD ENGINEER.

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Knight Piésold CONSULTING

TABLE 2

WOODFIBRE LNG LTD.
WOODFIBRE LNG PROJECT

MILL CREEK (MILL-R2)
SUMMARY OF DISCHARGE MEASUREMENTS

Print Feb/22/22 10:50:06

Date	Number of Gaugings	Method	Stage [m]	Stage +/- [m]	Discharge [m^3/s]	Discharge Error
6/11/2019	3	Dye Dilution	4.69	0.020	3.51	15%
8/14/2019	2	Area-Velocity	4.23	0.010	0.38	10%
9/6/2019	2	Area-Velocity	4.14	0.005	0.21	10%
10/2/2019	2	Area-Velocity	4.36	0.005	0.90	10%
10/25/2019	4	Dye Dilution	5.12	0.050	13.17	20%
11/7/2019	1	Area-Velocity	4.30	0.010	0.54	15%
5/28/2020	3	Dye Dilution	4.78	0.020	4.99	10%
7/29/2020	2	Area-Velocity	4.37	0.005	0.81	10%
9/2/2020	2	Area-Velocity	4.26	0.010	0.46	10%
9/17/2020	2	Area-Velocity	4.17	0.005	0.32	10%
10/29/2020	3	Dye Dilution	4.79	0.050	6.12	15%
4/1/2021	3	Dye Dilution	-	-	1.55	-
4/21/2021	3	Dye Dilution	4.78	0.050	4.48	20%
5/28/2021	3	Dye Dilution	4.85	0.050	9.55	15%
8/27/2021	2	Area-Velocity	4.34	0.010	0.79	10%
11/22/2021	2	Area-Velocity	4.49	0.020	1.38	10%

\\KPL\VA-Prj$\1\03\00494\18\A\Data\Hydrology\End of Year 2021 QAQC\MILL-R2\[MILL-R2 QAQC 2021.xlsm]Q Table

NOTES:

1) NUMBER OF GAUGINGS REFERS TO THE NUMBER OF GAUGINGS AVERAGED TO PRODUCE ONE RATING POINT.
2) DISCHARGE ERROR REFERS TO THE IN-SITU MEASUREMENT ERROR ESTIMATED BY THE FIELD ENGINEER.
3) STAGE ERROR IS BASED ON A VISUAL ASSESSMENT OF THE WAVE AMPLITUDE IN THE GAUGE POOL.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
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MILL CREEK WATERSHED

N

5,510,000

5,505,000

470,000

480,000

490,000

500,000

LOCATION TO:	DRAINAGE AREA (km²)
Mill Creek Mouth	41
Mill Creek Gauge	38

LEGEND:

- ACTIVE WOODFIBRE LNG HYDROLOGY GAUGE
- WATERSHED BOUNDARY

1 0.5 0 1 2 3 4 5 Km

NOTES:

1. BASE MAP: ESRI WORLD TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:50,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	22FEB'22	ISSUED WITH LETTER	ELK	KK	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

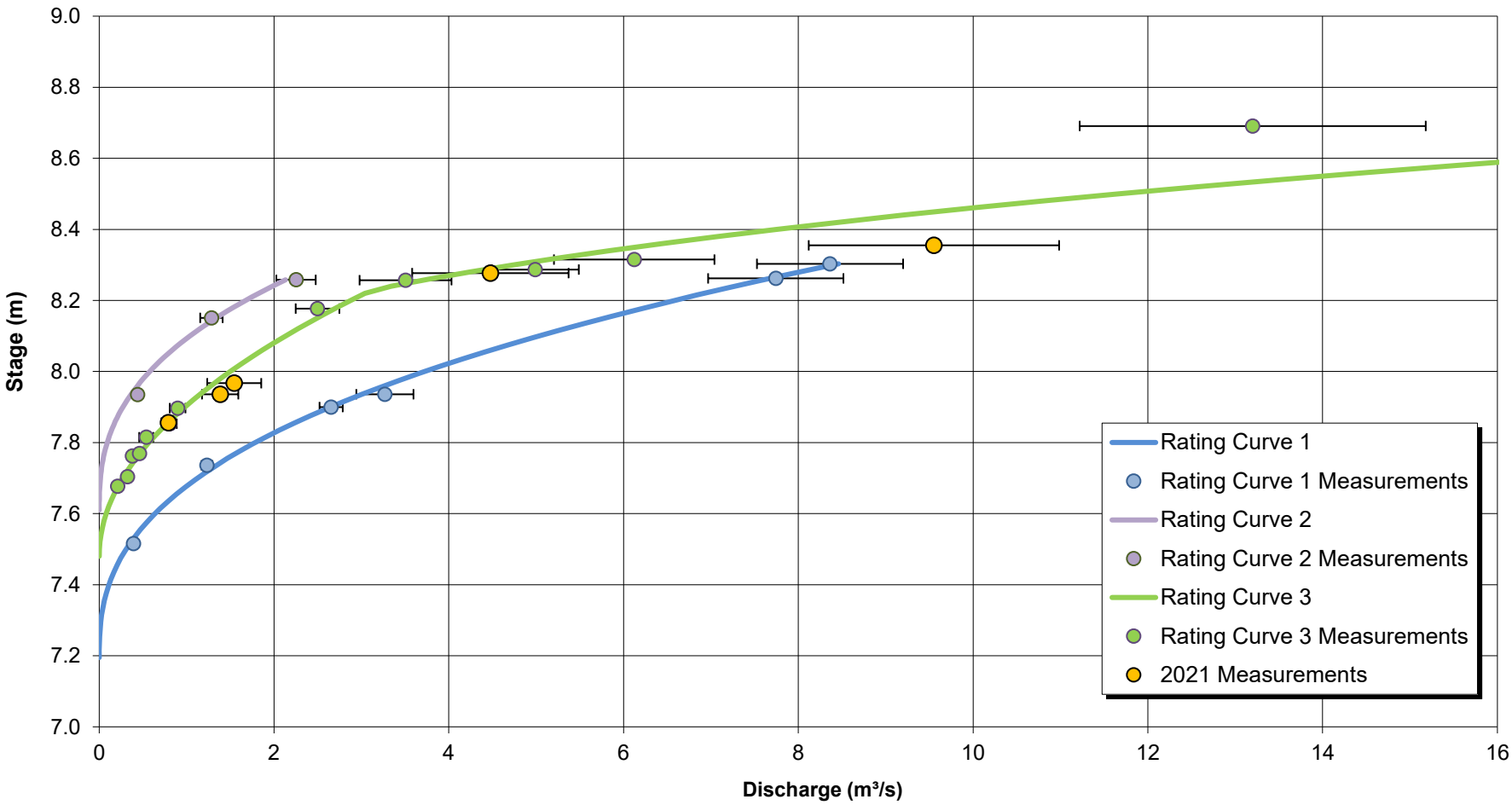
MILL CREEK WATERSHED

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-00494/18	VA21-02130

FIGURE 1 REV 0

SAVED: M:\1\03\00494\18\A\GIS\Figs\VA21-02130\Fig1_MillCreekWatershed_R0.mxd: Feb 22, 2022 9:27 AM: kkrauszova



REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	22FEB'22	ISSUED WITH LETTER	KRH	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK (MILL)
RATING CURVES - MEASURED RANGE

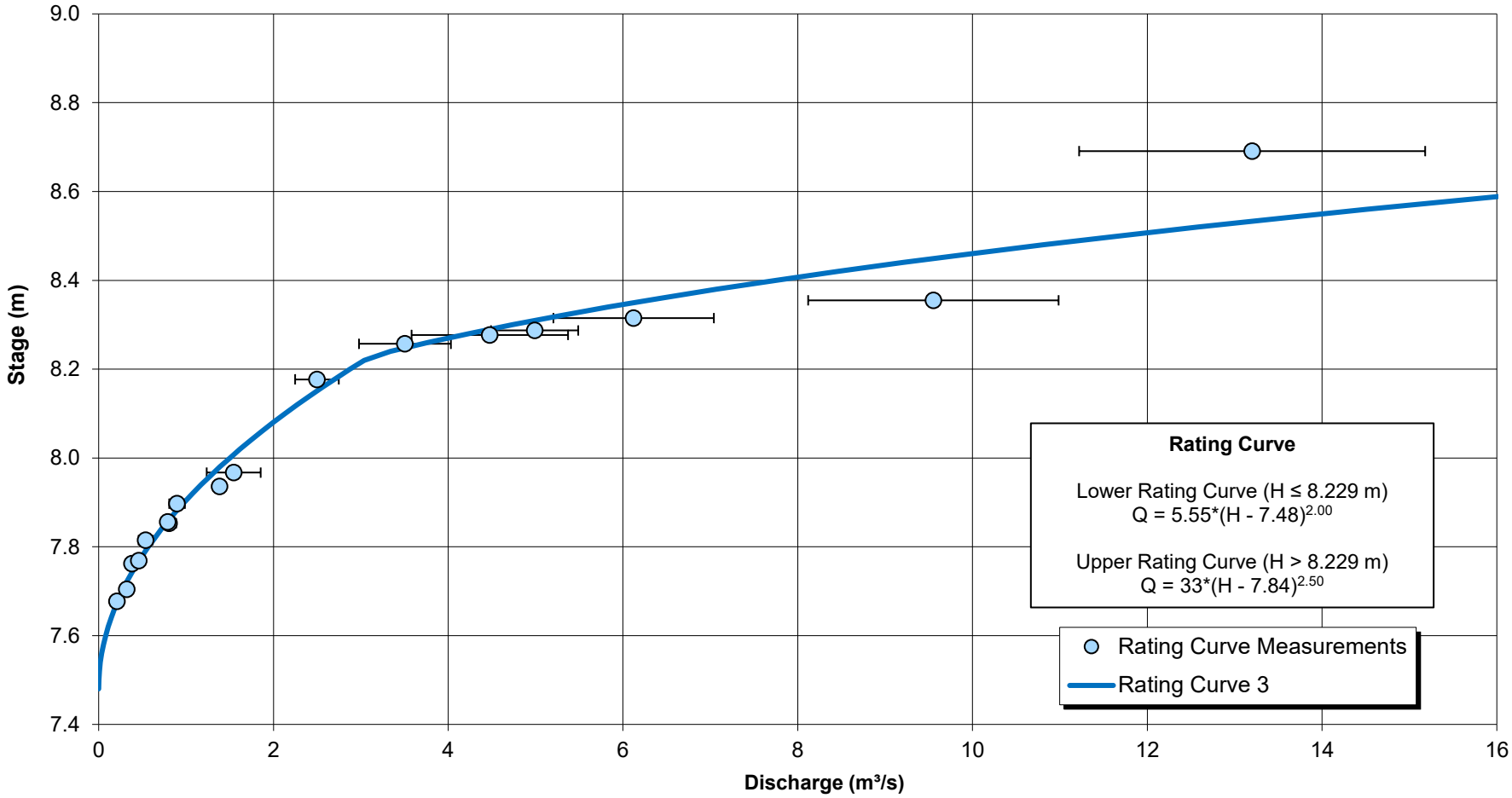
Knight Piésold CONSULTING

P/A NO. VA103-494/18

REF. NO. VA21-02130

FIGURE 2

REV 0



REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	22FEB'22	ISSUED WITH LETTER	KRH	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK (MILL)
RATING CURVE 3 - EXTRAPOLATED TO MAXIMUM RECORDED STAGE-DISCHARGE MEASUREMENT

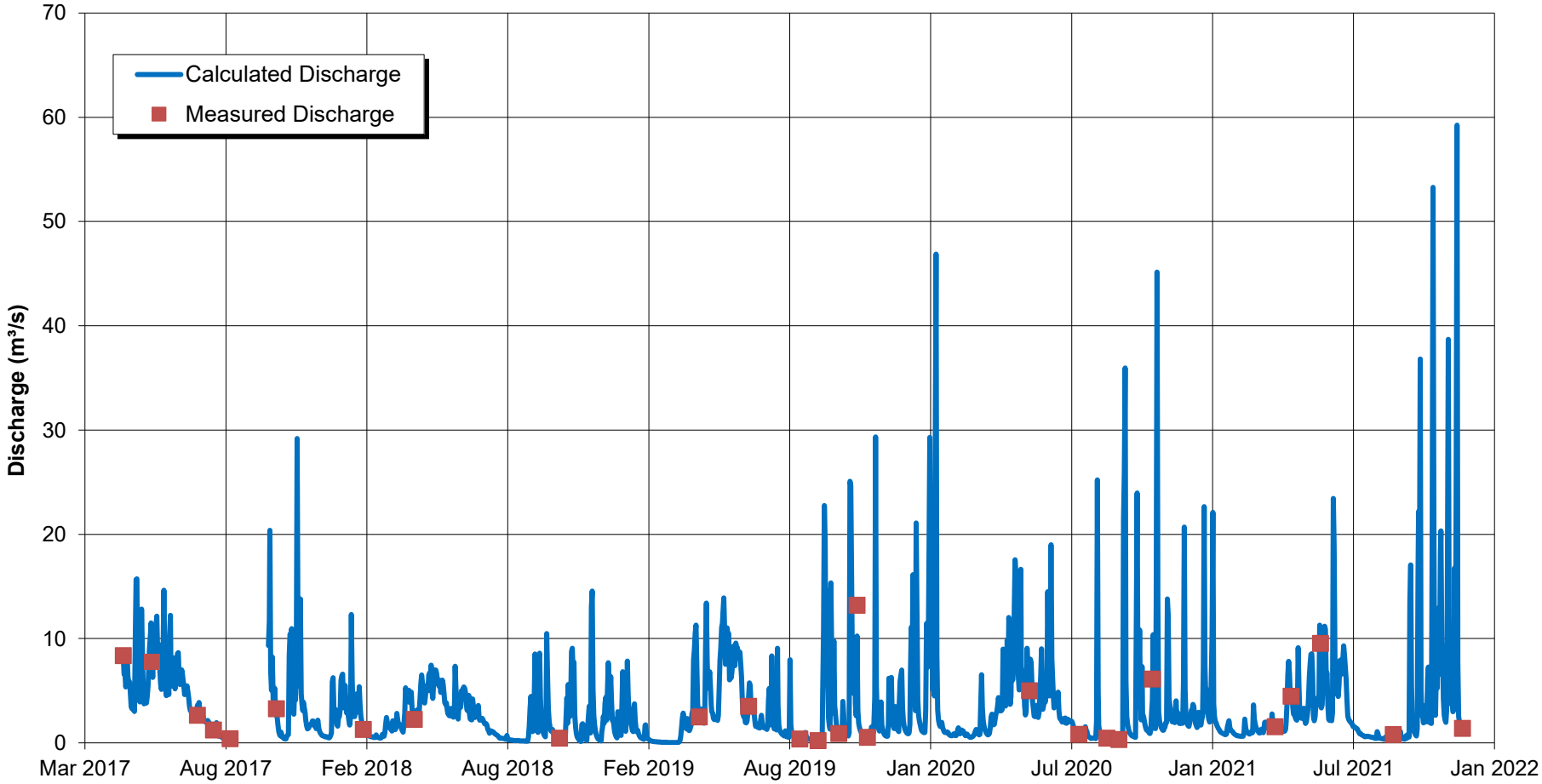
Knight Piésold CONSULTING

P/A NO. VA103-494/18

REF. NO. VA21-02130

FIGURE 3

REV 0



NOTE:
1. MANUAL MEASUREMENTS OF INSTANTANEOUS DISCHARGE DO NOT NECESSARILY MATCH DAILY AVERAGE DISCHARGE ON THE SAME DATE DUE TO DAILY FLUCTUATIONS IN DISCHARGE.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	22FEB'22	ISSUED WITH LETTER	KRH	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK (MILL)
DAILY AVERAGE DISCHARGE HYDROGRAPH

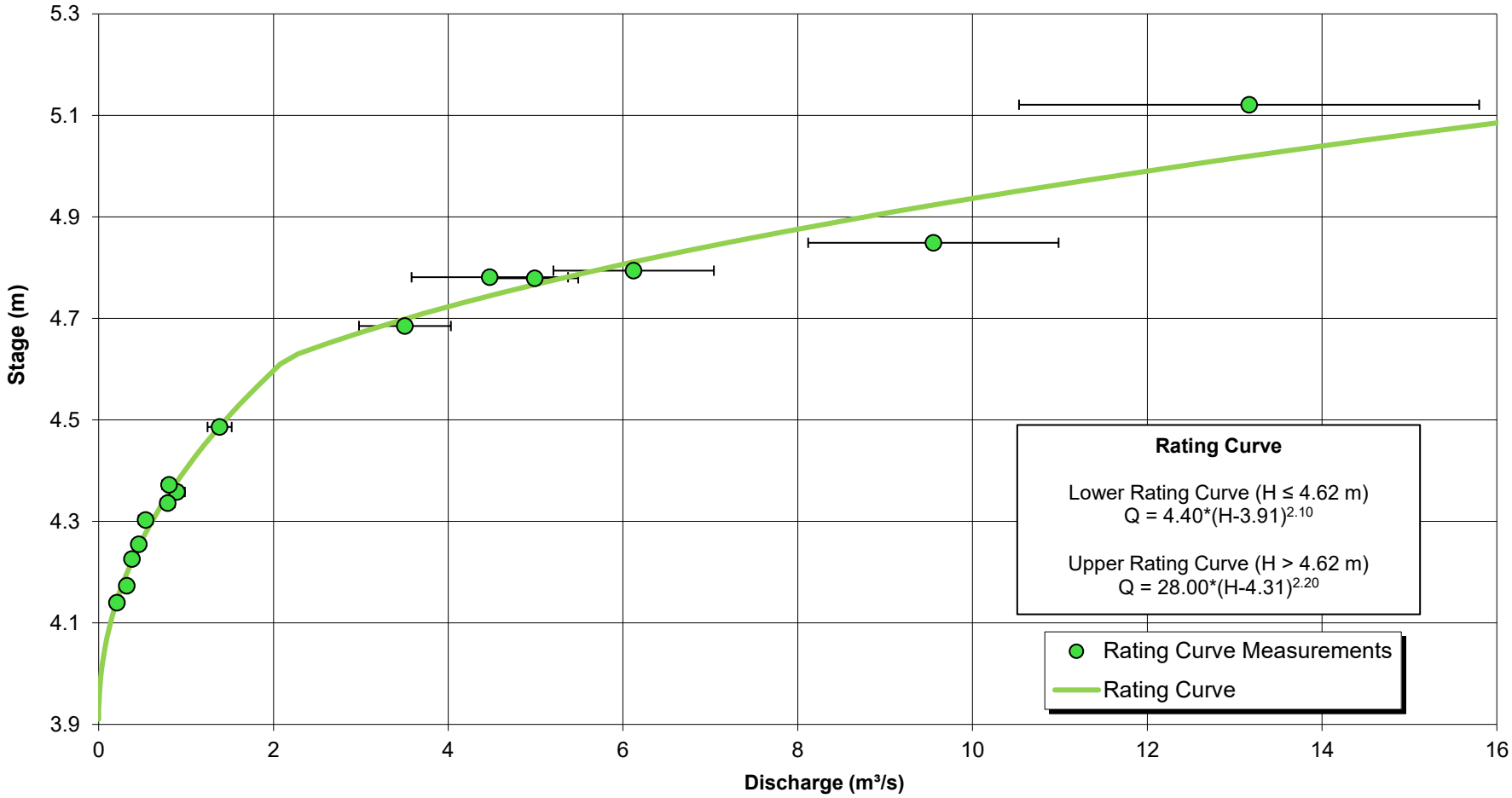
Knight Piésold CONSULTING

P/A NO. VA103-494/18

REF. NO. VA21-02130

FIGURE 4

REV 0



REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	22FEB'22	ISSUED WITH LETTER	KRH	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK (MILL-R2)
RATING CURVE - EXTRAPOLATED TO MAXIMUM RECORDED STAGE-DISCHARGE MEASUREMENT

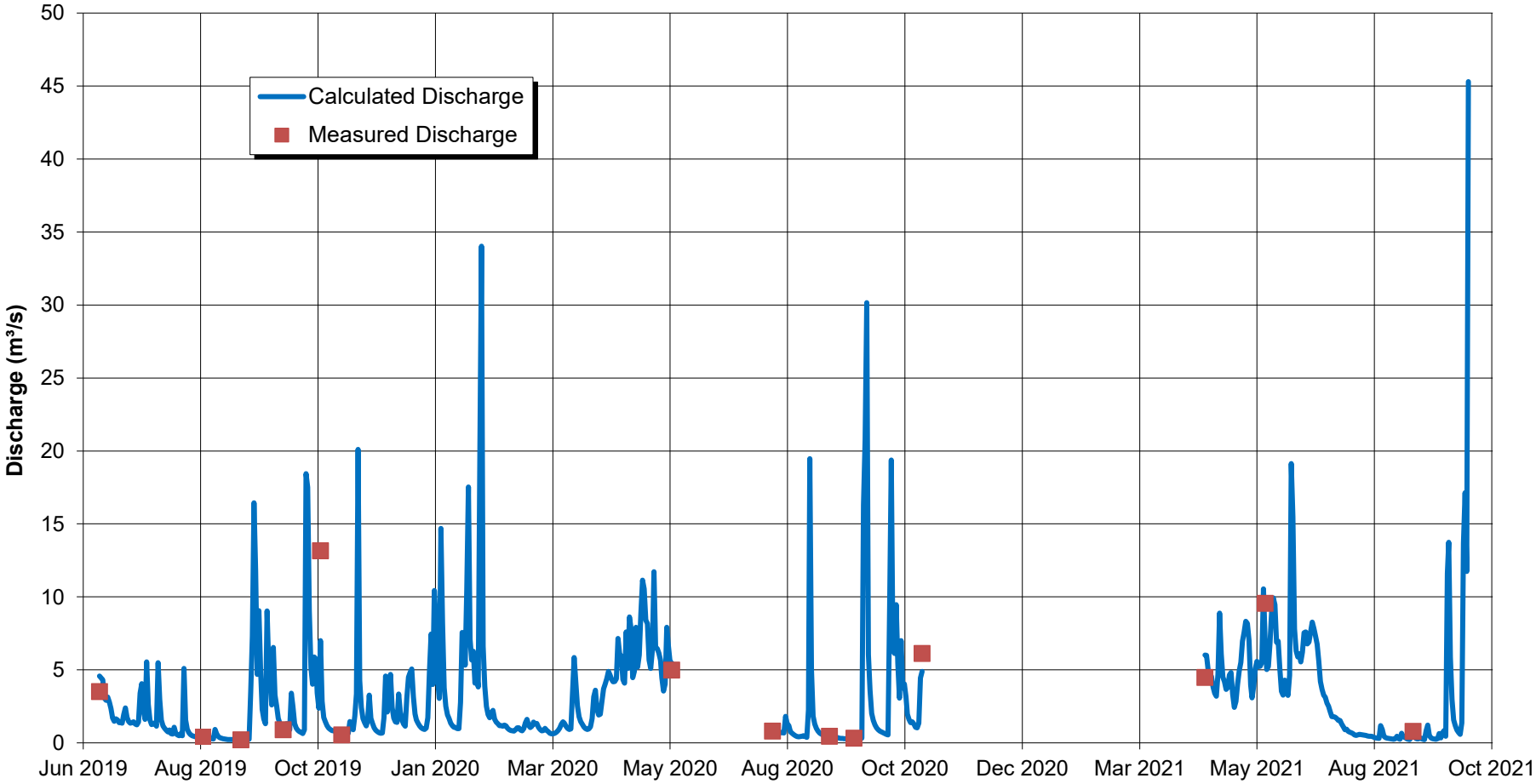
Knight Piésold CONSULTING

P/A NO. VA103-494/18

REF. NO. VA21-02130

FIGURE 5

REV 0



NOTE:
1. MANUAL MEASUREMENTS OF INSTANTANEOUS DISCHARGE DO NOT NECESSARILY MATCH DAILY AVERAGE DISCHARGE ON THE SAME DATE DUE TO DAILY FLUCTUATIONS IN DISCHARGE.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	22FEB'22	ISSUED WITH LETTER	KRH	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

MILL CREEK (MILL-R2)
DAILY AVERAGE DISCHARGE HYDROGRAPH

Knight Piésold CONSULTING

P/A NO. VA103-494/18

REF. NO. VA21-02130

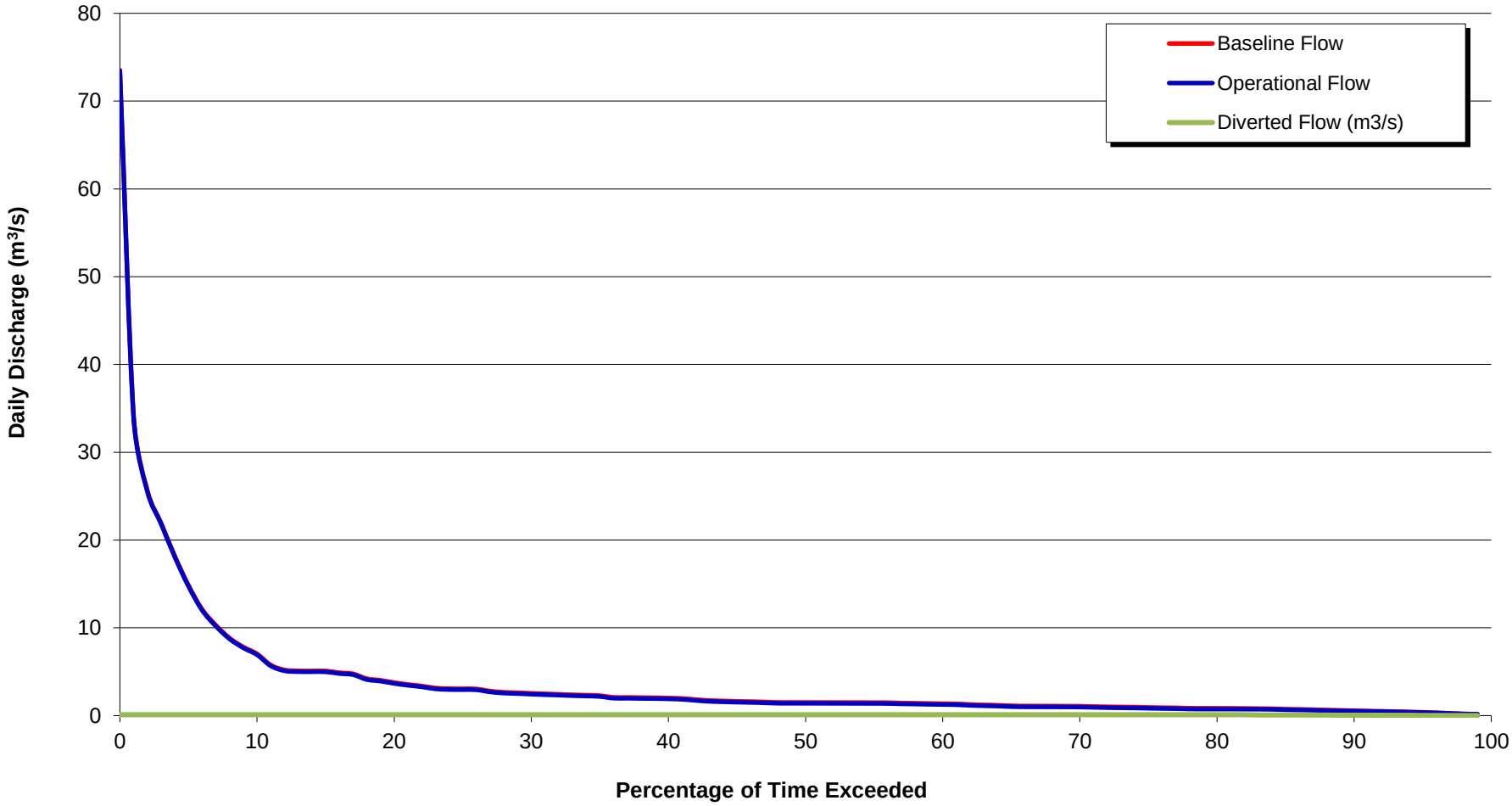
FIGURE 6

REV 0

APPENDIX B

Mill Creek Synthetic Flow Duration Curves

(Figures B-1 to B-12)



6	16AUG'22	ISSUED WITH REPORT VA103-494/24-2	SKC	TJP
REV	DATE	DESCRIPTION	PREP'D	RVW'D

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

JANUARY FLOW DURATION CURVE
MILL CREEK INTAKE

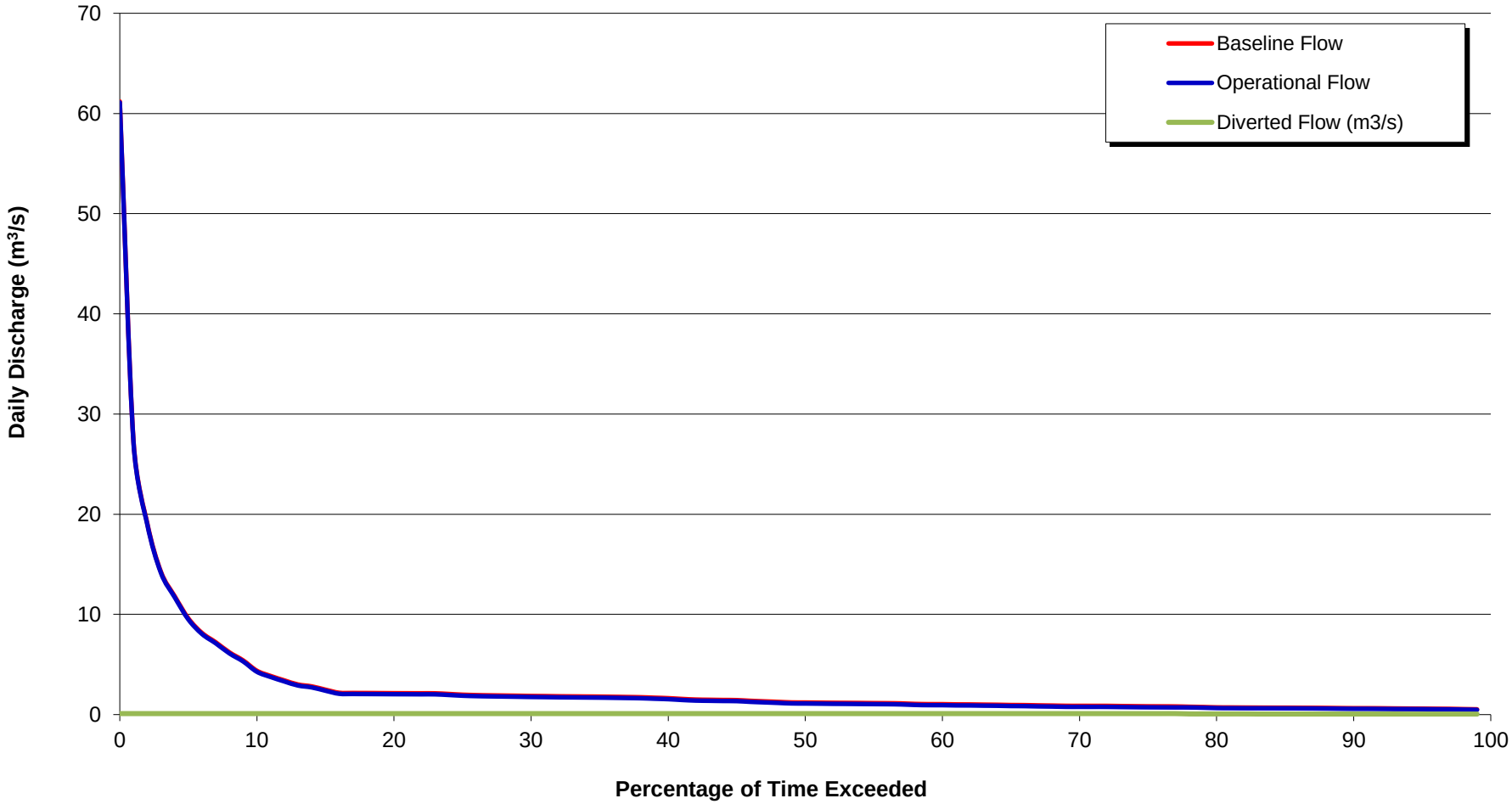
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-1

REV 6



REV	DATE	DESCRIPTION	PREP'D	RVW'D
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WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

FEBRUARY FLOW DURATION CURVE
MILL CREEK INTAKE

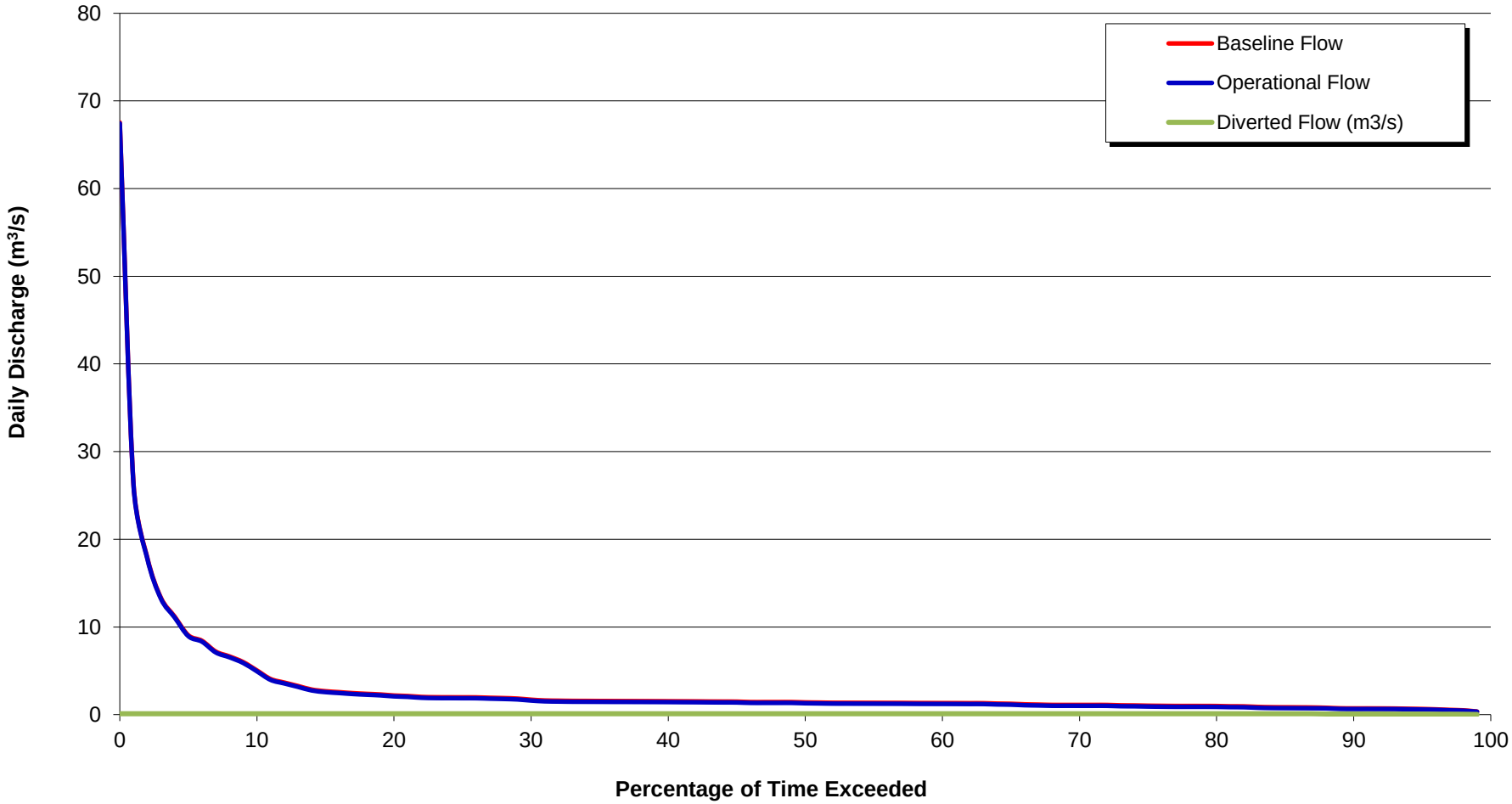
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-2

REV 6



REV	DATE	DESCRIPTION	PREP'D	RVW'D
6	16AUG'22	ISSUED WITH REPORT VA103-494/24-2	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

MARCH FLOW DURATION CURVE
MILL CREEK INTAKE

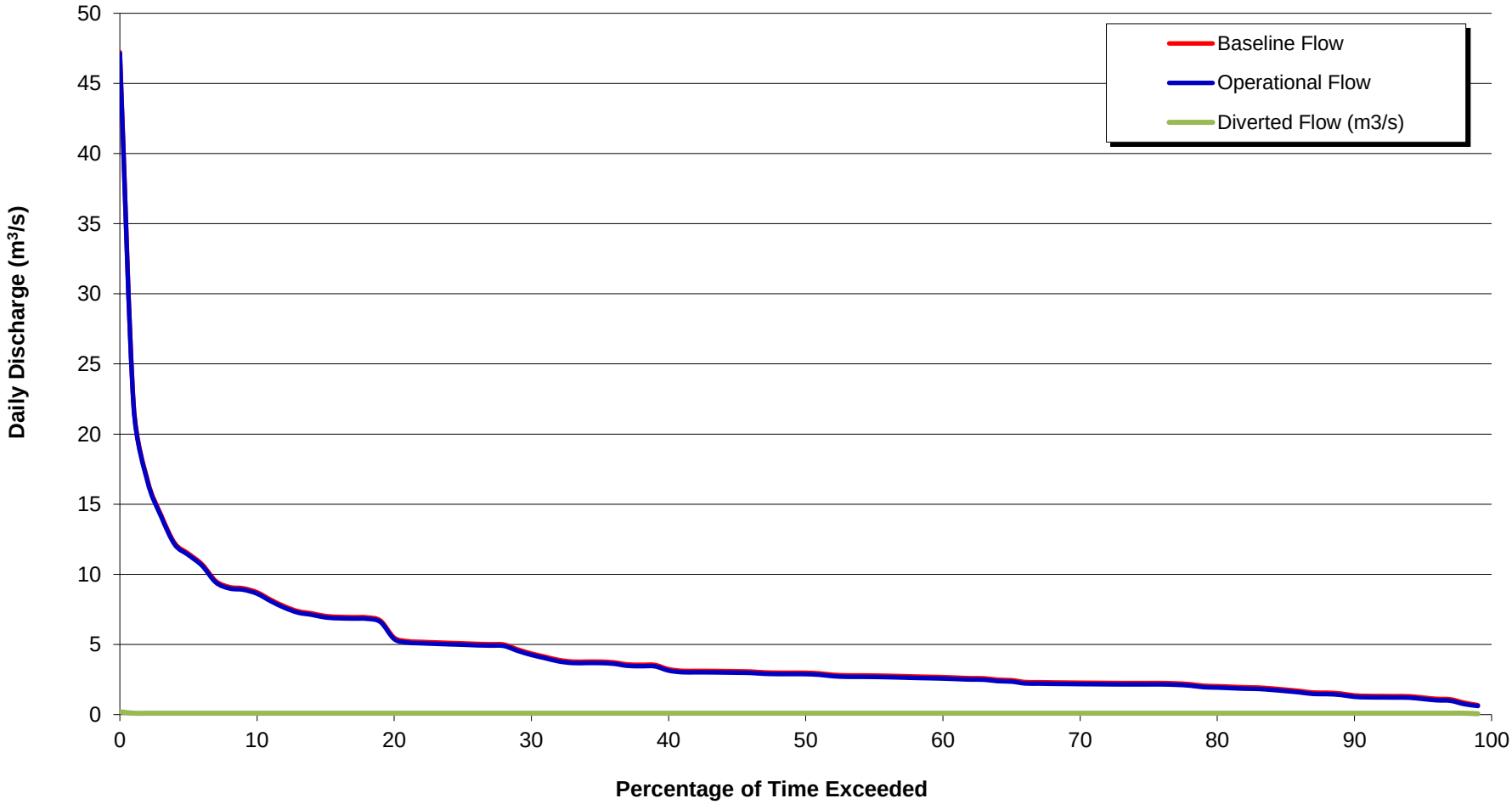
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-3

REV 6



REV	DATE	DESCRIPTION	PREP'D	RVW'D
6	16AUG'22	ISSUED WITH REPORT VA103-494/24-2	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

APRIL FLOW DURATION CURVE
MILL CREEK INTAKE

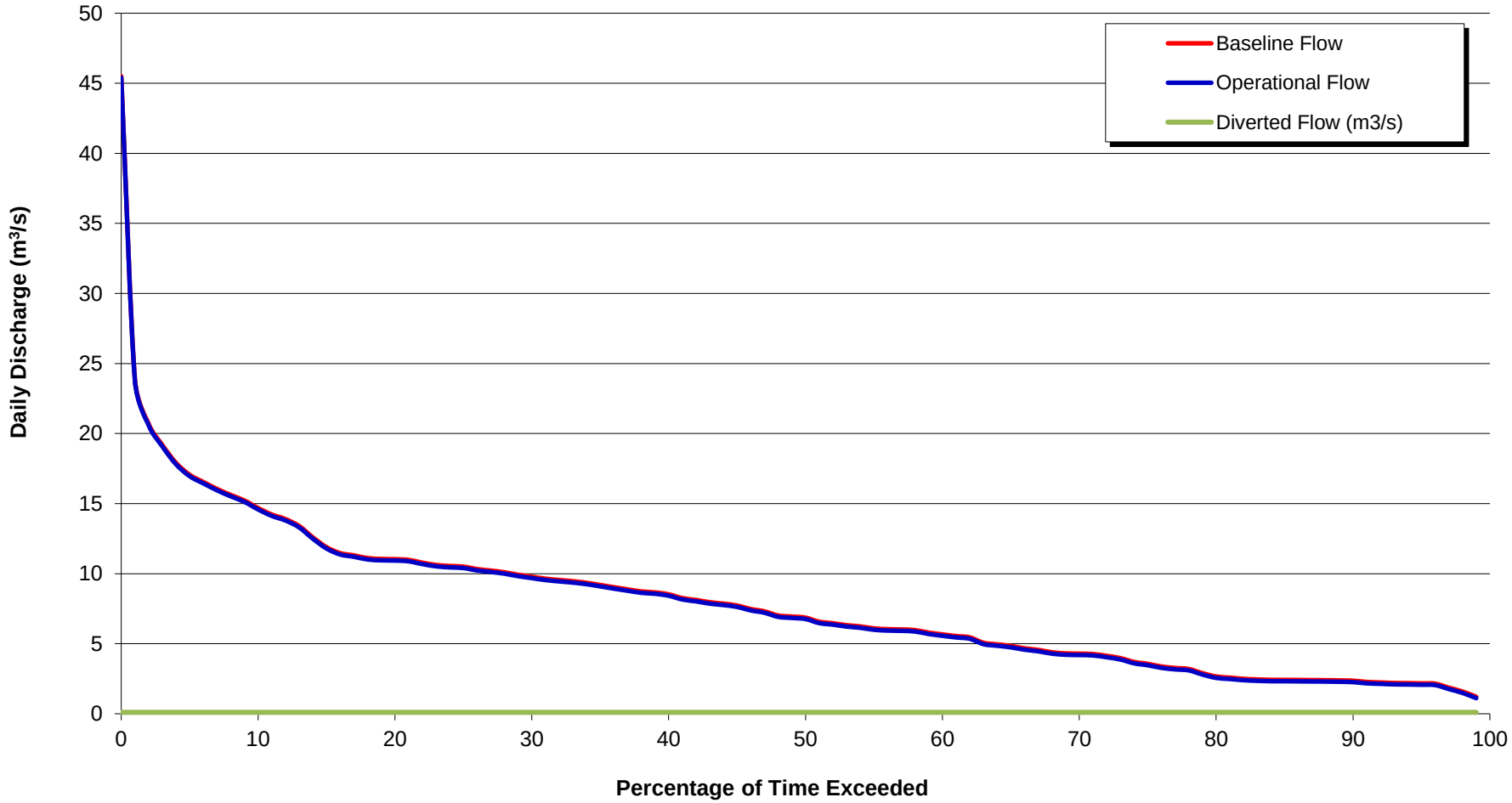
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-4

REV 6



REV	DATE	DESCRIPTION	PREP'D	RVW'D
6	16AUG'22	ISSUED WITH REPORT VA103-494/24-2	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

MAY FLOW DURATION CURVE
MILL CREEK INTAKE

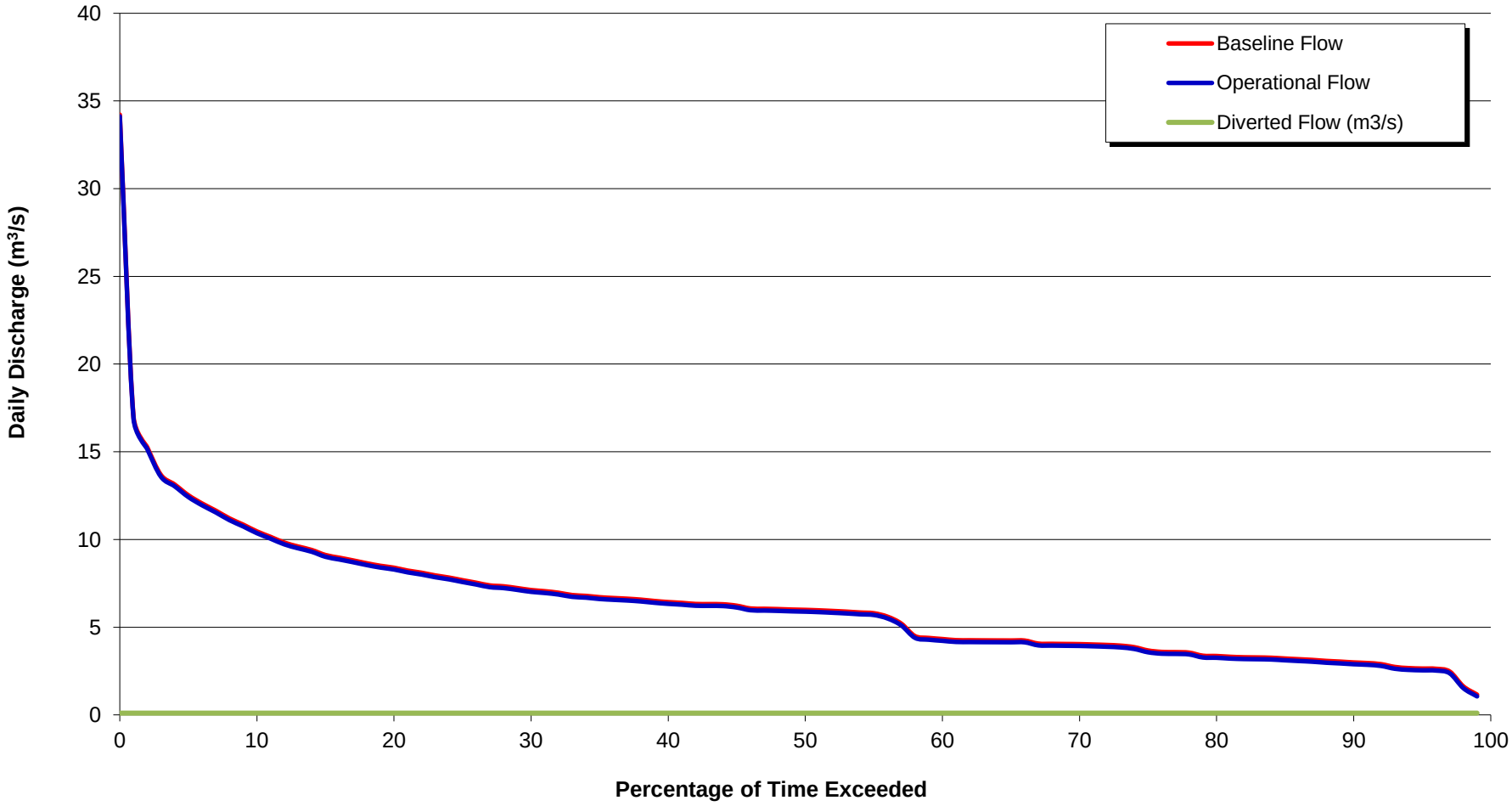
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-5

REV 6



REV	DATE	DESCRIPTION	PREP'D	RVW'D
6	16AUG'22	ISSUED WITH REPORT VA103-494/24-2	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

JUNE FLOW DURATION CURVE
MILL CREEK INTAKE

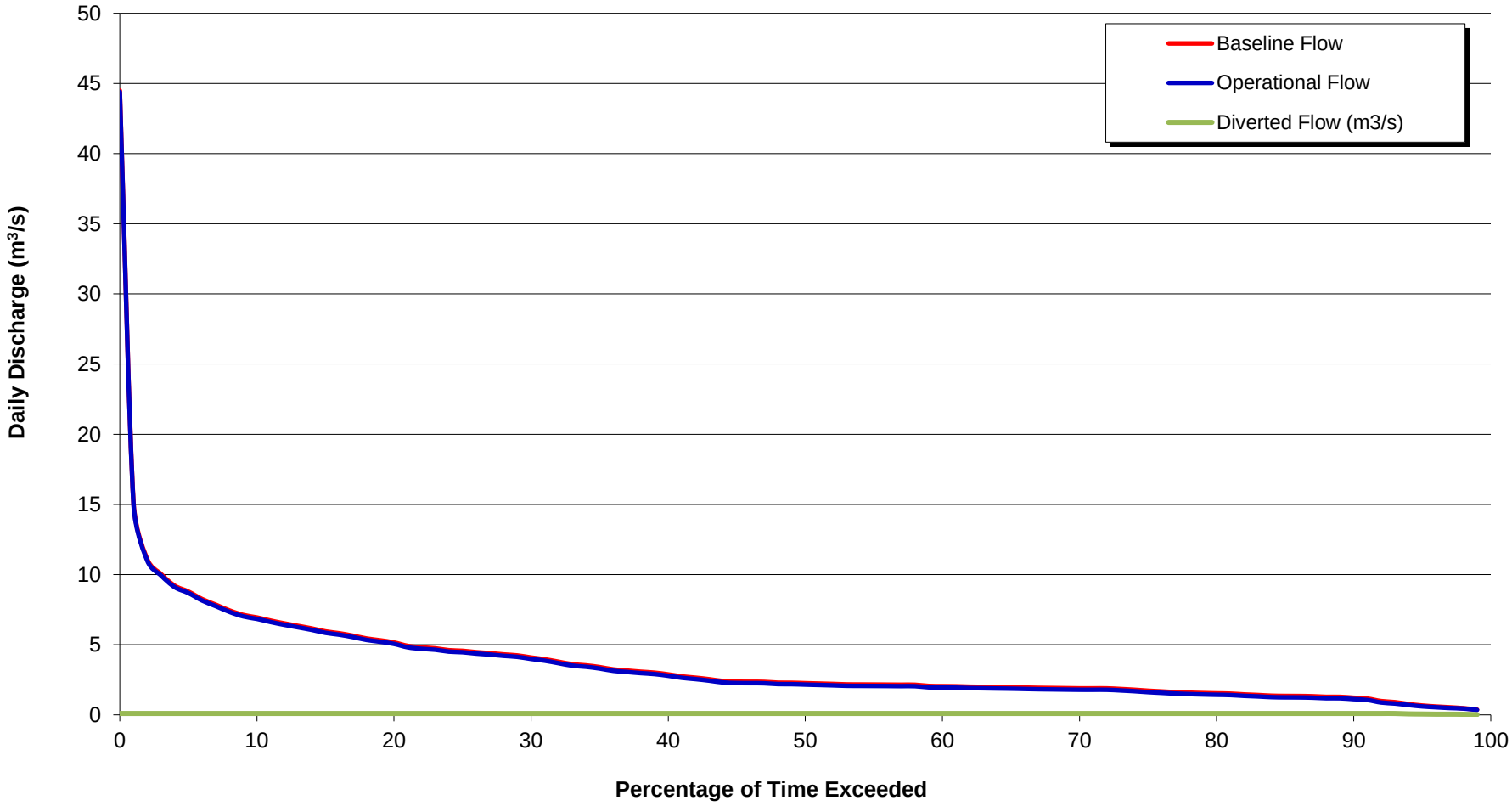
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-6

REV 6



REV	DATE	DESCRIPTION	PREP'D	RVW'D
6	16AUG'22	ISSUED WITH REPORT VA103-494/24-2	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

JULY FLOW DURATION CURVE
MILL CREEK INTAKE

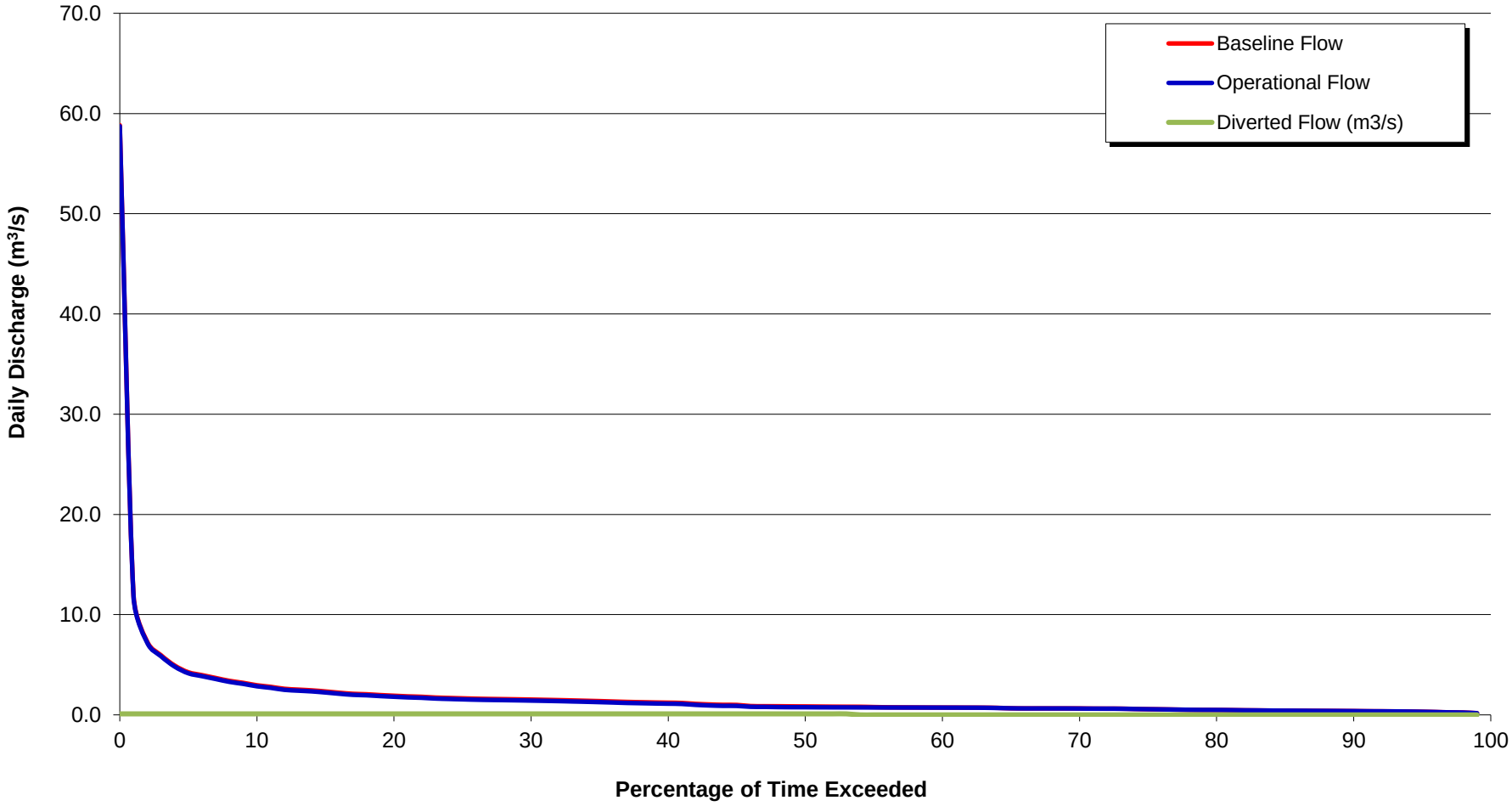
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-7

REV 6



REV	DATE	DESCRIPTION	PREP'D	RVW'D
6	16AUG'22	ISSUED WITH REPORT VA103-494/24-2	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

AUGUST FLOW DURATION CURVE
MILL CREEK INTAKE

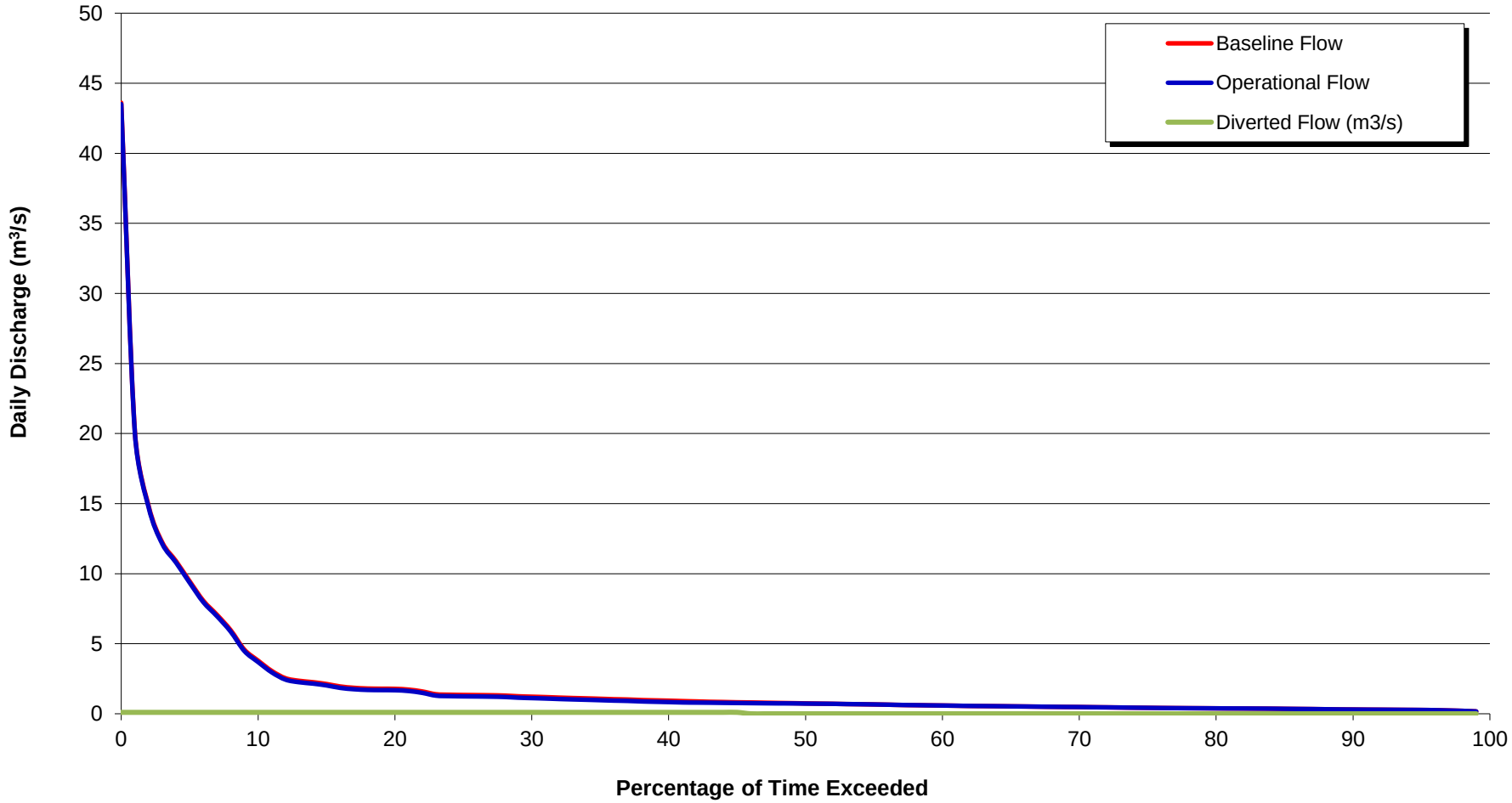
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-8

REV 6



REV	DATE	DESCRIPTION	PREP'D	RVW'D
6	16AUG'22	ISSUED WITH REPORT VA103-494/24-2	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

SEPTEMBER FLOW DURATION CURVE
MILL CREEK INTAKE

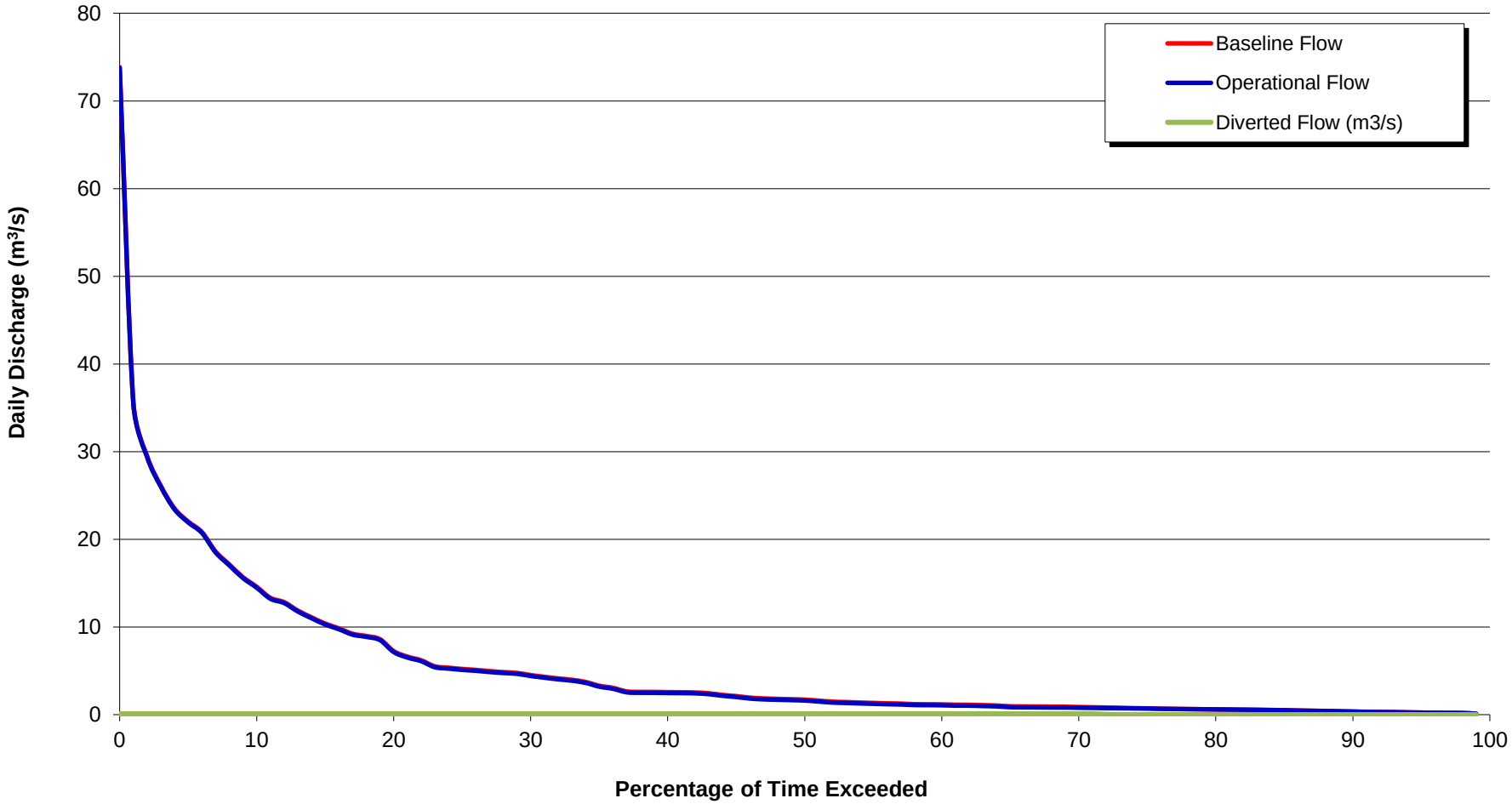
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-9

REV 6



REV	DATE	DESCRIPTION	PREP'D	RVW'D
6	16AUG'22	ISSUED WITH REPORT VA103-494/24-2	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

OCTOBER FLOW DURATION CURVE
MILL CREEK INTAKE

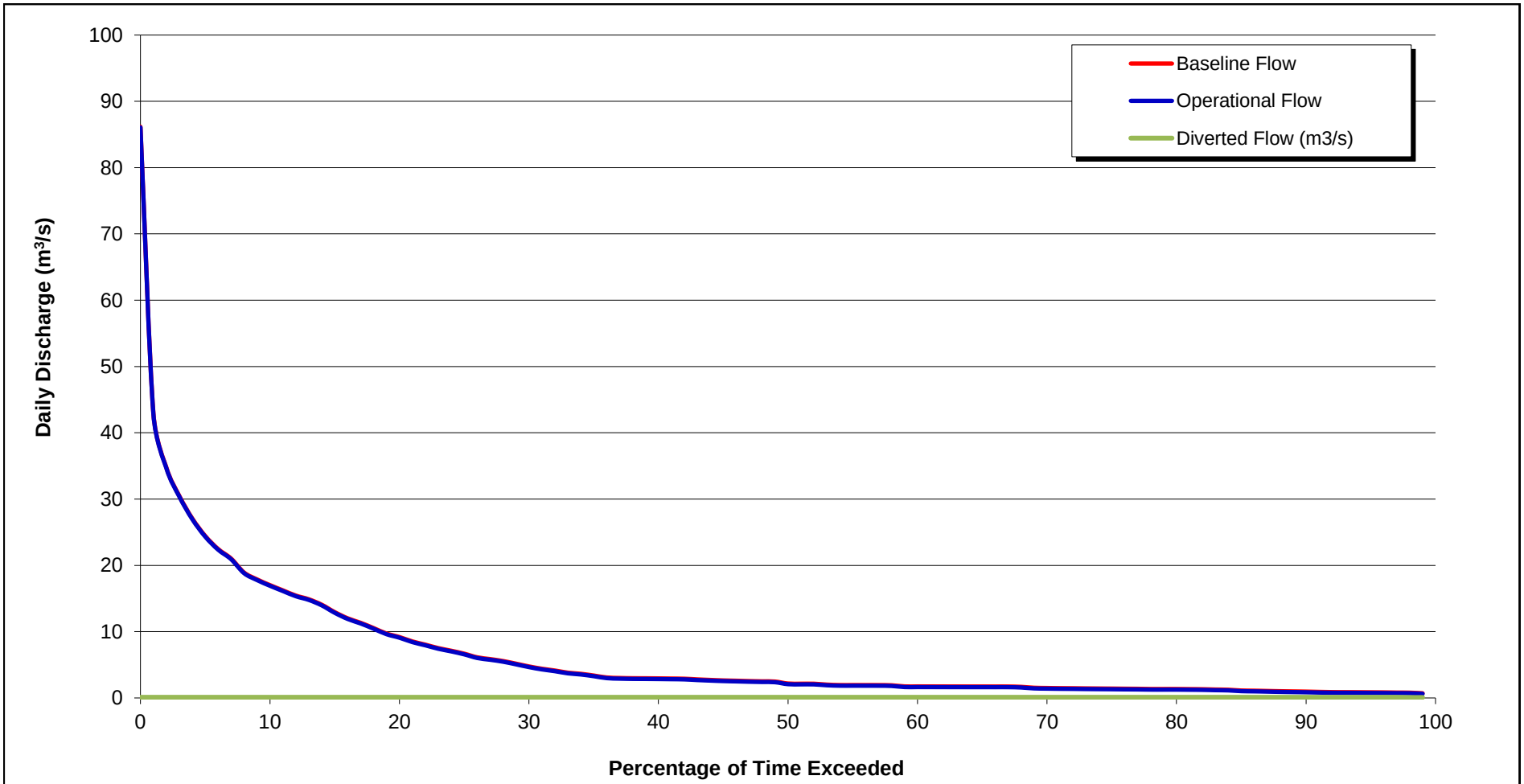
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-10

REV 6



WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

NOVEMBER FLOW DURATION CURVE
MILL CREEK INTAKE

Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-11

REV 6

REV	DATE	DESCRIPTION	PREP'D	RVW'D
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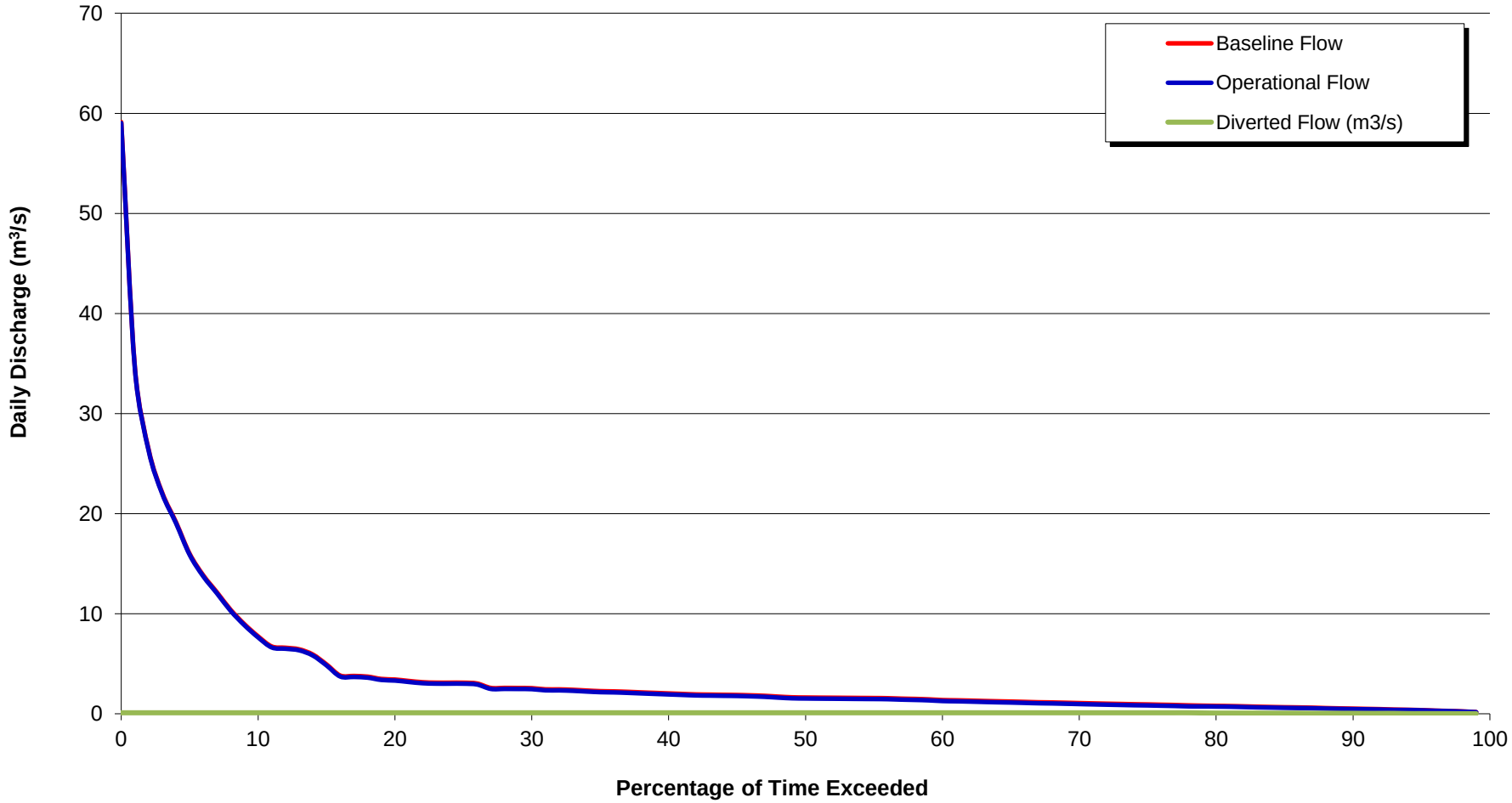

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WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

DECEMBER FLOW DURATION CURVE
MILL CREEK INTAKE

Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 2

FIGURE B-12

REV 6

APPENDIX B

Woodfibre Creek Instream Flow Requirement, Construction Water Study (Rev 4)

Prepared for
Woodfibre LNG Limited
1020-1075 West Georgia St
Vancouver, British Columbia
Canada, V6E 3C9

Prepared by
Knight Piésold Ltd.
Suite 1400 - 750 West Pender Street
Vancouver, British Columbia
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VA103-494/24-3

WOODFIBRE CREEK INSTREAM FLOW REQUIREMENT
CONSTRUCTION WATER STUDY

Rev	Description	Date
0	Issued in Final	May 21, 2019
1	Updated to Address Agency Review Comments	August 30, 2019
2	Updated to Include Construction Camp Water Requirements.	December 11, 2020
3	Updated to Address Review Comments. Updated Hydrology. Updated Maximum Diversion Rate.	August 16, 2022
4	Updated to Address Client Review Comments	September 23, 2022

Knight Piésold CONSULTING

Management System Certified by: bsi ISO 9001 ISO 14001 ISO 45001 CERTIFIED

EXECUTIVE SUMMARY

Woodfibre LNG Ltd. (Woodfibre LNG) will construct and operate the Woodfibre Liquefied Natural Gas (LNG) Project (the Project), which is located on the former Woodfibre Pulp Mill site approximately seven kilometres (km) southwest of Skwxwú7mesh (Squamish), British Columbia. The Project will have capacity to liquefy up to 2.1 million tonnes per year of natural gas, have a storage capacity of 250,000 cubic metres (m^3), and export the LNG via tankers. The Project underwent a comprehensive environmental assessment process from 2013 to 2015 and Woodfibre LNG received:

- An environmental assessment certificate (EAC) for the Certified Project Area (CPA) under the British Columbia *Environmental Assessment Act* (BCEAA; EAC #E15-02) in 201
- An environmental assessment approval from Squamish Nation through the Squamish Nation Environmental Assessment Agreement (SNEAA) in 2015
- A positive federal Decision Statement under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) in 2016

Two EAC amendments were granted by the British Columbia Environmental Assessment Office (EAO) in 2017 and 2019, and the federal Decision Statement was reissued in 2018 in response to changes to the Designated Project. Woodfibre LNG also received an extension on EAC#15-02 from the BC EAO in October 2020. The provincial, Skwxwú7mesh Úxwumixw (Squamish Nation), and federal environmental assessment processes have each yielded conditions of approval that Woodfibre LNG must address, including that Woodfibre LNG undertake an instream flow requirements (IFR) study to assess the potential effects of diverting water for construction and operation from Mill Creek and Woodfibre Creek.

Water is required for construction of the facility and will be sourced from Mill Creek or Woodfibre Creek. The proposed Woodfibre Creek construction water source point of diversion (PoD) is located approximately 100 m upstream from the mouth of the Creek at Howe Sound. This IFR report is intended to support assessment of construction water diversion from Woodfibre Creek and presents:

- A description of watershed, hydrological and fisheries baseline studies
- A summary of proposed Project water use and current water infrastructure
- A risk assessment of the proposed withdrawals following the BC Environmental Flow Needs Policy
- Supplementary measures to mitigate any residual risk

This report is intended to meet Condition 5 of the Project's provincial Environmental Assessment Certificate for instream flow requirements. Specifically, this report supports the construction water requirements for the Project, and for use in the Project's Water Management Plan. This report only addresses Woodfibre Creek.

Physical Setting, Hydrology and Fisheries Studies

Woodfibre Creek is a tributary of Howe Sound, located in the southern Coast Mountains approximately 7 km southwest of Squamish and 45 km north of Vancouver in BC. The Woodfibre Creek watershed area is approximately 22 km^2 at the mouth, where the stream discharges into Howe Sound. Woodfibre LNG operates an active streamflow gauging station, located just upstream of the hydropower intake site, at an elevation of approximately 350 metres above sea level (masl) and 2 km from the mouth. The Creek has a

mainstem length of approximately 6.8 km from the source to the mouth, and a mean channel slope of approximately 15%.

Fish and aquatic habitat information for Woodfibre Creek are based on publicly available datasets, and sampling and interpretation completed previously as part of the Project environmental assessment. Anadromous fish are present in Woodfibre Creek from Howe Sound to approximately 150 m upstream, where a 10 m high falls prevents upstream access. Several species of salmon, trout, and sculpin were captured below the falls. Rainbow trout were captured above the falls; and it is assumed that fish densities are very low.

Hydrologic conditions in Woodfibre Creek were assessed based on approximately four years of measured streamflow records collected at the Woodfibre Creek gauging station. These data were correlated with streamflow data collected by Water Survey of Canada (WSC) on the Capilano River to produce a long-term synthetic daily flow series for the gauging station. This synthetic daily flow series was used as the basis of assessing baseline and Project affected flow conditions. The mean annual discharge (MAD) for Woodfibre Creek at the gauging was estimated to be 2.35 m^3/s (1960 to 2020 period), which equates to a mean annual unit runoff of 118 $L/s/km^2$ for the 20 km^2 watershed.

Proposed Short-Term Project Water Use and Water Infrastructure

Woodfibre LNG will require up to 0.10 m^3/s of fresh water year-round during the construction phase of the Project, which will be used for sanitary purposes, concrete mixing, dust suppression, vehicle washing, lubrication or other, as required. Woodfibre LNG currently holds five water licences for water use on Woodfibre Creek; however, these licences are for power generation and cannot be used prior to a change in use. The existing powerhouse will be demolished in preparation for construction. Woodfibre LNG is proposing to pump water from Woodfibre Creek via a fish-screened intake, located approximately 100 m from the mouth of the creek to a holding tank for subsequent use. A flow meter will be installed on the pipeline to measure the diverted water quantity.

Woodfibre LNG will request approval for construction water use pursuant to the *Water Sustainability Act* (WSA). Any amendments to Woodfibre LNG's existing Woodfibre Creek water licences would occur at a later date when the permanent water requirements are known.

Construction Water Withdrawal Risk Assessment

The Environmental Flow Needs (*EFN) Implementation Guidance for British Columbia* and BC EFN Policy were used to assess the proposed construction water need of 0.10 m^3/s (maximum withdrawal rate). No other water is currently permitted for withdrawal. Based on the BC EFN Policy criteria, the Woodfibre Creek construction withdrawal is considered low risk.

Supplementary Measures

The risk to fish from the proposed construction water withdrawal is considered low, overall. However, during late summer, there are periods when baseline streamflow can be low and water withdrawal could represent a large portion of the available water. Supplementary measures to avoid impacting the lowest flows is proposed, which would limit construction water withdrawal and reduce the allowable diversion rate if streamflow goes below 0.67 m^3/s at the PoD, such that the proportion of flow withdrawn remains low (<15% of streamflow). As streamflow reduces further, the allowable diversion rate as a proportion of real-time flow reduces to 10% then 5% to reduce risk to fish. Between August 1 and October 31, a minimum instream

flow requirement of 0.47 m^3/s (20% MAD) has been set to maintain resident rainbow trout rearing and pink salmon spawning habitat. If flows fall below 0.47 m^3/s, a maximum flow of 0.005 m^3/s (5 L/s) will be diverted for the residential construction camp.

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APPENDICES

Appendix A Woodfibre Creek Hydrologic Analysis (VA22-01360)
Appendix B Woodfibre Creek Synthetic Flow Duration Curves

ABBREVIATIONS

BC ..... British Columbia
CPUE ..... Catch Per Unit Effort
EAC ..... Environmental Assessment Certificate
EAO ..... Environmental Assessment Office
EFN ..... Environmental Flow Needs
ENV ..... British Columbia Ministry of Environment and Climate Change Strategy
FLNRORD ..... Ministry of Forests, Lands, Natural Resource Operations and Rural Development
IFR ..... Instream Flow Requirements
JTH ..... J.Termuende Hydrological
km ..... kilometers
KP ..... Knight Piésold Ltd.
LNG ..... liquefied natural gas
m ..... meters
MAD ..... Mean Annual Discharge
masl ..... meters above sea level
OGC ..... BC Oil and Gas Commission
Project ..... the Woodfibre LNG Project
PoD ..... Point of Diversion
SN ..... Squamish Nation
Woodfibre LNG ..... Woodfibre LNG Limited
WSA ..... Water Sustainability Act
WSC ..... Water Survey of Canada

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

Woodfibre LNG Ltd. (Woodfibre LNG) will construct and operate the Woodfibre Liquefied Natural Gas (LNG) Project (the Project), which is located on the former Woodfibre Pulp Mill site approximately seven kilometres (km) southwest of Skwxwú7mesh (Squamish), British Columbia. The Project will have capacity to liquefy up to 2.1 million tonnes per year of natural gas, have a storage capacity of 250,000 cubic metres (m^3), and export the LNG via tankers. The Project underwent a comprehensive environmental assessment process from 2013 to 2015 and Woodfibre LNG received:

- An environmental assessment certificate (EAC) for the Certified Project Area (CPA) under the British Columbia *Environmental Assessment Act* (BCEAA; EAC #E15-02) in 2015
- An environmental assessment approval from Squamish Nation through the Squamish Nation Environmental Assessment Agreement (SNEAA) in 2015
- A positive federal Decision Statement under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) in 2016

Two EAC amendments were granted by the British Columbia Environmental Assessment Office (EAO) in 2017 and 2019, and the federal Decision Statement was reissued in 2018 in response to changes to the Designated Project. Woodfibre LNG also received an extension on EAC#15-02 from the BC EAO in October 2020. The provincial, Skwxwú7mesh Úxwumixw (Squamish Nation), and federal environmental assessment processes have each yielded conditions of approval that Woodfibre LNG must address, including that Woodfibre LNG undertake an instream flow requirements (IFR) study to assess the potential effects of diverting water for construction and operation from Mill Creek and Woodfibre Creek.

1.2 SCOPE OF REPORT

Knight Piésold Ltd (KP) has been retained by Woodfibre LNG to conduct an instream flow requirement (IFR) study for Woodfibre Creek to assess the effects of the proposed water withdrawals of construction and operations water. This report has been prepared to support Woodfibre LNG's application for approval for construction water use pursuant to the *Water Sustainability Act* (WSA) and Condition 5 of the Project's provincial Environmental Assessment Certificate for instream flow requirements. Some of the conditions placed on Woodfibre LNG by Squamish Nation (SN), federal Minister of Environment and Climate Change (ENV) and the BC EAO are addressed in this report. However, a subsequent detailed IFR study that assesses the proposed water withdrawals for operation of the Woodfibre LNG facilities will be presented in an Operational Water Requirements report to address any outstanding water related conditions.

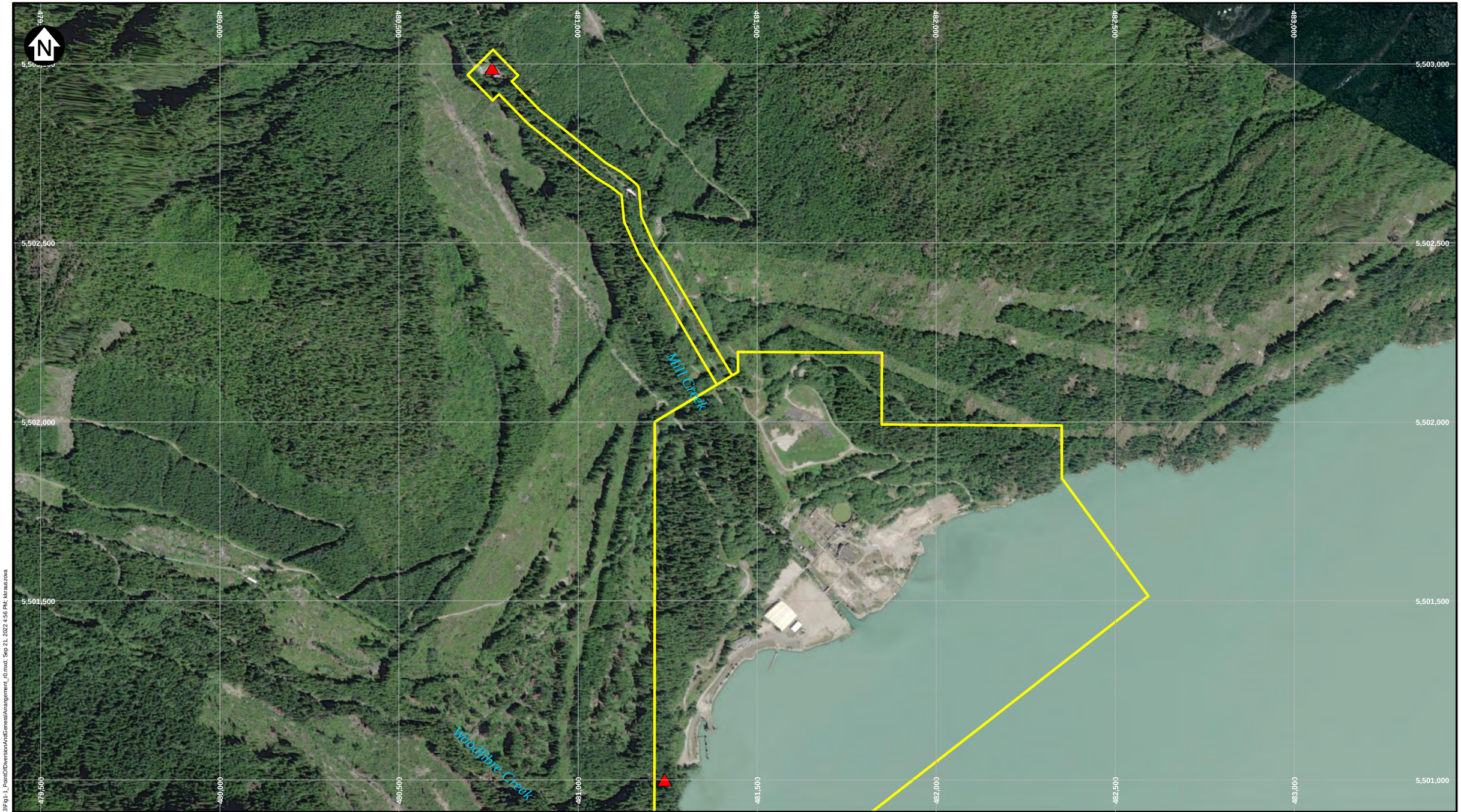
This IFR report presents:

1. A description of the physical characteristics of Woodfibre Creek including watershed, channel morphology and hydrological conditions.
2. A fisheries baseline description, providing a summary of fish presence/absence, distribution, periodicity, and habitat requirements.
3. A summary of proposed Project water use and water infrastructure.
4. Proposed allowable diversion rates and supplementary measured to mitigate any residual risk.

1.3 CONSTRUCTION WATER REQUIREMENTS

The Project requires up to 0.10 m^3/s of water year-round to provide water for construction of the LNG facility and ancillary works, to be sourced from Mill Creek or Woodfibre Creek. Water will be diverted from either stream, depending on construction requirements, but the maximum diversion rate from Woodfibre Creek shall not exceed 0.10 m^3/s. Water use for the construction for the project includes sanitary purposes, concrete mixing, dust suppression, vehicle washing, lubrication or other as required. The duration and quantity of the water withdrawals (up to the permitted limit) will be dependent upon the construction schedule and Project logistics. For the purpose of this assessment, it is assumed that the maximum water requirement is diverted continuously, to provide a conservative assessment of potential effects.

Water will be diverted from Woodfibre Creek via a pump intake to be located approximately 100 m upstream from the mouth of the creek. The intake will be fitted with a fish screen to meet DFO (2020) guidelines. Water is anticipated to be pumped to a holding tank, for subsequent use at the Project. The Woodfibre Creek proposed point of diversion are shown on Figure 1.1.



LEGEND:

- CPA
- PROPOSED WATER DIVERSION

100 50 0 100 200 Meters

NOTES:

1. BASE MAP: ESRI ONLINE WORLD IMAGERY.
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:10,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
1	21SEP'22	ISSUED WITH REPORT	TJP	KK	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

POINT OF DIVERSION

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-494/24	3

FIGURE 1.1 REV 0

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2.0 PHYSICAL SETTING

2.1.1 WOODFIBRE CREEK WATERSHED

Woodfibre Creek is a tributary of Howe Sound, as shown on Figure 2.1, located in the southern Coast Mountains approximately 7 km southwest of Squamish and 45 km north of Vancouver, BC. The Woodfibre Creek watershed and Howe Sound have physiographic characteristics that are typical of the Coast Mountains, a mountain range created by tectonic uplift and intense glacial erosion. These characteristics include high mountain peaks composed of plutonic bedrock, active glaciers in high-elevation headwater areas, U-shaped valleys that were intensely scoured by much larger glaciers during the Ice Age, and discordant valley bottom elevations between tributary and main valleys due to variable degrees of glacial scour. Howe Sound is one of many fjords along the British Columbia coast, where a glacially scoured valley was flooded by the sea following deglaciation at the end of the Pleistocene Epoch around 10,000 years ago. Woodfibre Creek flows into Howe Sound near the head of the fjord. Howe Sound is essentially the flooded lower section of the Squamish River valley.

The Canadian Hydrographic Service publishes tidal information for a station located near Squamish. The typical diurnal tidal range is 3 m to 4 m, and the extreme range is over 5 m.

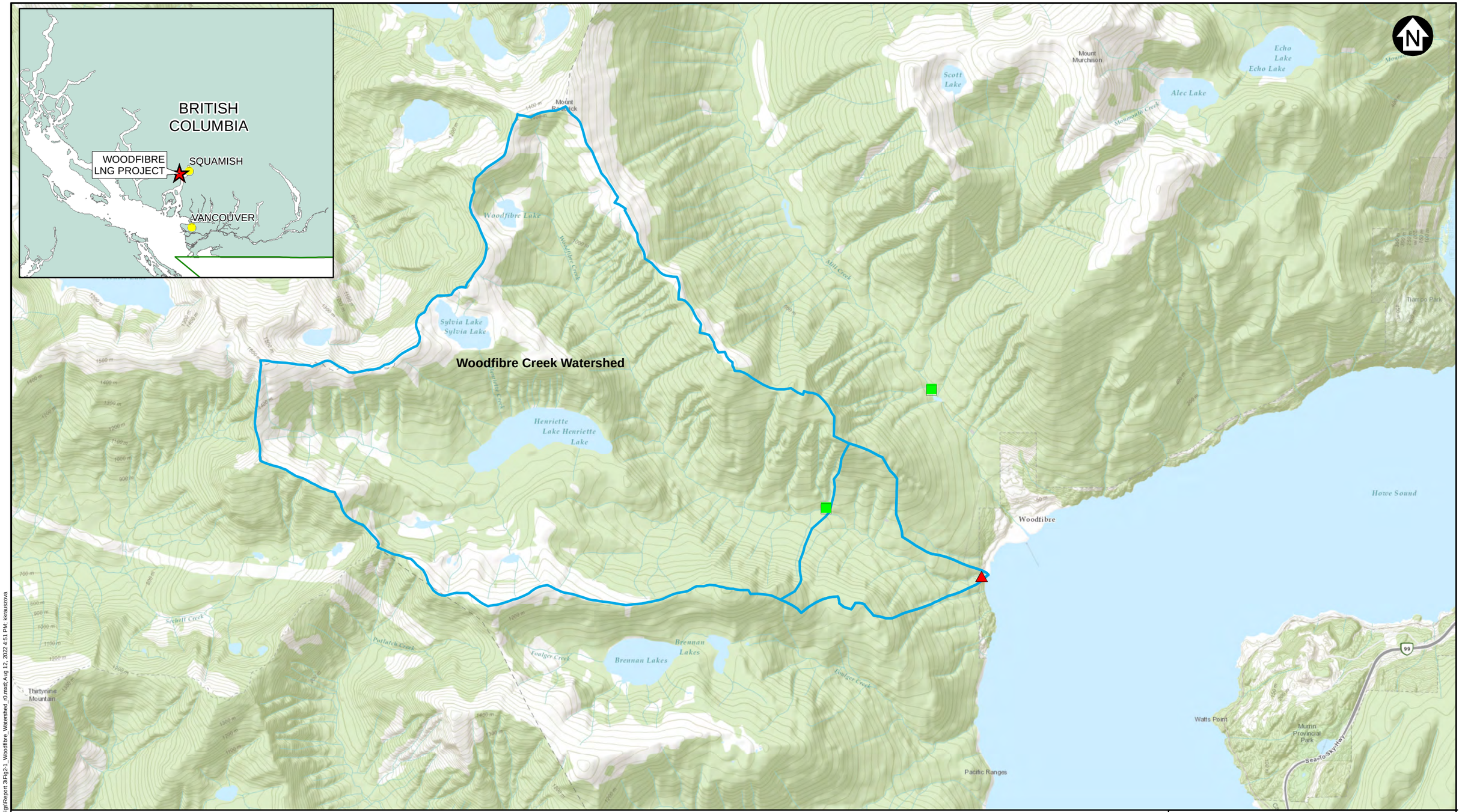
The Woodfibre Creek watershed is approximately 22 km^2 at the mouth and ranges in elevation from 1,600 metres above sea level (masl) to sea level at the mouth, where the stream discharges into Howe Sound.

Woodfibre Creek flows in a southeast direction, and crosses the southeast corner of the Woodfibre property, before discharging into Howe Sound. Woodfibre Creek has a densely vegetated but previously logged watershed with a mean basin elevation of 928 m. Glaciers cover a negligible area of the watershed. The Woodfibre Creek watershed contains five lakes: Henriette Lake, Sylvia Lake, Woodfibre Lake, and two smaller unnamed lakes. Henriette Lake has a control structure at the outlet, which was used historically to regulate streamflow for power and mill operations. The control structure is not currently operated by Woodfibre LNG; it is left in a set position. Although not currently operated, this structure is evident in streamflow conditions in Woodfibre Creek, resulting in relatively high flows during summer and reduced freshet flows.

2.1.2 WOODFIBRE CREEK CHANNEL MORPHOLOGY

Woodfibre Creek has a mainstem length of approximately 6.8 km from its source near Woodfibre Lake to its mouth at sea level and a mean channel slope of approximately 15%. Channel gradient remains quite high to the confluence with Howe Sound and there is a negligible fan, creating a relatively short tidally influenced zone.

A brief overview of the creek is provided in the following sections, based on review of data collected from Golder (2014), Google Earth imagery and from KP visits to site in 2017 and 2018.



LEGEND:

- PROPOSED WATER DIVERSION
- ACTIVE WOODFIBRE LNG HYDROLOGY GAUGE
- WATERSHED BOUNDARY

LOCATION TO:	DRAINAGE AREA:
POINT OF DIVERSION	22 KM2
WOODFIBRE CREEK GAUGE	20 KM2

0 0.5 1 2 3 4 Km

NOTES:

1. BASE MAP: ESRI WORLD TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:40,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	05AUG'22	ISSUED WITH REPORT	TJP	KK	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

WOODFIBRE CREEK WATERSHED

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-00494/24	3

FIGURE 2.1 REV 0

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2.1.2.1 REACH 1

Between the mouth and the 10 m high falls at approximately 0+150 m chainage, the creek has a prevailing canyonized cascade-pool morphology, with no gravel bars or islands. Additional smaller falls or cascades were noted between the mouth and 0+150 m chainage; however, the anadromous boundary was noted to be the 10 m high falls (Golder, 2014). The stream gradient between the mouth and the 10 m high falls is 19%. The tidally influenced area is relatively short, as the gradient steepens with a first set of small falls at approximately 50 m upstream of the mouth. The surrounding forest varies in successional stage along the distance of the creek, dominated by western hemlock, western red cedar and amabilis fir. Riparian conditions near the mouth include a deciduous understory of red alder and big leaf maple (Golder, 2014).

Photo 2.1 Reach 1 looking upstream to the end of the tidally influenced zone

Photo 2.2 Reach 1 looking downstream to the mouth

Photo 2.3 First small falls within Reach 1 that presents an upstream barrier to fish at low flows

Photo 2.4 10 m high falls at approximately 0+150 m chainage that presents an upstream barrier to fish

2.1.2.2 REACH 2

The creek upstream of the 10 m high falls continues to have a pool-cascade morphology with scattered falls, largely confined within rock canyon walls. A hydropower water intake exists at approximately 2 km upstream from the mouth, at an elevation of approximately 350 m, at the top of a large falls.

Photo 2.5 **Looking downstream of the hydropower intake showing the steep cascade-pool morphology at approximately 2 km upstream of the mouth**

Photo 2.6 **Upstream of the hydropower intake, looking downstream at the channel confined by bedrock and large boulders**

3.0 FISHERIES AND AQUATIC HABITAT BASELINE

3.1 HISTORICAL INFORMATION

Fish and aquatic habitat information for Woodfibre Creek presented in this section are based on publicly available data, and a review of sampling and interpretation completed previously as part of the Project environmental assessment. KP has not conducted any additional fish or fish habitat data sampling in Woodfibre Creek.

Limited publicly available historical fish and aquatic information exists for Woodfibre Creek, and fisheries information in the provincial database, Fish Inventories Data Queries (FIDQ), is sparse and outdated (Ministry of Environment and Climate Change Strategy, 2022). Fish observations recorded in the provincial database are from 1979, 1980, and 2010, and identification was restricted to rainbow trout and coastal cutthroat trout. The watershed is identified as anadromous, however there are no escapement data provided on the FIDQ.

Golder Associates prepared a Freshwater Fish Baseline Study for Woodfibre LNG for the Project environmental assessment (Golder, 2014). Golder described the Woodfibre Creek aquatic habitat as cascade-pool morphology within steep rock canyon walls, and no presence of gravel bars or islands. The predominant bed substrate was identified as boulders, with the secondary substrate comprised of fines, cobbles, and bedrock. Spawning substrates were noted to be limited and patchy in the lower section of Woodfibre Creek (Reach 1), located in pool tailouts and glide habitats where water velocity is lower. Spawning rainbow trout utilize the pool tailouts and returning salmon utilize the glides for spawning; however overall spawning substrates were limited. Golder noted the upstream barrier to anadromous fish to be at the 10 m high falls approximately 150 m upstream of the confluence with Howe Sound. While the average gradient in Reach 1 is 19.1%, it was noted to vary locally at the meso-habitat scale. Channel widths were noted to range from 4 m to 19 m (Golder, 2014).

Instream cover for fish was noted to be abundant, estimated at 30% of the total creek in the lower section comprised primarily of boulders and deep pools. Riparian vegetation is predominantly early successional forest with deciduous riparian shrubs in the lower reach, blending into a more mature riparian forest upstream.

Golder conducted fish sampling at two sites within the lower section in Woodfibre Creek in the Project area in 2013 and 2014 and conducted an adult salmon count on September 10, 2013. Golder recorded 1 live pink salmon and 2 dead pink salmon on the one-day survey in September 2013, all within the lower 25 m of the creek. Golder noted that the pinks were all located in a pool with low water velocity and boulder cover. This pool was identified as one of three potential spawning locations in lower Woodfibre Creek.

Minnow trapping at two sites in lower Woodfibre Creek over three sampling events yielded rainbow trout, sculpins, and chinook salmon. Rainbow trout were the predominant species throughout each of the three minnow trapping events: only one chinook was captured in the July 2014 survey, and sculpin species had a lower Catch Per Unit Effort (CPUE) than rainbow trout on all sampling dates. The CPUE in the lower creek ranged from a high of 1.19 fish/24 hours in July 2014 at Site 2 (below the falls) to a low of 0.37 fish/24 hours in April 2014 at Site 2. Sampling at Site 1 only occurred on September 11, 2013 and did not occur on the April and July 2014 sampling days.

Rainbow trout and sculpins were also the only species captured by Golder while electrofishing in lower Woodfibre Creek, however, rainbow trout were also captured upstream of the 10 m falls, confirming that there are resident fish above the anadromous barrier. The CPUE downstream of the falls ranged from a low of 0 to a high of 1.86 fish/minute in July 2014, and sculpins comprised the majority of the electrofishing catch.

FSCI Biological Consultants conducted backpack electrofishing in August 2010 just downstream of the hydropower intake, approximately 2 km upstream of the mouth. Rainbow trout were the only fish species captured, and the average CPUE throughout sampling was 0.82 fish/minute (FSCI, 2010).

A summary of the fish capture data to date is provided in Table 3.1.

Table 3.1 Woodfibre Creek Fish Presence Summary

Reach	Fish Species Present	Life Stage	Reference
Downstream of 10 m High Barrier Falls	Rainbow trout, coastal cutthroat trout	n/a	Fish Inventories Data Queries
	Pink salmon	adult	Golder
	Coho salmon, chinook salmon, rainbow trout, sculpin	n/a	Golder
Upstream of the 10 m High Barrier Falls	Rainbow trout	n/a	Golder
	Rainbow trout	juvenile	FSCI Biological Consultants
	Rainbow trout	adult	FSCI Biological Consultants

Although a limited number of fish have been captured in Woodfibre Creek, it is likely that the resident rainbow trout and coastal cutthroat populations are small-bodied, similar to other high-gradient streams confluent with Howe Sound. Life stage was not assigned to the rainbow trout captured during Golder's sampling upstream of the anadromous barriers on Woodfibre Creek; however, fork length ranged from 44 mm to 126 mm (Golder, 2014). Both adult and juvenile rainbow trout were captured upstream of the anadromous barrier during FSCI Biological Consultants' sampling; however, not all fish were measured to fork length. Adult rainbow trout fork length ranged from 136 mm to 208 mm, and juvenile fork length ranged from 66 mm to 209 mm. In the McNab Creek watershed, cutthroat trout aged 2+ had fork lengths ranging from 151 mm to 179 mm (M.A. Whelen and Associates Ltd., 1999), and the largest rainbow trout captured in Rainy River by Hatfield Consulting Ltd. (2013) had a fork length of 304 mm. Fish sampling by Hatfield Consultants Ltd. in 1998 in Rainy River found rainbow trout ranging in size from 102 mm to 195 mm, with fish aged as 2+ ranging in size from 126 mm to 132 mm. Rainbow trout ranged from 112 mm to 235 mm in McNair Creek and 112 mm to 197 mm in Dakota Creek (Hatfield Consultants Ltd., 1998). In contrast, rainbow trout from larger systems such as the Babine River can attain sizes of 308 mm by age three and 531 mm by age 5 (Narver, 1975), and 600 mm rainbow trout have been recorded in the Salmo River (Baxter Environmental, 2002).

3.2 POST EA-MONITORING

Keystone Environmental (2021) conducted fish sampling downstream of the barrier falls in Woodfibre Creek in 2020: five baited minnow traps were set for approximately 46 hours each on May 12, 2020 and seven baited minnow traps were set for approximately 22 hours each on September 30, 2020. One sculpin and one rainbow trout were the only fish captured in the minnow traps in May. Five rainbow, and four sculpin were captured in October.

The sculpin captured by Keystone Environmental (2021) was 71 mm in length in May 2020 and ranged in size from 80 mm to 102 mm in October. The rainbow trout had captured in May had a fork length of 115 mm and the rainbow trout captured in October ranged in size from 55 mm to 102 mm.

3.3 SUMMARY

Species habitat use for key life history timing events can be shown graphically on Species Periodicity Charts. These charts can be helpful for determining seasonal instream flow needs for fish species of concern throughout the year. The species periodicity charts for pink salmon and rainbow trout are shown in Tables 3.2 and 3.3, respectively, and are based on available species life history information for creeks in the Howe Sound region (Ministry of Environment and Climate Change Strategy, 2018).

Table 3.2 Pink Salmon Periodicity Chart

Species	Phase	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Pink salmon	migration																								
	spawning																								
	incubation/emergence																								
	rearing																								

Table 3.3 Rainbow Trout Periodicity Chart

Species	Phase	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Rainbow trout	migration																								
	spawning																								
	incubation/emergence																								
	rearing																								

4.0 HYDROLOGY

The Project area is located within Hydrologic Zone 27 (Western South Coast Mountains), on the boundary with Zone 26, as delineated by Obedkoff (2003). In this zone, Pacific frontal systems encounter the abruptly rising terrain of the Coast Mountains and produce large quantities of precipitation as they are forced upward. Spatial variability in annual precipitation is extensive due to orographic enhancement on windward slopes and rain shadow effects in leeward areas. The proportion of precipitation falling as snow varies with elevation, with little snow falling at sea level and large snowpacks accumulating on upper mountain slopes. Even at high elevations, however, winter rainfall and snowmelt are common, leading to a complex hydrologic regime.

4.1 WOODFIBRE CREEK BASELINE HYDROLOGY

4.1.1 MEASURED STREAMFLOW DATA

Woodfibre LNG operates an active hydrometric gauging station just upstream of the Woodfibre Creek hydropower intake location at an elevation of approximately 350 masl and 2 km from the mouth. The median watershed elevation above the gauge is 1,057 masl. The watershed area at the gauge is 20 km^2. The measured hydrologic record on Woodfibre Creek consists of measured data collected by KP since April 2017. The current rating curve for the active hydrometric gauging station on Woodfibre Creek is shown on Figure 4.1.

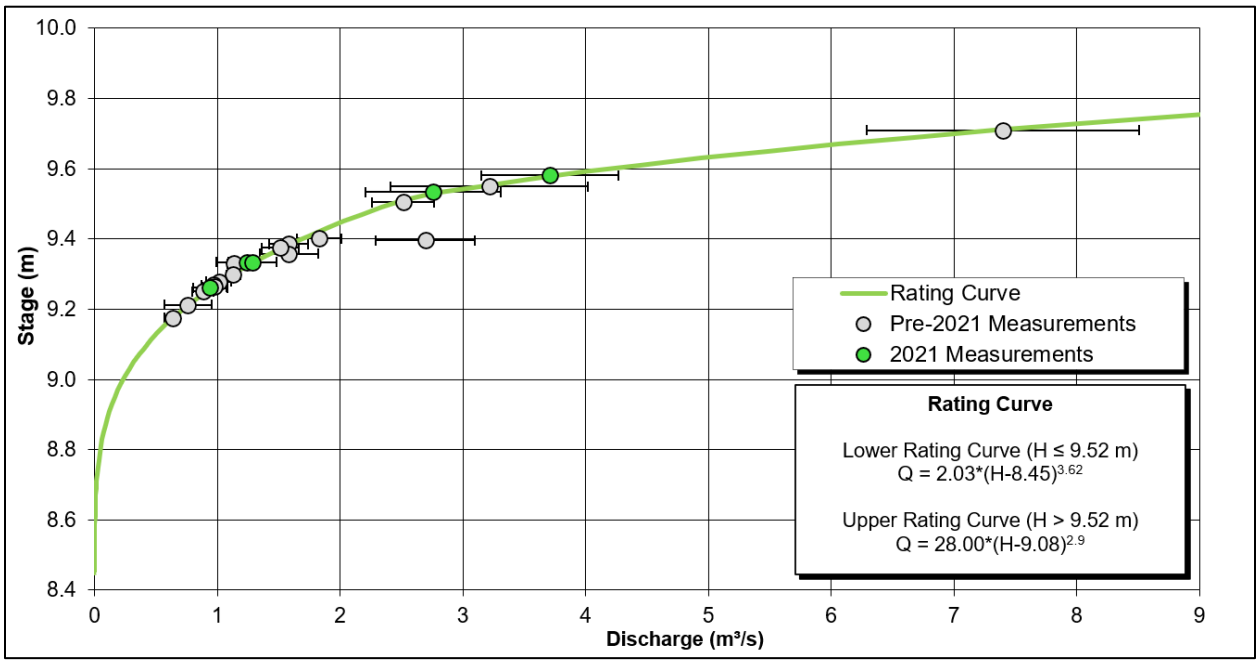


Figure 4.1 Woodfibre Creek (WOOD) Rating Curve

The daily average discharge hydrograph for the Woodfibre Creek hydrometric station is presented on Figure 4.2.

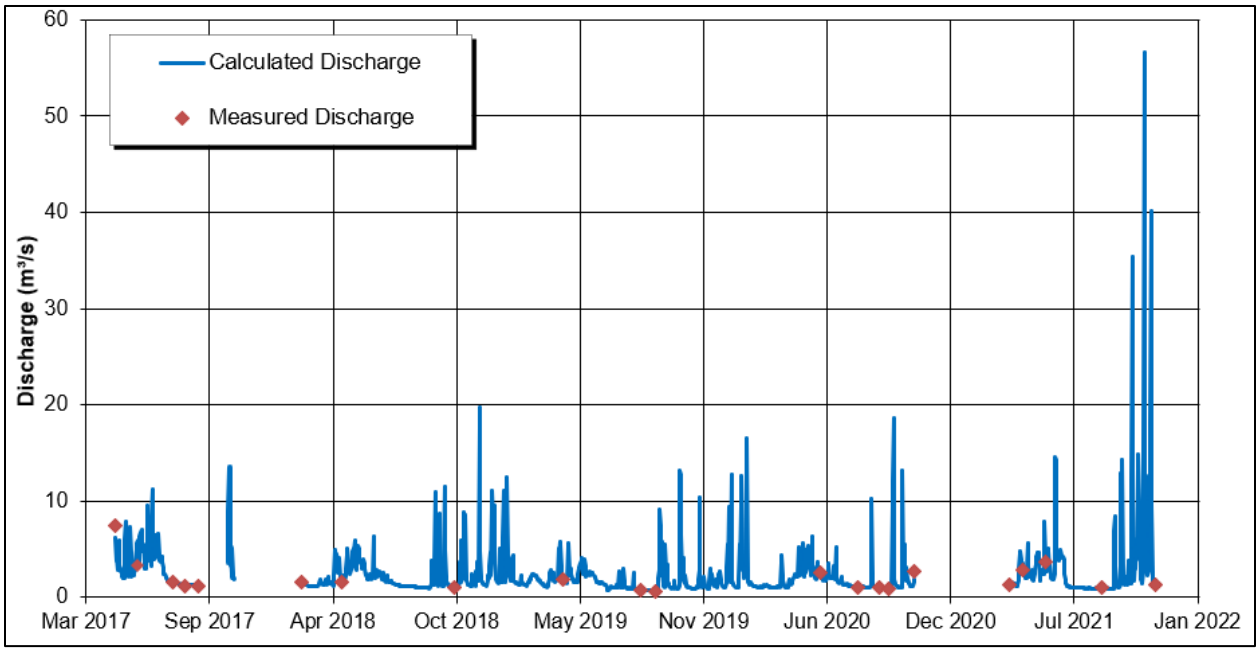


Figure 4.2 Woodfibre Creek (WOOD) Daily Average Discharge Hydrograph

Details of the hydrology data collection and processing are discussed in the *Woodfibre Creek Hydrologic Analysis* (KP, 2022), provided in Appendix A.

4.1.2 WOODFIBRE CREEK LONG TERM SYNTHETIC HYDROLOGY

As part of a baseline hydrology characterization of Woodfibre Creek, a synthetic long-term flow record using site-specific and regional measured streamflow records was developed. Fifty-five complete years of record are available from the WSC Station “Capilano River above Intake” (08GA010), which, in conjunction with discharge data from Palisade Lake provided by Metro Vancouver, were used in an empirical frequency pairing analysis. Capilano River is a regulated system due to summer releases from Palisades Lake reservoir, which are managed by Metro Vancouver. Details on regulated flows are not consistently available; however, a naturalized streamflow record for Capilano has previously been developed for the Project for the period of record between 1960 and early 2018 using records of release rates from Metro Vancouver or by comparison of unit runoff between regulated and unregulated rivers.

Periods with regulation were also removed from the Capilano River dataset for April 1, 2019 to May 28, 2021 by removal of periods with sudden, steady increases in Capilano River flow that are not reflected in the Mill Creek data, which is an unregulated system. This analysis cannot be done directly with the Woodfibre Creek data, as during the early 1900s, dams and a flow control structure was built on Henriette Lake to regulate releases. This flow control structure is not operated by Woodfibre LNG but remains in place. The naturalized flow record for Capilano River therefore includes 55 complete years of record and six years with incomplete records.

The mean annual discharge (MAD) for Woodfibre Creek at the KP hydrology gauge was estimated to be 2.35 m^3/s (1960 to 2020 period), which equates to a mean annual unit runoff of 118 $L/s/km^2$ for the 20 km^2 portion of the watershed. At the time of this analysis, more than 4 years of data are available at Woodfibre

Creek, and the synthetic flow record is considered to be good quality. Further details of the long-term synthetic recorded development are discussed in Appendix A.

Streamflow at the proposed PoD has been conservatively assumed to be equivalent to the hydrology gauge data, despite the 10% increase in drainage area (20 km^2 at the gauge and 22 km^2 at the PoD). The mean monthly hydrograph is relatively uniform with sustained flows though the fall and winter, and a modest nival freshet in spring, indicating that a substantial proportion of winter precipitation falls as rain (rather than snow). Flows decrease through June, July and August as snowmelt and precipitation decrease.

The mean monthly hydrograph is shown on Figure 4.3. Average, minimum and maximum monthly mean flow conditions for the synthetic dataset are presented in Table 4.1. Daily flow conditions tend to be more variable than monthly flow conditions, with the watershed responding rapidly to intense rainfall events, although the effect of regulation at Henriette Lake are evident and daily flows remain quite high in August and September compared to regional datasets. Synthetic daily flows during 2009, a year where the annual average discharge was equal to the long-term MAD, are shown on Figure 4.4.

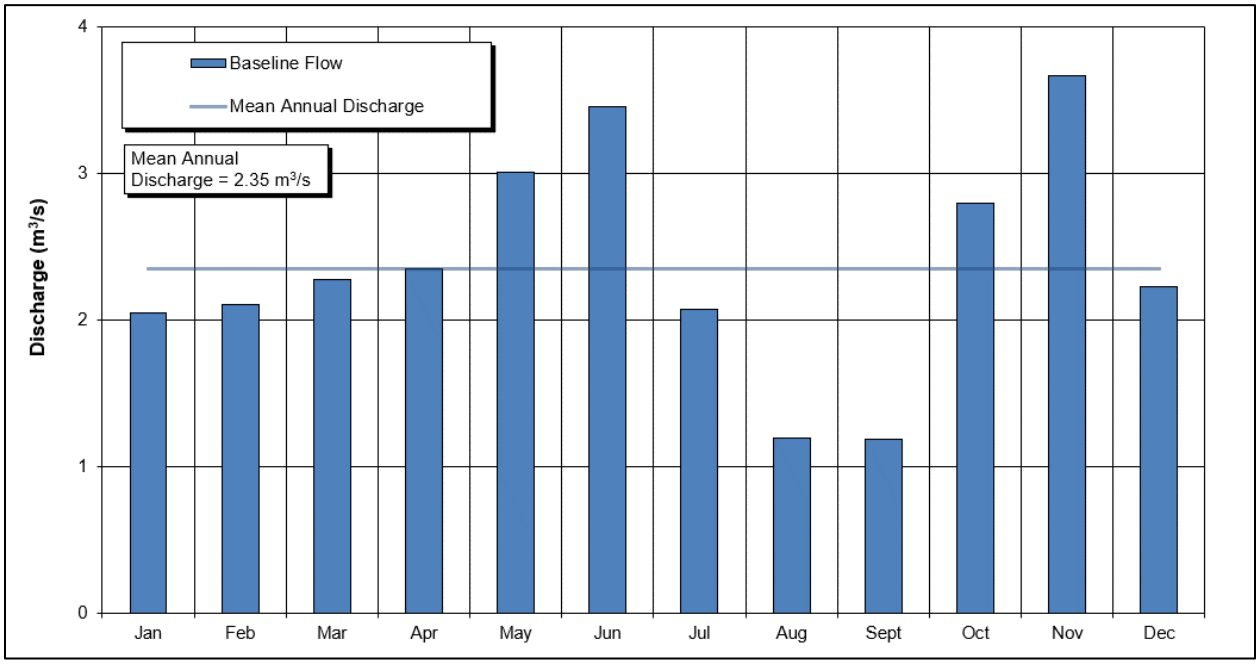


Figure 4.3 Mean Monthly Hydrograph – Woodfibre Creek at the PoD

Table 4.1 Average, Minimum and Maximum Monthly Flows - Woodfibre Creek at the PoD

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average (m^3/s)	2.05	2.10	2.27	2.35	3.01	3.46	2.08	1.19	1.19	2.80	3.67	2.23	**2.35**
Max (m^3/s)	4.65	5.42	5.11	3.67	4.44	6.95	5.51	2.91	3.22	6.58	7.54	5.14	**2.99**
Min (m^3/s)	0.77	0.97	1.06	1.30	0.99	0.58	0.63	0.81	0.64	0.69	1.49	0.90	**1.74**

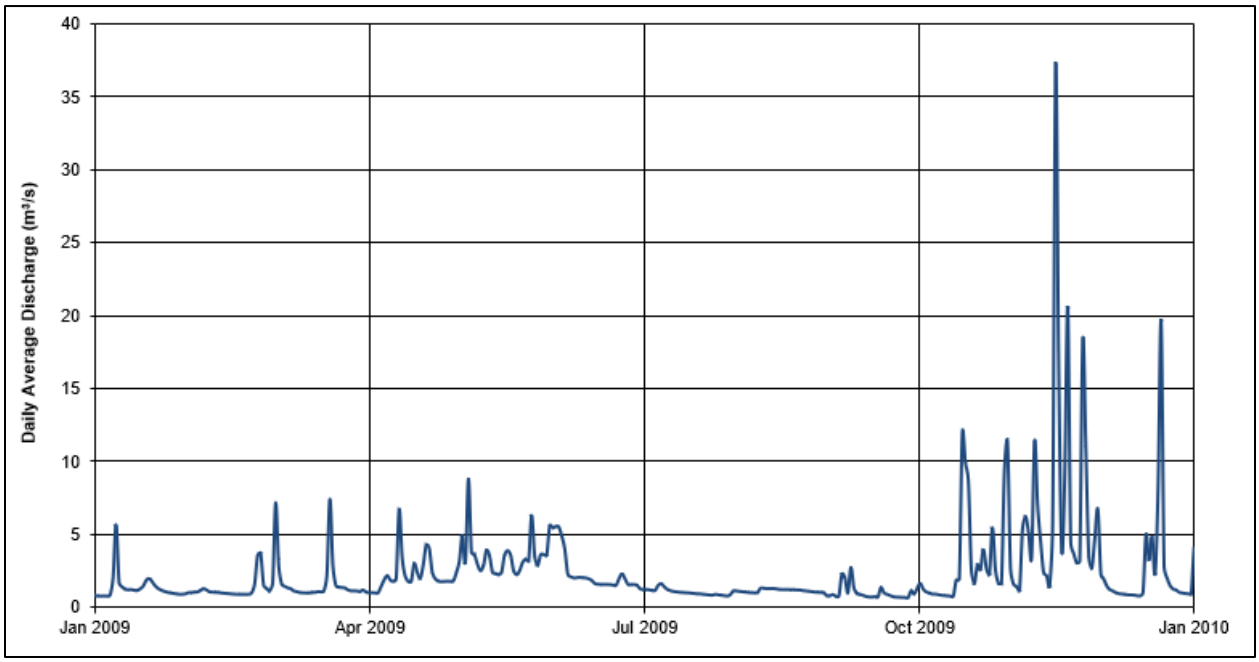


Figure 4.4 2009 Daily Hydrograph – Woodfibre Creek at the PoD Synthetic Daily Flow Series

5.0 CONSTRUCTION ENVIRONMENTAL FLOW NEEDS

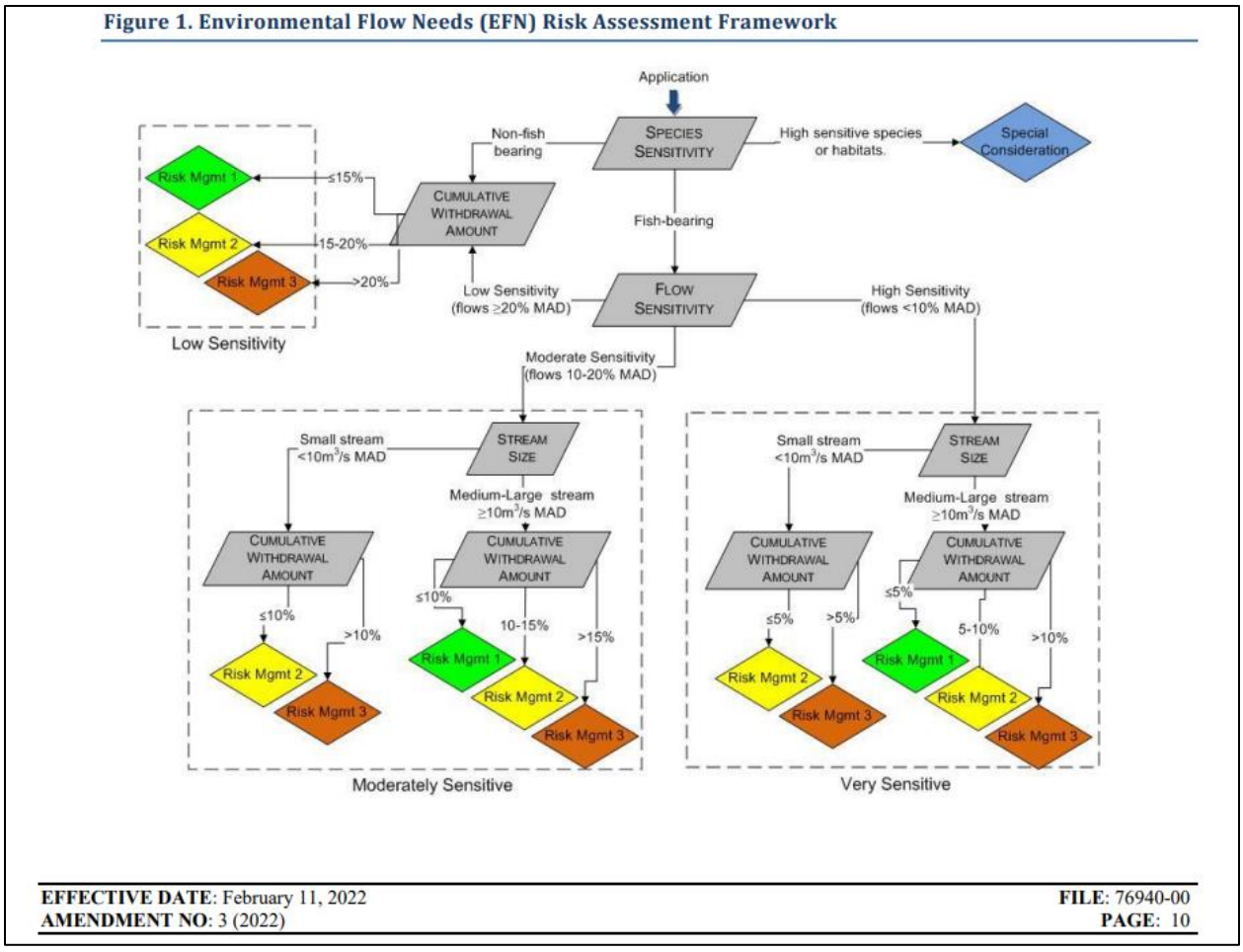
5.1 CONSTRUCTION ENVIRONMENTAL FLOW NEEDS METHODOLOGY

The BC EFN Policy (FLNRORD and ENV, 2016 and updated in 2022) presents a risk-based assessment approach that considers fish presence/absence, baseline hydrologic regime and stream size. KP has used this guidance document to assess the proposed construction water requirement and quantify the risk level of withdrawals from Woodfibre Creek.

The BC EFN policy presents an “Environmental Flow Needs Risk Assessment Framework” for applications for water licences and use approvals under the Water Sustainability Act (*WSA)*. This framework includes the following steps:

1. Determine the Area of Influence
2. Application Risk Screening
3. Screen for Fish Bearing Status and High Sensitivity Species
4. Determine Flow Sensitivity
5. Determine Stream Size
6. Determine Cumulative Withdrawal within the Area of Influence
7. Assign Preliminary Risk Rating

A flowchart, reproduced from the policy and presented on Figure 5.1 for reference.



Note(s):

1. Source: FLNRORD and ENV (2022)

Figure 5.1 Risk Management Decision-Making Process for Consideration of Environmental Flow Needs within the BC EFN Policy

5.2 CONSTRUCTION IFR FOR WOODFIBRE CREEK

5.2.1 AREA OF INFLUENCE

The point of diversion considered in this assessment is approximately 100 m from the mouth of Woodfibre Creek. The area of influence for this flow reduction is the lower 100 m of Woodfibre Creek to the confluence with Howe Sound.

5.2.2 APPLICATION RISK SCREENING

Woodfibre LNG currently holds water licences for power generation within the Woodfibre Creek watershed. Details of these licences are presented in Table 5.1. No other users have active licences to divert water in Woodfibre Creek or its upstream tributaries.

Table 5.1 Existing Woodfibre Creek Water Licences

Licensee	License Number:	Purpose:	POD Number:	POD Location	Priority Date	Quantity
Woodfibre LNG Limited (131378)	F126502	Power: General	PD46518	Sylvia Lake	30-Sep-1959	0.0566 m^3/sec
	F004897	Power: Stream Storage	PD46518	Sylvia Creek	28-Sep-1920	431,718 m^3/year
	F126616	Power: General	PD44677	Henriette Lake	30-Sep-1959	0.9982 m^3/sec
	F126618	Power: Stream Storage	PD44675	Henriette Creek	8-May-1946	10,348,897.2 m^3/year
	F126617	Power: General	PD44673	Woodfibre Creek	24-Jun-1909	0.4248 m^3/sec

5.2.3 SCREEN FOR FISH BEARING STATUS AND HIGH SENSITIVITY SPECIES

Woodfibre Creek is fish-bearing, as discussed in Section 3. There are no known *SARA* listed or provincially listed fish species documented in Woodfibre Creek. The EFN Guideline allows for cultural sensitivities under Special Considerations. The importance of restoring salmon productivity (all anadromous species) is a high cultural priority for Squamish Nation (Xay Temixw, 2001).

5.2.4 FLOW SENSITIVITY

Flow sensitivity refers to whether flow withdrawal is expected to cause a negative effect, with less tolerance for flow withdrawal from “high” sensitivity streams. High sensitivity is defined as a month where the ratio of mean monthly flow to mean annual flow is less than 10%, indicating that flows are low in that month compared to normal conditions and there is little tolerance for additional withdrawal. Flow sensitivity in Woodfibre Creek is classified as “Low” year-round, meaning that the ratio of mean monthly flow to mean annual flow is greater than 20%. The flow sensitivity for Woodfibre Creek is shown in Table 5.2, and there is sufficient water availability for the proposed withdrawal.

Table 5.2 Woodfibre Creek Flow Sensitivity at the PoD

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Discharge (m^3/s)	2.05	2.10	2.27	2.35	3.01	3.46	2.08	1.19	1.19	2.80	3.67	2.23
Ratio Monthly/Annual (% MAD)	87%	89%	97%	100%	128%	147%	88%	51%	50%	119%	156%	95%
Sensitivity	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low

5.2.5 STREAM SIZE

Small streams, defined as streams with a MAD less than 10 m^3/s, and streams that freeze over in winter are considered more ecologically sensitive to water withdrawals. The estimated MAD in Woodfibre Creek at the PoD location is 2.35 m^3/s. Using the metrics in the guidance document, this creek is classified as “Small”.

5.2.6 CUMULATIVE WITHDRAWAL

Woodfibre LNG holds active licenses on Woodfibre Creek, which are currently used to produce power. Both the pulp mill and powerhouse for the hydropower facility will be demolished during construction of the LNG facility. No water will be diverted under these licenses during construction. During construction, the only water diversion will be for the proposed construction water requirement.

5.2.7 RISK RATING

The risk rating, based on the BC EFN Policy (FLNRORD and ENV, 2022) is presented in Table 5.3 based on the proposed construction withdrawal.

Table 5.3 Risk Assessment for Cumulative Withdrawals in Woodfibre Creek at the PoD

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flow (m^3/s)	2.05	2.10	2.27	2.35	3.01	3.46	2.08	1.19	1.19	2.80	3.67	2.23
Cumulative Withdrawal Amount[1] (m^3/s)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Withdrawal Ratio (%)	5%	5%	4%	4%	3%	3%	5%	8%	8%	4%	3%	4%
Risk Management Level	1	1	1	1	1	1	1	1	1	1	1	1

Note(s):

1. The actual diversion will be less than 0.10 m^3/s because this quantity is not required continuously and may be sourced from mill creek rather than Woodfibre Creek.

Because the stream is classified as low sensitivity and cumulative withdrawals are less than 15% of the mean monthly flow, the risk rating is Risk Level 1 across all months indicating a low level of risk.

5.2.8 RESULTS

This assessment indicates there is sufficient water in Woodfibre Creek to meet construction water needs of 0.10 m^3/s while fulfilling environmental needs. Any residual risk can be addressed through monitoring and supplemental measures.

5.2.8.1 CONSTRUCTION FLOW CONDITIONS

Allowing for the continuous diversion of 0.10 m^3/s (subject to the supplemental measures described in Section 6.2) during Project construction, mean monthly baseline and operational flows are summarized on Figure 5.2 and in Table 5.4, which show that the proposed reduction in MAD is 4% on an average annual basis. The largest percentage reductions occur in August and September, when streamflows are lowest. Monthly flow duration curves, showing baseline and operational flow conditions are included in Appendix B.

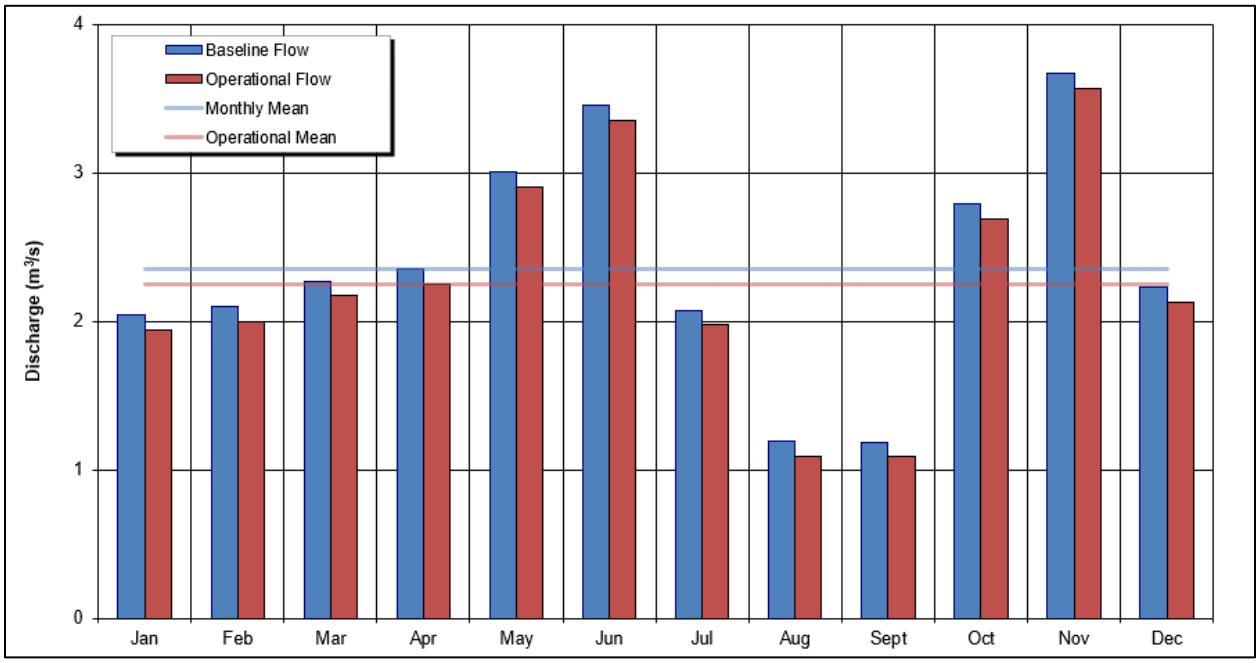


Figure 5.2 Baseline and Construction Mean Monthly Flows – Woodfibre Creek at the PoD

Table 5.4 Baseline and Construction Mean Monthly Flows – Woodfibre Creek at the PoD

Month	Baseline Flows	Construction Instream Flows	
	Q (m^3/s)	Q (m^3/s)	% Reduction
Jan	2.05	1.95	5%
Feb	2.10	2.00	5%
Mar	2.27	2.17	4%
Apr	2.35	2.25	4%
May	3.01	2.91	3%
Jun	3.46	3.36	3%
Jul	2.08	1.98	5%
Aug	1.19	1.09	8%
Sep	1.19	1.09	8%
Oct	2.80	2.70	4%
Nov	3.67	3.57	3%
Dec	2.23	2.13	4%
Annual	**2.35**	**2.25**	**4%**

6.0 SUMMARY AND RECOMMENDATIONS

6.1 SUMMARY

Woodfibre LNG is proposing the development and operation of a LNG processing and export facility on the previous Woodfibre pulp and paper mill site near Squamish, BC. Water is required for construction of the facility, a portion of which may be sourced from Woodfibre Creek. The proposed water source is a pump intake with fish screening, located approximately 100 m upstream from the mouth of Woodfibre Creek.

The conclusion of this study is that the proposed flow withdrawals are small (approximately 4% of streamflow on average) and the risk to fish from the proposed short-term construction water withdrawal is considered low, overall. However, there are times of the year (particularly during July, August, and September) when baseline streamflow can be low and water withdrawal could represent a large portion of the available water. It is proposed that supplementary measures be incorporated into the water management plan to mitigate risk to fish during low-flow periods.

6.2 SUPPLEMENTARY MEASURES

Stated objectives of the BC EFN Policy include avoiding fish-flow conflicts and being scientifically defensible; the policy was derived in part from methods currently used in B.C., scientific literature, and expert opinion (FLNRORD and ENV, 2022). As noted above (Section 3), small-bodied rainbow trout are the predominant species found in Woodfibre Creek, with low densities of other salmon species (pink, chinook, coho) and coastal cutthroat trout. The species and life stage of interest downstream of the barrier falls were therefore identified as rainbow trout during the rearing period when flows are low, and pink salmon spawning.

As shown on Figure 5.2 and detailed in Table 5.4 the instream flow with the withdrawal of construction water of 0.10 m^3/s and the supplemental measured described below equates to a reduction in baseline flows of 3% - 8% throughout the year. Although these construction flow withdrawals are expected to have minimal impact of fish habitat, consistent with Risk Management Level 1, supplementary measures consistent with Risk Management Level 2 have been or will be implemented, including:

1. Establish adequate baseline hydrology data
2. Collection of site-specific fisheries information
3. Real-time streamflow monitoring during construction
4. Real-time monitoring of diverted flows
5. Flow diversion restrictions

The allowable flow diversion rate (diversion limit) will be reduced as instream flow falls to reduce risk during higher habitat stress conditions. Water withdrawal will be limited to:

- 15% of total streamflow, up to a maximum of 0.10 m^3/s when instantaneous flows are more than 20% MAD (low sensitivity conditions)
- 10% of total streamflow when instantaneous flow is between 10 - 20% MAD (moderate sensitivity conditions)
- 5% of total streamflow when instantaneous flow is < 10% MAD (high flow sensitivity)

Additionally, between August 1 and October 31 (the critical stream flow periods, CSFP, as defined by Squamish Nation), a minimum instream flow requirement of 0.47 m^3/s (20% MAD) has been set to maintain resident rainbow trout rearing and pink salmon spawning habitat. If flows fall below 0.47 m^3/s, a maximum flow of 0.005 m^3/s for the residential camp for workers will be diverted.

Allowable flow diversion rates are shown in Table 6.1. Although the diversion rate could be adjusted continuously to meet the percentage withdrawal limits, a look-up table with discrete steps has been proposed to provide a an easy-to-understand and practical protocol that the Environmental Monitor and Contractor can follow.

Table 6.1 Construction Management Plan Flow Diversion Limits

Streamflow at Gauging Station/PoD (m^3/s)	%MAD	November 1 to July 31		August 1 to October 31	
		Maximum Diversion Limit (m^3/s)	% Diversion	Maximum Diversion Limit (m^3/s)	% Diversion
≥0.67	>28%	0.10	<15%	0.10	<15%
≥0.60	26%	0.09	15%	0.09	15%
≥0.50	21%	0.08	15%	0.08	15%
≥0.47	20%	0.05	10%	0.005	1%
≥0.40	17%	0.04	10%	0.005	1%
≥0.30	13%	0.03	10%	0.005	2%
≥0.24	11%	0.02	10%	0.005	2%
<0.24	<11%	5% of measured flow	5%	0.005	>2%

In order to manage construction water requirements during restricted diversion periods, the following will be conducted:

1. Schedule high water demand activities outside the low flow period, to the extent practical.
2. Provide water storage to accommodate short term flow restrictions.
3. Use Mill Creek to supplement Woodfibre Creek withdrawals to meet construction water requirements.

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8.0 CERTIFICATION

This report was prepared and reviewed by the undersigned.

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Approval that this document adheres to Knight Piésold Quality Systems: SRM

APPENDIX A

Woodfibre Creek Hydrologic Analysis (VA22-01360)

(Pages A-1 to A-24)

Knight Piésold CONSULTING

Management System Certified by: bsi ISO 9001 ISO 14001 ISO 45001 CERTIFIED

September 23, 2022

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Mr. Darren Cowan
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Dear Darren,

RE: Woodfibre Creek Hydrologic Analysis

Woodfibre LNG Limited (Woodfibre LNG) is proposing the development and operation of a liquefied natural gas (LNG) processing and export facility (the Project) on the previous Woodfibre Pulp and Paper Mill site located approximately 7 km west-southwest of Squamish, British Columbia (BC). Water is required for construction and operation of the facility, which will be sourced from Mill Creek or Woodfibre Creek. Knight Piésold Ltd. (KP) has been retained by WLNG to assist with the hydrometric monitoring of Woodfibre Creek, in support of water availability studies and Project permitting.

A regional hydrologic analysis was completed to identify trends and characteristics in precipitation and runoff, then the short-term measured data were correlated with data collected by Water Survey of Canada (WSC) at a suitable surrogate station to develop a long-term synthetic daily streamflow series for Woodfibre Creek. A hydrologic analysis of Woodfibre Creek was conducted previously (KP, 2018). However, since completion of the previous analysis, over 2.5 years of additional data have been collected in Woodfibre Creek. This letter presents the synthetic flow series development, based on data measured between April 2017 and May 2021.

1.0 HYDROLOGIC SETTING

The Project area is located within Hydrologic Zone 27 (Western South Coast Mountains), as delineated by Ahmed (2017). In this zone, Pacific frontal systems encounter the abruptly rising terrain of the Coast Mountains and produce large quantities of precipitation as they are forced upward. Spatial variability in annual precipitation is extensive due to orographic enhancement on windward slopes and rain shadow effects in leeward areas. The proportion of precipitation falling as snow varies with elevation, with little snow falling at sea level and large snowpacks accumulating on upper mountain slopes. Even at high elevations, however, winter rainfall and snowmelt are common, leading to a complex hydrologic regime. In general, streamflow in South Coast watersheds like Woodfibre Creek (i.e., coastal, but also with high-elevation mountainous terrain) are highest in autumn due to frontal rainstorm activity, with a secondary peak in spring due to snowmelt. Flows are lowest in late summer when precipitation is low. Winter flows tend to be moderate as much of the precipitation falls as snow but can be punctuated by warm rainfall events and rainfall at lower elevation.

Mean annual precipitation varies dramatically from only 1,490 mm at Gibsons, located approximately 35 km southwest of the Project, to 3,320 mm at Port Mellon, located 25 km southwest of the Project and then to 2,230 mm in Squamish. This is indicative of topographic convergence of frontal systems in Howe Sound, and extreme orographic enhancement of precipitation due to rapid uplift. Similarly, mean annual unit runoff

varies dramatically from 125 L/s/km^2 (or 4,000 mm) in Rainy River and 118 L/s/km^2 (or 3,660 mm) in Capilano River, located close to the Project area, to only 32 L/s/km^2 (or 1,000 mm) in Roberts Creek, located 20 km to the southwest and with a lower-elevation basin.

The median watershed elevation above the Woodfibre Creek gauge is 1,057 meters above sea level and glaciers cover a negligible area in the watershed. The watershed area is 20 km^2 at the gauge and 22 km^2 at the mouth. Over the 100+ year history of activity at the Woodfibre mill site, there has been a significant amount of water management infrastructure built in the Woodfibre Creek watershed. Flow diversions, reservoir construction, and flow regulation were undertaken to provide water for power and mill operations. Although not currently operated, these structures continue to affect streamflow conditions in Woodfibre Creek and the flow regime should be considered regulated. The Woodfibre Creek watershed is shown on Figure 1.

2.0 STREAMFLOW DATA COLLECTION

KP installed a hydrometric station (WOOD) on Woodfibre Creek approximately 100 meters upstream of the existing hydropower intake in April 2017. The station is located on the left bank of a pool, downstream of a cascade, as shown on Photo 1. Water level is hydraulically controlled by a cascade at the outlet of the pool, shown on Photo 2. The low-flow control section consists of cobbles between large boulders, while the high-flow control also includes the bedrock banks. The hydrometric station consists of a pressure transducer connected to a datalogger that records stage at fifteen-minute intervals.

Photo 1 WOOD Station – May 24, 2017

Photo 2 Hydraulic Control at WOOD – July 20, 2017

2.1 WOOD RATING CURVE AND DISCHARGE HYDROGRAPH

A total of twenty-one stage/discharge measurements have been collected at WOOD. The discharge measurements were conducted using area-velocity and Rhodamine dye dilution measurements depending on flow conditions at the time of each site visit. The station includes three benchmarks, located in bedrock above the normal high-water level, and two reference marks for determining stage. Benchmark 1 was assigned an elevation of 10 m and this datum is used for converting water level to gauge height (stage).

One rating curve was plotted through the 21 stage-discharge points using the standard form for a rating curve equation (power function) with the constant, offset, and exponent constrained within expected values

based on hydraulic theory (Maidment, 1993) and experience with similar conditions in mountainous streams. The rating curve has two segments for defining low and high flows, as shown on Figure 2. The first is applied up to a stage of 9.520 m. The second segment is extrapolated to the maximum recorded stage-discharge measurement collected during its period of application. Due to upstream flow regulation, low flows collected at the WOOD station have not fallen below 0.63 m^3/s and are well-distributed up to 5.4 m^3/s. The highest flow recorded is 19.6 m^3/s.

The daily average discharge hydrograph for WOOD is presented on Figure 3, which was developed by applying the rating curve to the available stage record and then averaging the fifteen-minute streamflow record over 24-hour periods. The hydrograph has gaps due to logger malfunctions on the following dates (inclusive):

- September 5, 2017 to October 17, 2017
- October 25, 2017 to February 13, 2018
- October 20, 2020 to April 1, 2021

Further details of the hydrometric monitoring are presented in Appendix A.

3.0 LONG-TERM SYNTHETIC FLOW SERIES

A synthetic daily streamflow series was developed with the intent of assessing long-term streamflow conditions in Woodfibre Creek by correlation of Woodfibre Creek measured streamflow data with concurrent data from a streamflow gauging station operated by Water Survey of Canada (WSC).

3.1 HYDROGRAPH COMPARISON

The median watershed elevation above the Woodfibre Creek gauge is 1,057 meters above sea level and glaciers cover a negligible area in the watershed. Several WSC stations, shown on Figure 4, were reviewed to determine an appropriate surrogate station. A suitable site should have similar watershed characteristics to Woodfibre Creek and have available concurrent data. Roberts Creek at Roberts Creek (08GA0470) was excluded due to differences in watershed characteristics and flow regulation. Clowhom River near Clowhom Lake (08GB013) was considered, but correlation of concurrent daily flows found that the stations had substantial differences in timing and magnitude of response to precipitation events. Seymour River above Below Orchid Creek (08GA077) was also considered and although not noted as regulated by WSC, summer regulation was evident in the flow record (visually and by chronological correlation of concurrent flows) and Metro Vancouver records note regulation of Loch Lemond. A summary of the regional WSC gauging stations, along with the Mill Creek station, is presented in Table 1.

Table 1 Regional WSC Gauging Station Summary

Station Name	Station ID	Gauge Elevation (masl)	Years of Record	Years of Complete Record	Start Year	End Year	Drainage Area (km^2)	Mean Annual Discharge (m^3/s)	Average Annual Unit Runoff ($L/s/km^2$)
Clowhom River Near Clowhom Lake	08GB013	60	30	28	1993	2022	147	15.6	106
Seymour River below Orchid Creek	08GA077	290	31	29	1992	2022	63	6.5	103
Capilano River above the Intake	08GA010	160	92	108	1914	2022	173	20.3	118
Woodfibre Creek	WOOD	350	6	4	2017	2022	20	2.35	118

Capilano River Above Intake (08GA010) was identified as the most representative long-term WSC station due to availability of concurrent data, its proximity to the Project and similarity of drainage area and basin characteristics such as median drainage elevation and negligible glacial cover. Daily discharge records are available at Capilano River between 1914 and 2021, except 1972 and 1973, and portions of 2007 and 2017. This station has a watershed area of 173 km^2 and a mean annual unit runoff or 118 $L/s/km^2$.

Capilano River is a regulated system due to summer releases from Palisades Lake reservoir, which are managed by Metro Vancouver. Details on regulated flows are not consistently available; however, a naturalized streamflow record for Capilano has previously been developed for the Project for the period of record between 1960 and early 2018 using records of release rates from Metro Vancouver. Periods with regulation were also removed from the Capilano River dataset for April 1, 2019 to May 28, 2021 by removal of periods with sudden, steady increases in Capilano River flow that are not reflected in the Mill Creek data, which is an unregulated system (refer to VA22-01362). These periods were also removed from the Woodfibre Creek data.

The naturalized flow record for Capilano River therefore includes 55 complete years of record (i.e. 1960 – 1971, 1974 – 2006, 2008 – 2016) and six years with incomplete records (2007 and 2017 – 2021).

A comparison of concurrent records between Woodfibre Creek and Capilano River for April 18, 2017 to May 28, 2021 are presented on Figure 5. This figure confirms that the two streams have similar runoff and seasonal flow patterns for the measured concurrent period, although unit runoff in Woodfibre Creek is higher than that in Capilano River in late summer and during low winter flow conditions, due to regulation of Henriette Lake.

3.2 EMPIRICAL FREQUENCY PAIRING ANALYSIS

A discharge relationship was developed by correlating the frequency distributions of concurrent daily flows for Woodfibre Creek versus Capilano River. As more than three years of data are available for the concurrent record, the data were evaluated on a month-by-month basis.

The discharge relationships were developed using an analytical technique known as EFP (Butt, 2013). EFP requires that daily flows for the concurrent period of record for two datasets be ranked in descending order of magnitude. When comparing these sets of data, each flow value of equal rank has an equal probability of exceedance within its respective dataset (since the datasets are of equal length). A comparison of ranked daily flows therefore amounts to a comparison of flow frequency distributions. The EFP technique assumes that the correlation of the flow frequency relationship developed from the sample (concurrent record) is generally representative of the correlation that would exist between concurrent long-term records. Butt (2013) demonstrated the general validity of this assumption for watershed pairs that are in regional proximity to one another and have similar hydrologic regimes.

The frequency pairing approach, rather than the more common chronological pairing approach, overcomes the often substantial differences in the timing and magnitude of rainstorm or snowmelt events between watersheds and differences in storage and attenuation, and has been shown to be a more accurate and precise model for synthetically generating long-term flow patterns (Butt, 2013). The objective of the EFP is not necessarily to reproduce exact historical flow patterns at the point of interest, so that one can determine what the flow was on any particular day, but rather to generate a dataset that provides a representation of the expected long-term mean annual discharge and associated variability of flows.

3.3 WOODFIBRE CREEK REGULATION ADJUSTMENTS

EFP analysis assumes that the flows in Woodfibre Creek can be predicted by the magnitude and timing of hydrologic events on Capilano River. During the period of gauging on Woodfibre Creek, Woodfibre LNG has not adjusted the gates on Henriette Lake (Woodfibre LNG, pers. comm.) so the measured record varies in response to hydrologic events, although the dam and gates act to attenuate the lake outflows resulting in reduced peak flows and increased flows during naturally low flow periods. The watershed area above Henriette Dam is approximately 8 km, or 40% of the watershed area above the WOOD gauge. Synthetic flows for Woodfibre Creek were developed by correlation of the measured WOOD flows with Capilano flows on a monthly basis. This approach produces synthetic daily flows that retain the effect of Henriette Dam. High and low flows were extrapolated with consideration of the line of equal runoff and generally assumed that WOOD would have lower unit runoff at high flows and higher unit runoff at low flows due to Henriette Lake attenuation. EFP relationships were developed from the available data, and an example correlation for May is shown on Figure 6. The EFP relationships were applied to the corresponding long-term Capilano River records to produce a long-term synthetic discharge series for the Woodfibre Creek gauge.

3.4 RESULTS

The estimated long-term monthly and annual flows at the intake location are summarized in Table 1. The corresponding annual hydrograph of mean monthly discharge at the Woodfibre Creek gauge is shown on Figure 7. The flow duration curve for the long-term synthetic series at the gauge is shown on Figure 8. The mean annual discharge (MAD) is estimated to be 2.35 m^3/s (1992 to 2020 period), which equates to a mean annual unit runoff of 118 $L/s/km^2$ for the 20 km^2 watershed.

4.0 DISCUSSION

The available Woodfibre Creek gauge measured streamflow record includes approximately four years of measured data, producing a long-term synthetic streamflow timeseries that is of sufficient length for the purpose of assessing “normal” streamflow conditions, where “normal” includes flows between approximately 5% and 200% MAD. The long-term synthetic flow series is considered to be of moderate quality, as Woodfibre Creek is a regulated system where the impacts of regulation cannot be defined with certainty.

The continued field data collection at the Woodfibre Creek gauge is recommended in order to:

- Increase the quality of the stage/discharge rating curves for the purpose of improving the quality of the streamflow records.
- Increase the length of the streamflow records with regional stations to improve calibration regressions for the purpose of generating a reliable long-term synthetic streamflow series.

If you have any questions or comments, please contact the undersigned.

Yours truly,
Knight Piésold Ltd.

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Approval that this document adheres to the Knight Piésold Quality System: SRM

Attachments:

Table 2 Rev 0	Long-Term Synthetic Discharge at Woodfibre Creek (WOOD) Gauge
Figure 1 Rev 0	Woodfibre Creek Watershed
Figure 2 Rev 0	Woodfibre Creek (WOOD) – Rating Curve – Extrapolated to Maximum Recorded Stage
Figure 3 Rev 0	Woodfibre Creek (WOOD) Gauge – Daily Average Discharge Hydrograph
Figure 4 Rev 0	Hydrologic Zones and Regional Hydrology Stations
Figure 5 Rev 0	Woodfibre Creek and Capilano River – Concurrent Unit Runoff
Figure 6 Rev 0	Woodfibre Creek and Capilano River – Frequency Paired Relationship: July
Figure 7 Rev 0	Woodfibre Creek Synthetic Series – Mean Monthly Hydrograph
Figure 8 Rev 0	Woodfibre Creek Synthetic Series – Flow Duration Curves
Appendix A	Woodfibre Creek Hydrologic Analysis

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/skc

Knight Piésold CONSULTING

TABLE 2

WOODFIBRE LNG LTD.
WOODFIBRE LNG PROJECT

LONG-TERM SYNTHETIC DISCHARGE AT WOODFIBRE CREEK (WOOD) GAUGE
(m^3/s)

Print: Aug/31/21 09:27:22

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1960	1.58	1.70	1.65	2.41	2.91	2.75	1.42	1.30	0.94	3.25	2.01	2.02	1.99
1961	3.48	4.26	2.33	2.29	3.74	3.92	1.49	1.29	1.04	2.92	3.08	2.10	2.66
1962	1.75	2.10	1.06	2.41	2.36	3.39	1.66	1.39	1.25	3.27	4.12	3.15	2.33
1963	1.36	3.29	1.79	2.06	2.17	1.73	2.03	1.27	0.83	3.95	4.56	2.36	2.28
1964	1.53	1.34	1.22	1.85	3.37	6.95	5.00	1.31	1.66	1.95	2.79	1.49	2.54
1965	1.13	1.58	1.38	2.32	2.74	2.73	1.34	1.23	0.67	3.88	3.98	2.25	2.10
1966	1.82	1.47	2.27	2.41	3.37	4.66	2.64	1.28	0.98	2.45	3.52	5.14	2.67
1967	2.19	1.91	2.19	1.70	3.88	6.53	2.27	1.28	0.90	6.58	2.28	2.10	2.82
1968	3.29	3.29	3.10	1.49	3.14	4.38	2.72	1.25	1.39	4.38	3.10	2.34	2.82
1969	1.41	1.35	1.72	3.24	4.11	4.70	1.74	1.30	2.70	2.12	2.09	1.94	2.37
1970	1.44	1.49	1.90	2.81	2.00	1.98	1.26	1.29	1.45	2.25	2.86	1.77	1.87
1971	1.68	2.66	1.54	1.75	3.14	4.73	3.66	1.29	1.09	2.45	2.96	0.98	2.33
1974	2.22	1.60	3.14	2.21	3.85	5.87	5.09	1.31	1.08	1.13	3.63	2.08	2.77
1975	1.02	1.02	1.77	1.44	3.71	5.00	2.74	1.52	0.86	5.39	5.24	2.93	2.72
1976	1.30	1.19	1.29	1.94	4.10	4.90	4.29	1.32	1.27	1.51	1.55	2.29	2.25
1977	1.32	1.97	1.53	2.24	2.43	2.56	1.28	1.20	1.68	3.04	3.88	2.42	2.13
1978	1.51	1.78	2.45	1.72	2.69	2.44	1.18	1.18	2.20	1.13	1.65	0.90	1.74
1979	0.77	1.77	2.60	1.93	2.95	2.59	1.77	0.95	1.47	2.80	1.49	3.97	2.09
1980	1.08	3.96	1.38	2.84	2.30	2.20	2.10	1.15	1.27	1.08	6.05	3.79	2.43
1981	1.20	2.78	1.45	2.81	2.39	3.46	1.23	0.86	1.77	5.13	3.72	2.24	2.42
1982	1.12	3.00	1.54	1.97	3.47	6.43	2.43	1.21	0.72	4.14	2.60	2.25	2.57
1983	2.41	5.40	3.29	1.82	3.04	3.77	3.86	1.27	1.10	1.70	7.22	0.95	2.99
1984	2.16	2.76	2.58	2.13	3.24	4.54	2.65	1.21	0.88	3.36	3.91	1.15	2.55
1985	0.98	0.97	1.06	2.52	2.98	3.38	1.35	1.08	0.76	3.60	1.75	1.15	1.80
1986	2.53	2.49	3.22	1.57	3.63	2.36	1.56	0.88	0.77	1.10	2.86	2.58	2.13
1987	2.24	1.98	3.88	2.11	3.80	2.42	1.57	0.93	0.69	0.80	2.90	2.20	2.13
1988	1.42	1.52	1.74	2.69	3.75	3.24	1.85	1.21	1.05	1.59	4.71	1.73	2.21
1989	1.54	1.45	1.89	2.80	3.02	3.43	2.14	1.23	0.66	3.01	3.69	1.78	2.22
1990	1.53	1.35	1.77	2.60	2.50	3.63	1.24	1.22	0.84	2.21	7.28	1.58	2.31
1991	1.71	5.42	1.13	2.42	2.60	2.18	1.39	2.91	0.81	0.71	3.94	2.19	2.28
1992	4.65	2.66	1.59	3.50	1.58	1.59	1.19	1.17	1.14	3.91	3.09	1.10	2.26
1993	1.26	1.25	3.05	3.65	2.99	2.12	1.24	1.19	0.65	1.46	1.97	3.16	2.00
1994	2.51	2.55	4.29	2.40	2.32	2.61	1.66	0.97	0.75	1.86	2.18	3.96	2.34
1995	2.65	3.44	3.19	1.98	2.78	2.39	1.49	1.29	0.73	3.77	7.54	3.51	2.90
1996	2.79	2.53	1.77	3.42	2.14	1.63	1.24	1.02	0.78	3.08	2.78	1.72	2.08
1997	2.80	1.18	3.58	3.35	4.08	4.10	2.81	1.15	2.10	4.92	3.76	1.83	2.97
1998	2.64	2.82	1.91	1.36	2.73	2.05	1.69	1.04	0.64	2.23	6.00	2.98	2.34
1999	2.03	1.88	2.16	2.04	3.26	6.71	5.51	1.32	0.89	2.31	5.26	2.37	2.98
2000	1.10	1.46	1.55	2.15	3.42	5.56	2.29	1.20	0.88	2.65	1.50	1.40	2.09
2001	1.50	1.01	1.79	1.99	2.87	2.40	1.21	1.71	0.85	1.90	4.28	2.01	1.96
2002	2.75	1.74	1.24	3.41	3.51	5.35	1.67	1.10	0.92	0.69	4.43	1.98	2.40
2003	2.75	1.18	4.04	2.52	1.90	1.87	1.17	0.81	0.75	5.19	2.05	2.04	2.19
2004	2.23	1.45	2.06	1.96	2.25	2.03	1.06	1.08	1.44	2.30	3.31	2.37	1.96
2005	3.72	1.06	2.26	3.01	2.71	1.58	1.97	0.81	0.84	3.21	2.75	3.38	2.27
2006	2.47	1.48	1.67	2.00	3.20	4.05	1.39	1.07	0.70	1.07	6.07	2.18	2.28
2007	1.83	2.00	5.11	2.73	3.25	4.71			1.31	3.86	3.11	2.61	
2008	1.16	1.10	1.50	1.36	4.44	4.33	2.32	1.29	0.77	2.46	3.75	1.12	2.13
2009	1.34	1.25	1.74	2.19	3.44	2.48	1.06	1.15	1.00	3.17	7.01	2.38	2.35
2010	3.95	2.47	1.62	2.37	2.38	3.36	1.71	1.06	1.54	3.31	2.36	3.26	2.45
2011	2.20	1.65	2.51	1.71	3.37	5.98	4.14	1.35	1.54	2.32	2.67	1.45	2.57
2012	2.20	1.48	1.64	3.15	3.25	5.31	3.03	1.09	0.65	3.21	4.77	2.04	2.65
2013	1.00	1.25	4.05	3.45	3.78	2.93	1.21	0.85	2.68	1.41	1.68	1.06	2.11
2014	1.54	1.08	3.49	2.54	2.92	1.63	1.21	1.07	1.04	5.02	5.11	3.90	2.55
2015	2.10	3.62	3.14	1.30	0.99	0.58	0.63	1.00	1.77	1.56	3.74	3.73	2.01
2016	3.86	2.97	4.07	2.23	1.82	1.95	1.53	0.94	0.81	5.16	6.04	1.00	2.70
2017	1.92	2.46	3.26	3.67	4.36	4.64	1.68	0.98			5.79	1.27	
2018	3.07												
2019				2.55	2.10	1.28	1.13	0.94	2.48	2.33	1.59	1.59	
2020	3.94	1.92	1.37	1.80	3.33	2.61	1.44	1.18	3.22	2.11	2.88	2.20	2.33
2021	2.77	1.31	1.56	1.85	2.71	4.34	1.11						
Average	**2.06**	**2.09**	**2.26**	**2.34**	**3.00**	**3.47**	**2.01**	**1.19**	**1.19**	**2.80**	**3.67**	**2.23**	**2.35**
Maximum	**4.65**	**5.42**	**5.11**	**3.67**	**4.44**	**6.95**	**5.51**	**2.91**	**3.22**	**6.58**	**7.54**	**5.14**	**2.99**
Minimum	**0.77**	**0.97**	**1.06**	**1.30**	**0.99**	**0.58**	**0.63**	**0.81**	**0.64**	**0.69**	**1.49**	**0.90**	**1.74**

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER VA22-01360	SKC	TJP

Woodfibre Creek Watershed

LOCATION TO:	DRAINAGE AREA (km)
Woodfibre Creek Mouth	22
Woodfibre Creek Gauge	20

LEGEND:

- ACTIVE WOODFIBRE LNG HYDROLOGY GAUGE
- WATERSHED BOUNDARY

0 0.5 1 2 3 4 Km

NOTES:

1. BASE MAP: ESRI WORLD TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:40,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	23SEP'22	ISSUED WITH LETTER	TJP	KK	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

WOODFIBRE CREEK WATERSHED

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-00494/24	VA22-01360

FIGURE 1 REV 0

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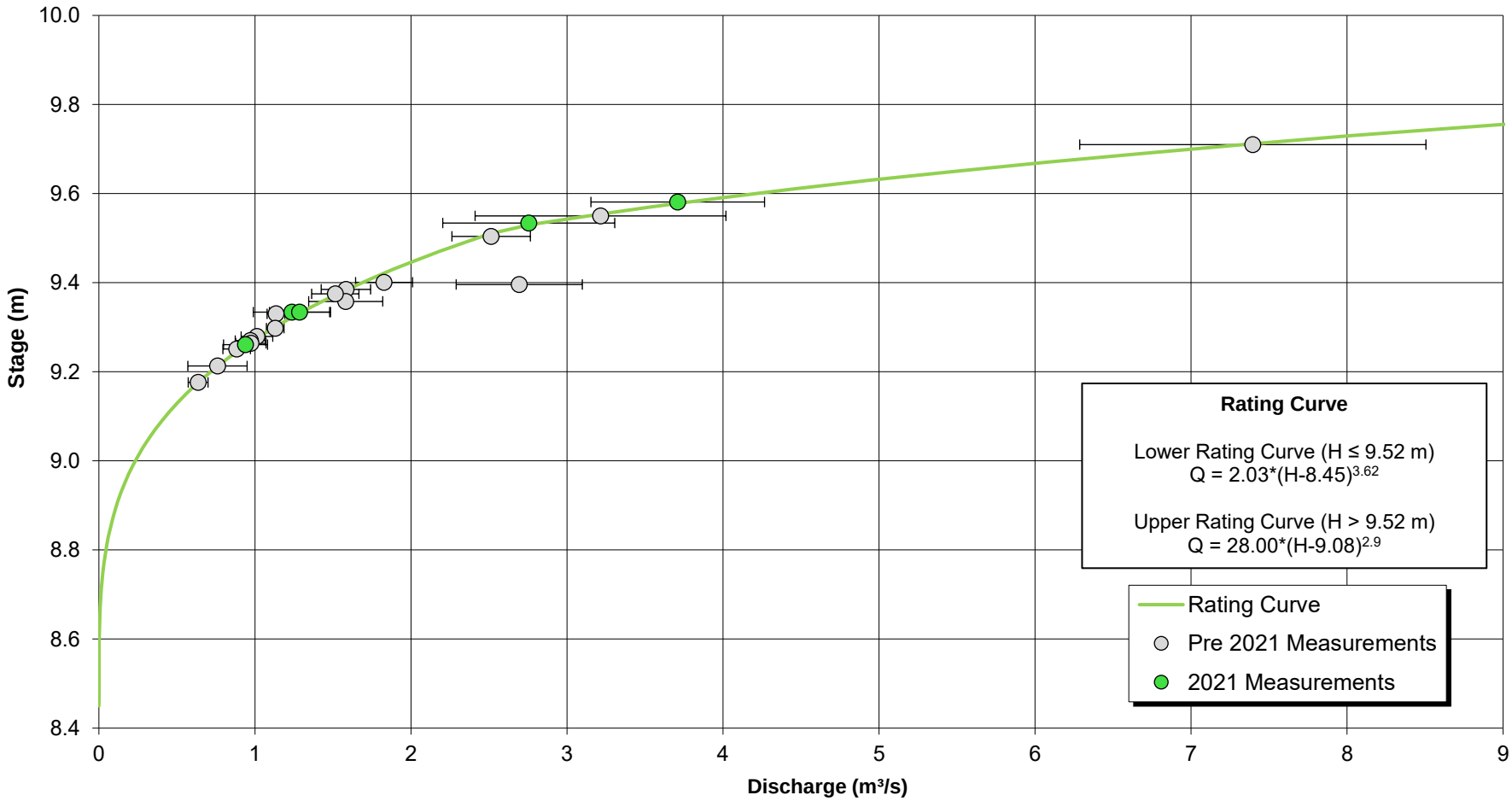


REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER VA22-01360	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

WOODFIBRE CREEK (WOOD)
RATING CURVE
EXTRAPOLATED TO MAXIMUM RECORDED STAGE

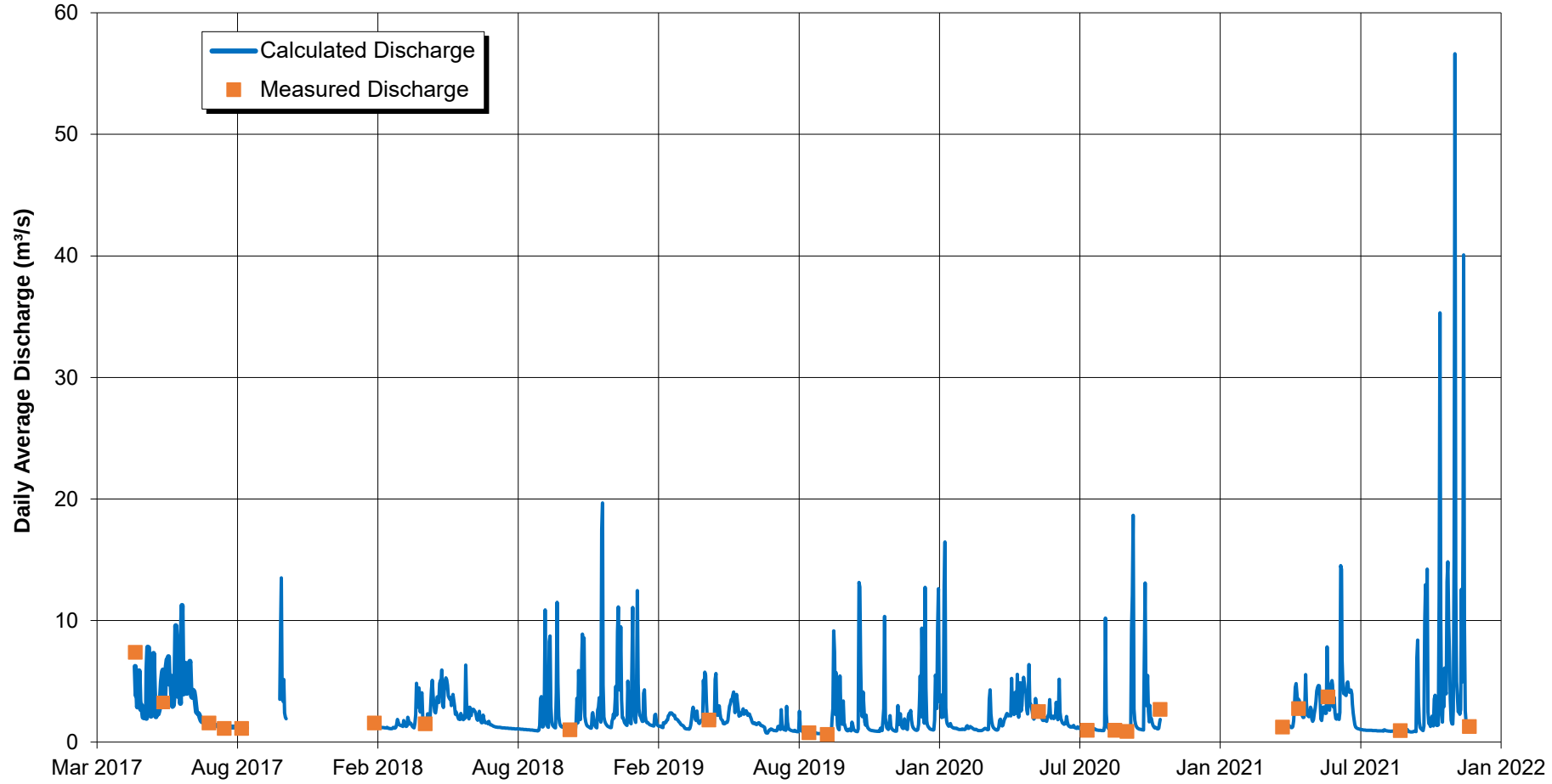
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01360

FIGURE 2

REV 0



NOTE:
1. MANUAL MEASUREMENTS OF INSTANTANEOUS DISCHARGE DO NOT NECESSARILY MATCH DAILY AVERAGE DISCHARGE ON THE SAME DATE DUE TO DAILY FLUCTUATIONS IN DISCHARGE.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER VA22-01360	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

WOODFIBRE CREEK (WOOD) GAUGE
DAILY AVERAGE DISCHARGE HYDROGRAPH

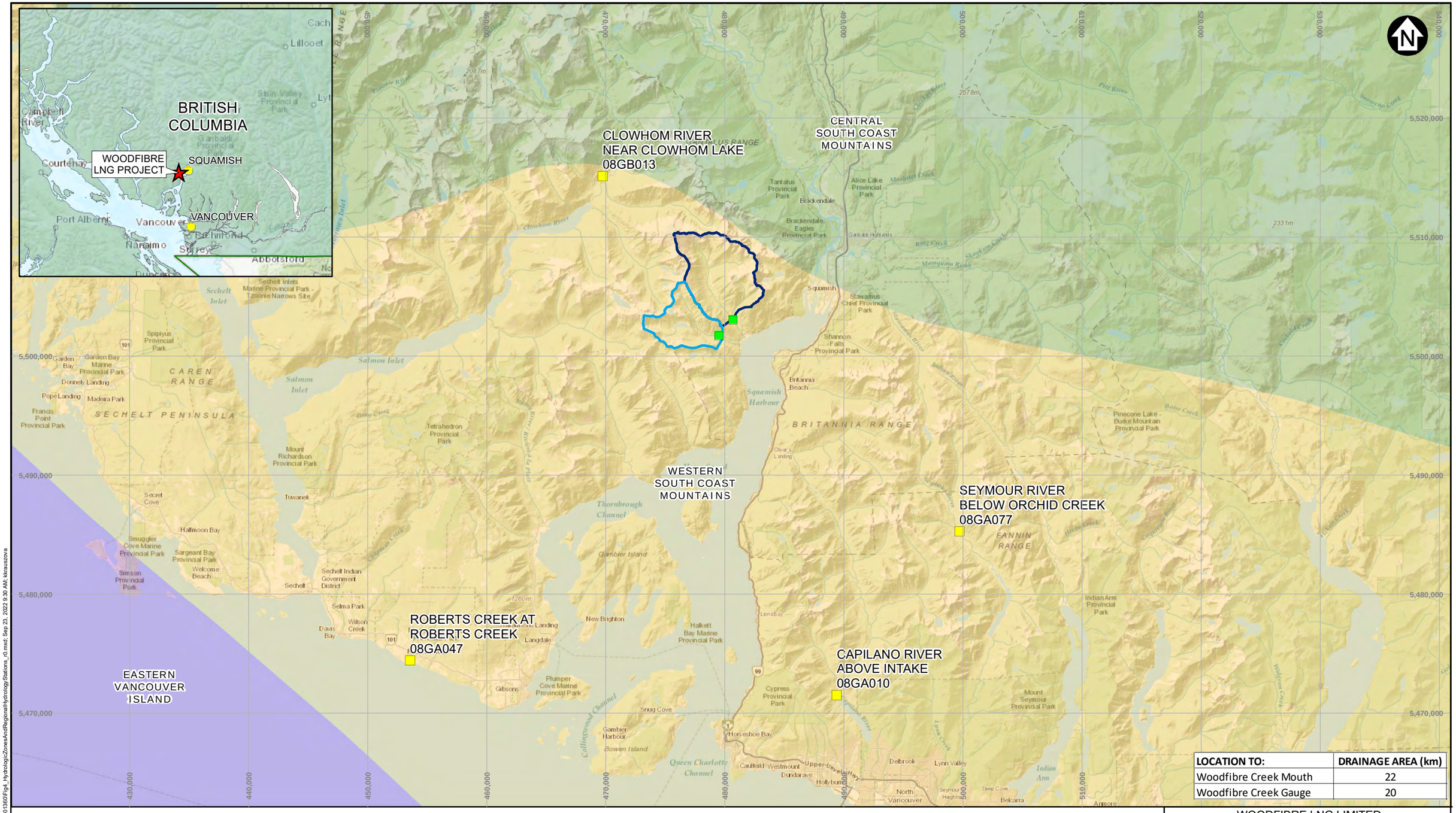
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01360

FIGURE 3

REV 0



LOCATION TO:	DRAINAGE AREA (km)
Woodfibre Creek Mouth	22
Woodfibre Creek Gauge	20

LEGEND:

- WSC STATION
- ACTIVE WOODFIBRE LNG HYDROLOGY GAUGE
- WOODFIBRE CREEK WATERSHED BOUNDARY
- MILL CREEK WATERSHED BOUNDARY

HYDROLOGIC ZONE

- CENTRAL SOUTH COAST MOUNTAINS (ZONE 26)
- EASTERN VANCOUVER ISLAND (ZONE 28)
- WESTERN SOUTH COAST MOUNTAINS (ZONE 27)

0 3.75 7.5 15 22.5 30 Km

NOTES:

1. BASE MAP: ESRI WORLD TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:300,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	23SEP'22	ISSUED WITH LETTER	TJP	KK	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

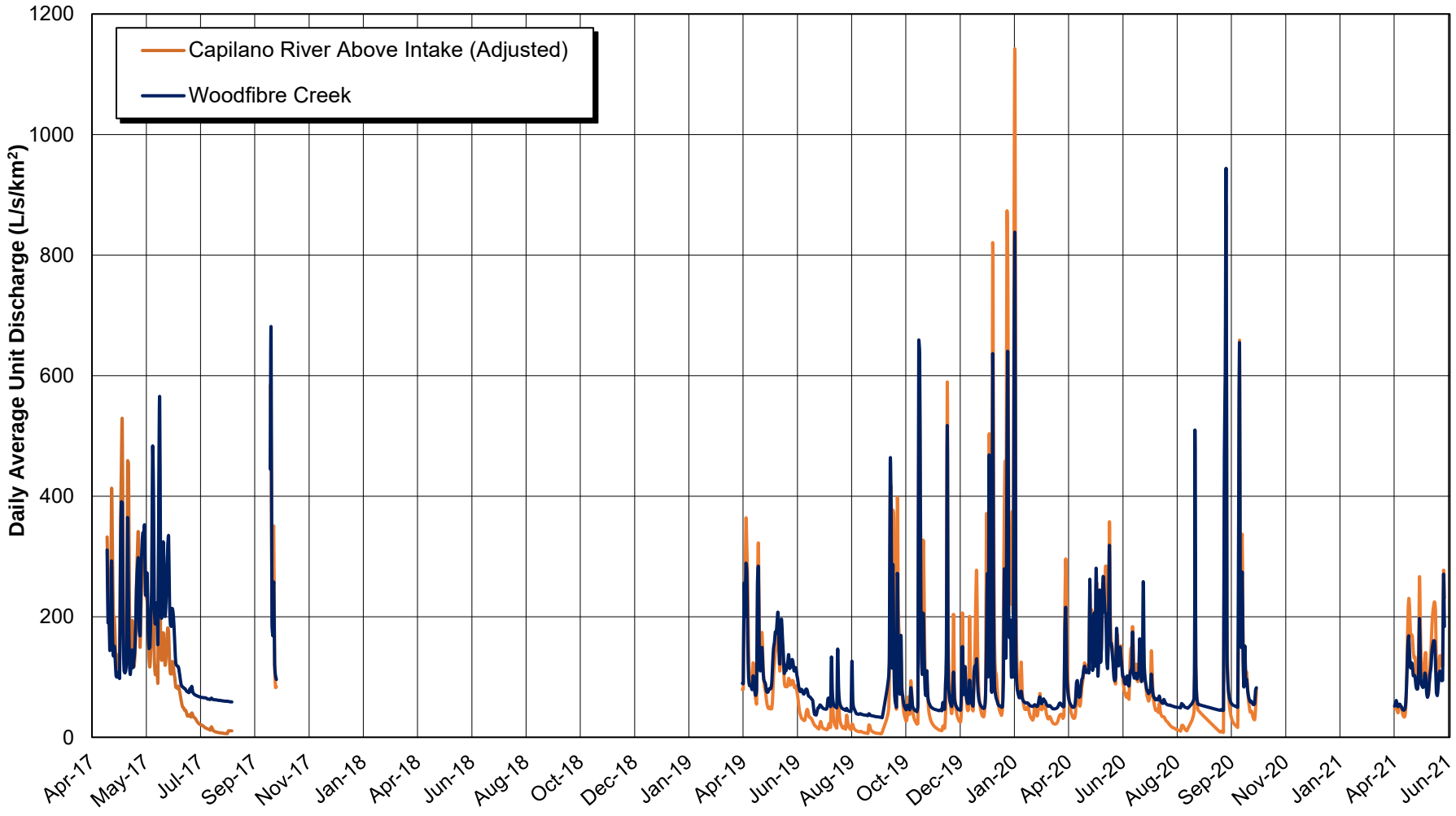
HYDROLOGIC ZONES AND REGIONAL HYDROLOGY STATIONS

Knight Piésold CONSULTING

P/A NO. VA103-00494/24 | REF NO. VA22-01360

FIGURE 4 REV 0

SAVED: M:\103\00494\24\A\GIS\Figs\VA22-01360\Fig4_HydrologicZonesAndRegionalHydrologyStations_r0.mxd: Sep 23, 2022 9:30 AM: kkrauszova



NOTES:
1. PERIOD OF RECORD FOR CONCURRENT PROJECT AND WSC STATION DISCHARGE IS APRIL 2017 TO MAY 2021.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

WOODFIBRE CREEK AND CAPILANO RIVER CONCURRENT UNIT RUNOFF

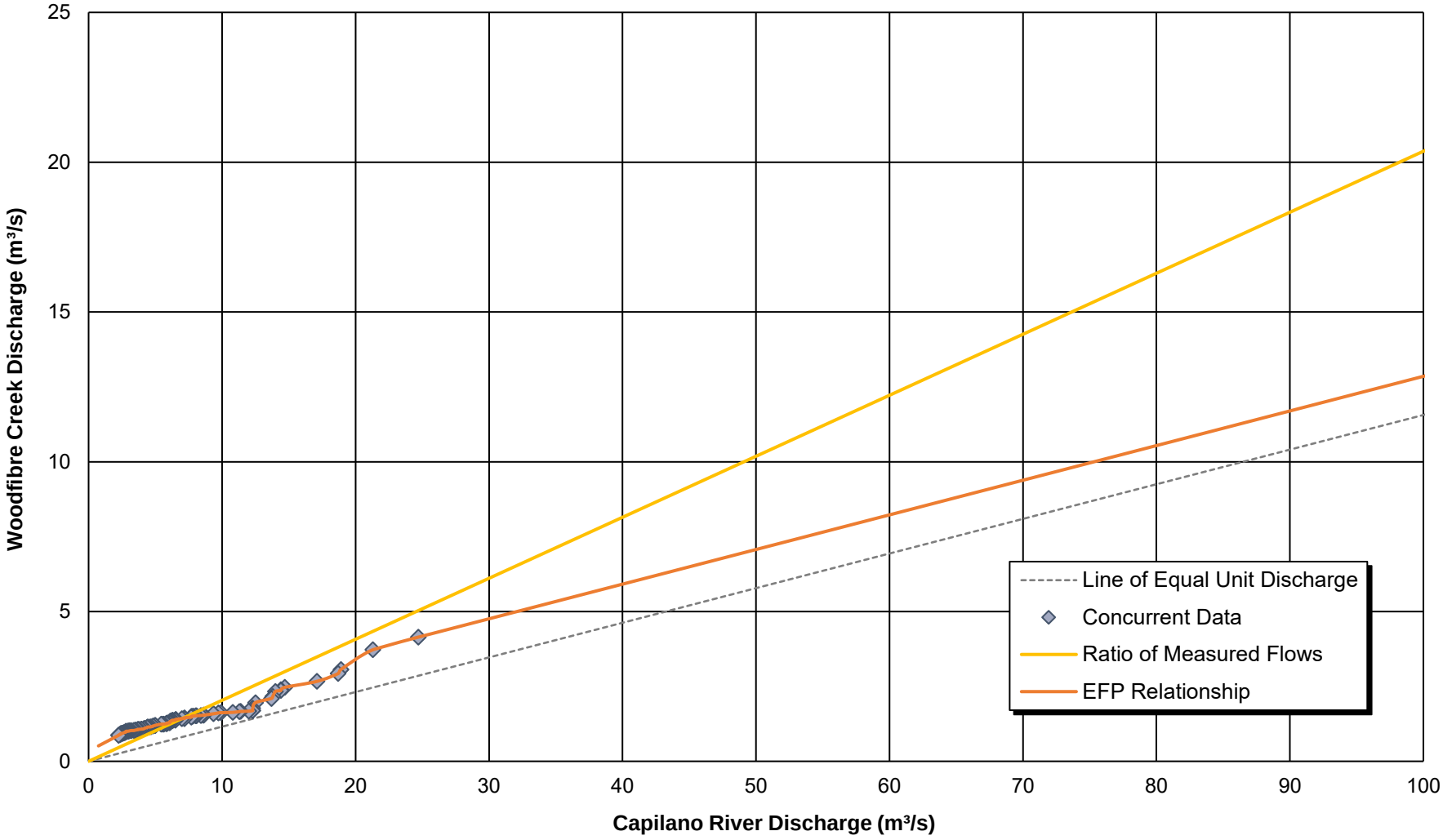
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01360

FIGURE 5

REV 0



NOTES:
1. PERIOD OF RECORD USED FOR CONCURRENT PROJECT AND WSC STATION DISCHARGE IS APRIL 1, 2019 TO MAY 28, 2021

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

WOODFIBRE CREEK AND CAPILANO RIVER FREQUENCY PAIRED RELATIONSHIP: JULY

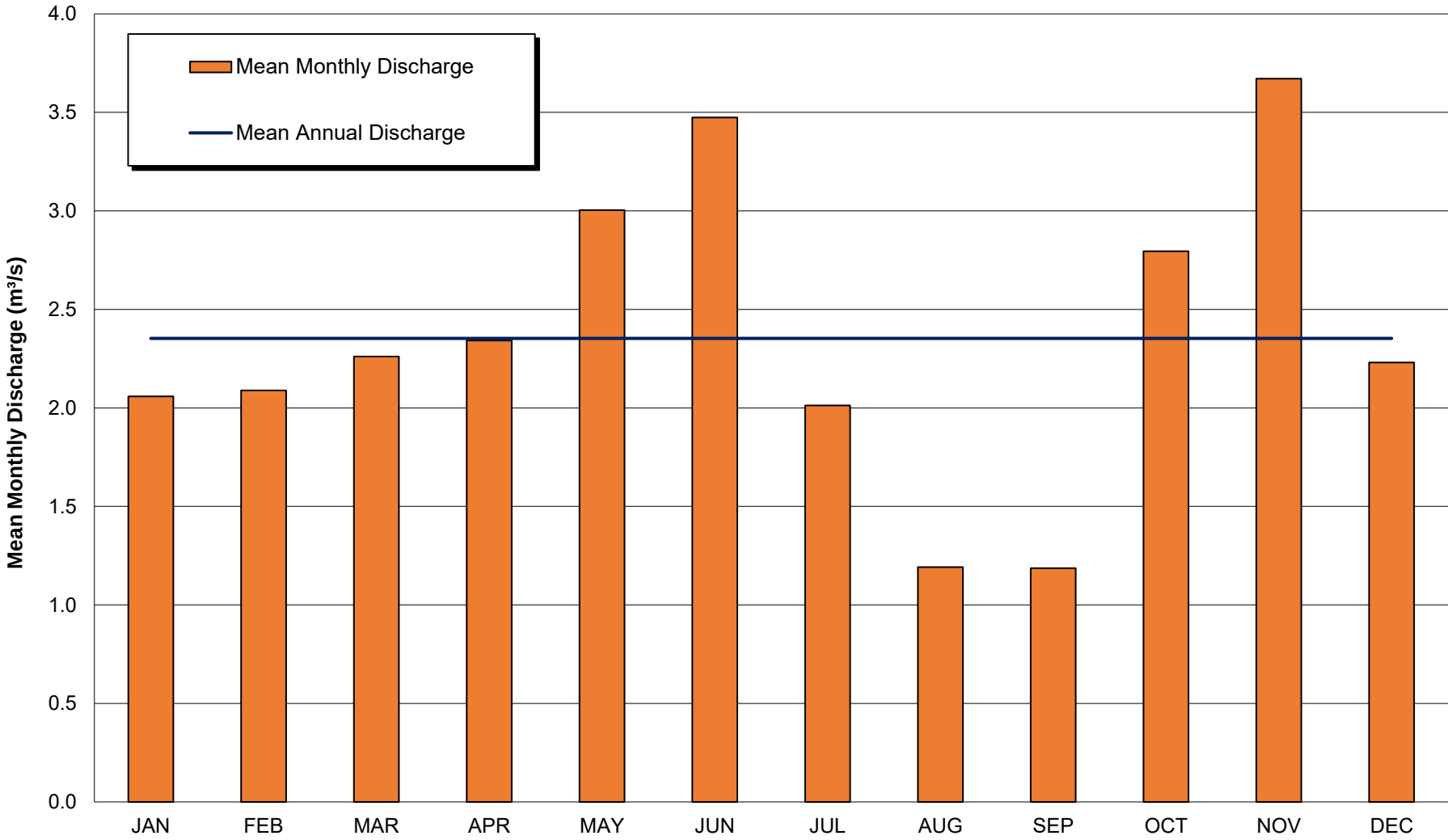
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01360

FIGURE 6

REV 0



NOTES:
1. MEAN MONTHLY FLOWS ESTIMATED FROM LONG-TERM SYNTHETIC SERIES (1960 - 2021).
2. MEAN ANNUAL DISCHARGE IS 2.35 m^3/s

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

WOODFIBRE CREEK SYNTHETIC SERIES MEAN MONTHLY HYDROGRAPH

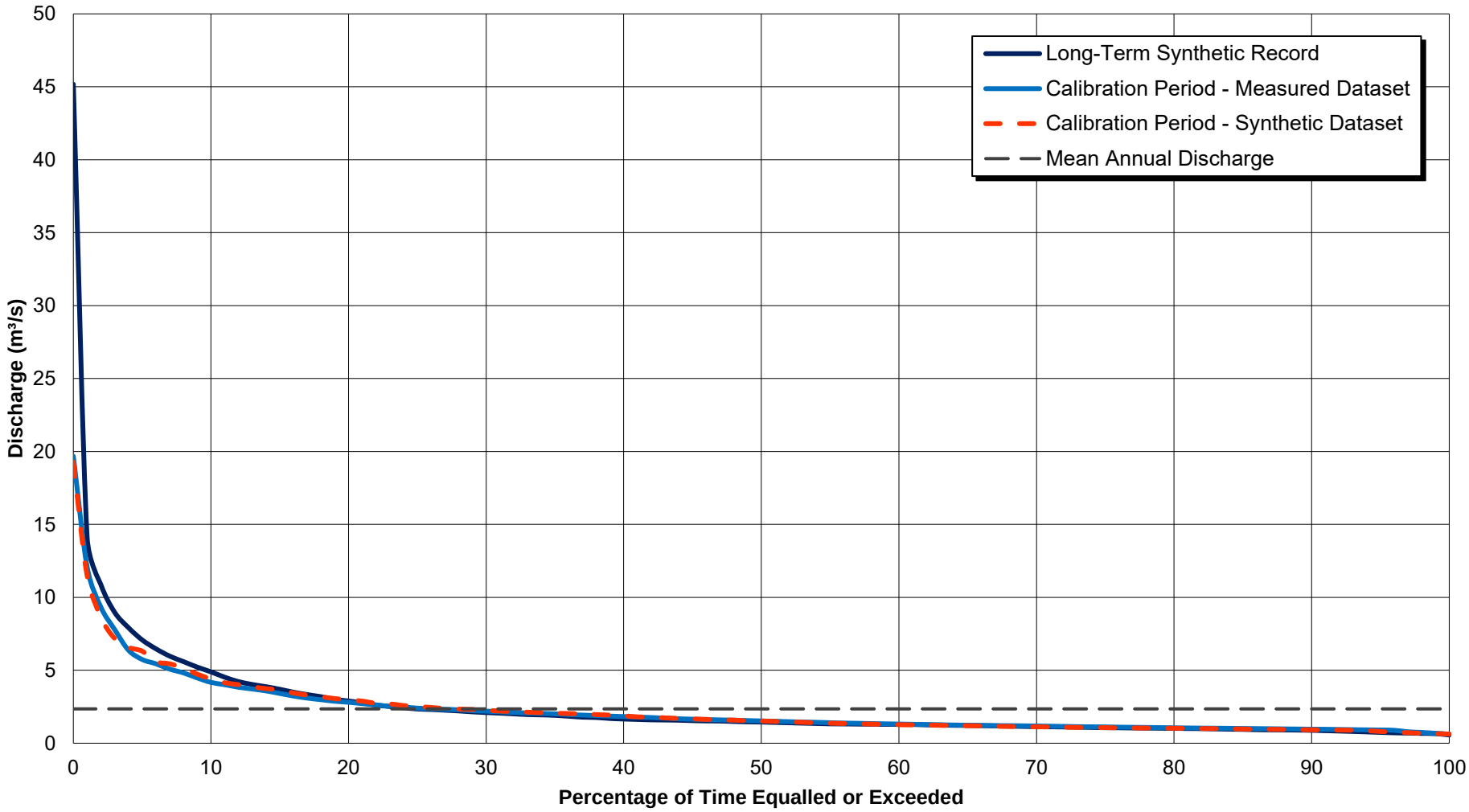
Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01360

FIGURE 7

REV 0



NOTES:
1. PERIOD OF RECORD FOR CONCURRENT PROJECT AND WSC STATION DISCHARGE IS APRIL 2017 TO MAY 2021.
2. THE PERIOD OF RECORD FOR THE LONG-TERM SYNTHETIC SERIES IS JAN 1, 1960 TO JULY 25, 2021, WITH GAPS IN THE RECORD IN 1972-1973 AND 2017-2021.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	26JUL'22	ISSUED WITH LETTER	SKC	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

WOODFIBRE CREEK SYNTHETIC SERIES FLOW DURATION CURVES

Knight Piésold CONSULTING

P/A NO. VA103-494/24

REF. NO. VA22-01360

FIGURE 8

REV 0

APPENDIX A

Woodfibre Creek Hydrologic Analysis

(Pages A-1 to A-8)

Knight Piésold CONSULTING

Management System Certified by: bsi ISO 9001 ISO 14001 ISO 45001 CERTIFIED

February 22, 2022

Darren Cowan
Permitting Manager
Woodfibre LNG Limited
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Vancouver, British Columbia
Canada, V6E 4E6

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Dear Darren,

RE: Woodfibre Creek Hydrologic Analysis

Woodfibre LNG Limited (Woodfibre LNG) is developing a liquefied natural gas (LNG) export facility (the Project) on the former Woodfibre Pulp and Paper Mill site, located near Squamish, British Columbia (BC). Knight Piésold Ltd. (KP) has been retained by Woodfibre LNG to assist with the hydrometric monitoring of Woodfibre Creek, in support of water availability studies and Project permitting. As part of this work, KP has installed and operated streamflow gauging stations on Mill Creek and Woodfibre Creek. This letter presents the details of the Woodfibre Creek field data collection by KP and the available measured record from April 2017 to November 2021.

1.0 HYDROLOGIC SETTING

The Project area is located within Hydrologic Zone 27 (Western South Coast Mountains), on the boundary with Zone 26, as presented by Ahmed (2017). In this zone, Pacific frontal systems encounter the abruptly rising terrain of the Coast Mountains and produce large quantities of precipitation as they are forced upward. Spatial variability in annual precipitation is extensive due to orographic enhancement on windward slopes and rain shadow effects in leeward areas. The proportion of precipitation falling as snow varies with elevation, with little snow falling at sea level and large snowpacks accumulating on upper mountain slopes. Even at high elevations, however, winter rainfall and snowmelt are common, leading to a complex hydrologic regime. In general, streamflow in South Coast watersheds like Woodfibre Creek (i.e. coastal, but also with high elevation mountainous terrain) is highest in autumn due to frontal rainstorm activity, with a secondary peak in spring due to snowmelt. Flows are lowest in late summer when precipitation is low. Winter flows tend to be moderate as much of the precipitation falls as snow but can be punctuated by warm rainfall events and rainfall at lower elevation.

Mean annual precipitation varies from only 1,490 mm at Gibsons, located approximately 35 km southwest of the Project, to 3,322 mm at Port Mellon, located 25 km southwest of the Project and then to 2,230 mm in Squamish. This is indicative of topographic convergence of frontal systems in Howe Sound, and extreme orographic enhancement of precipitation due to rapid uplift. Similarly, mean annual unit runoff varies dramatically from 125 l/s/km^2 (or 4,000 mm) in Rainy River, located near Port Mellon and 116 l/s/km^2 (or 3,660 mm) in Capilano River, located close to the Project area, to only 32 l/s/km2 (or 1,000 mm) in Roberts Creek, located 40 km to the southwest and with a lower elevation basin.

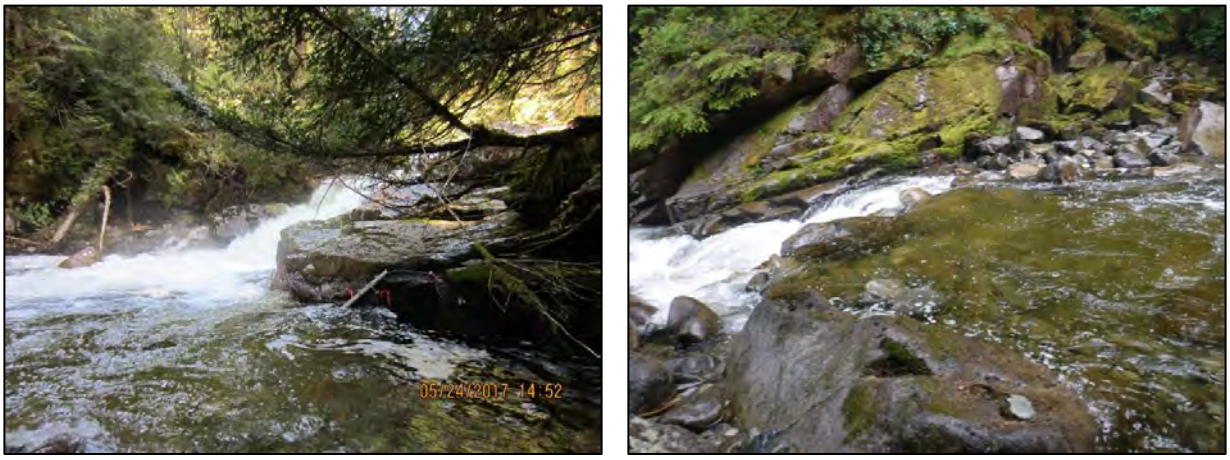
The median watershed elevation above the Woodfibre Creek gauge is 1,057 meters above sea level and glaciers cover a negligible area in the watershed. The watershed area at the streamflow gauging station is

20 km^2, increasing to 22 km^2 at the mouth. Over the 100+ year history of activity at the Woodfibre mill site, there has been a significant amount of water management infrastructure built in the Woodfibre Creek watershed. Flow diversions, reservoir construction and flow regulation were undertaken to provide water for power and mill operations. Although not currently operated, these structures continue to effect streamflow conditions in Woodfibre Creek and the flow regime should be considered regulated. The Woodfibre Creek watershed is shown on Figure 1.

2.0 STREAMFLOW DATA COLLECTION

2.1 WOOD STATION

KP installed a hydrometric station (WOOD) on Woodfibre Creek approximately 100 meters upstream of the existing hydropower intake in April 2017. The location is shown on Figure 1. The station is located on the left bank of a pool, downstream of a cascade, as shown on Photo 1a. Water level is hydraulically controlled by a cascade at the outlet of the pool, shown on Photo 1b. The low-flow control section consists of cobbles between large boulders, while the high-flow control also includes the bedrock banks. The hydrometric station consists of a pressure transducer connected to a datalogger that records stage at fifteen-minute intervals. The pressure transducer and datalogger were replaced at the end of the 2020 monitoring program as part of routine maintenance.



(a) (b)

Photo 1 (a) WOOD Station looking upstream (May 24, 2017), and (b) looking downstream at the hydraulic control (July 20, 2017)

2.1.1 WOOD RATING CURVE AND DISCHARGE HYDROGRAPH

A total of 21 stage/discharge measurements have been collected at WOOD, as summarized in Table 1. The discharge measurements were conducted using area-velocity or Rhodamine dye dilution methods, depending on flow conditions at the time of each site visit. The station includes three benchmarks, located in bedrock above the normal high-water level, and two reference marks for determining stage. Benchmark 1 was assigned an elevation of 10 m and this datum is used for converting water level to gauge height (stage). Twenty of the 21 stage-discharge measurements were used to develop a rating curve for the gauge. One data point, collected in October 2020, falls outside the rating curve and is considered erroneous.

One rating curve was plotted through the 20 applicable stage-discharge points using the standard form for a rating curve equation (power function), with the constant, offset, and exponent constrained within

expected values based on hydraulic theory (Maidment, 1993) and experience with similar conditions in mountainous streams. The rating curve is shown on Figure 2. The number and distribution of discharge measurements delineating the rating curve meets the RISC (2018) recommendations over the measured range of flows and, in particular, over the range of flows most relevant to the water availability studies and Project permitting. Due to upstream flow regulation, low flows collected at the WOOD station have not fallen below 0.6 m^3/s and are concentrated between 0.6 m^3/s to 1.1 m^3/s.

All data points collected in 2021 fall on the rating curve, suggesting that the curve is stable and no shift has occurred during the period of record. The data collected at WOOD is considered to meet Grade A standards based on the B.C. Hydrometric RISC standards (2018), except RISC (2018) notes that rating curves developed from dilution methods should be graded as "BP" (i.e., Best Practice) due to lack of Provincial guidelines on the method.

The daily average discharge hydrograph for WOOD is presented on Figure 3, which was developed by applying the rating curve to the available stage record and then averaging the fifteen-minute streamflow record over a calendar day. The hydrograph has gaps from September 5, 2017 to October 17, 2017, from October 25, 2017 to February 13, 2017, and from October 29, 2020 to April 1, 2021 (dates are inclusive) due to logger malfunctions.

3.0 DISCUSSION

Streamflow gauging will continue on Woodfibre Creek to support the water availability studies and Project permitting. The rating curve is believed to accurately calculate streamflow over the range of conditions most important for the water availability studies and Project permitting. However, over the last three years of monitoring flows have not fallen below 0.6 m^3/s. Low flow measurements will continue to be targeted to improve low flow rating curve accuracy. At least five site visits covering an adequate range of streamflows should be conducted annually at the Woodfibre Creek gauging station to confirm rating curve stability and meet the Grade A standard for data collection guidelines outlined in RISC (2018).

Yours truly,
Knight Piésold Ltd.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
T. J. PERKINS
32079
2022-02-22

Prepared: Kaelan Hagen, GIT
Project Scientist

Reviewed: Toby Perkins, M.A.Sc., P.Eng.
Senior Engineer

Approval that this document adheres to the Knight Piésold Quality System: SRW

Attachments:

Table 1 Rev 0	Summary of Discharge Measurements
Figure 1 Rev 0	Woodfibre Creek Watershed
Figure 2 Rev 0	Woodfibre Creek (WOOD) Rating Curve – Extrapolated to Maximum Recorded Stage-Discharge Measurement
Figure 3 Rev 0	Woodfibre Creek (WOOD) Daily Average Discharge Hydrograph

References

Ahmed, A. (2017). “Inventory of Streamflow in the South Coast and West Coast Regions”, October 2017, Knowledge Management Branch, British Columbia Ministry of Environment and Climate Change Strategy, Victoria, B.C.

Maidment, David R. (1993). Handbook of hydrology. Vol. 9780070. McGraw-Hill, New York.

Resources Information Standards Committee (RISC). 2018. Manual of British Columbia Hydrometric Standards, Version 2.0, December 2018. Knowledge Management Branch, B.C. Ministry of Environment and Climate Change Strategy, Victoria, B.C.

/krh

Knight Piésold CONSULTING

TABLE 1

WOODFIBRE LNG LTD.
WOODFIBRE LNG PROJECT

WOODFIBRE CREEK (WOOD)
SUMMARY OF DISCHARGE MEASUREMENTS

Print Feb/22/22 10:53:33

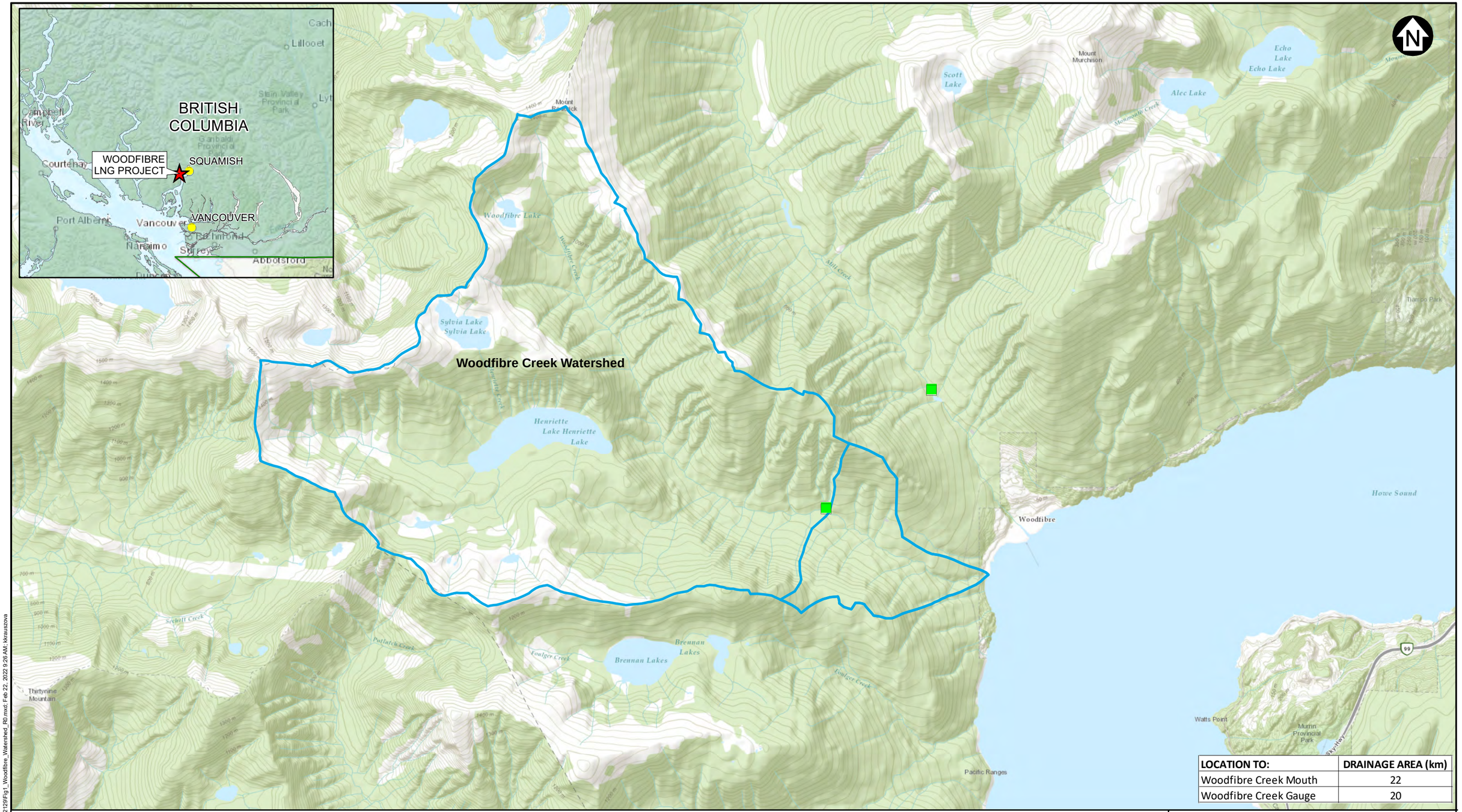
Date	Number of Gaugings	Method	Stage [m]	Stage +/- [m]	Discharge [m^3/s]	Discharge Error
4/18/2017	3	Dye Dilution	9.71	0.010	7.40	15%
5/24/2017	3	Dye Dilution	9.55	0.010	3.22	>25 %
7/20/2017	2	Area-Velocity	9.39	0.005	1.58	10%
8/8/2017	2	Area-Velocity	9.33	0.005	1.14	5%
8/30/2017	2	Area-Velocity	9.30	0.010	1.13	5%
2/13/2018	4	Dye Dilution	9.36	0.010	1.58	15%
4/18/2018	4	Dye Dilution	9.38	0.010	1.52	10%
10/17/2018	2	Area-Velocity	9.28	0.020	1.01	10%
4/10/2019	5	Dye Dilution	9.40	0.010	1.83	10%
8/14/2019	2	Area-Velocity	9.21	0.005	0.76	5%
9/6/2019	2	Area-Velocity	9.18	0.002	0.64	10%
5/29/2020	4	Dye Dilution	9.50	0.020	2.51	10%
7/29/2020	2	Area-Velocity	9.27	0.010	0.97	10%
9/2/2020	2	Area-Velocity	9.26	0.020	0.97	10%
9/17/2020	2	Area-Velocity	9.25	0.005	0.88	10%
10/29/2020	3	Dye Dilution	9.40	0.010	2.69	15%
4/1/2021	3	Dye Dilution	9.33	0.010	1.24	20%
4/21/2021	3	Dye Dilution	9.53	0.020	2.76	20%
5/28/2021	3	Dye Dilution	9.58	0.020	3.71	15%
8/27/2021	4	Dye Dilution	9.26	0.010	0.94	15%
11/22/2021	4	Dye Dilution	9.33	0.020	1.29	15%

\\KPL\VA-Prj$\1\03\00494\18\A\Data\Hydrology\End of Year 2021 QAQC\WOOD\[WOOD QAQC_Nov2021.xlsm]Q Table

NOTES:

1) NUMBER OF GAUGINGS REFERS TO THE NUMBER OF GAUGINGS AVERAGED TO PRODUCE ONE RATING POINT.
2) DISCHARGE ERROR REFERS TO THE IN-SITU MEASUREMENT ERROR ESTIMATED BY THE FIELD ENGINEER.
3) STAGE ERROR IS BASED ON A VISUAL ASSESSMENT OF THE WAVE AMPLITUDE IN THE GAUGE POOL.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	22FEB'22	ISSUED WITH LETTER VA21-02129	KRH	TJP



LOCATION TO:	DRAINAGE AREA (km)
Woodfibre Creek Mouth	22
Woodfibre Creek Gauge	20

LEGEND:

- ACTIVE WOODFIBRE LNG HYDROLOGY GAUGE
- WATERSHED BOUNDARY

0 0.5 1 2 3 4 Km

NOTES:

1. BASE MAP: ESRI WORLD TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:40,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	22FEB'22	ISSUED WITH LETTER	TJP	KK	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

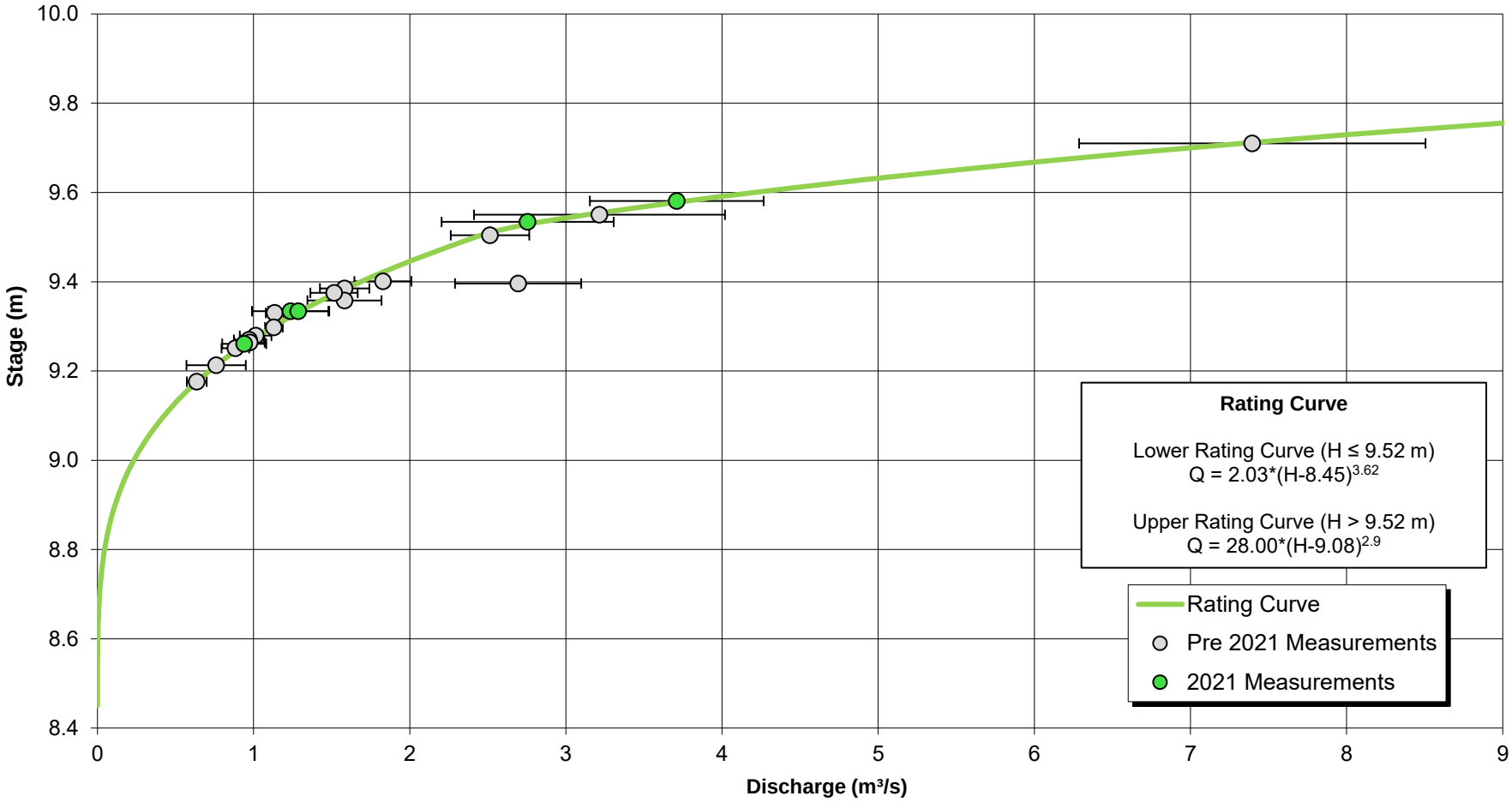
WOODFIBRE CREEK WATERSHED

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-00494/18	VA21-02129

FIGURE 1 REV 0

SAVED: M:\1\03\00494\18\A\GIS\Figs\VA21-02129\Fig1_Woodfibre_Watershed_R0.mxd Feb 22, 2022 9:26 AM, kkrauszova



REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	22FEB'22	ISSUED WITH LETTER VA21-02129	KRH	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

WOODFIBRE CREEK (WOOD)
RATING CURVE - EXTRAPOLATED TO MAXIMUM RECORDED STAGE-DISCHARGE MEASUREMENT

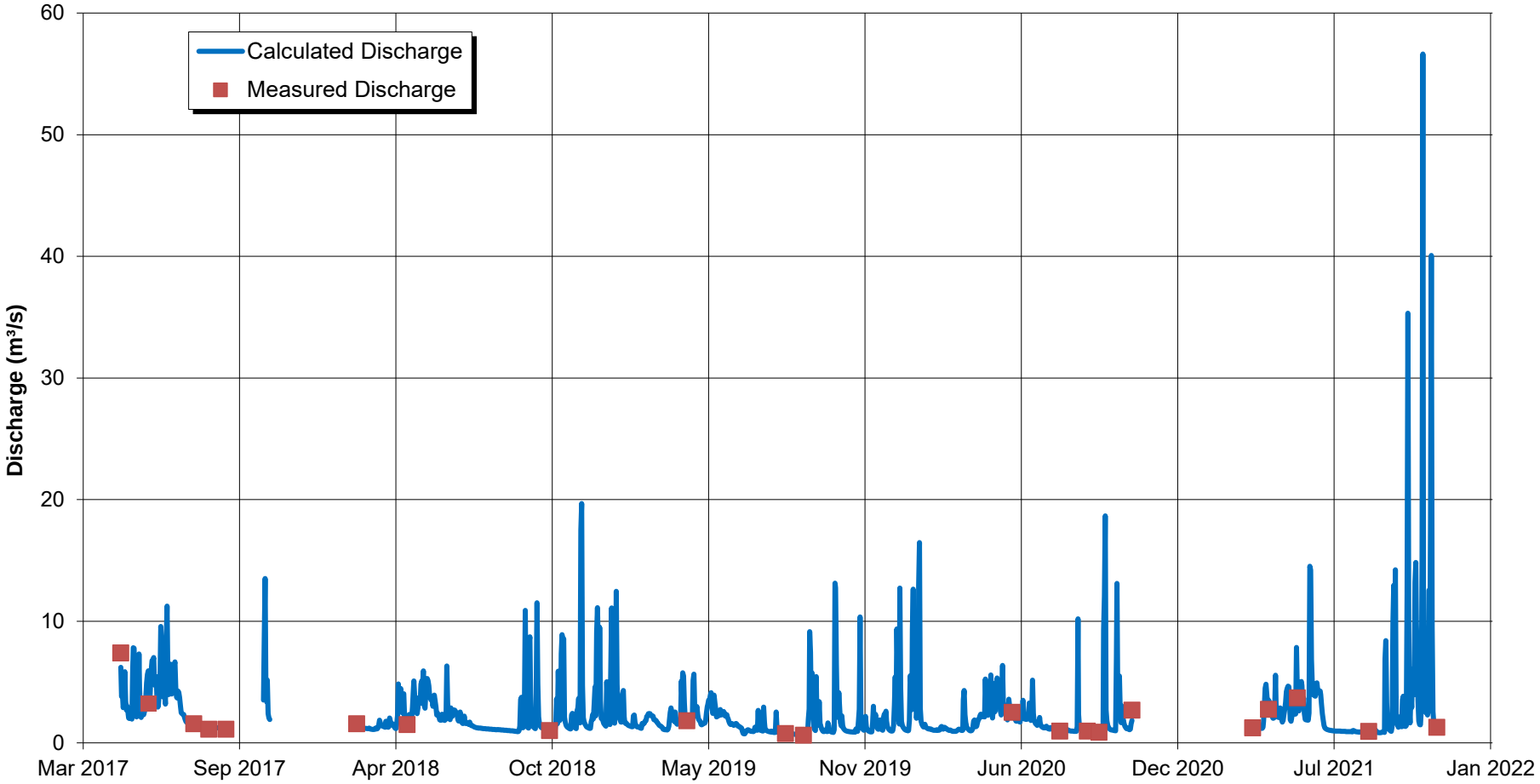
Knight Piésold CONSULTING

P/A NO. VA103-494/18

REF. NO. VA21-02129

FIGURE 2

REV 0



NOTE:
1. MANUAL MEASUREMENTS OF INSTANTANEOUS DISCHARGE DO NOT NECESSARILY MATCH DAILY AVERAGE DISCHARGE ON THE SAME DATE DUE TO DAILY FLUCTUATIONS IN DISCHARGE.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	22FEB'22	ISSUED WITH LETTER VA21-02129	KRH	TJP

WOODFIBRE LNG LTD.

WOODFIBRE LNG PROJECT

WOODFIBRE CREEK (WOOD)
DAILY AVERAGE DISCHARGE HYDROGRAPH

Knight Piésold CONSULTING

P/A NO. VA103-494/18

REF. NO. VA21-02129

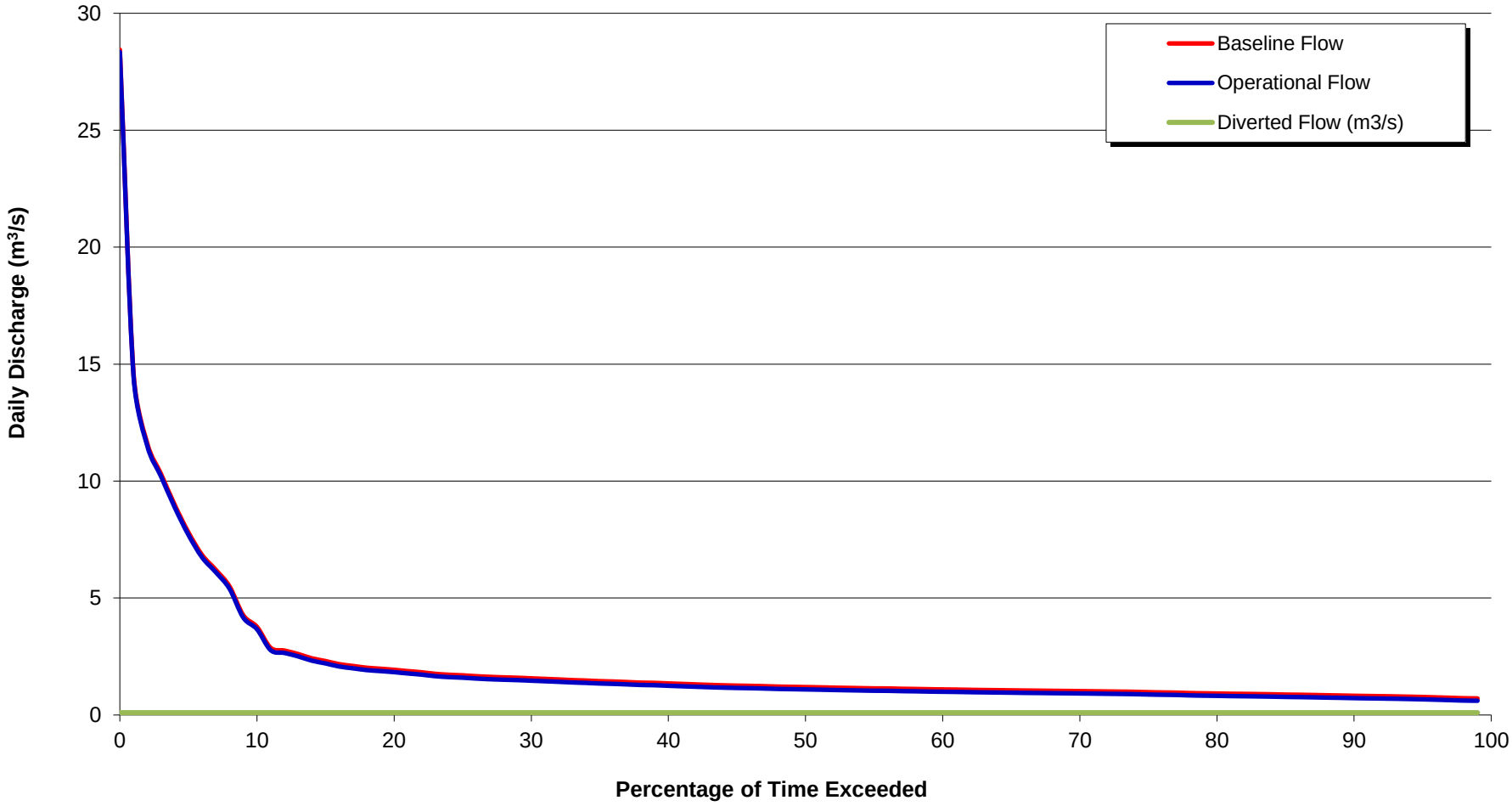
FIGURE 3

REV 0

APPENDIX B

Woodfibre Creek Synthetic Flow Duration Curves

(Figures B-1 to B-12)



3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP
REV	DATE	DESCRIPTION	PREP'D	RVW'D

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

JANUARY FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

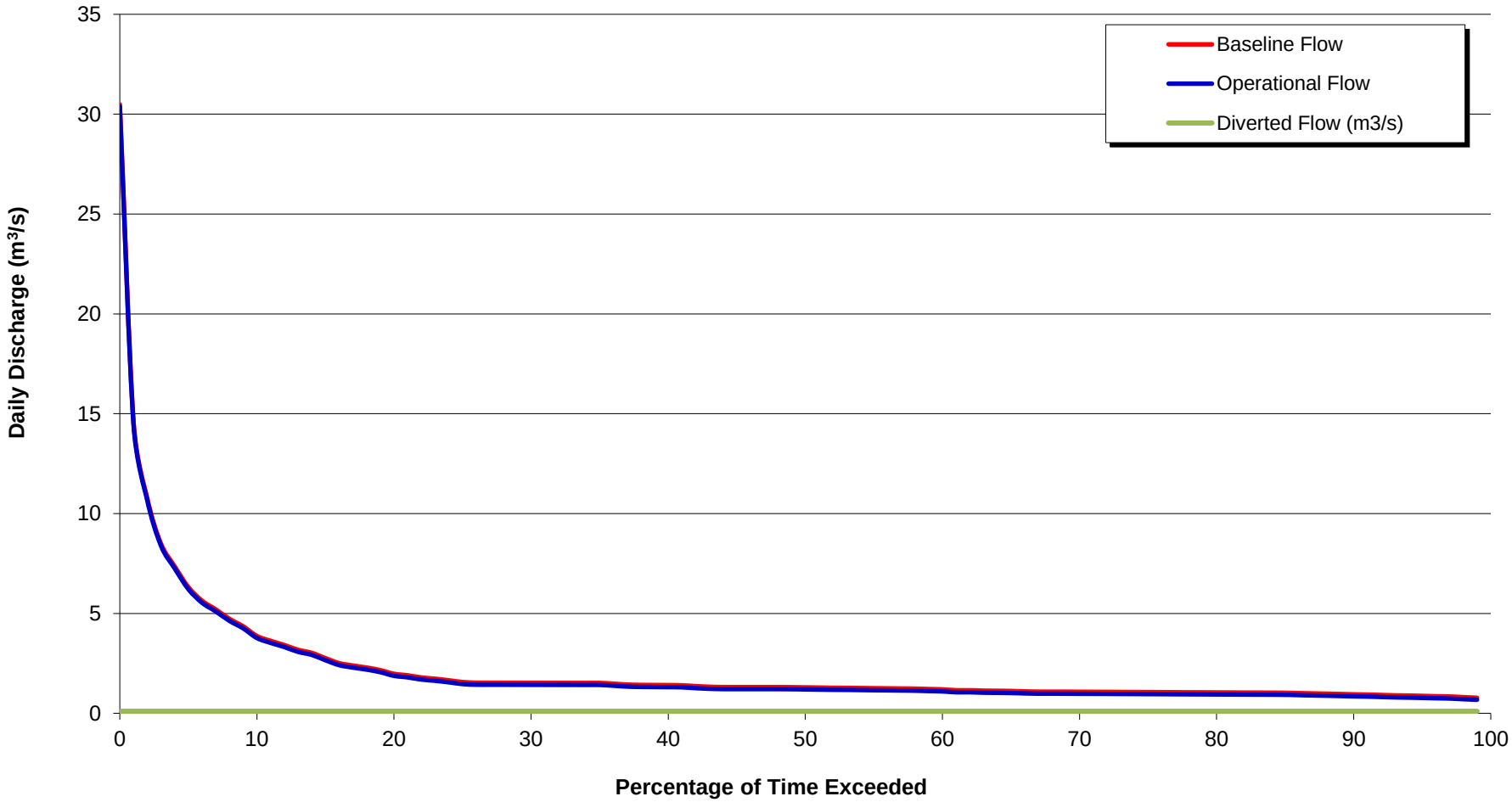
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-1

REV 3



REV	DATE	DESCRIPTION	PREP'D	RVW'D
3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

FEBRUARY FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

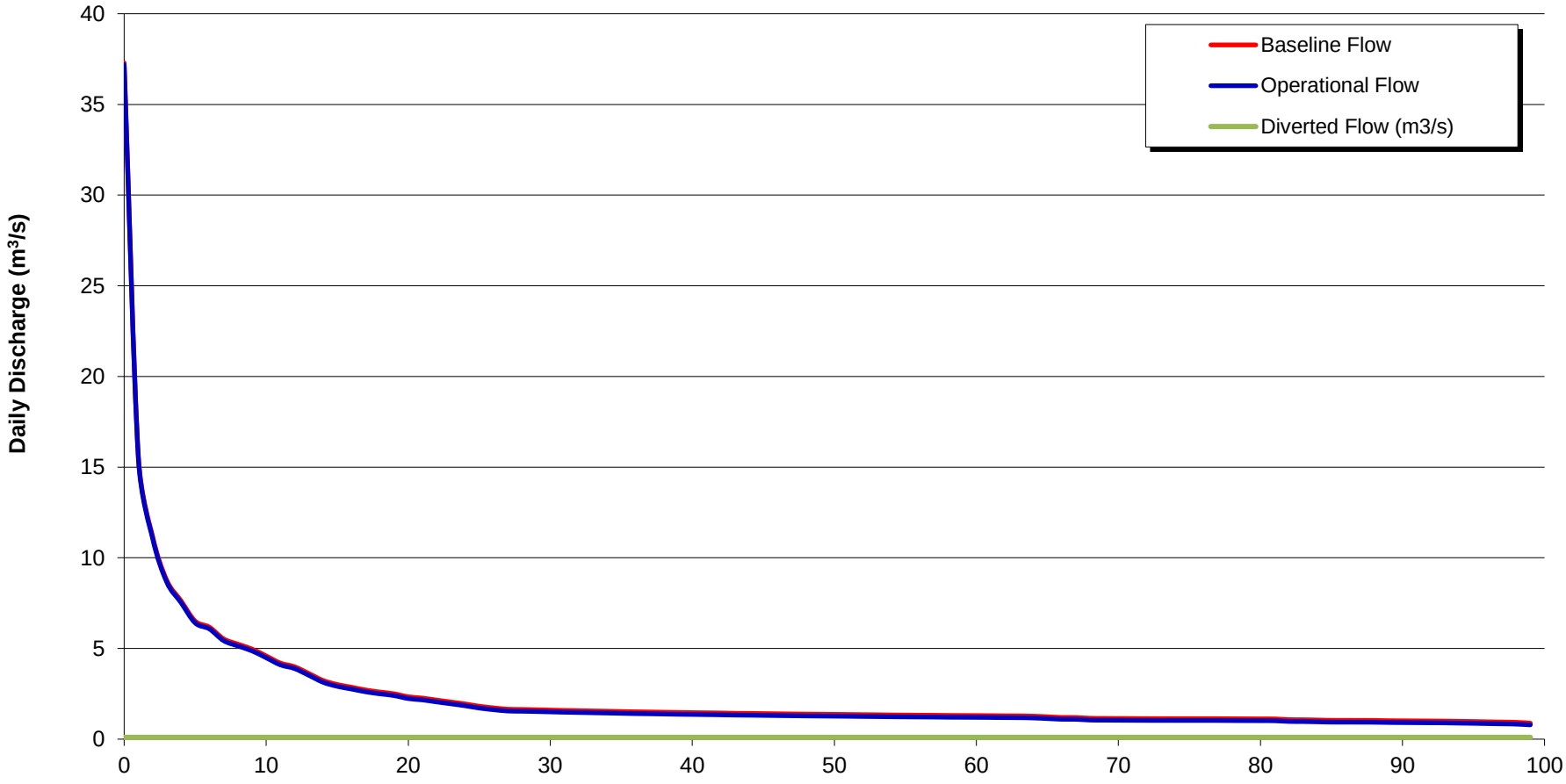
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-2

REV 3



REV	DATE	DESCRIPTION	PREP'D	RVW'D
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WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

MARCH FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

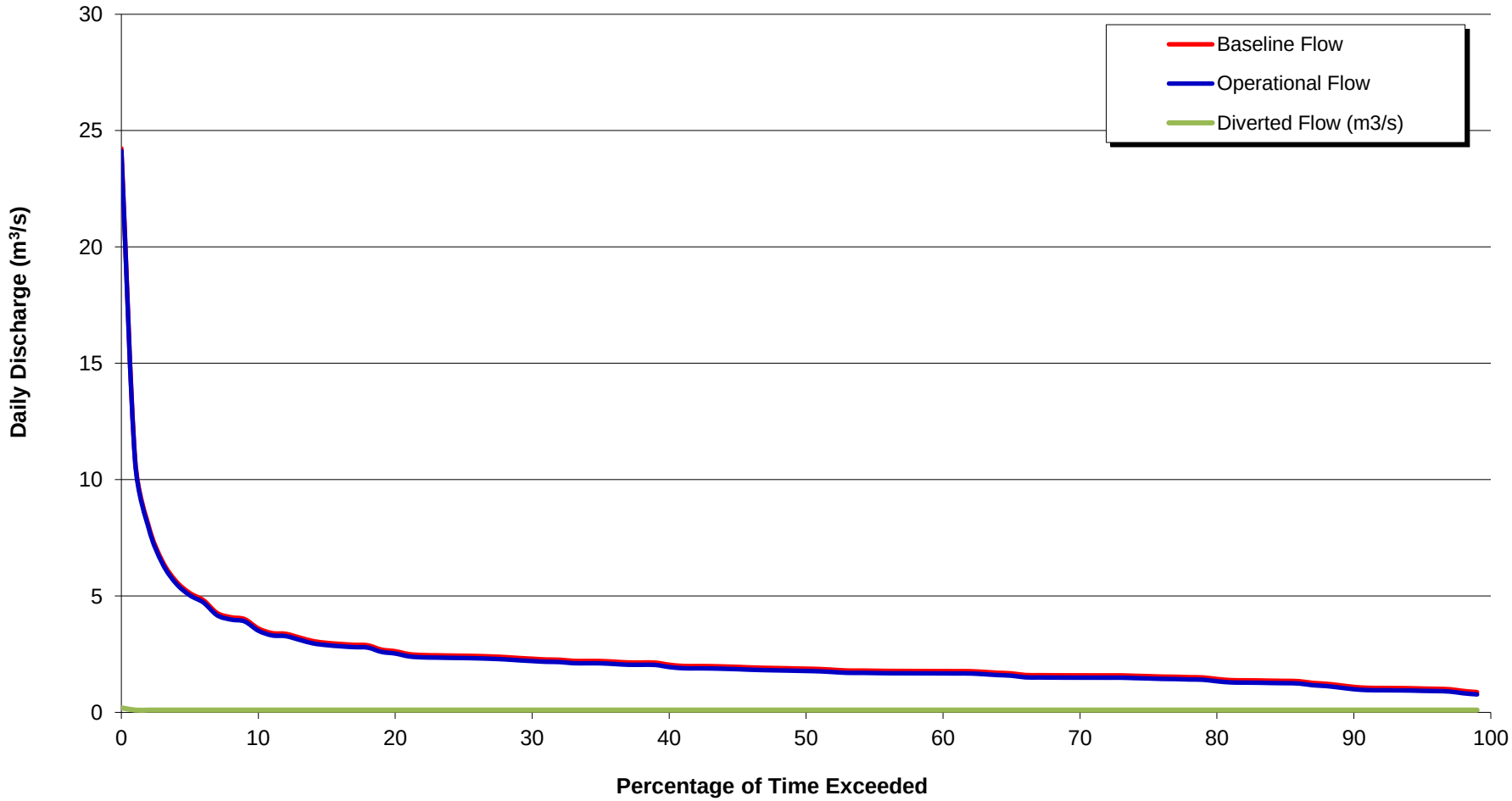
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-3

REV 3



REV	DATE	DESCRIPTION	PREP'D	RVW'D
3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

APRIL FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

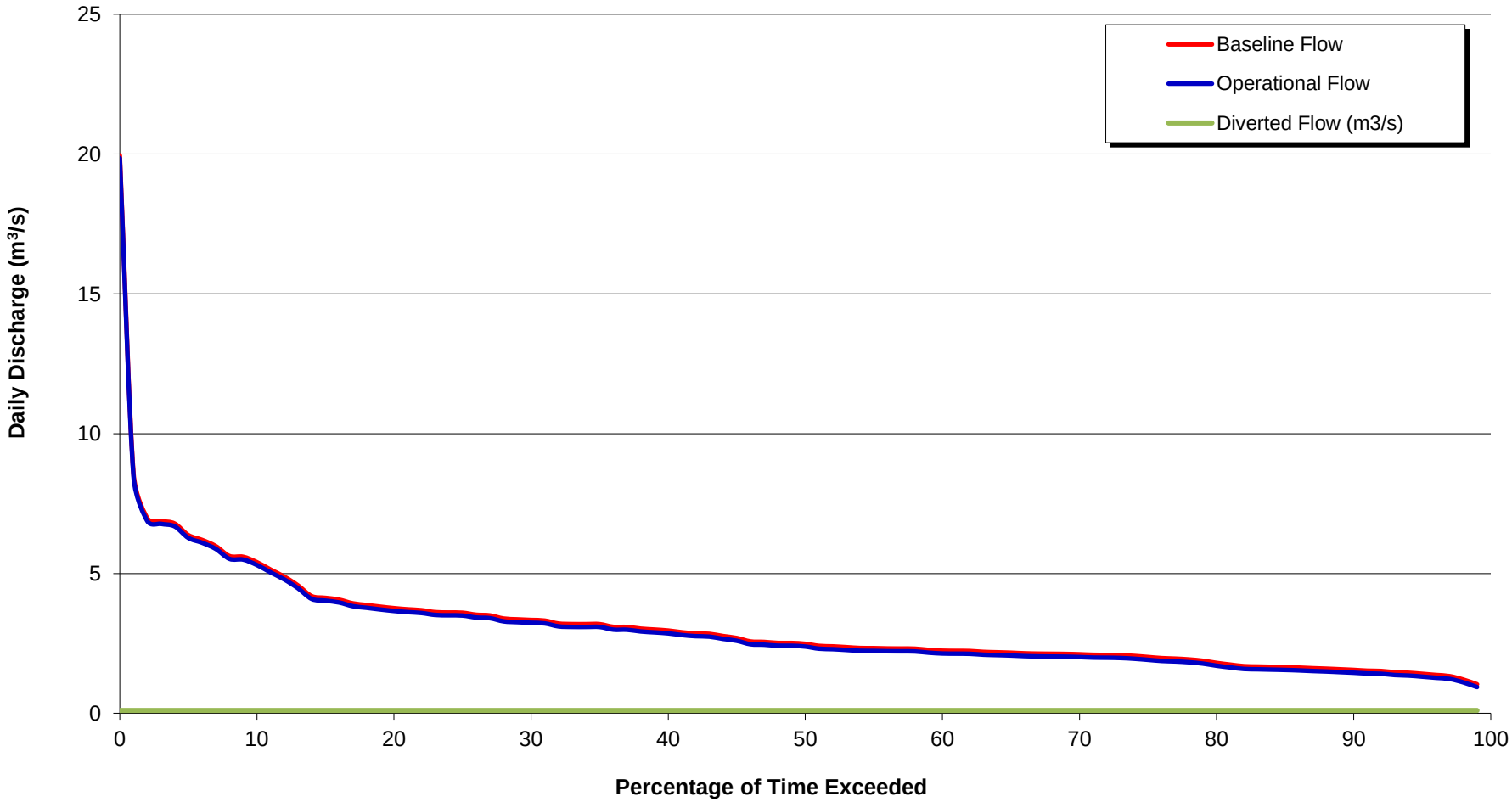
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-4

REV 3



3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP
REV	DATE	DESCRIPTION	PREP'D	RVW'D

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

MAY FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

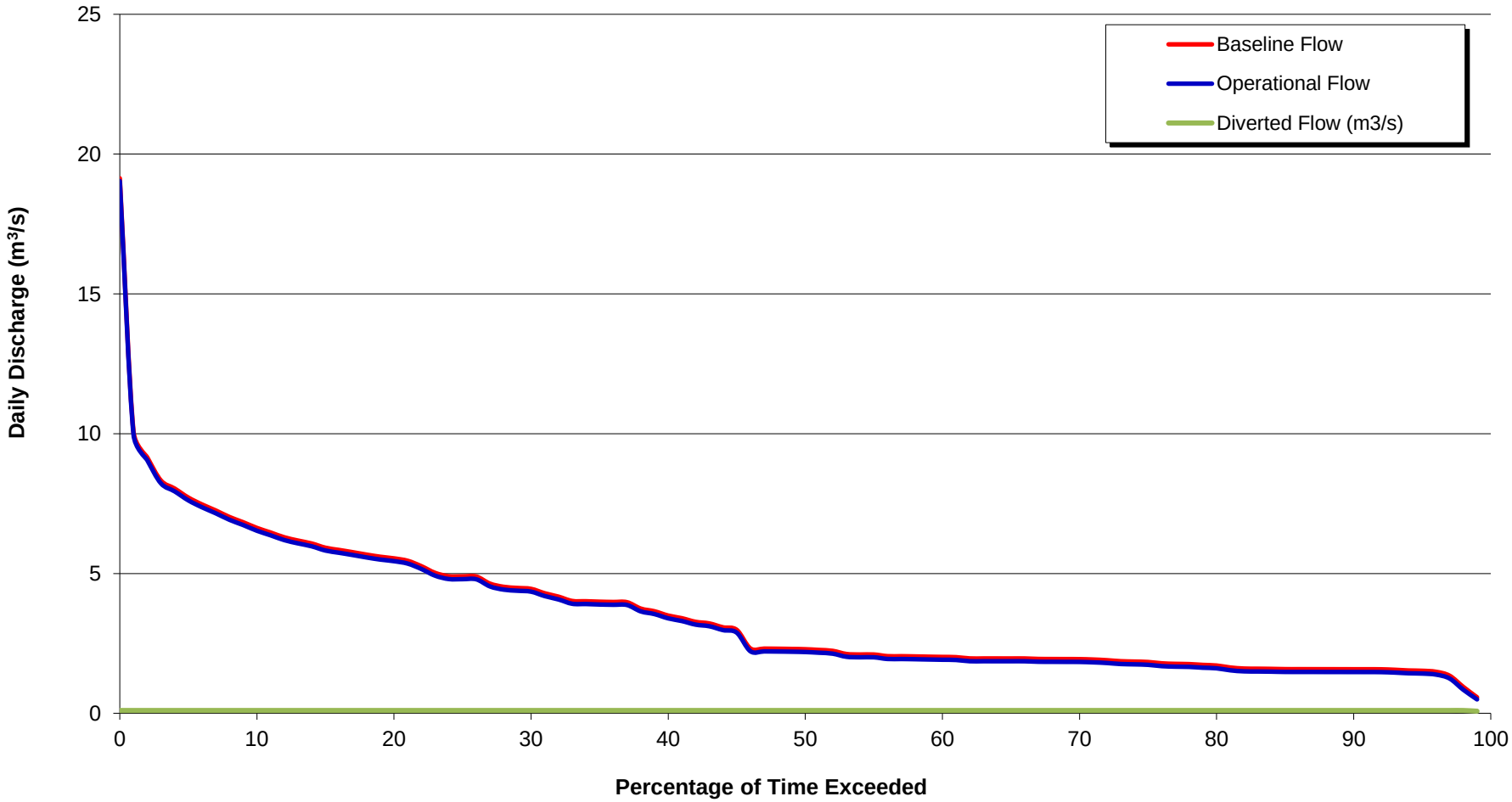
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-5

REV 3



REV	DATE	DESCRIPTION	PREP'D	RVW'D
3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

JUNE FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

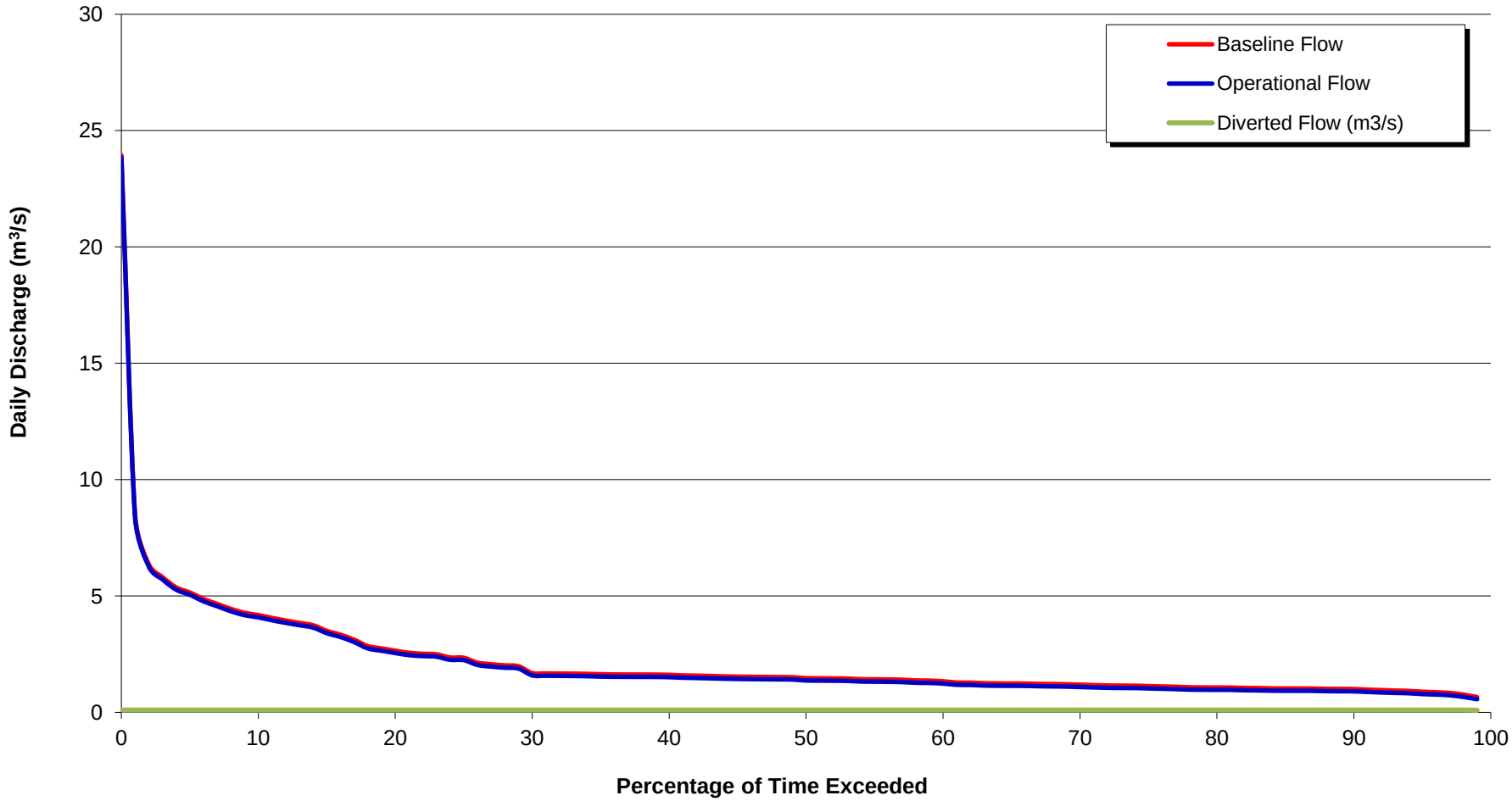
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-6

REV 3



REV	DATE	DESCRIPTION	PREP'D	RVW'D
3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

JULY FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

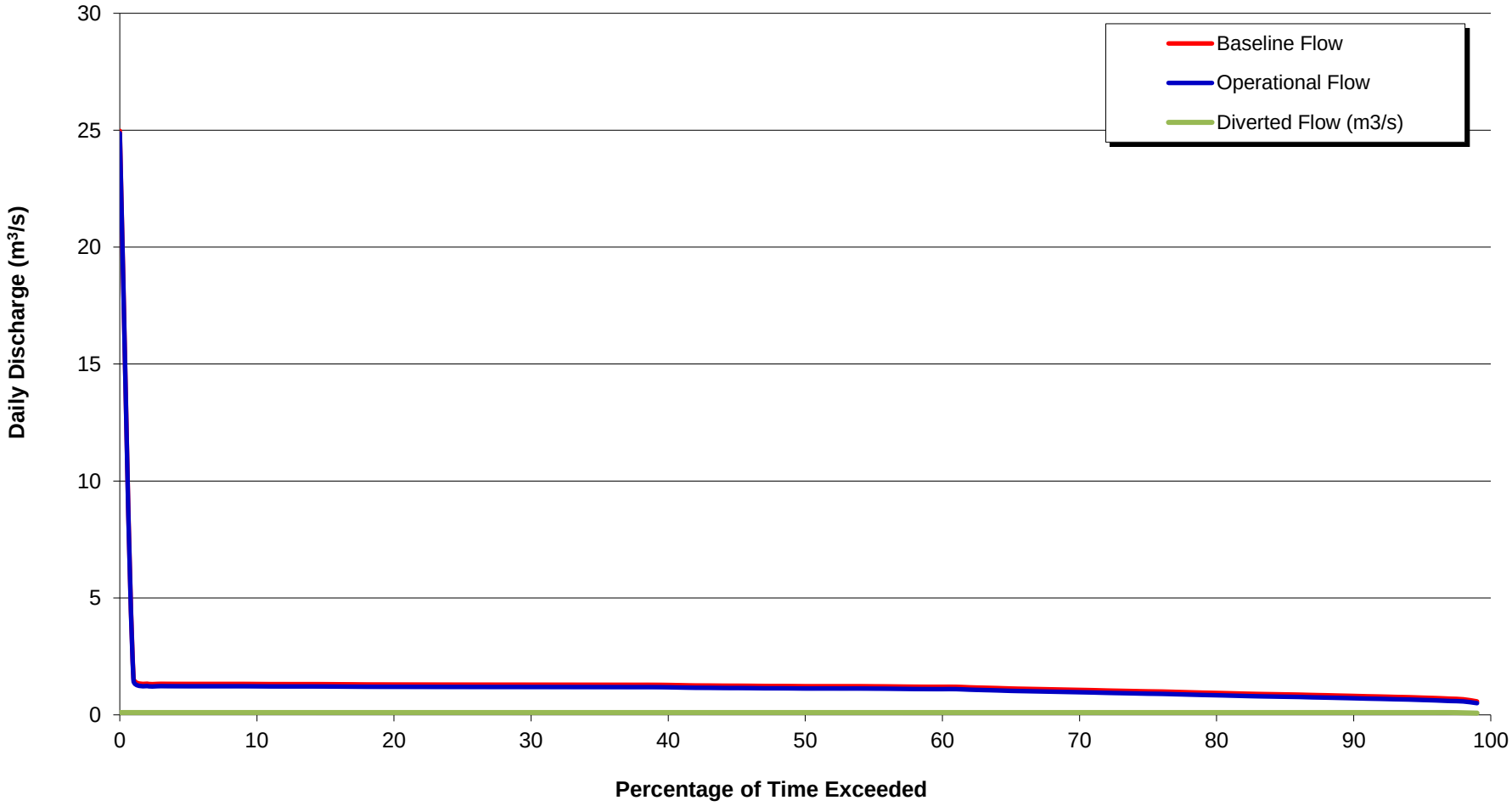
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-7

REV 3



3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP
REV	DATE	DESCRIPTION	PREP'D	RVW'D

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

AUGUST FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

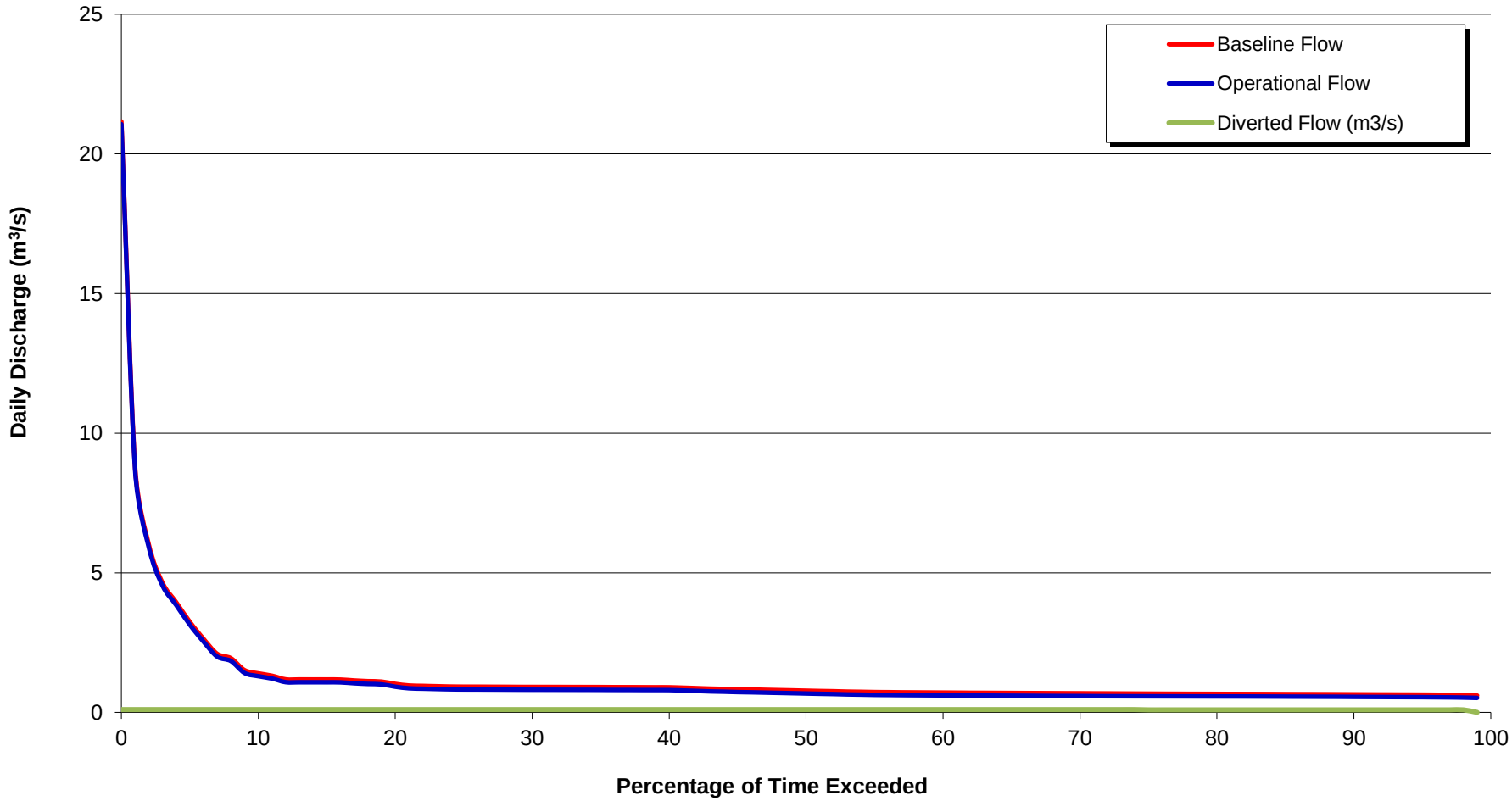
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-8

REV 3



REV	DATE	DESCRIPTION	PREP'D	RVW'D
3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

SEPTEMBER FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

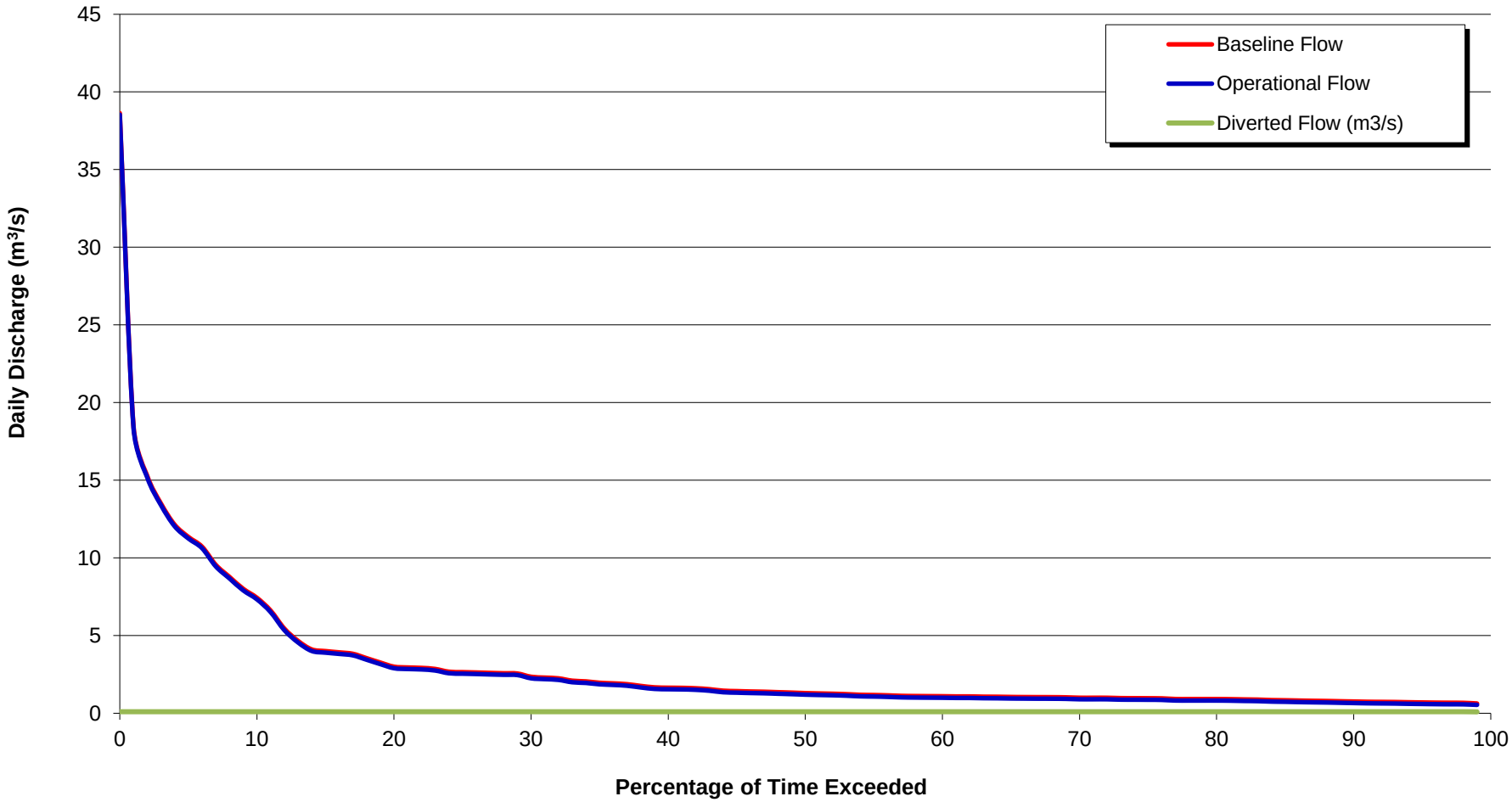
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-9

REV 3



REV	DATE	DESCRIPTION	PREP'D	RVW'D
3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

OCTOBER FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

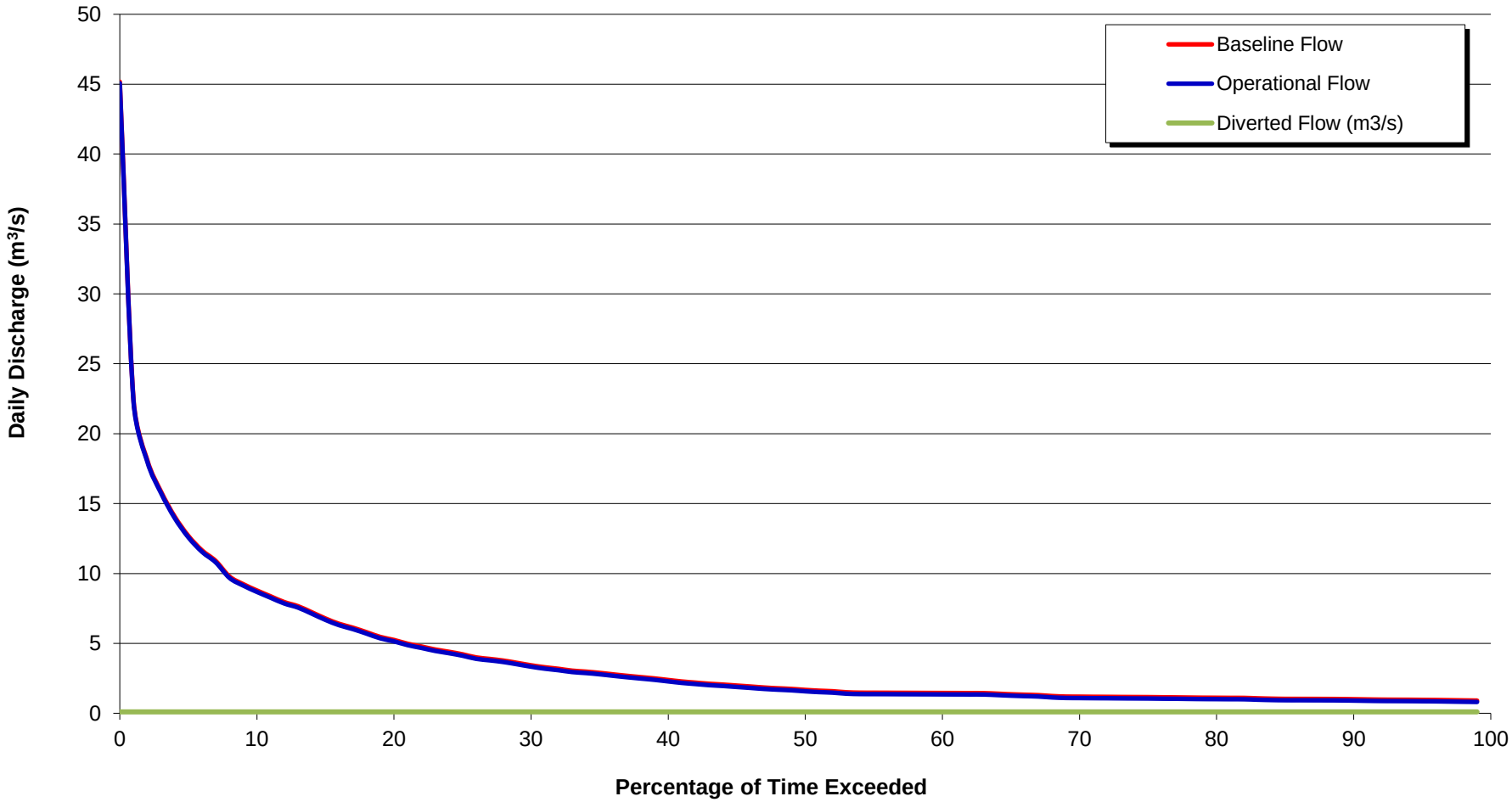
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-10

REV 3



REV	DATE	DESCRIPTION	PREP'D	RVW'D
3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

NOVEMBER FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

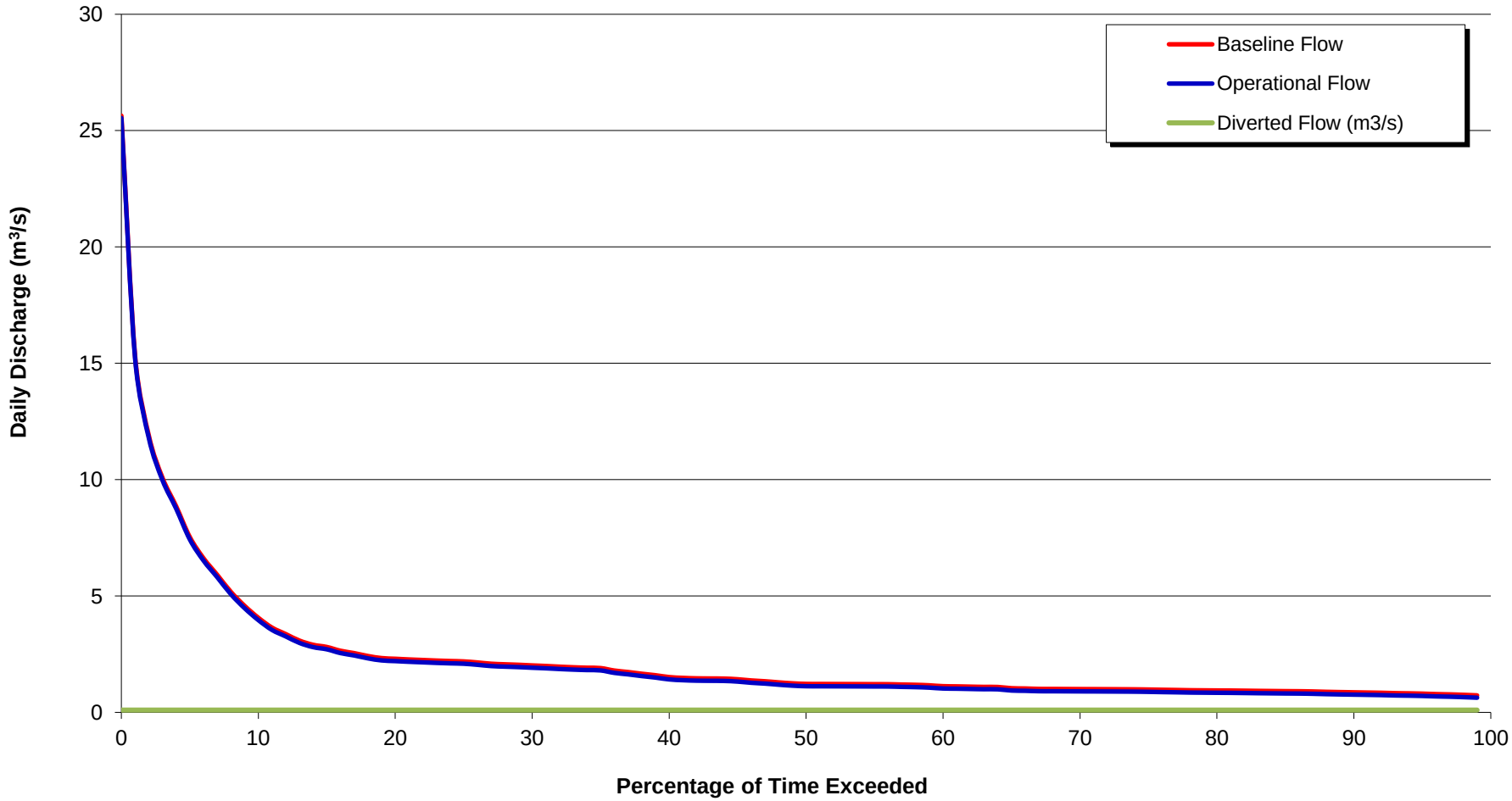
Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-11

REV 3



REV	DATE	DESCRIPTION	PREP'D	RVW'D
3	16AUG'22	ISSUED WITH REPORT VA103-494/24-3	SKC	TJP

WOODFIBRE LNG LIMITED

WOODFIBRE LNG CONSTRUCTION WATER SUPPLY

DECEMBER FLOW DURATION CURVE
WOODFIBRE CREEK INTAKE

Knight Piésold CONSULTING

P/A NO. 103-494/24

REF. NO. 3

FIGURE B-12

REV 3