Title of document: **TREATED WATER DIFFUSER DESIGN**

Client: **AGNICO EAGLE MINES**

Project: DETAILED ENGINEERING OF WATER MANAGEMENT AND GEOTECHNICAL INFRASTRUCTURE AT AMARUQ

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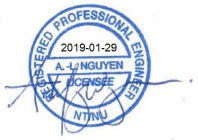

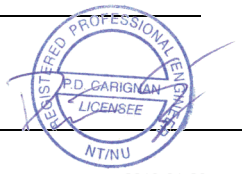

2019-01-29

REVISION INDEX

Revision				Pages Revised	Remarks
#	Prep.	Rev.	Date		
EPA	ALN	PC	Nov. 26, '18		Issued for comments
EPB	ALN	PC	Nov. 27, '18		Issued for Client's comments
E00	ALN	PC	Dec. 18, '18		Issued for design
E01	ALN	PC	Jan. 29, '19	all	Issued for design

NOTICE TO READER

This document contains the expression of the professional opinion of SNC-Lavalin Inc. ("SNC-Lavalin") as to the matters set out herein, using its professional judgment and reasonable care. It is to be read in the context of the agreement dated October 4th, 2017 (the "Agreement") between SNC-Lavalin and Agnico Eagle Mines (the "Client") and the methodology, procedures and techniques used, SNC-Lavalin's assumptions, and the circumstances and constraints under which its mandate was performed. This document is written solely for the purpose stated in the Agreement, and for the sole and exclusive benefit of the Client, whose remedies are limited to those set out in the Agreement. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

SNC-Lavalin has, in preparing estimates, as the case may be, followed accepted methodology and procedures, and exercised due care consistent with the intended level of accuracy, using its professional judgment and reasonable care, and is thus of the opinion that there is a high probability that actual values will be consistent with the estimate(s). Unless expressly stated otherwise, assumptions, data and information supplied by, or gathered from other sources (including the Client, other consultants, testing laboratories and equipment suppliers, etc.) upon which SNC-Lavalin's opinion as set out herein are based have not been verified by SNC-Lavalin; SNC-Lavalin makes no representation as to its accuracy and disclaims all liability with respect thereto.

To the extent permitted by law, SNC-Lavalin disclaims any liability to the Client and to third parties in respect of the publication, reference, quoting, or distribution of this report or any of its contents to and reliance thereon by any third party

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1.0 Introduction

1.1 Context

Agnico Eagle Mines Limited, Meadowbank Division ("AEM") is developing the Whale Tail Pit, a satellite deposit on the Amaruq property, as a continuation of current mine operations and milling at the Meadowbank Mine. The Amaruq property is a 408 km² site located on Inuit Owned Land, approximately 150 km north of the Hamlet of Baker Lake and approximately 50 km northwest of the Meadowbank Mine in the Kivalliq region of Nunavut. The property was acquired by AEM in April 2013.

The Meadowbank Mine is an approved mining operation and AEM is looking to extend the life of mine operation by constructing and operating Whale Tail Pit, which is located on the Amaruq exploration property, in accordance with Type A Water Licence 2AM-WTP-1826.

1.2 Scope

SNC Lavalin (SLI) was mandated to realize the detailed engineering of the water management pumping infrastructure with regard to piping and pumps required to manage the surface water at the Amaruq mine site.

As part of the water management infrastructure, a diffuser is required when discharging treated water from the Amaruq Arsenic Water Treatment Plant (AsWTP) in Mammoth Lake during the summer and winter months.

The following technical note presents the design of the treated water diffuser.

1.3 Reference Document

Table 1-1 summarizes all of the pertinent drawings and documents relevant to the design of the treated water diffuser. Drawings can be found in *Appendix A*.

Table 1-1 : Reference Documents

Document Number	Revision	Title
1789310_247-TM	--	TECHNICAL MEMORANDUM – EFFLUENT PLUME MODELING IN MAMMOTH LAKE
61-695-270-204	R0	AGNICO EAGLE - AMARUQ DIVISION 695 - WATER MANAGEMENT 270 - PIPING PIPING PROFILE PIPELINE AND DIFFUSER INSTALLED IN MAMMOTH LAKE

Document Number	Revision	Title
61-695-270-205	R0	AGNICO EAGLE - AMARUQ DIVISION 695 - WATER MANAGEMENT 270 - PIPING PIPING DETAILS TYPICAL DETAILS FOR DIFFUSER AND BOULDER INSTALLATION
61-695-270-206	R0	AGNICO EAGLE - AMARUQ DIVISION 695 - WATER MANAGEMENT 270 - PIPING PIPING PROFILE PIPELINE AND DIFFUSER INSTALLED IN MAMMOTH LAKE FOR WINTER OPERATION
61-695-270-207	R0	AGNICO EAGLE - AMARUQ DIVISION 695 - WATER MANAGEMENT 270 - PIPING PIPING DETAILS TYPICAL DETAI LS FOR DIFFUSER AND BOULDER INSTALLATION FOR WINTER OPERATION

2.0 Design Basis

2.1 Purpose

Surface runoff are collected and transferred to the Attenuation Pond. The raw water is then treated at the Amaruq AsWTP to remove total suspended solids and arsenic. Treated water produced from the Amaruq AsWTP will be discharged into Mammoth Lake. A diffuser will be used to disperse the treated water in the Mammoth Lake water column. Two different types of diffuser will be used: one during the summer months, the other for winter months.

2.2 Discharge Capacity

During the summer monts, treated water from the Amaruq AsWTP will be transferred to Mammoth Lake using up to 2 x 14-in HDPE pipelines and will be discharged in the lake via 2 submerged diffusers. Each line and diffuser is designed for a flow of 800 m^3/h. The total treatment capacity of the Amaruq AsWTP is 1600 m^3/h.

During the winter months, treated water will be transferred to Mammoth Lake using 1 x 6-in HDPE pipelines and will be discharged in the lake using 1 submerged diffuser. The diffuser will be designed for a discharge capacity of 84 to 105 m^3/h.

2.3 Treated Water Quality Data

The quality of the treated water that will be discharged in Mammoth Lake is summarized in the following table (reference document 1789310_247-TM) and will meet the Water License and the Metal and Diamond Mining Effluent Regulations (MDMER).

Table 2-1: Expected Water Discharge Quality

Parameters	Units	Mean Monthly Concentration
pH		6 – 9.5
Total Suspended Solids	mg/L	15
Total Ammonia	mg-N/L	0.23
Total Phosphorus	mg-P/L	0.27
Aluminum	mg/L	0.32
Arsenic	mg/L	0.11
Cadmium	mg/L	0.000097
Chromium	mg/L	0.019
Copper	mg/L	0.014
Iron	mg/L	1.1
Lead	mg/L	0.0037
Mercury	mg/L	0.000074
Nickel	mg/L	0.059
Zinc	mg/L	0.019

3.0 Diffuser Design

3.1 Diffuser Requirements

The treated water diffusers are designed to obtain the required dilution factor in order to meet the receiving environment water quality guidelines at the edge of the mixing zone.

Of all the parameters listed in table 2-1, total phosphorus required the highest dilution factor in order to meet the CCME or the site specific water quality objective (SSWQO) discharge criterion of 0.01 mg/L. The diffusers are designed to provide a minimum dilution factor of 27 for phosphorus with a water depth of 7.9 m under open water conditions and a flow rate of 800 m^3/h. The minimum dilution factor provided by the diffuser is sufficient for all other constituents in the treated water.

To achieve the required dilution, in the summer months, a diffuser equipped with 10 ports spaced at 12.6 m intervals will be required. Two diffusers will be required to be able to discharge a total flow of 1600 m^3/h. In the winter months, one diffuser will be used equipped with 3 ports spaced at 14.0 m.

The summer and winter diffusers will be approximately installed in Mammoth Lake at the following coordinates:

- West diffuser: Northing: 7254804, Easting: 604936

- East diffuser: Northing 724861, Easting: 605017

The two summer diffusers will be placed parallel to one another, with a distance separating them of at least 100 m. The winter diffuser will be placed in between the two summer diffuser. It is important to note that during the summer months, the winter discharge pipeline and diffuser are not used.

3.2 Design Details

Figure 3-1 shows the treated water discharge locations in Mammoth Lake as well as the diffusers.

For the summer operation, each line will be equipped with a diffuser. Each diffuser consists of:

- 10 discharge ports spaced out at 12.5m intervals starting at the end of the line on a 14-in DR17 HDPE pipeline;
- Each port consists of an Ø80mm diameter pipe mounted on a saddle with a total length of 725 mm. The end of the pipe is equipped with an orifice plate with an opening of 61 to 62 mm;
- The diffuser and submerged portion of the pipelines are weighted using boulders as ballasts.

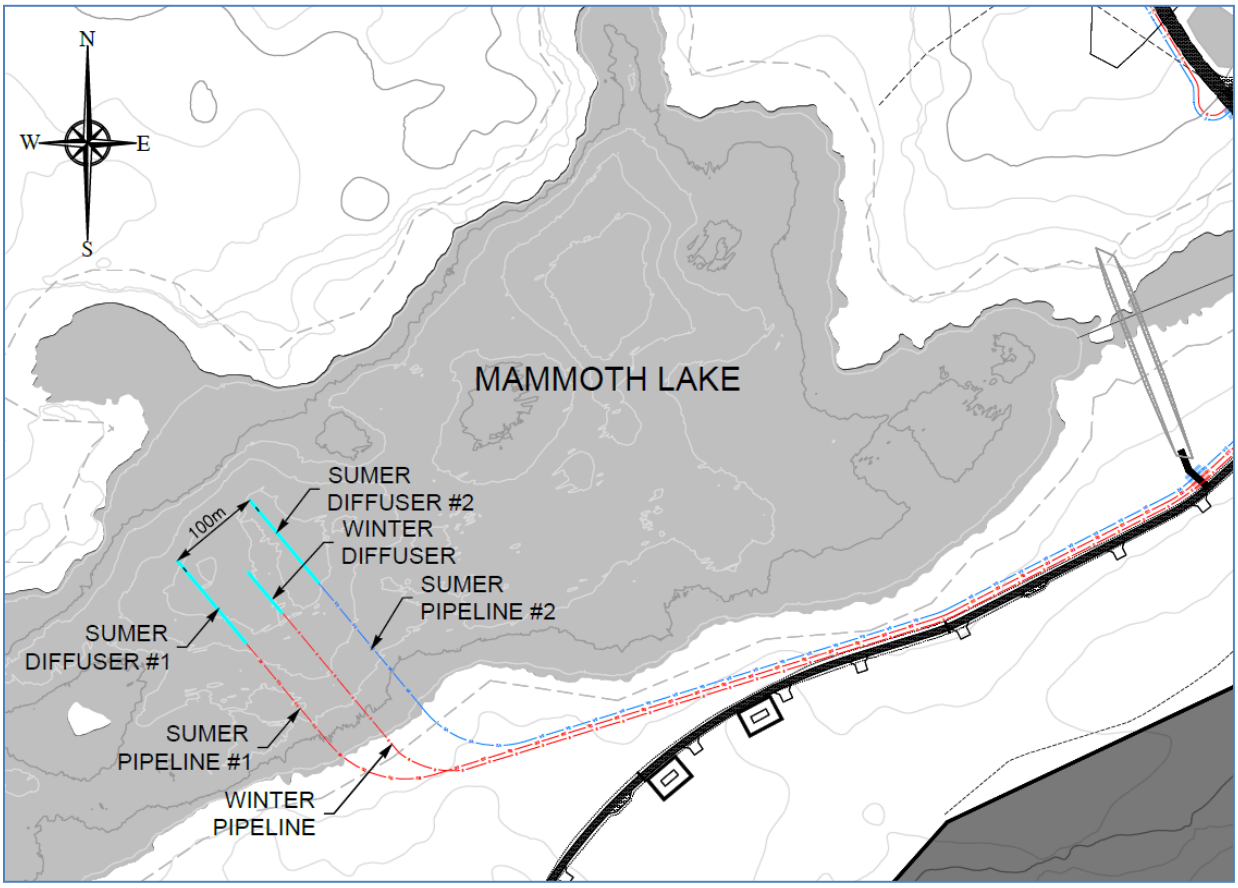
Refer to drawings 61-695-270-204 and 61-695-270-205 for details on the diffusers and submerged pipelines for summer operation.

For the winter operation, one diffuser will be installed, consisting of:

- 3 discharge ports spaced out at 14.0 m intervals starting at the end of the line on a 14-in DR17 HDPE pipeline;
- Each port consists of an Ø80mm diameter pipe mounted on a saddle with a total length of 725 mm. The end of the pipe is equipped with an orifice plate with an opening of 61 to 62 mm;
- The diffuser and submerged portion of the pipelines are weighted using boulders as ballasts.

Refer to drawings 61-695-270-206 and 61-695-270-207 for details on the diffusers and submerged pipelines for winter operation.

Figure 3-1 : Location of Summer Discharge in Mammoth Lake



3.3 Installation Methodology

The following section describes the general installation procedure for the diffuser and pipeline in Mammoth Lake. The installation will take place over the winter months to prevent erosion issues during the installation. The general installation procedure for the diffusers is as follows:

1. Assemble the diffuser and submerged pipeline segment on the shoreline using pipe-butt welding for the whole length.
   a. Install flanges at both ends of the pipeline.
   b. Install a blind flange on the diffuser end and keep the other end open on the shoreline.
   c. Install clamp rings at regular intervals starting from the end of the diffuser that is farthest from the shore. Install electro-fused flex-restraints on each side of every clamp ring as specified in construction drawings.
2. Install the discharge ports by mounting 3-in saddles on the 14-in DR17 HDPE and drilling a 3-in hole. Each saddle is electro-fused or mechanically secured. Screw in the 3-in diffuser riser. Refer to drawing 61-695-270-204 to 61-695-270-207 for details.

3. The positioning of the diffuser and submerged pipeline is to be carried out the winter months on the ice cover of Mammoth Lake. Wait until a thick ice cover has formed over Mammoth Lake to execute positioning. Refer to drawing 61-695-270-200 and 61-695-270-204 for the location of the diffuser/pipeline. Ensure a 100 m spacing between the two summer diffuser lines.

4. Place a boulder next to each clamp ring on the ice cover and attach it to the pipeline according to specifications. The boulder shall be equipped with an eye-bolt through which a steel wire can be threaded and attached to the clamp ring. Boulder attachment method and other details are shown on the construction drawings.

5. The end of the pipeline that in onshore should be anchored to the shore to prevent it from slipping into the water. One possible approach that could be considered is to use a group of massive boulders that shall be attached to a backup ring placed near the end of the pipeline. The backup ring shall be free to slide along the pipe. Steel wires that link the pipeline to the boulders shall not be taut during installation. The exact method to anchor the line on the shore will be detailed based on site conditions.

4.0 Date of Construction

The diffusers are planned to be installed between March and April 2019.

The summer diffusers are planned to be operational in July 2019.

The winter diffuser is planned to be operational in January 2020.

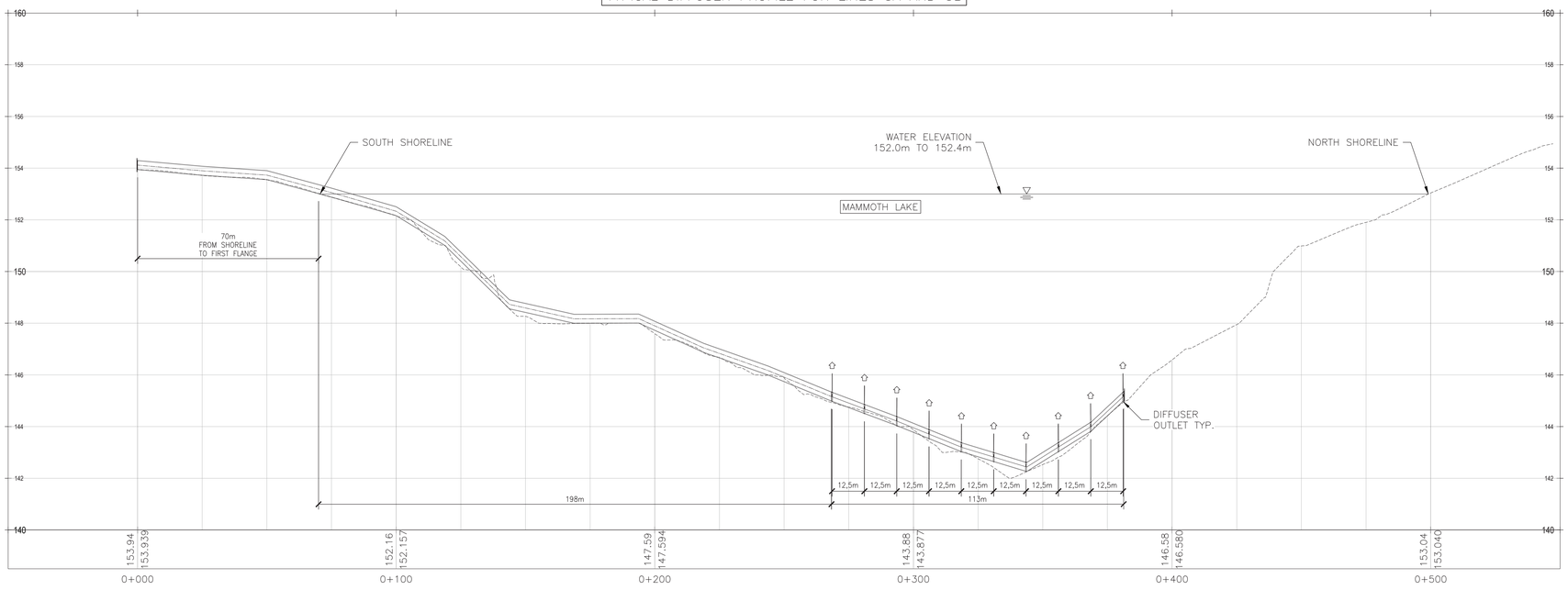
Appendix A: Diffuser Drawings

Document Number	Revision	Title
61-695-270-204	R0	AGNICO EAGLE - AMARUQ DIVISION 695 - WATER MANAGEMENT 270 - PIPING PIPING PROFILE PIPELINE AND DIFFUSER INSTALLED IN MAMMOTH LAKE
61-695-270-205	R1	AGNICO EAGLE - AMARUQ DIVISION 695 - WATER MANAGEMENT 270 - PIPING PIPING DETAILS TYPICAL DETAILS FOR DIFFUSER AND BOULDER INSTALLATION
61-695-270-206	R0	AGNICO EAGLE - AMARUQ DIVISION 695 - WATER MANAGEMENT 270 - PIPING PIPING PROFILE PIPELINE AND DIFFUSER INSTALLED IN MAMMOTH LAKE FOR WINTER OPERATION
61-695-270-207	R0	AGNICO EAGLE - AMARUQ DIVISION 695 - WATER MANAGEMENT 270 - PIPING PIPING DETAILS TYPICAL DETAILS FOR DIFFUSER AND BOULDER INSTALLATION FOR WINTER OPERATION

NO. DESSIN
DRAWING NO. 651298-VIEWPORTS

FORMAT ARCHD

TYPICAL DIFFUSER PROFILE FOR LINES 5A AND 5B



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Date 2018-10-26
PERMIT NUMBER: P 260
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PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
651298	8200	41	0005	E00

NOTES GÉNÉRALES / GENERAL NOTES

Notes:
1) The Profile view shows the pipeline and diffuser to be installed in Mammoth Lake required for lines 5A and 5B (WTP to Mammoth Lake).
2) The pipeline is a 14-in HDPE DR17.
3) Refer to drawing 61-695-270-205 for typical details on the installation of the diffuser and boulders on the pipeline.

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG

AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
R0	2018-10-24	ISSUED FOR CONSTRUCTION	PC	ALN	

REVISIONS

2018-10-24

TITRE / TITLE
AGNICO EAGLE – AMARUQ DIVISION
695 – WATER MANAGEMENT
270 – PIPING
PROFILE VIEW
PIPELINE AND DIFFUSER INSTALLED
IN MAMMOTH LAKE

DESSINÉ PAR / DRAWN BY	STÉPHANE LANTEIGNE	DATE 2018-08-31
VÉRIFIÉ PAR / CHECKED BY	PIERRE CARIGNAN	2018-08-31
APPROUVÉ PAR / APPROVED BY	ANH-LONG NGUYEN, RENÉ LAVIOLETTE	2018-08-31
ÉCHELLE / SCALE 1:1000	DATE	2018-08-31

NO. DESSIN / DRAWING NO. 61-695-270-204

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
6118	R0	1 / 1

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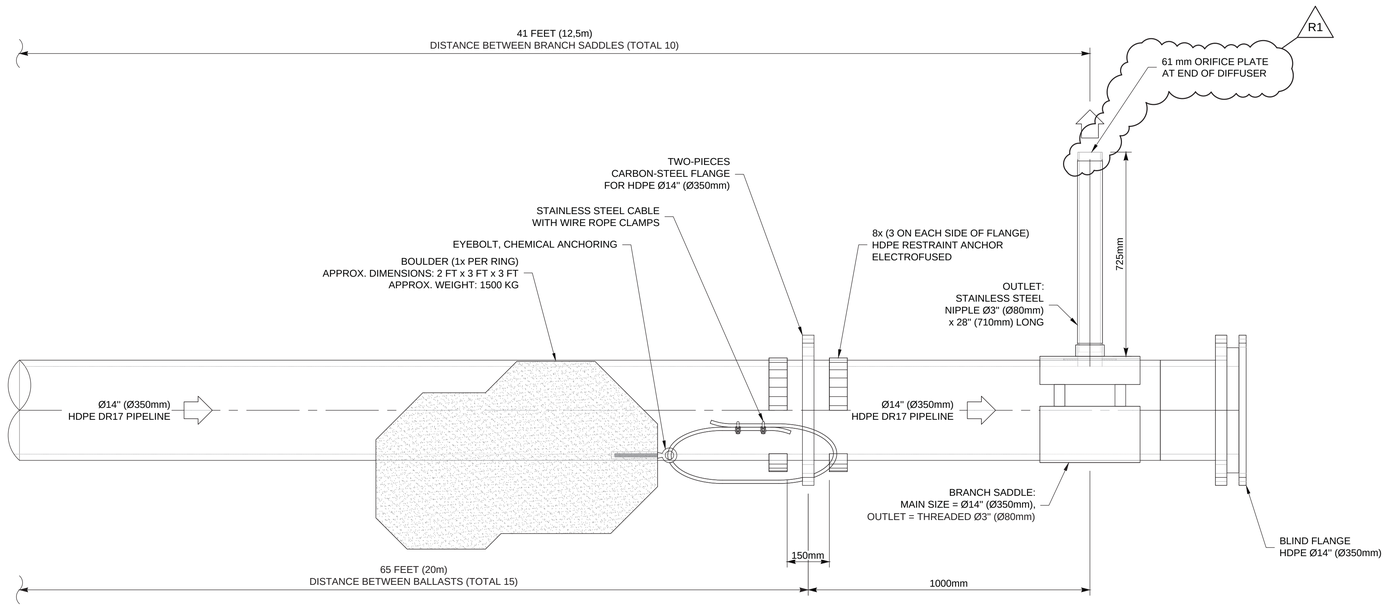
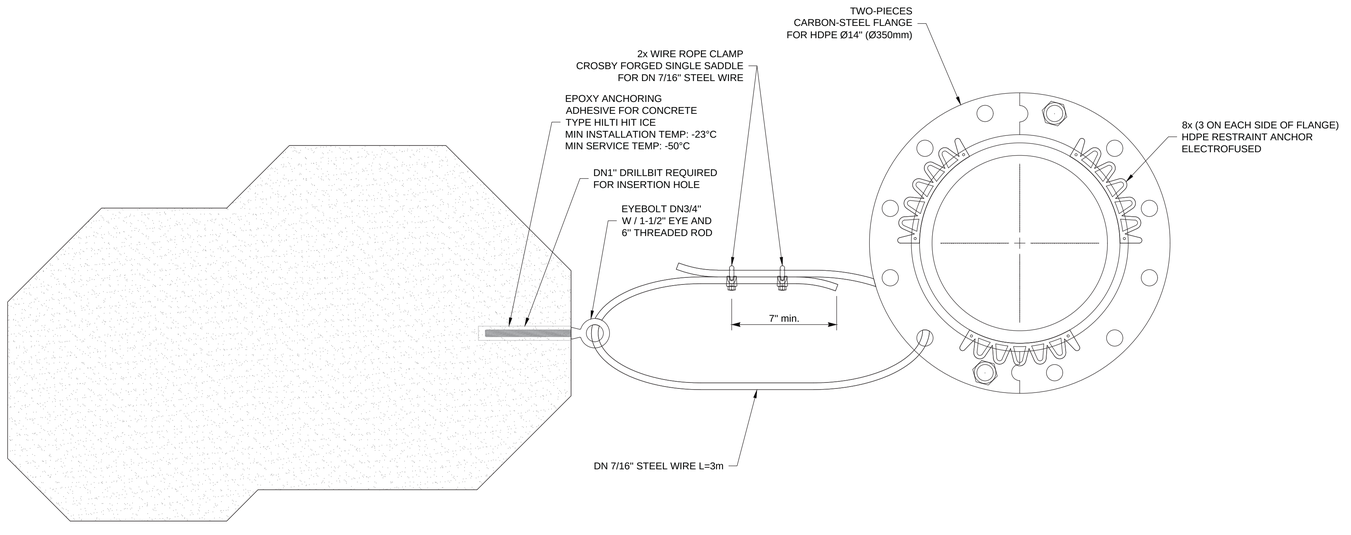


TYPICAL DETAIL
DIFFUSER OUTLETS AND BALLASTING
ELEVATION VIEW
1:10



TYPICAL DETAIL - BALLASTING
ELEVATION VIEW
1:5

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PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
651298	8200	41_D6	0006	E01

NOTES GÉNÉRALES / GENERAL NOTES

Notes:
1) Boulders are used as ballast. They are installed every 20m approximately along the pipeline, from the diffuser end to the shoreline.

Disclaimer :
1) The proposed method for ballasting the diffuser and submerged pipeline length is not according to standard practice nor does it comply with the pipe manufacturer's recommendations. It is based upon AEM's experience and site constraints.
2) The spacing between ballasts here specified is greater than the maximum recommended spacing and may cause the pipeline to arc upwards between ballasts. This may cause air to be entrapped along the line and reduce pumping capacity. The air should be pushed out of the line once pumping starts. However, if this is not the case, air pockets may be evacuated subsequently by drilling a small hole at the apex of the submerged arc. This will require a diver. Pre-Drilling is not recommended and will affect the pipe's structural integrity.
3) The proposed spacing dictates the boulder sizing. The greater the spacing, the greater the boulder size. The proposed boulders are important weights acting on a small pipe surface and may cause the pipeline to kink, especially given the cold temperatures that could render the pipe more brittle.
4) Given AEM's chosen installation method, the final pipeline location cannot be guaranteed. The pipeline may sink elsewhere than at the intended coordinates, determined by Golder Associates Inc. Indeed, the rate at wich it will sink, as well as where it sink are dependent upon the climate and weather as well as the rate at wich the ice melts.
To mitigate the risk:
a) Allow for a longer pipeline length on the south shore of Mammoth Lake. If the pipeline is dragged towards the lake, the end will not be lost underwater.
b) Properly anchor the pipeline on both the south and the north shores, according to recommendations. The anchors will attempt to prevent important displacements, but cannot guarantee that minor displacements will occur.

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG

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REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
R1	2018-12-18	ISSUED FOR CONSTRUCTION	PC	ALN	
R0	2018-10-24	ISSUED FOR CONSTRUCTION	PC	ALN	

REVISIONS

2018-12-18

TITRE / TITLE
AGNICO EAGLE – AMARUQ DIVISION
695 – WATER MANAGEMENT
270 – PIPING
PIPING DETAILS
TYPICAL DETAILS FOR DIFFUSER
AND BOULDERS INSTALLATION

DESSINÉ PAR / DRAWN BY	STÉPHANE LANTEIGNE	DATE 2018-08-31
VERIFIÉ PAR / CHECKED BY	PIERRE CARIGNAN	2018-08-31
APPROUVÉ PAR / APPROVED BY	ANH-LONG NGUYEN, RENÉ LAVIOLETTE	2018-08-31
ÉCHELLE / SCALE 1:10	DATE	2018-08-31

NO. DESSIN / DRAWING NO. 61-695-270-205

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
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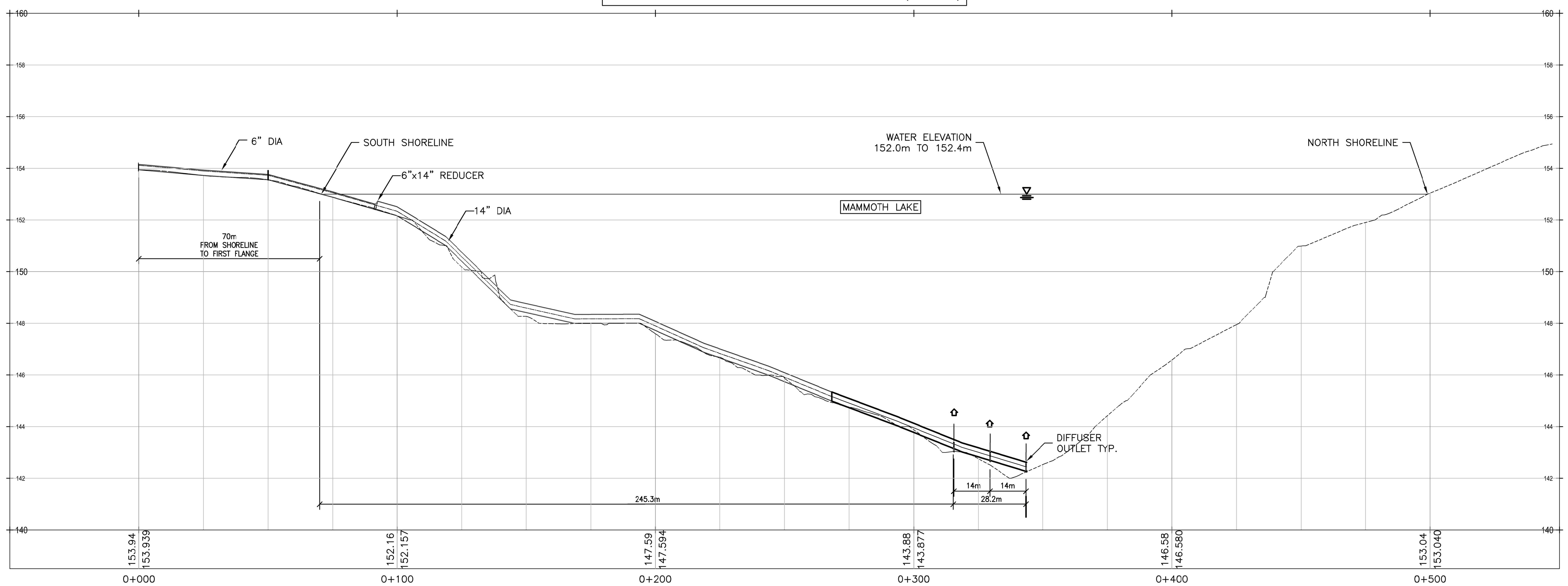
TYPICAL DIFFUSER PROFILE FOR LINES 8 (WINTER)



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PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
651298	8200	41 D6	0007	E00

NOTES GÉNÉRALES / GENERAL NOTES

Notes:
1) The Profile view shows the pipeline and diffuser to be installed in Mammoth Lake required for line 8 (WTP to Mammoth Lake).
2) The submerged pipeline is a 14-in HDPE DR17.
3) Refer to drawing 61-695-270-207 for typical details on the installation of the diffuser and boulders on the pipeline.

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
00	2019-01-28	ISSUED FOR CONSTRUCTION	PC	ALN	

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REGISTERED PROFESSIONAL ENGINEER P.D. CARIGNAN LICENSEE NT/NU 2019-01-29

REGISTERED PROFESSIONAL ENGINEER A.-L. NGUYEN LICENSEE NT/NU 2019-01-28

TITRE / TITLE
AGNICO EAGLE – AMARUQ DIVISION
695 – WATER MANAGEMENT
270 – PIPING
PROFILE VIEW
PIPELINE AND DIFFUSER INSTALLED
IN MAMMOTH LAKE FOR WINTER OPERATION

DESSINÉ PAR DRAWN BY	MOVILA MARIUS	DATE 2019-01-28
VÉRIFIÉ PAR CHECKED BY	PIERRE CARIGNAN	2019-01-28
APPROUVÉ PAR APPROVED BY	ANH-LONG NGUYEN, RENÉ LAMOLETTE	2019-01-28
ÉCHELLE SCALE 1:1000	DATE	2019-01-28

NO. DESSIN DRAWING NO. 61-695-270-206

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6118	R0	1 / 1

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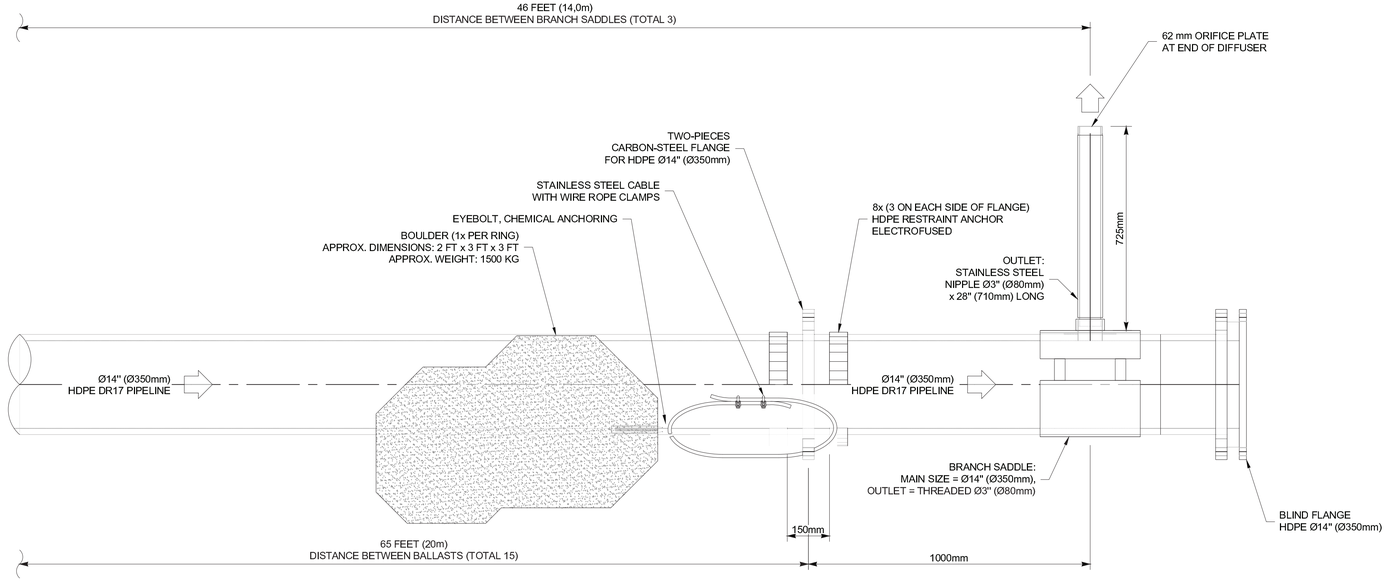

TYPICAL DETAIL
DIFFUSER OUTLETS AND BALLASTING
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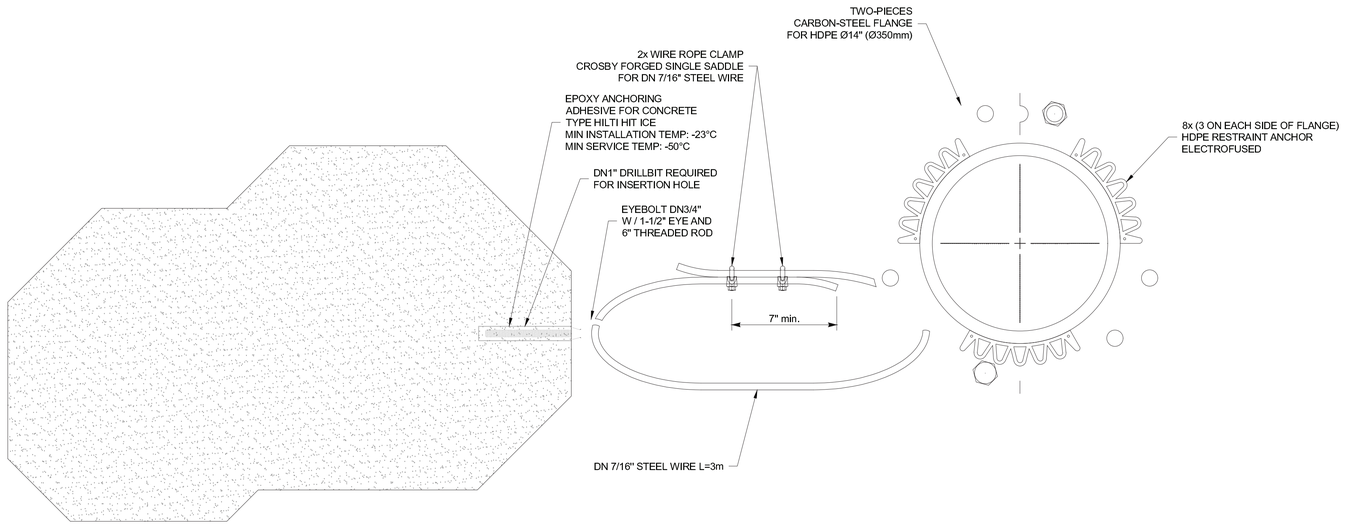
1:10



TYPICAL DETAIL - BALLASTING
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PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
651298	8200	41_D6	0008	E01

NOTES GÉNÉRALES / GENERAL NOTES

Notes:
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2019-01-29

TITRE / TITLE
AGNICO EAGLE – AMARUQ DIVISION
695 – WATER MANAGEMENT
270 – PIPING
PIPING DETAILS
TYPICAL DETAILS FOR DIFFUSER AND BOULDERS INSTALLATION FOR WINTER OPERATION

DESSINÉ PAR / DRAWN BY	MOVILA MARIUS	DATE 2019-01-28
VERIFIÉ PAR / CHECKED BY	PIERRE CARIGNAN	2019-01-28
APPROUVÉ PAR / APPROVED BY	ANH-LONG NGUYEN	2019-01-28

ÉCHELLE / SCALE	DATE
1:10	2019-01-28

NO. DESSIN / DRAWING NO.
61-695-270-207

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT.
6118	R0	1 / 1

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